Forum on Natural Capital Accounting for Better Policy Decisions:

Taking Stock and Moving Forward

October 2017

WAVES

Wealth Accounting and the
Valuation of Ecosystem Services
www.wavespartnership.org

WORLD BANK GROUP

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Taking Stock and Moving Forward

Edited by Michael Vardon, Steve Bass, Sofia Ahlroth and Arjan Ruijs

WAVES is a World Bank-led global partnership that aims to promote sustainable development by ensuring that natural resources are mainstreamed in development planning and national economic accounts.

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Suggested Citation
Vardon, M., Bass, S., Ahlroth, S. and Ruijs, A. (Eds) (2017). Forum on Natural Capital Accounting for Better Policy Decisions: Taking Stock and Moving Forward. World Bank WAVES, Washington D.C.

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Abbreviations

25 YEP	25 Year Environment Plan
A4S	Accounting for Sustainability Project
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
AFR	Africa
ANU	Australian National University
BANGUAT	Bank of Guatemala
Bappenas	Ministry of Development Planning, Indonesia
BCCR	Central Bank of Costa Rica
BCG	Central Bank, Guatemala
BMZ	Deutsche Gesellschaft Fur Internationale Zusammenarbeit
BOM	Bureau of Meteorology, Australia
BPC	Botswana Power Corporation
BPS	National Statistics Office, Indonesia
BUAN	Botswana University of Agriculture and Natural Resources
BUR	Biennial Update Report, Costa Rica
CAR	Regional autonomous corporations
CBD	Convention on Biological Diversity
CBS	Statistics Netherlands
CEA	Competent Environmental Authorities, Colombia
CGE	Computable general equilibrium
CIC	Core implementing country
CICES	Common International Classification of Ecosystem Services
CO_2	Carbon dioxide
COMPES	Council for the National Economic and Social Policy, Colombia
COP	Community of practice
COP	Conference of the Parties
COP21	UNFCCC COP Paris 2015
CRIRSCO	Combined Reserves International Reporting Standards Committee
DANE	National Administrative Department of Statistics, Colombia
Defra	Department for Environment, Food, and Rural Affairs, United Kingdom
DENR	Department of Environment and Natural Resources, Philippines
DfID	Department for International Development, United Kingdom
DNP	National Planning Department, Colombia
DP	Development partner
DPSIR	Drivers, pressures, state, impacts, and responses
DTRP	Department of Town and Regional Planning, Botswana
DWA	Department of Water Affairs, Botswana
EAP	East Asia and Pacific
EC	European Community
ECA	Europe and Central Asia
ECLAC	Economic Commission for Latin America and Caribbean
ECN	Energy Research Centre of the Netherlands
EDPRS	Economic Development for Poverty Reduction Strategy
EEA	European Environment Agency

EEA	Experimental Ecosystem Accounting
EFTA	European Free Trade Agreement
EGSS	Environmental goods and service sector
EMEC	Environmental Medium-Term Economic Model
ENA	National Water Study
ENCC	National Climate Change Strategy
ENRA	Environmental and Natural Resources Accounting
ENRAP	Environmental and Natural Resources Accounting Project
EO4EA	Earth Observations for Ecosystem Accounts
ESCAP	Economic and Social Commission for Asia and the Pacific
EU	European Union
FCPF	Forest Carbon Partnership Facility
FDI	Foreign Direct Investment
FIP	Forest Investment Program
FONAFIFO	National Forest Financing Fund
GFS	Government Finance Statistics
GG	Green growth
GDN	Global Development Network
GDP	Gross domestic product
GDSA	Gaborone Declaration for Sustainability in Africa
GE	Green economy
GEF	Global Environment Facility
GEO	Group on Earth Observations
GGCR	Green Growth and Climate Resilience Strategy
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GOI	Government of Indonesia
GRI	Global Reporting Initiative
GSBPM	Generic Statistical Business Process Model
GWP	Global Water Partnership
HDI	Human Development Index
IARNA	Institute of Agriculture, Natural Resources, and Environment, Guatemala
ICE	National Electricity Institute Costa Rica
ICT	Information communication technology
IDA	International Development Association
IDB	Inter-American Development Bank
IDEAM	Institute for Hydrology, Meteorology and Environmental Studies
IEEM	Integrated Economic-Environmental Modeling
IEEM-GUA	Integrated Economic-Environmental Modeling Platform for Guatemala
IFC	International Finance Corporation
IFRS	International Financial Reporting Standards
IIRS	International Integrated Reporting Council
IMF	International Monetary Fund
INDC	Intended nationally determined contribution
INE	Institute of National Statistics, Guatemala
INEC	National Institute of Statistics and Census, Costa Rica

IR	Intermediate Results Indicator
ITB	Bandung Institute of Technology
IWRM	Integrated water resources management
IWRM-WE	Integrated Water Resources Management & Water Efficiency Plan, Botswana
KG STAT	Kyrgyz Republic Implementation of the National Strategy for Development of Statistics
KTH	Royal Institute of Technology
LAC	Latin America and the Caribbean
LAIS	Land Administration Information System
M&E	Monitoring and evaluation
MADS	Ministry of Environment and Sustainable Development, Colombia
MARN	Ministry of Environment, Guatemala
MAVDT	Ministry of Environment, Housing and Territorial Development, Colombia
MDTF	Multidonor trust fund
MFA	Ministry of Foreign Affairs, Netherlands
MFDP	Ministry of Finance, Development and Planning, Botswana
MGB	Mines and Geosciences Bureau, Philippines
MIDEPLAN	Ministry of Planning and Economic Policy, Costa Rica
MINAE	Ministry of Environment and Energy, Costa Rica
MMEWR	Mining Energy and Water Resources, Botswana
NAMRIA	National Mapping and Resource Information Authority
NASA	National Aeronautics and Space Administration
NBSAPs	National Biodiversity Strategies and Action Plans
NCA	Natural capital accounting
NCEAS	National Center for Ecological Analysis and Synthesis
NCM	Nordic Council of Ministers
NCP	National Conservation Policy
NDP	National Development Plan
NEDA	National Economic Development Authority, Philippines
NEO	National Energy Outlook
NEPM	National Environment Protection Measure
NEPP	National Environmental Policy Plans
NEWP	Natural Environment White Paper
NFP	National Forest policy
NGO	Nongovernmental organization
NPV	Net present value
NRA	Natural resources accounting
NRM	Natural resource management
NRS	National Reserve System
NSCB	National Statistical Coordination Board, Philippines
NSW	National Study of Water, Colombia
NWMP	National Water Master Plan
OCSE	Office of the Commissioner for Sustainability and the Environment, ACT
OECD	Organisation for Economic Co-operation and Development
ONS	Office of National Statistics
PAGE	Partnerships for Action on Green Economy
PBL	Environmental Assessment Agency, Netherlands
PDO	Project Development Objective

PEENRA	Philippine Economic-Environmental and Natural Resources Accounting
PES	Payment for ecosystem services
PNGIRH	National Policy for Integrated Water Resource Management
POMCA	Watershed Use and Management Plan
PRTR	Pollutant Release and Transfer Register
RAN-GRK	National Action Plan for Reducing Emissions of Greenhouse Gases
RCMRD	Regional Centre for Mapping of Resources for Development
REDD+	Reducing emissions from deforestation and forest degradation
RETF	Recipient executed trust fund
RVO.nl	Netherlands Enterprise Agency
SAM	Social accounting matrix
SASB	Sustainability Accounting Standards Board
SC	Steering committee
SDG	Sustainable Development Goal
SEEA	System of Environmental-Economic Accounting
SEEA-CF	SEEA Central Framework
SEEA-EEA	SEEA Experimental Ecosystem Accounting
SEAs	Strategic Environmental Assessments
SEEAW	System of Environmental-Economic Accounting for Water
SEGEPLAN	National Planning Agency, Guatemala
SINAC	National System of Conservation Areas
SISNERLING	Integrated System of Environmental Economic Accounting
SIWI	Stockholm International Water Institute
SNA	System of National Accounts
SNAPP	Science for Nature and People Partnership
TC	Technical committee
TJ	Terajoule
TNC	The Nature Conservancy
TWG	Technical working group
UK	United Kingdom
UN	United Nations
UNCEEA	United Nations Committee of Experts on Environmental-Economic Accounting
UNEP	United Nations Environmental Programme
UNFC	United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources
UNFCCC	United Nations Framework Convention on Climate Change
UNGRD	Disaster Risk Management National Unit, Colombia
US	United States
USAID	United States Agency for International Development
USGS	United States Geological Survey
WACA	West Africa Coastal Areas Management Program
WAVES	Wealth Accounting and the Valuation of Ecosystem Services
WEF	World Economic Forum
WRMP	National Water Resources Master Plan
WTO	World Trade Organization
WUC	Water Utilities Corporation, Botswana
WUF	Water use fee
WWF	World Wildlife Fund

Acknowledgments

A great many people were involved in the organization of the Policy Forum and in the compilation of the papers into this publication. We would particularly like to thank the following:

- Forum hosts—the Netherlands Ministry of Foreign Affairs and the World Bank WAVES Program
- Forum facilitators—Ros Goodrich and Steve Bass
- Organizing committee, Sofia Ahlroth, Henry Alterio, Steve Bass, J. P. Castaneda, Sonu Jain, Stig Johansson, Arjan Ruijs, Omer Van Renterghem, and Michael Vardon
- Participants (see annex 2)
- Authors, not all of whom were at the Forum, and are listed in each chapter (biographies can be found in annex 3)

We would also like to like the funders of WAVES, the European Commission, Denmark, France, Germany, Japan, the Netherlands, Norway, Switzerland, and the United Kingdom.

Preface

It is with great pleasure that we present this publication that has resulted from the discussions and written contributions to the first WAVES Policy Forum. Cohosted by our respective organizations in The Hague in November 2016, the Forum brought together users and producers of natural capital accounts in a way not done before. The forum provided a platform for very productive lesson sharing and for building a consensus on priorities to improve policy decisions through natural capital accounting (NCA). The subsequent process of drafting and updating the many country and thematic papers has provided a focus for the ongoing engagement of account producers and users.

This resulting publication, with input from nearly 50 world experts, is authoritative in highlighting the many uses for NCA. This work draws not only from countries with long-established NCA programs like the Netherlands, but also from countries that have more recently started implementing NCA, such as the WAVES countries. The broad range of active policy applications is very encouraging, with good examples in the water, forest, and energy sectors, as well as in multifaceted strategies like green growth and climate change.

Perhaps even more importantly, the Policy Forum has led to the identification of many opportunities to use NCA in policy and government processes. The editorial team has synthesized 10 draft principles for achieving greater uptake of NCA by decision makers that can now be tested. As Peter Burnett's chapter encourages: Just do it!

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Executive Summary

The Hague Forum: "Natural Capital Accounting for Better Policy"

Policy decisions on poverty reduction, investment, economic growth, and environmental management are increasingly sensitive to natural resource values, scarcities, and deterioration. Worldwide, many countries have made progress in constructing natural capital accounts, although its regular use to design and review policy is still an aspiration for most. However, the understanding and use of natural capital accounting (NCA) is now at a stage where it can better inform policy decisions, as the growing number of examples illustrates.

The Netherlands Ministry of Foreign Affairs and the World Bank–led WAVES Global Partnership share an ambition to improve the uptake, use, and effectiveness of NCA. Based on the successful lesson sharing at the first NCA forum, "Natural Capital Accounting for Better Policy," organized by both parties in The Hague on November 22–23, 2016, this publication presents a rich and diverse set of case studies from 12 countries that take stock of NCA, how it engages decision makers, and how it improves policy. This report offers an initial synthesis of achievements, challenges, lessons, tentative principles, and productive ideas for next steps, drawing on experiences and interactions among a range of countries, from low- to high-income countries and those with long or short experience with NCA. The aim is to help NCA developers and policy makers in all countries learn how to obtain good natural capital information to influence real-life policy decisions.

Why, who, and how: Closing the gap between NCA production and NCA use in policy making

Work on NCA needs a new emphasis if it is to inform policy decisions. To actually use the accounts, insights from NCA, indicators, analyses, and so forth, NCA has to get inside the institutional machinery of decision making. The cases in this publication provide examples of NCA that have been (or could be) used in all stages of the policy cycle, namely:

- Issue or problem identification
- Policy response
- Implementation
- Monitoring and
- Review

The extent to which NCA has been used to develop policy has varied among countries. Many countries have only recently begun NCA programs, but there are also many countries that are already using NCA for policy monitoring and review, often by deriving indicators from the accounts, for example, for water, climate, energy, the Sustainable Development Goals (SDGs), green growth, or for State of Environment reporting. Actual use of NCA for policy design and implementation comes from countries with longer experiences with NCA, but even those relatively new to NCA are beginning to use the accounts to develop policy responses, such as master plans or forestry, water, or mining strategies.

The different chapters show the many different NCA users. For example, NCA is used by particular government agencies for the following:

- Natural resources (for example, water, forests, minerals)
- Geographical areas
- Strategic decision making and
- Research.

NCA is also used by businesses and civil society.

The accounts are, however, not automatically put to use even if they are in place. Unless special attention is given to NCA use, it will take time for NCA to make its way into policy formulation processes. Active engagement is needed between NCA producers and potential policy users. Besides analytical and research institutes, so far government agencies and subnational institutes responsible for natural resources like energy, water, minerals, land, and forests have been the main users of NCA in most countries. In the WAVES countries, high-level steering committees, including officials from ministries of finance, planning, development, and others, have been formed to generate policy momentum. Such high-level policy engagement is one of the key drivers of NCA acceptance. Furthermore, the chapters in this document show that many countries and institutions have begun implementing NCA, but relatively few have effectively integrated NCA into public policy processes and the associated government "machinery." A key achievement of those countries with long-standing NCA programs, like the Netherlands, Sweden, and the United Kingdom, is that they have managed to build enduring links among the NCA users and producer communities. In each of these countries, there is a clear delineation of roles, with NCA production being undertaken in national statistical offices, and policy departments receiving the information. Over time, relationships have been built among producers and users of accounts and with the research community. This has helped bring credibility and legitimacy to NCA production, improving efficiency and aligning NCA producers and users.

However, those countries that have more recently begun NCA programs also have notable achievements. Botswana, for example, has institutionalized accounting within the Department of Water Affairs, and the importance of NCA is recognized at the highest levels of government. Costa Rica has institutionalized account production in its central bank and established collaborative mechanisms between the producers and users of accounts for water, energy, and forests. Colombia has institutionalized NCA production in the national statistical office, with NCA being explicitly mentioned in the 2014–18 National Development Plan. Indonesia is aligning its existing NCA production system to better meet the needs of climate change policy. Rwanda has developed formal processes for sharing data among government agencies and has used NCA information for water management. The Philippines has mandated the inclusion of NCA in mining policies. Finally, Guatemala's national development plan calls for the creation of statistical mechanisms to monitor its progress. It can be concluded that NCA is well placed to be a key navigational feature for adaptive, multi-issue policy making in the future, and will help better link institutions together for sustainable development.

Opportunities for NCA to improve policy decisions

The policy areas that NCA is particularly well-placed to inform are those that concern complex and dynamic links between the environment and the economy; concern many parts of government as well as business and civil society; are information and/or consultation intensive; and are high profile and/or include major policy or investment decisions. The papers point to three such policy areas:

- SDGs and the 2030 Agenda
- Green growth/green economy (GG/GE) and circular economy and
- Climate change.

NCA is "wired" to inform comprehensive, complex, and multistakeholder policy processes such as these. The policy demand for NCA can also be reinforced by the trend for improvements in regular cross-sectoral processes, such as national development planning, competition analysis, risk analysis, science-policy fora, environmental/biodiversity mainstreaming, review processes such as parliamentary commissions, and future-search and visioning exercises. Calls for more evidence-based approaches to policy also increase the need for integrated environmental-economic information that NCA provides. Countries cite international drivers as opening up such opportunities, such as Colombia with its aspirations to accede to the Organisation for Economic Co-operation and Development (OECD).

Next steps

First, greater collaboration between producers and users, in-country and regional, can generate the critical mass of expertise needed to promote, develop, and use NCA in policy and to have it broadly accepted by the public and private sectors. There is also clearly a role for continued collaboration at the global level, building on the first NCA Policy Forum.

Developing practical guidance documents is another priority. Guidance and associated capacity-building work could cover applying NCA to complex policy agendas, such as the SDGs, green growth, and nationally determined contributions (NDCs); using NCA to manage particular policy instruments, such as reducing emissions from deforestation and forest degradation (REDD+) or payments for ecosystem services (PES); applying NCA to analytical tools such as input-output and scenario modeling; communications work on NCA and especially its results, using infographics, case studies, messaging, and the like.

1 | Introduction to the "Forum on Natural Capital Accounting for Better Policy Decisions"

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1.1 | Rationale and purpose of the "Forum on Natural Capital Accounting for Better Policy Decisions"

Policy decisions on poverty reduction, investment, economic growth, and environmental management are increasingly sensitive to natural resource values, scarcities, and deterioration. Many countries have made progress in natural capital accounting (NCA), although using it to inform policy is still an aspiration for most. Yet many are now at a stage where NCA could make a positive impact on policy decisions.

The Netherlands Ministry of Foreign Affairs (MFA) and the World Bank–led WAVES Global Partnership share an ambition to improve the uptake, use, and effectiveness of NCA. In 2016, they came together to work out how to do so—complementing the recent emphasis on accounts generation with greater effort to engage the institutions involved in decision making. They felt that real progress can be made if "supply-side" and "demand-side" stakeholders worked more closely together to define the information needed for good decisions, provide the information in the right ways, and monitor progress. They set up an organizing committee to prepare for an initial NCA policy forum meeting to bring the stakeholders together and explore progress and best bets in ensuring that NCA is policy relevant and timely.

The Forum's first meeting was subsequently held November 22–23, 2016, in The Hague. Its aim was for NCA developers and policy makers from high-, middle-, and low-income countries to share and explore country experiences using natural capital accounts and address the challenges of getting quality natural capital information to influence real-life policy decisions.

1.2 | Activities and results of the first Forum meeting

Demand-led and inclusive: The cohosts, WAVES and the Netherlands MFA, organized the Forum to be as demand-led as possible. Country questionnaires were distributed in advance to seek information on the development, institutional setup, and the use of accounts—with an almost 100-percent return rate. This confirmed the common aspiration for NCA to be better linked to critical policy decisions. The Forum was therefore focused on policy challenges, rather than the technical production questions that have dominated NCA conferences to date. It was agreed that major policy trends, such as the Sustainable Development Goals (SDGs), green growth, and billions of dollars in natural resource investment, urgently need better information on natural capital. The surveys also discovered the surprising range of players involved in "real policy"—not only government, but also business and civil society, and through both formal and informal mechanisms—who need access to information so they can make better decisions.

Background papers: An introductory paper, an analysis of the country questionnaires, and invited country and thematic papers and presentations were collated in advance and placed on the Forum website: https://www.wavespartnership.org/en/waves-policy-forum-natural-capital-accounting-better-policy.

Beginnings of a community of practice: Forty-five participants were brought together from 15 low-, middle-, and high-income countries. They covered the entire spectrum from "supply side" (NCA production) to "demand side" (policy and decision making), with many working in between (researchers, advocates, knowledge intermediaries, and so forth). Some had decades of NCA experience, such as the Dutch hosts, while others had only just started on the NCA path. However, all had a rich and diverse policy-making experience to share. For much of the time, people stayed in the same "mixed" discussion tables of seven to eight people, helping to forge relationships and a sense of common purpose. Discussion was open and honest, encouraged by a nonattribution policy. The Forum confirmed participants' strong appetite to continue to learn together, to collaborate, and to help others. A lively evening interaction with the NCA "Let's Do Business" seminar confirmed that more participation from businesses in the Forum would be very useful in future.

Lessons and challenges shared on linking NCA to policy: The workshop offered a "rapid-fire" sharing of country and sector experiences, alternating with discussion sessions. Its goal was to be an inspiring global "taster" of NCA achievements, challenges, and lessons. The Forum attracted significant attention through the MFA's and World Bank's social media.

Early consensus messages generated: The participants' collegiate approach, and the seven discussion sessions, enabled participants to pull together shared conclusions on why and how NCA can improve policy decisions. Their consensus was well captured in initial messages that NCA.

1. Provides systematic, structured, and integrated information offering a holistic view of the economy and the environment;
2. Links to existing information systems, is consistent with, and is complementary to, economic accounts;
3. Adds value by integrating existing information and offering it to policy makers regularly and in a consistent format;
4. Can be readily used in the models and tools that are regularly employed in economic policies, complementing their analysis with environmental aspects;
5. Can support decisions in important policy agendas, such as green growth, climate change, and achieving the SDGs;
6. Can be scaled up and down, and aggregated in various ways to support different levels of policy making;
7. Promotes openness and transparency; and
8. Requires improved communications for NCA to be better understood and used.

Priorities and gaps identified in stakeholder engagement, knowledge, and impact of NCA: While the shared experience and discussions improved almost everyone's knowledge of how to strengthen NCA links to policy, the Forum also gave a strong sense of priorities and gaps. An energetic work scoping session raised ideas regarding further thematic work on SDGs, NDCs (nationally determined contributions), reducing emissions from deforestation and forest degradation (REDD+), and payments for ecosystem services (PES); in-country and regional work, for example, encouraging leadership groups; and improved communications tactics such as employing infographics to explain the implications of accounts. There was consensus among Forum participants that linking NCA and policy enables reciprocal progress—sometimes data drives policy action, at other times, for example, international policy commitments drive the production of data. Moreover, the session confirmed participants' appetite for working together through a continuing Forum.

1.3 | Purpose and structure of this first Forum publication

Thanks to the contributions of the many presenters and discussants, the Forum can offer the country and thematic papers presented in finalized form in one document. The Forum coordinators are grateful to the authors for revising their papers based on the learning and discussion at the first Forum. Together, the papers amount to a global stock-taking of NCA and how it engages policy, with an initial synthesis of achievements, challenges, preliminary lessons, and tentative principles drawn largely from the rich and diverse case studies. This compilation seeks to inform both policy audiences (potential users or commissioners of accounts) and producers of accounts.

The publication is structured into four parts:

- Part 1 contains the material prepared by the editors based on the Forum discussions and the contributed papers. This is the introduction, scene setting, summary, and analysis of progress on NCA and policy.
- Part 2 offers the paper from the Dutch hosts, which summarizes their 40 years of experience in producing and applying NCA.
- Part 3 brings together the contributions of countries' experiences, arranged alphabetically by country.
- Part 4 includes the theme-based contributions from academic and international organizations that draw on the experience of many countries.

The preface, acknowledgments, and executive summary precede these four main parts. Three annexes include a summary analysis of the country questionnaires used to plan the first Forum, as well as short biographies of the authors and a list of Forum participants.

1.4 | In closing

The first NCA policy forum, "Natural Capital Accounting for Better Policy," successfully achieved its initial objectives. It pulled together an engaged group of NCA experts and policy players from diverse countries. It confirmed the value of NCA for informing better decisions and shared initial experience on how to implement NCA. It offered initial messages to attract players across the world who need to act. The Forum identified where further research, communication, and innovation would help to extend NCA's reach and potential. Moreover, the Forum catalyzed a strong sense of collaboration and commitment to do this work together. The Forum is as much about its participants as it is about its purpose.

2 | The Policy and Institutional Context for Natural Capital Accounting

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Summary

Work on natural capital accounting (NCA) needs a new emphasis if it is to change the way government decisions and public policy are made. It must move from a focus on accounts generation (supply side) toward improving decisions on natural capital and helping the decision makers involved (demand side). This is not a mechanical task, but a broadly political one. To inform the shift, this paper examines the nature of both policy and the institutions that inform, formulate, decide, and implement policy.

Policy is multifaceted: it is not just "what government says" in formal policy documents. Its facets include policy content, policy processes, stakeholders, and the knowledge and values that underpin them. Policy is a product of context—which is political and dynamic, yet deeply rooted in a country's institutional settings. Policy might therefore seem "messy"—but this very messiness offers many levers for change, many of them open to NCA.

Yet the prize for NCA is not simply to improve one-off policies, but also to get inside the institutional machinery of decision making—so that all aspects of policy become informed by NCA in the future. A country's economic and political institutions are the most significant determinant of whether it succeeds or struggles, with as much impact on gross domestic product (GDP) and the human development index (HDI) as resource endowments and geography. If the "universal, integrated, and transformative" Sustainable Development Goals (SDGs) are to be achieved, a country's institutional framework needs to be much more integrated and better informed by natural capital than it has been in recent years. This paper suggests four basic stages of institutional reform that countries tend to go through—from silos, to safeguards, to synergies, to full structural reform—and notes how NCA can play central roles at each stage. This implies that NCA can be built step by step, starting with physical stock accounts of the particular natural capital that a country wishes to safeguard, right through to full wealth accounts that will inform major structural changes in the economy and society.

2.1 | Introduction: Why NCA must start from a policy and institutional perspective

The "Forum on NCA for Better Policy Decisions" aims to improve our understanding of the links between natural capital and policy—so that natural capital accounts (box 2.1) are policy relevant, timely, and become part of a country's institutional machinery.

The Forum's first meeting brought together people from the supply side of NCA (account developers and data suppliers) with those on the demand side (government decision makers as well as those who influence policy through, for example, their research or advocacy). These participants agreed that they need each other if policy is to be effective and well implemented. Demand-side players have a role in ensuring policy processes draw on good natural capital information. Supply-side players have a role in structuring NCA so that it produces relevant and timely information to improve real-life policy decisions.

However, there was also a consensus in the Forum that NCA must shift from a supply side emphasis (generating accounts) toward a more policy-centered approach (changing policy and the decision-making framework)—table 2.1:

Table 2.1: NCA must shift from a supply-side emphasis toward a demand-side, decision-centered approach

From ...	To ...
Technical focus—get NCA methods and data right	Decision focus—get natural capital policy right
Supply side—NCA production is separate from policy production; NCA struggles to get policy uptake	Demand side—policy players engage with NCA players, and thus shape NCA purpose/focus
Government focus on policy—as a government domain, that is, "what government wants"	Stakeholder view of policy—what business, civil society, and government want, and how they agree
Focus on formal policy decision—NCA trying to change one policy decision or plan	Enable policy discourse by many—NCA helping debate and review as well as making decisions
Data provision—NCA producers putting out raw data and hoping they will be used	Information demand—"policy entrepreneurship," or getting policy-relevant information to many users
NCA is a "magic bullet"—promoted on its own	NCA works with complementary tools
Experimental—one-off approaches	Mandated—comprehensive and routine NCA system

This chapter attempts to clarify the nature of both policy and the institutions that inform, formulate, decide, and implement policy.

2.2 | The policy context for NCA

Policy: A set of ideas or a plan of what to do in particular situations—agreed to officially by a group of people, a business organization, a government, or a political party. (Cambridge English Dictionary)

Public policy is multifaceted. The different dimensions of policy can be expressed as follows:

- *Policy content*—This may range from a broad narrative (policy discourse) to a general course of action or aspiration (vision), or to precise decisions on what to do or not do (policies).
- *Policy process*—This covers the cyclical and iterative steps of informing, developing, agreeing, enforcing, and reviewing policy content (figure 2.1); it is usually government led, for example, regular policy/plan reviews or one-off commissions, but increasingly involves other stakeholders.
- *Policy stakeholders*—The policy leadership, authority, and capacities of government and the political system, plus the demands, inputs, and validation by others with a stake in the policy content (for example, communities and business) that may or may not be involved in policy processes.
- *Policy knowledge*—The set of values, norms, and assumptions behind policy decisions, plus the evidence that is brought to bear to support or challenge them.

Too often, only the first two facets are considered—resulting in a very thin picture of policy, or one that works only on paper (impotent "planners' dreams"). In practice, real-world policy is very much a product of context—which is political, dynamic, and rooted in a country's institutional settings.

Box 2.1: What is natural capital accounting?

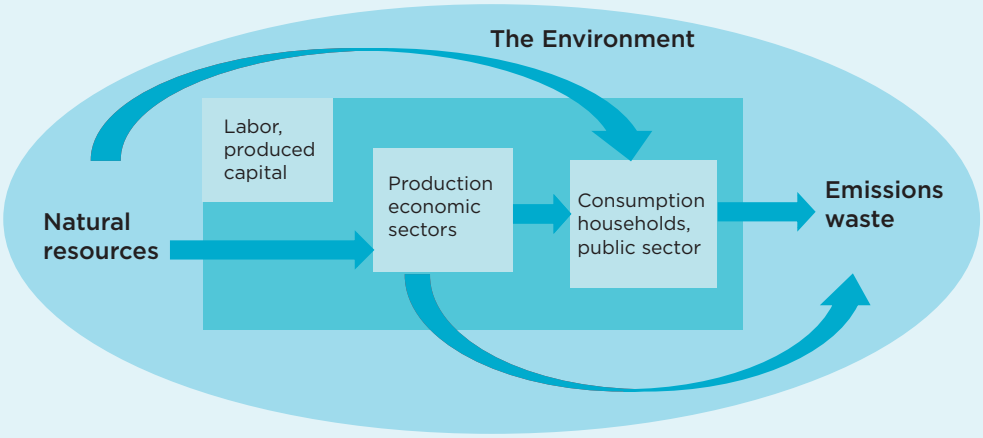
Natural capital accounting integrates natural resource and economic analysis, providing a broader picture of development progress than standard measures such as GDP.

Natural capital accounts are a set of objective data that show how natural resources contribute to the economy and how the economy affects natural resources. These accounts can provide detailed statistics for better management of the economy, such as accounts for the sectoral inputs of water and energy, and outputs of pollution that are needed to model green-growth scenarios.

The concept of accounting for natural capital has existed for more than 30 years. In 2012, the United Nations Statistical Commission adopted the System for Environmental-Economic Accounts (SEEA). This system now provides an internationally agreed-upon method to account for material natural resources.

The figure below illustrates the universe of natural capital accounts. The data that go into the rectangle representing the economy are from the System of National Accounts (SNA) and are economic in nature. NCA provides data on natural resources, such as minerals, timber, and fisheries going into economic production and consumption, as well as the resulting emissions and waste. Integrating data on economic activities and the environment enables the analysis of different scenarios, for example, how the development of the economy affects the environment or how the degradation of the environment will affect the economy. This in turn enables the development and application of better policies that take into account the links between the environment and the economy.

The environmental and economic context for NCA



For more information on this topic, see the WAVES website, Natural Capital Accounting, http://www.wavespartnership.org/en/natural-capital-accounting, and System of Environmental-Economic Accounting, https://unstats.un.org/unsd/envaccounting/seea.asp.

Policy is inherently political. It is not only about policy as written on paper, but how it is interpreted and the importance that stakeholders accord it. In practice, such issues can be highly political and deeply entrenched. *Power structures* determine who gets to decide what policies are made and in what ways. Powerful players are often from business and finance, but they may have an incomplete or biased view of the value of natural capital. Moreover, their power base means they are able to resist scrutiny or change. In contrast, weaker players may be highly dependent on natural capital for their livelihoods, but their voices are not heard. Discourse on natural capital is often subject to myth, haste, or obfuscation, and often does not make progress because it has little information of the type that NCA can provide.

Routine policy processes can offer useful ways of reviewing and improving natural resource policy. But they may be submerged under discussion of

- *Hot issues*—Crises, events, big investment opportunities, or enduring political priorities like jobs and economic growth may drive decisions more than formal written policy and routine plans.
- *Contested values*—Balanced decision-making criteria (for example, sustainable development) are often promoted, but rarely used in practice; powerful players push for efficiency and profit, and weaker players push for fairness or sustainability.
- *Winners and losers*—The specific trade-offs (of who wins, who loses, when, where, and how) matter to all stakeholders, but achieving a balance is of particular importance to elected officials and public sector managers.

To handle such political issues better, there is usually a need for

- *Effective societal demand to complement government leadership*—Policy decisions have more traction and impact if both leaders and citizens are able to work together.
- *Embracing effective informal policy mechanisms*—Many operating at local and community levels, these can be more accessible and rapidly deployable than formal policy procedures.
- *Clear and well-handled distributional issues*—Rather than broad national conclusions, for example, on which sector produces the overall highest added value per unit of natural capital, local differences can be of much higher environmental, social, or economic significance.

Policy is dynamic. Effective policy will anticipate and respond to change. Today's world is complex, nonlinear, and hyperlinked, and political, economic, social, and environmental tipping points are increasingly likely. Policy decisions need to become more integrated, holistic, and adaptive. Yet in too many countries, written policy remains outdated and inflexible. In such circumstances, informal interpretations of policy often prevail, but may be inefficient or inequitable. This policy inertia can be damaging if it continues to be implemented without reviewing its impacts. NCA can provide the data to support the policy review process. This highlights the need for

- *Responsive administrative machinery*—Effective policy establishes a feasible trajectory or set of long-term outcomes, for example, national "2030 visions," and specifies mechanisms for adaptive strategy, for example, development of scenarios and back-casting from agreed outcomes.
- *Policy reform "space"*—Such space enables continuous improvement of policy, with opportunities for stakeholders to inform and be informed, debate, explore, and change position toward progressive policy on issues like climate change, green economy, and inequality.

Although policy is "messy," that messiness offers many levers for change. On one hand, it is important to understand policy in its many guises. On the other hand, it is also important to not allow its complexity to paralyze the process. That complexity means there are plenty of entry points for information on natural capital and diverse players who care about natural capital issues. A policy analytical framework can be generated to guide NCA development and might include

- *Mapping policy content,* processes, stakeholders, and knowledge (the four facets above), and understanding the dynamic political and institutional context, and
- *Identifying leverage points for NCA in the policy process,* for example, natural resource crises preoccupying political attention; the need to improve the identification and management of natural resource scarcity and risk; opportunities in the national plan review cycles; and new paradigms, such as green growth and the SDGs.

2.3 | The tools of public policy

Policy: The art, study, or practice of government or administration; the conduct of public affairs; political science. (Oxford Dictionary)
Public policy: Policy, esp. of government, that relates to or affects the public as a whole; social policy. (Oxford Dictionary)
Public policy is a large and complex field with many tools available. The public policy toolkit may be categorized in several ways; there is no generally embraced typology. One simple typology is "carrots, sticks, and sermons" (for example, Bemelmans-Videc, Rist, and Vedung 2010). "Carrots" are economic incentives, such as subsidies, tax concessions, and grants, or regulations to empower people to manage resources in a good way, such as property rights. "Sticks" can be either economic or regulatory in nature: taxes and fees, market regulation, pollution control, and other legislative instruments punishable with fines or other means, including jail. In addition to such economic or legislative instruments, policy makers can try to influence the behavior of people and businesses by providing information or education—these are the "sermons."

"Ownership" is another category. For example, the management of public resources or activities by the state or a local authority that provides services to people and businesses, the most obvious example being state-owned enterprises for water and electricity supply and the management of national parks. Carrots, sticks, and sermons can also be used by state-owned and private enterprises to influence the behavior of the users of these services.

To provide a general frame of reference for this discussion, and for future analysis of how NCA can assist public policy, a five-class categorization of the public policy toolkit is suggested:

- **Laws/regulation:** Market controls; regulation of consumption and production activities (for example, the use of harmful substances, pollution controls); establishment and enforcement of property rights; management plans for land, water, and other resources; development approvals; and environmental impact assessments
- **Economic measures:** Taxes, fees (for example, resource pricing), subsidies, government spending on environmental protection, grants for environmental protection, payments for ecosystem services, polluter-pays systems, foreign investment controls, export approvals, and import tariffs
- **Information:** Education and information campaigns
- **Ownership/stewardship:** Owning and operating public assets (for example, national parks) and enterprises (for example, water suppliers)
- **Do nothing:** A deliberate decision by the government to do nothing

2.4 | The institutional context for NCA

Institution: An organization founded for a religious, educational, professional, or social purpose; an established law or practice. (Oxford English Dictionary)
Institution: Stable, valued, recurring patterns of behavior. (Huntington 1965)
Institutions: The humanly devised constraints that structure political, economic, and social interactions. (North 1991)
Institutions: Are the "rules of the game," both the formal legal rules and the informal social norms that govern individual behaviour and structure social interactions (institutional frameworks). (Williamson 2000)

Institutions are a significant determinant of national success. Institutions are a key component of social capital: they are the principal social assets that we rely on to demand, deliberate, decide on, and deliver policy, and to distribute the resulting benefits, risks, and costs. As such, they will enable—or constrain—the emergence and success of a country's economy that uses natural capital wisely. Indeed, it is a country's economic and political institutions that most determine whether the country will succeed or struggle: institutions have at least as much

impact on a country's gross domestic product (GDP) and human development index (HDI) as its resource endowments and geography do (Rodrik and Subramanian 2003).

It is not surprising that the 2017 World Economic Forum (WEF) asserted that systemic institutional change is now a priority for tackling the world's complex problems. And, true to itself as a leadership institution, WEF has emphasized the primacy of "responsive and responsible leadership" in driving that change."[1] (Schwab 2017). The necessary changes entail new awareness, empowerment, new metrics and rules, new organizational functions, and new behaviors that recognize the potentials of natural capital within ecological limits, and the potentials of human capital within the limits of human rights (PEP 2016). New metrics are a clear opening for NCA in this agenda.

Table 2.2: Institutional reform toward integrated environment, economic, and social objectives: a four-stage empirical framework

Stage of institutional reform	Level of integration at this stage	Current status, observations	Instruments that help reach this stage including NCA (in italics)
1: Silos—"Do nothing"	***Separate***—Social, environmental, and economic objectives are not integrated and are often in conflict	Very few countries are still at this stage, but prevailing incentives can be hard to shift, even in countries that are in stage 2 or 3	• Prevailing institutional incentives—professional disciplines, government departmental divisions—maintain (and often robustly defend) silos • *Thematic accounts*, for example, for forests, water, and agriculture, as a first step
2: Safeguards—"Do no harm"	***Checks and balances***—Among social, environmental, and economic objectives, seek a minimal "do no harm" outcome	Most countries have achieved this stage, with many provisions in legislation, but provisions are often misunderstood and ignored in practice	• *Physical natural capital stock accounts* • Environmental/social impact assessments • *"Alternative livelihoods,"* cash transfers, and compensation schemes
3: Synergies—"Do what we can for co-benefits"	***Win-wins***—Social, environmental, and economic objectives are sought, but limited to where institutional and finance rules allow	Many countries are at this stage; public and professional discussion is constructive and focused on integrated rules or schemes	• *Monetary natural capital accounts* • *Environmental expenditure accounts* • Strategic environmental assessment • Payments for ecosystem services and conditional cash transfers • Joint environmental/social protection schemes, for example, jobs through land restoration • Certification • Public expenditure reviews on environment, climate, and sustainable development
4: Full integration—"Do more by changing the rules"	*Systemwide*—Sustainability, efficiency, equity, and long-term orientation; a truly circular economy, an economy of permanence; addressing structural barriers to scaling/speeding up SD	Few countries are at this stage yet, however, the theoretical need is understood—and implied by SDGs	• *Full set of wealth/natural capital accounts linked to system of national accounts and ecosystem services* • Multistakeholder policy and accountability bodies • Empowerment—rights' reforms, redistributing control of assets • Inclusive institutional formalization

Source: Developed from Raworth, Wykes, and Bass (2014).

The good news is that, given the increasing complexity of linked policy challenges (above), the institutional framework in most countries has progressed in the last 20 years or so to better integrate economic, environmental, and social goals. Countries' progression can be summarized as four stages of institutional integration (table 2.2). The bad news is that few countries have progressed much further than the "safeguards—do no harm" stage (stage 2).

Certain policy ambitions and/or instruments are more relevant, or better suited, to one stage of institutional reform than others. This is certainly one implication of the observations summarized in table 2.2. Problems can arise when particular narratives are employed, business cases made, or instruments used, which do not suit the stage that the country has reached. For example, countries that are only at the silo stage, or the do no harm safeguard stage, may not be interested in natural capital accounts or green fiscal reforms, even though some parts of NCA may be able assist in these early stages. Interventions must match the stage a country has reached. The possible roles for NCA change with each stage, as table 2.2 suggests, but, in general, the more advanced the stage, the greater the use is for NCA.

In conclusion, the shift toward institutional integration can be helped by the type of information that NCA can provide:

- *Evidence-based policy*—More and more countries are replacing static policies or elite opinion-based policy with legislated evidence-based approaches, treating policy as a hypothesis to be kept under review through adaptive strategy. NCA can provide the evidence needed.
- *Knowledge management systems*—Bringing together scattered data and one-off studies, for example, through State of Environment reports. NCA provides the knowledge-organizing framework.
- *Transparent, participatory processes*—These are now a norm; in contrast with closed governmental processes, they make information more accessible and improve its supply.
- *Interdisciplinarity*—The NCA process requires communication among economists, statisticians, natural scientists, and the business community, but results in better mutual understanding.

2.5 | Integrating NCA in the policy process, tools, and institutions

The policy context, tools, and institutions all have to be understood to determine how and where NCA can play a role in policy. Any policy process or instrument comes with an opportunity cost, for either private or public actors, and will impact how businesses and households act, and thus have repercussions in the economy. When deciding on the appropriate policy process, tool, or institution, the basic questions a decision maker faces are:

- What is the problem?
- What can be done about it?
- What will be the economic, social, and environmental costs, risks, and benefits?
- Who wins and who loses?

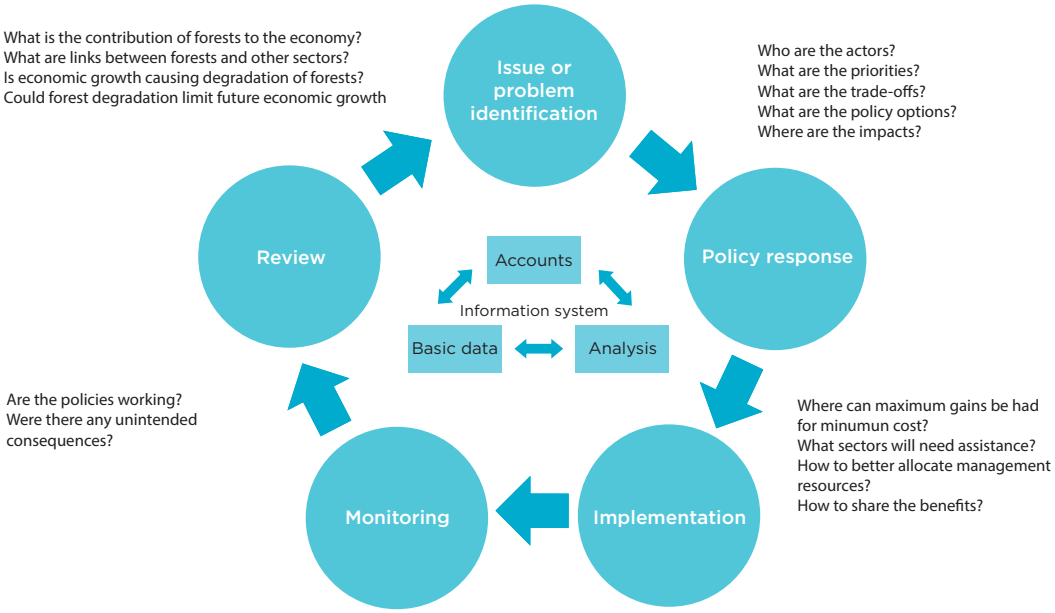
NCA can help to answer these questions for all types of policy measures during all phases of the policy cycle. Figure 2.1 depicts a notional policy cycle of informing, developing, agreeing, enforcing, and reviewing policy content. The cyclical process is often iterative, and the entry points for NCA can be in any part of the cycle. Figure 2.1 also shows the types of questions that can be answered with the help of NCA using forests and forestry as examples.

In the analysis phase, accounts can be used in conjunction with different analytical tools (for example, economic models) to answer questions about economic-environmental issues and optional policy responses. Accounts and related data can be disaggregated to provide information both for production (different economic sectors/

industries) and consumption (households with different income levels), and can also address allocation issues (who wins and who loses). The value added of using natural capital accounts as opposed to environmental and sectoral statistics (for example, for energy, water, or forest statistics) is that the accounts allow for better analysis of the link between environmental and economic systems, and are easily integrated into economic models and other economic tools.

For successful analysis of policy measures, it is not always necessary to have the full suite of natural capital accounts available. There is considerable power in simply using physical natural capital accounts in conjunction with economic data from standard national accounts. For example, in combination with data on costs for various measures and investments, physical accounts can be used in cost-efficiency analyses and for analyzing impacts on the economy, resource use, and emissions from changes in regulations and taxes or charges. Monetary natural capital accounts can be used to compare the value of different types of capital and how changes in management may impact the value, similar to cost-benefit analyses.

Figure 2.1: The policy cycle and associated NCA uses



Source: Adapted from Vardon et al. (2016).

There are multiple policy instruments and decision-making processes that can use information from NCA. Recurring cycles that can benefit include budget cycles for national and local governments, as well as strategic planning (national development plans, land use master plans, green growth strategies, and others). Account production should be synchronized with these cycles when feasible.

Other process or policy entry points are single opportunities, such as policy or planning reviews and enquires, and, in these cases, the accounts can be complemented with other data to provide quantitative information about the issues and potential policy responses. In such cases, the data from accounts provide a ready source of information for unanticipated processes. Accounts can support policy processes for energy and climate change commissions as well as expenditure reviews.

In summary, natural capital accounts can be used to track the development of the economic-environmental system, but they can also form a basis for forward-looking analysis. NCA's myriad uses, along with the types of questions asked by decision makers and the types of information and analysis that are applicable, are shown in table 2.3—in categories that align to the policy cycle shown in figure 2.1.

Table 2.3: NCA use for policy

Policy use	Decision makers' questions	Information system (data, accounts, and analytical tools)	Types of answers
Identification of issues	• How are we doing? What has changed, and how does that link to changes in the economy and other factors? • Given assumptions about domestic and international development, how will we fare in the future?	• Accounts data and derived indicators, simple projections • Input-output analysis, environmental-economic models, scenario modeling, spatial analysis, footprint analysis	• Interpretations from the data on past and present state • Scenarios for future development of economy and environment
Policy response	• If we want to change the current state or projected future state, what can we do? • Who benefits from changes in policy? • Who bears the costs of producing these benefits?	• Accounts data and derived indicators, input-output analysis, computable general equilibrium modeling, environmental-economic models, scenario modeling, cost-benefit analysis, integrated assessment	• Economic and environmental effects of restrictions on scenarios to achieve policy targets • Ex ante assessment of the policies' effects on the economy and environment
Policy implementation	• How can we target the policy response to get the most improvement for least cost? • Which activities should be done first? • What price should be put on natural resources?	• Accounts data, derived indicators, environmental-economic modeling, spatial analysis, industry analysis, cost-benefit analysis, business case	• Detailed assessment of all the pros and cons of the policy interventions
Policy monitoring	• Are the policies making progress toward goals and targets?	• Accounts data and derived indicators	• Ex durante assessment of policy progress and evaluation of the need to adjust policy instruments
Policy review	• How can we make the existing policy more effective to achieve the goals and targets? • Are there any unintended consequences of the policy response? • Do we need different policy responses?	• Accounts data and derived indicators, econometric modeling	• Ex post policy evaluation of effectiveness and efficiency of policy instruments

Examples of NCA use and related policy analysis are included in many of the chapters in this document, and a general summary is provided in chapter 3.

2.6 | Next steps

The implication of NCA having particular roles at different stages of a country's institutional reform process is that it can play a role in driving institutions to the next stage. Thus, NCA can be built step by step with the policy and institutional framework (table 2.2), for example, starting with thematic accounts for particular silos in stage 1, moving to physical stock accounts of particular natural capital that the country wishes to safeguard (stage 2), through to flow accounts that optimize natural capital use for sustainable development projects in stage 3, right through to full wealth accounts and incorporation of ecosystem services that will inform major structural changes in the economy and foundational rights (stage 4).

Moreover, a more comprehensive look at the notional policy cycle suggests seven points where NCA can add value:

1. *Analysis:* NCA supports quantitative and qualitative natural capital policy analysis—for example, feeding modeling, to ensure decisions are based on the best possible information.
2. *Dialogue:* NCA supports stakeholders reflecting on natural capital progress and futures—for example, feeding projections, scenarios, and the like that draw the larger policy picture out from all the data, and that focus discussion on high-level issues and directions.
3. *Policy choice:* NCA supports the detailed design and assessment of policy options—ensuring a well-informed business case and policy coherence.
4. *Budget and finance:* By integrating environmental and economic information, and tailoring that information to policy analysis, NCA helps to select cost-effective options. For example, NCA can support the setting of carbon, pollution, and resource taxes and fees by identifying the environmental impact of economic activity.
5. *Implementation:* NCA can target policy toward specific localities, times, stakeholders, or resources through its flexibility to change or add accounting units to suit the policy goals.
6. *Monitoring and baseline:* Through its systemic approach and the standardization and consistency it delivers, NCA supports regular monitoring of policy goals, for example, reducing resource intensity, decoupling, value added, and improving net savings—and in turn, informing dialogue.
7. *Engagement:* NCA supports an integrated and multistakeholder approach to policy—to both serve policy and drive policy change.

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2.8 | Endnote

1 Others argue for greater economic democracy, equitable distribution of resource rights, evidence-based policy making, and/or sustainability standards in every sector. The potential scope of institutional reform is large and contested.

3 | Natural Capital Accounting for Policy—A Global View of Achievements, Challenges, and Prospects

Steve Bass, International Institute for Environment and Development
Sofia Ahlroth, WAVES, World Bank
Arjan Ruijs, PBL Netherlands Environmental Assessment Agency
Michael Vardon, Australian National University, Fenner School of Environment and Society

Summary

Natural capital accounting (NCA) has been used in all phases of the policy cycle and incorporated into the policy machinery of several governments. Uses range from the monitoring of sector-based policies, like water, energy, and forests, to more complex areas of implementing or analyzing cross-sectoral policies for green growth and climate change. Countries like the Netherlands, Sweden, and the United Kingdom, which have had NCA programs for many years, have developed the capacity and relationships between the users and producers of accounts to enable more effective use of the accounts in policy processes. While it takes time to produce NCA with the full range of functions, countries with relatively new programs have also had achievements in applying NCA to decision making, for example, in setting prices for water and energy, as well as in enriching national, sectoral, and regional planning. There are several challenges to introducing NCA into the policy process, including the prevailing policy focus on the short term (limited policy readiness for change), acceptance of the information (its perceived credibility and trustworthiness), communication of complex information, alignment of NCA supply with NCA demand, ensuring collaboration and understanding among diverse professions and institutions, and maintaining high-level support. The many opportunities for using NCA include the Sustainable Development Goals (SDGs), green growth, climate change, the intended nationally determined contributions (INDCs), and sector policies (for example, water, energy, and forests). The assessment of experience to date has enabled the identification of 10 "living principles" to ensure that NCA is policy ready. The principles are grouped under four headings—comprehensive, purposeful, trustworthy, and mainstreamed—and can be tested and revised. The next steps are to work together to develop more thematic applications of NCA, especially to realize the opportunities identified, as well as to develop practical guidance documents.

3.1 | Introduction

This chapter offers an overview of how NCA has progressed in improving policy decisions to date, the associated challenges, and the opportunities and prospects for the future. It draws on the NCA Forum discussions and on further analysis of the country and thematic papers. Our findings are diverse. But because there are clear and common lessons, and we are confident of common factors of success, we have been able to identify some tentative principles of effective NCA for policy: we term these "living principles" knowing that the Forum and others will want to test them and keep them under review.

We begin with a brief assessment of the written material offered to the Forum by the participants and their colleagues. In all, 24 papers were supplied, presenting direct experience and insights from 10 countries—Australia, Botswana, Colombia, Costa Rica, Guatemala, the Netherlands, the Philippines, Rwanda, Sweden, and the United Kingdom—and also drawing on the experience of other countries and organizations (for example, European Commission, Inter-America Development Bank, and United Nations Economic Commission for Europe). The papers involved 48 authors, spanning the NCA user and producer spectrum, including analysists, accountants, economists, lawyers, scientists, statisticians, researchers, and public officials.

The material is rich and also refers readers to additional experience not shared directly with the Policy Forum. Thus, while not of all of the diverse experience of NCA and policy linking was represented at the Forum, the

papers provide a gateway to this: for example, the wide-ranging work of the WAVES partner countries. We hope that, by publishing the papers, we will encourage others to document and share their experience to further build the body of knowledge and understanding. This task is vital if we are to embed NCA in the policy and processes of government as well as in the thinking of business and society more generally.

Table 3.1 presents a broad overview of the papers by thematic area and by stage in the policy cycle. Most papers have described uses of NCA in more than one stage in the policy process (for example, analysis and review). In some cases, the uses are planned or potential uses, rather than actual uses to date. In addition to the thematic and issue-based applications presented, several papers synthesized the achievements and lessons of countries that have already been applying NCA over a longer timeframe to distill lessons on how NCA can be better applied to policy (for example, chapters 4 and 5). Other papers focused on the institutional processes followed and developments taking place within their countries to link NCA to policy (for example, chapters 8, 10, and 12).

Table 3.1: Overview of papers contributed for the 2016 Policy Forum by theme and stage in policy cycle

	Identification	Response	Implementation	Monitoring	Analysis and review
Energy	Ruijs (chapter 17)	Ruijs (chapter 17)	Ruijs (chapter 17)	Ruijs (chapter 17) Rivera et al. (chapter 11)	Ruijs (chapter 17) Rivera et al. (chapter 11)
Water	Oosterhuis (chapter 16) Pule and Galegane (chapter 7) Castaneda et al. (chapter 12)	Pule and Galegane (chapter 7) Castaneda et al. (chapter 12)	Pule and Galegane (chapter 7) Romero et al. (chapter 9) Nagy et al. (chapter 25) Uwera et al. (chapter 19)	Oosterhuis (chapter16) Pule and Galegane (chapter 10) Romero et al. (chapter 9) Uwera et al. (chapter 19)	Romero et al. (chapter 9) Uwera et al. (chapter 19) Castaneda et al. (chapter 12)
Forests and land	Castaneda et al. (chapter12)	Uwera et al. (chapter 19) Castaneda et al. (chapter12)	Uwera et al. (chapter 19) Romero et al. (chapter 8) Castaneda et al. (chapter 12)	Uwera et al. (chapter 19) Romero et al. (chapter 8)	Uwera et al. (chapter 19) Banerjee et al. (chapter 13) Castaneda et al. (chapter 12)
Minerals				Gervacio (chapter 18) Uwera et al. (chapter 19)	Gervacio (chapter 18)
Biodiversity and ecosystems			Vardon et al. (chapter 24)	Ledoux and Wejchert (chapter 23) Vardon et al. (chapter 24)	
SDGs and sustainability	Barter (chapter 21)			Barter (chapter 21) Steinbach (chapter 20)	Banerjee et al. (chapter 22) Barter (chapter 21) Steinbach (chapter 20) Castaneda et al. (chapter 12)
Green growth/ economy	Castaneda et al. (chapter 15)			Schenau (chapter 6) Romero et al. (chapter 11) Steinbach (chapter 20)	Castaneda et al. (chapter 12)
Climate change		Medrilzam and Adinia (chapter 14)	Medrilzam and Adinia (chapter 14)	Medrilzam and Adinia (chapter 14)	Romero et al. (chapter 8) Castaneda et al. (chapter 12)
***State of Environment* reporting**				Smith et al. (chapter 6)	Smith et al. (chapter 6)

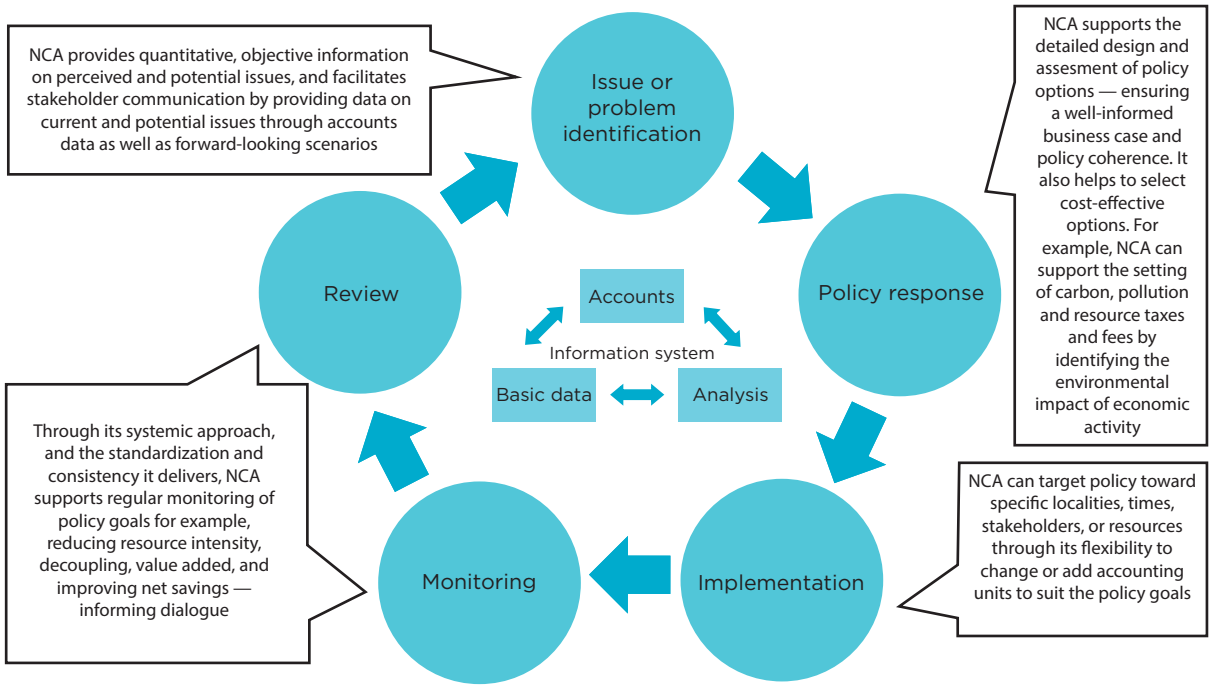
3.2 | NCA's policy achievements to date

3.2.1 | Policy uses

The papers in this publication provide examples of how NCA has been (or could be) used in policy. Figure 3.1 gives a schematic overview of this using the five stages of the policy cycle, namely:

- Issue or problem identification
- Policy response
- Implementation
- Monitoring
- Analysis and review.

Figure 3.1: How NCA supports an integrated and multistakeholder approach to policy—to both serve policy policy and drive policy change



Source: Adapted from Vardon et al. (2016).

The level of policy use of NCA has varied between countries. All examples of NCA use for policy design come from countries that have been producing NCA for a long time (for example, the Netherlands, Sweden, and the United Kingdom). That said, many countries with recently started NCA programs are beginning to use the accounts to develop policy responses (for example, master plans or strategies) as well as to implement, monitor, or review existing policies or international obligations (table 3.1).

The most straightforward use of NCA is for policy monitoring and review, often by deriving indicators from the accounts. This is the case for water in several countries (chapter 25) and for several topics in many countries, including Costa Rica (chapter 11), Sweden (chapter 20), and the Netherlands (chapter 15)—topics that are often linked to national environmental objectives or international obligations, including climate change (chapter 17).

The United Kingdom already uses NCA to review sustainability (chapter 21), while the Australian Capital Territory has advanced plans to use NCA for *State of Environment* reporting and related sustainability recommendations (chapter 6), and Indonesia has plans to use NCA for setting its independent NDC (chapter 14).

NCA is frequently linked to long-term national development plans (chapter 10, chapter 12, chapter 18, chapter 19) as a way to identify issues as well as to monitor them. Most countries covered in this publication envisage using NCA to inform both monitoring and achieving the SDGs, and although it is still too early to have achieved any concrete outcomes, it is clearly high on their policy agendas. Similarly, NCA is foreseen to be useful for other multisectoral policy initiatives, like green growth. The European Commission is developing pilot ecosystem accounts and will test how they can support a number of European Union policies (chapter 23), while there has been work on linking NCA to the Aichi Targets for biodiversity (chapter 24) and to business reporting (chapter 26).

There are also many examples of countries using NCA to analyze specific policy issues. A common example is the use of water accounts for identifying links among various economic activities and water use, as well as for informing revision of water fees and cost recovery (chapter 7, chapter 9, chapter 25). In Colombia, the accounts were used to assess the environmental cost of the El Niño climate phenomenon in 2015 and to quantify the environmental benefits to be gained by Colombia in a peacetime scenario (chapter 8). In Guatemala, the accounts have been used to inform forest policy (chapter 12, chapter 13). In the Netherlands, energy accounts have been used at all stages in the policy cycle and are a good example of NCA being used in formulating responses to issues (chapter 17). Finally, in the Philippines, the accounts have been used to address the trade-offs between mining operations and natural resources in decision making (chapter 18).

In two cases, NCA was instrumental in identifying or clarifying issues or problems. In Botswana, NCA helped to identify wildlife using water in possible competition with other water users (chapter 10) and the potentially unsustainable harvest of fuelwood in Guatemala (chapter 16).

3.2.2 | Policy users

The users of NCA potentially include:

- Government agencies responsible for particular natural resources or geographical areas
- Government agencies with responsibilities for broad or cross-sectoral strategic direction, planning, or budgeting
- Research and analytical institutions, within or outside government
- Businesses and civil society

In the past, several countries started implementing NCA, but the accounts were not continued. Such was the case in Colombia (chapter 8), Indonesia (chapter 14), the Philippines (chapter 18), and Australia (chapter 3). The most frequent reason for this was that the accounts were not actually used by policy makers, that is, the key potential users of NCA. The lessons from countries like the Netherlands (chapter 4), with its long history of NCA, is that it takes a long time for NCA to make its way into policy formulation processes and more active engagement is needed between NCA producers and potential policy users.

Analytical institutions and academics have therefore often been the primary NCA users, only indirectly providing a bridge between accounts and policy through their analysis. Analysis outside of government is seen in a few countries, including Sweden (chapter 20), Guatemala (chapter 13), and the United Kingdom (chapter 21). In Guatemala, the production of the accounts was undertaken within a university, which acting as the bridge between the account producers and policy—although account production is now migrating into government (chapter 12).

Government agencies responsible for individual natural resources—in particular for energy, water, minerals, land, and forests—have been key users of NCA in several countries. This has been the case in Australia (chapter 25), Botswana (chapter 7), Colombia (chapter 9), the Netherlands (chapter 16, chapter 17), the Philippines (chapter 18), and Rwanda (chapter 19). Such policy uses of NCA are also made by subnational management authorities in Colombia and the Philippines (Vardon et al. 2016).

Few government agencies with broad responsibilities have yet to maximize NCA's potential to reveal environment-economy links and dynamics. The Netherlands, Sweden, and the United Kingdom have had some success with this, and the lessons can hopefully be transferred to other countries. In addition, the WAVES program was designed specifically with cross-sectoral and strategic level government planning in mind, striving to link different ministries through high-level steering committees including officials from ministries of finance, planning, development, and others. This targeting of central authorities has been instrumental in generating policy momentum in several countries (chapter 10, chapter 18). Global environmental issues like green growth and climate change, with potential impacts over the whole spectrum of the economy, have also raised interest in environmental-economic challenges within the realm of finance and development authorities.

Outside government, the business community and civil society have, to varying extents, recognized the potential of NCA. The business community has a range of initiatives (chapter 26), and civil society has taken an interest in NCA in some countries—for example, the Netherlands (chapter 17) and United Kingdom (chapter 21). However, in most countries, NCA knowledge is limited to a few accounts professionals and bureaucrats, and it has not yet made a serious impact in public debate or business decision-making.

3.2.3 | Institutionalization of NCA into policy processes

Many countries and institutions have begun implementing NCA, but relatively few have effectively integrated it into public policy processes and the associated government machinery. A key achievement of those countries with long-standing NCA programs—the Netherlands (chapter 4), Sweden (chapter 20), and the United Kingdom (chapter 21)—is that they have managed to build enduring links between the NCA user and producer communities. In each of these countries, there is a clear delineation of roles, with NCA production being undertaken in national statistical offices and policy departments receiving the information. In the case of the United Kingdom, the independent Natural Capital Committee reviews the accounts and makes recommendations to central government. In all three countries, NCA producers also have a legal mandate for their work, there are formal administrative arrangements, and high-level requests for information on particular issues. Over time, relationships have been built between producers and users of accounts and with the research community. This has helped to build credibility and legitimacy for NCA production, and to improve the efficiency and purposeful alignment of NCA producers and users. Ruijs and Van Der Esch (chapter 4) also note that a transparent process involving decision makers and other users is needed for deciding which accounts and statistics are required, which in turn ensures the long-term societal relevance of the information.

But the countries that have more recently started their NCA programs also have notable achievements. For example:

- Botswana has institutionalized NCA within the Department of Water Affairs and the importance of NCA is recognized at the highest levels of government.
- Costa Rica has institutionalized accounts production in the central bank, and collaborative mechanisms have been established between the producers and users of accounts for water, energy, and forests. A key feature in Costa Rica has been its inclusive approach to developing and using NCA.
- Colombia has institutionalized NCA production in the national statistical office, with NCA being explicitly mentioned in the National Development Plan 2014–18, and indicators from NCA are being used to support the country's Green Growth Strategy.

- Indonesia is aligning its existing NCA production system to better meet the needs of climate change policy through a process of collaboration between NCA producers and users.
- The Philippines has mandated the inclusion of resource accounting results as an information source for developing policies to protect the environment and promote responsible mining.
- Guatemala's national development plan calls for the creation of statistical mechanisms to monitor its progress. The accounts have been used as a basis for key indicators on sustainable development, and have triggered and informed a new forestry strategy.
- Rwanda has developed formal processes for sharing data between government agencies and has used accounts information for water management, including price setting and water allocation.

Rwanda's development of a formal process for data sharing is not unique. A key feature of NCA, underlined in many of the papers, is that developing NCA contributes to breaking down silos and enhancing communication between actors, such as ministries and agencies that had been working on separate, but interlinked, areas. Accounts development pulls together and consolidates scattered data, making more efficient use of existing data, and allowing data gaps and deficiencies to be identified and addressed. This also helps to increase trust in the data providers and hence the credibility of the accounts.

Forum participants concluded that, in such ways, NCA is also well placed as a key navigational instrument for adaptive, multi-issue policy making in the future, and to better link institutions together for sustainable development. Of particular interest is that NCA can support the achievement of SDG targets for building institutions, as shown in table 3.2.

Table 3.2: Links between institutional aspects of SDGs and NCA

SDG targets for institutions	How NCA fits
All SDGs: *Integrated institutions* are critical for meeting the challenges of sustainable development by 2030	Linking interests of environment/natural capital institutions and economic institutions
16.3 Promote the *rule of law* at the national and international levels and ensure equal access to justice for all	Fulfilling legal requirements for natural capital information and for policy that respects natural capital potentials and limits
16.5 Substantially *reduce corruption and bribery* in all their forms	Improving transparency in allocation, use, and benefit flows and asset ownership
16.6 Develop effective, *accountable, and transparent* institutions at all levels	Enabling institutions to report in their consumption of natural resources, the impact of their activities on the environment, and the mitigation measures put in place
16.7 Ensure r*esponsive, inclusive, participatory, and representative* decision making at all levels	Engaging multiple actors in generating up-to-date natural capital information and offering regular assessments of the extent and quality of natural capital and the sharing of the market and nonmarket benefits
16.8 Broaden and strengthen the *participation of developing countries* in the institutions of global governance	Equipping developing countries with better information on the status on their natural capital, its role in global public good provision, and factors driving change in the quantity and quality of resources
16.10 Ensure *public access to information* and *protect fundamental freedoms*, in accordance with national legislation and international agreements	Published NCA offers well-organized information that can be integrated into a wide range of existing economic and social data that are relevant to many stakeholders' goals; many simplified indicators from NCA are possible
16.b Promote and enforce *nondiscriminatory* laws and policies for sustainable development	Inclusion and balance assured by NCA that cover the breadth of natural capital stocks and flows, users and uses, and the distribution of benefits; NCA processes welcome inputs from all relevant stakeholders

Source: Authors' elaboration.

3.3 | NCA's challenges in improving policy

While many positive achievements are evident in the different cases, all countries face challenges—some operational and relatively easy to solve, others more deeply rooted in structural issues. The structural challenges may mean that account use does not go beyond the issue or problem identification stage in the policy cycle (figure 3.1).

The Policy Forum discussions, the contributed papers, and other experience reveal six types of challenges to NCA informing policy, although some progress has been made in each:

- Policy readiness for change
- Credibility and trustworthiness
- Policy-relevant communication
- How to align supply and demand and arrive at a clear NCA purpose
- Collaboration
- High-level support

Policy readiness for change. Multidimensional and long-term issues may not be highest on the policy agenda, and/or there may be little policy space in terms of debate and review processes to address them. The authorities with interest in tracking the natural capital base may be politically weak. Or there may not yet be a requirement or an appetite for evidence-based policy. Thus institutions may be unable to evolve from the silos stage to the stage where NCA helps to find synergies for sustainable use of natural capital, or where NCA is fully integrated into public policy making (table 2.1 in chapter 2).

Credibility and trustworthiness. For NCA information to be used, it must be credible and trustworthy. Trustworthiness challenges have been reported in some countries, but most countries have noted that it takes time before data are accepted politically—as being reliable and trustworthy—especially regarding new, and for some people complex, concepts. The international standardization of NCA has helped to ensure data reliability, particularly in the area of monetary valuation, although there are still some doubts (chapter 26). Note that having reliable data does not automatically mean the results are trusted by everybody—perhaps due less to data reliability and more to mistrust or misunderstanding over how the NCA information was analyzed or interpreted. Such analyses require assumptions to be made, additional information to be collected, and sometimes normative choices to be made, which are all debatable. Institutionally separating the task of building accounts from the task of using the accounts for policy analysis, such as we see in the Netherlands (chapter 4), may be one of the answers because it creates a greater sense of trust in the NCA data and allows institutions to specialize and build expertise. On the other hand, examples from Botswana (chapter 7), Colombia (chapter 8), Guatemala (chapter 12), and Indonesia (chapter 14) show that it is not essential for both tasks to be allocated to separate institutions.

Policy-relevant communication. Almost all countries struggle with the question of how results from NCA can be communicated to policy makers and to the population at large. Often too little is done. Yet, increasingly, NCA is being presented through infographics, maps, and charts to make complex results easier to understand. Examples of green growth indicators in the Netherlands (chapter 15), energy use in Costa Rica (chapter 11), or the peace dividend in Colombia (chapter 8) show the strength of graphic messages in conveying the results and their implications. Direct communication can be useful for policy makers with immediate interests. For example, in the United Kingdom, the Natural Capital Committee reports directly to the British government, which is obliged to respond to the committee's advice (chapter 21). In the Netherlands (chapter 4), NCA information is increasingly

communicated through the media. A dedicated communication strategy—elaborating what messages, to whom, and how they are delivered—can help to ensure messages reach their target audiences.

How to align supply and demand and arrive at a clear NCA purpose. One major barrier to mainstreaming NCA in policy making is misalignment between the supply of, and demand for, NCA results. Chapter 5 asserts that accounts should be designed for policy relevance, not just to meet accounting standards, but also to support the policy process. A stepwise approach is useful here: start with issues high on the policy agenda with a clear role for NCA, and later, once NCA is accepted as useful, tackle other environment-economic issues. Another barrier that could arise is if the accounts have not been designed to be fit-for-purpose: does the level of detail correspond with the questions at stake, the feasible policy options, and the decision-making level? For example, the limited use of water accounts for analyzing possible water policies in the Netherlands relates to a mismatch between the type and level of decision making on one hand, and the type and level of information in the accounts and related models on the other (chapter 16). The questions of detail and scale are especially important when NCA is used as an input in modeling or scenario exercises—the data may fit to some policy questions, but not to all (chapter 13).

Collaboration. A system in which NCA is fully integrated in the decision-making processes is characterized by cross-sectoral, multidisciplinary cooperation between ministries, statistical agencies, and research organizations; data sharing among institutions; and mutual trust. In many countries, the reality is still very different from this ideal, and those on the supply side of NCA have not yet had a productive history of working with those on the demand side. Countries experienced in NCA show that collaboration takes time and continuous effort to achieve, with multidisciplinary technical working groups and multiagency NCA–policy steering committees helping to forge effective paths (chapter 20, chapter 21, chapter 4). Some institutions beginning to explore NCA for specific purposes, such as the ACT's State of the Environment Reporting (chapter 6), have put in place processes for linking account producers and users, as well as linking to the research community.

In most countries that have only recently started building NCA, much of the necessary data exist, but they are dispersed over many organizations that do not necessarily want to share their data or are mandated to share it. And even if data sharing is possible, aligning interests may not be an easy thing to accomplish (chapter 23). Almost all countries have had to learn how to transcend the difficulties of cross-sectoral and multidisciplinary cooperation. The Indonesian experience (chapter 14) showed that a streamlined system could be achieved for tracking indicators and reporting on international and national targets, such as SDGs, Strategic Environmental Assessments (SEAs), government financial statistics (GFS), and INDCs.

High-level support. A final challenge—but a major one that must be overcome to successfully integrate NCA in decision-making processes—is how to create and sustain high-level political will and support for natural capital policy and the role of NCA. Those countries partnering with WAVES have powerful central ministries, such as finance and planning, backed by high-level officials or ministers, and are more successful in setting up accounts and realizing their added value than countries where this high-level support is lacking. The European examples show that once the utility and position of NCA is established, it can be mainstreamed. The Australian (chapter 6) and Dutch lessons (chapter 4), in contrast, show that NCA is having to continuously prove its added value to politicians, senior bureaucrats, and the wider public to keep earning a role in the institutional landscape.

3.4 | Opportunities for NCA to improve policy decisions

The policy areas that offer real potential for NCA:

- Concern complex and dynamic links between the environment and the economy;

- Concern many government agencies as well as business and civil society;
- Are information and/or consultation intensive, and may be suffering an information or democratic deficit; and
- Are high profile, involving major policy or investment decisions.

The country questionnaire, the papers in this volume, and the Forum discussion pointed to three such policy areas: the SDGs and the 2030 Agenda, green growth/green economy (GG/GE) and circular economy, and climate change. NCA is "wired" to inform comprehensive, complex, and multistakeholder policy processes such as these. The policy demand for NCA can also be reinforced by the trend for improvements in regular cross-sectoral processes, such as national development planning, competition analysis, risk analysis, science-policy fora, environmental/biodiversity mainstreaming, review processes such as parliamentary commissions, and future search and visioning exercises. Calls for more evidence-based approaches to policy bode well for NCA. Countries cite international drivers as opening up such opportunities, such as Colombia with its aspirations to accede to the Organisation for Economic Co-operation and Development (OECD).

3.4.1 | NCA for SDGs and the 2030 Agenda

Following agreement at the 2015 United Nations General Assembly, the SDGs are perhaps the highest-profile commitment to jointly achieving economic, environmental, and economic goals—one that has actively engaged businesses, too. Most countries are preparing national SDG plans, many of which are (or will be) integrated into national development planning cycles. There is active discussion on the indicators of SDG achievement and how to pull together baselines and assessments of progress. In circumstances where the integrated SDG agenda is already being pulled apart by governments into component SDGs—allocating individual SDGs to particular ministries—an information system is needed that can link the SDGs together, show where synergies are possible and where trade-offs may occur, and regularly inform multidimensional well-being measures (for example, in Sweden). There is much potential for NCA here, as the activities and plans for Indonesia, Colombia, and Guatemala note. Entry points for NCA will be national SDG plans and both international and national monitoring and evaluation responses.

3.4.2 | NCA for inclusive green growth, the green economy, and the circular economy

Over 65 countries are now preparing national GG/GE plans or strategies. United Nations (UN) agencies have come together to support developing countries in their efforts (UN Partnership for Action on Green Economy [PAGE]). The Global Green Growth Institute began with 18 founding member countries in 2010, and now has 24.[1] In addition, many development banks and development assistance agencies have programs that support GG/GE. Green-growth policies are diverse, but at their core they seek to improve a country's overall wealth, include those actors who have been marginalized by prevailing economic policies, and add value to natural resources within ecological limits. Where early GG/GE efforts focused on least-cost greenhouse gas abatement, there is now considerable interest in three areas with high potential for NCA support:

- First, a positive approach to the potentials of natural capital—realizing productive value from nature within ecological limits.
- Second, shifting subsidies away from "bads" that harm natural capital, toward "goods" that will protect and develop natural capital so that it can provide benefits to the economy and society.
- Third, new measures of progress such as beyond GDP and well-being. NCA in the Netherlands is already informing its GG policy and the circular economy; in Sweden, it is addressing bioeconomy policy; and in Colombia, NCA will be used to structure the analysis needed for the country's GG plan. Entry points include national GG plans and investment screening.

3.4.3 | Climate change policy and INDCs

Countries adopted a historic international climate agreement at the UN Framework Convention on Climate Change's Conference of the Parties (COP21) in Paris in 2015. Many countries have already publicly outlined what post-2020 climate actions they intend to take under the new international agreement. These intended nationally determined contributions (INDCs), which when submitted become nationally determined contributions (NDCs), communicate how the country will support the long-term goals of the Paris Agreement to:

- Hold the increase in global average temperature below 2°C,
- Pursue efforts to limit the increase to 1.5°C, and
- Achieve net-zero emissions after 2050.

It is widely recognized that the use of natural capital in the economy has both positive and negative implications for climate change. There is thus real potential for NCA to provide better natural resources data to NDC decisions and monitoring. For example, Indonesia is applying NCA information on natural resource stocks and flows, their use by economic activities, and their contribution to other capital stocks, thereby informing the NDC system dynamic modeling. The Swedish and Costa Rican papers indicate that NCA is helping broader climate change policy, such as tracking emissions. NCA can also track the net impact of climate change measures, such as carbon storage, that could negatively impact natural capital such as biodiversity. Entry points include INDC preparation and monitoring.

3.4.4 | NCA for resource and sector policy

In addition to the above high-profile, comprehensive, and ambitious policy agendas, Forum deliberations also pointed to continuing opportunities in traditional sector policy themes where NCA has already made a difference and is beginning to be part of the decision-making machinery—notably forest, water, and minerals policy. Such areas are actively developing market-based instruments such as certification, investment standards including for foreign direct investment (FDI), and means of transparency in integrated reporting (IIRC [International Integrated Reporting Council], GRI [Global Reporting Initiative]). Several business models aiming to yield multiple benefits, such as payment for ecosystem services (PES) and REDD+ (reducing emissions from deforestation and forest degradation), require information of the type that NCA can provide to keep them on track. Ecosystem accounts will enhance the applicability of NCA to these types of issues, and they are also possible to develop at different geographical scales. All of these developments offer opportunities to scale up and improve NCA's role in policy.

3.4.5 | NCA for analysis and indicators

In addition to the more theme-oriented entry points, another opportunity for NCA to gain momentum is its recent applications to analysis and indicators. NCA's basic structure makes it particularly capable of being integrated into coupled environment-economy models. Examples like the IEEM-model (see the papers from Banerjee) can relatively easily be adopted in other countries as well. Other international programs—like the Natural Capital Project[2] —also provide approaches, like InVEST (for example, Ma et al. 2016), that can use NCA information. Again, ecosystem accounts can provide a link to more complex issues such as regulating services (for example, water regulation, soil erosion, microclimate regulation). Moreover, especially concerning green growth and the SDGs, there is growing consensus on the types of indicator to be used, which are difficult to derive without the use of NCA.

3.5 | Principles and next steps

The myriad uses of NCA in policy are demonstrated in all of the papers in this publication. Real leadership has been displayed by the countries with a long history of NCA, but countries that have more recently adopted

NCA also have valuable examples of actual or planned policy applications. All countries have concluded that the institutional arrangements needed to translate NCA into policy are important, offering a range of lessons on how this can be done. We now consider how best to move forward—to scale up and speed up NCA's fruitful application to policy.

3.5.1 | Living principles of NCA that is "fit for policy purpose"

The first NCA Policy Forum meeting yielded many conclusive lessons, some of which are foundational for NCA to inform good policy. Thus, we have been bold enough to suggest 10 tentative principles for NCA that is fit for policy purpose. They draw on analysis of the Forum's country and thematic papers, and notably the NCA design principles from chapter 5, as well as other recent references, for example (Vardon et al. 2016). They are offered as living principles, with the intention that they be kept under review as further experience is shared.
NCA is fit for improving policy if it is.

Comprehensive:

1. *Inclusive*—Acknowledging the diverse stakeholders concerned with decisions affecting natural capital, responding to their information demands, respecting different notions of value, and using appropriate means of engagement
2. *Collaborative*—Linking the producers of NCA, the users of NCA for policy analysis and the policy makers using the NCA results, and building their mutual understanding, trust, and ability to work together
3. *Holistic*—Adopting a comprehensive, multi/interdisciplinary approach to the economic and environmental dimensions of natural capital and to their complex links with policy and practice

Purposeful:

4. *Decision-centered*—Providing relevant and timely information for indicator development and policy analysis to improve and implement decisions with implications for natural capital
5. *Demand-led*—Providing information actually demanded or needed by decision makers at specific levels

Trustworthy:

6. *Transparent and open*—Enabling and encouraging public access and use of NCA, with clear communication of the results and their interpretation including limitations of the data sources, methods, and/or coverage
7. *Credible*—Compiling, assessing, and streamlining data from all available sources, and deploying objective and consistent science and methodologies

Mainstreamed:

8. *Enduring*—With adequate, predictable resourcing over time; continuous application and availability; and building increasingly rich time series of data
9. *Continuously improving*—Learning focused, networked across practitioners and users, testing new approaches, and evolving systems to better manage uncertainty, embrace innovation, and take advantage of emerging opportunities
10. *Embedded*—NCA production and use becoming part of the machinery of government and business, building capacity, improving institutional integration for sustainable development, and incorporating NCA use in procedures and decision-support mechanisms

3.5.2 | Next steps

The papers in this publication amount to a global stock-take of how NCA has engaged with policy. They have provided the basis for an initial synthesis of achievements, challenges, and lessons, from which we have drawn

some tentative principles presented in this chapter. Ours is not the only interpretation possible of this material, and as one next step, we encourage readers to explore the rich and diverse case studies and make their own assessments and conclusions. This way a growing community of practice can continue to pull NCA further into the policy processes and institutions of government, and society more generally.

The papers also show the need to examine the policy challenges ahead of us and the opportunities for NCA to improve decisions that respond to them. The experiences of the WAVES partnership countries, as well as from the other countries and institutions that participated in the Forum, give some clear directions for future work, including collaboration between NCA producers and users and producing practical guidance documents.

Collaboration between producers and users. The NCA community of practice is growing and is now beginning to link NCA producers with users, thanks in part to the first NCA Policy Forum. This community of practice could soon be in a good position to spread lessons learned and develop NCA production processes, analytical tools, and applications to policy. The collaborative approach should continue—creating an environment of trust, transparency, engagement, and shared ownership. This will enable the sharing of NCA use strategies with high-level policy makers, key ministries, and institutions. And it could lead to practical work in preparing NCA systems that are fit for purpose, offering policy-relevant information when and where it is needed. Means of collaboration between NCA producers and policy users could include in-country and/or thematic learning and leadership groups, cross-country comparisons, addressing common institutionalization challenges and opportunities, as well as awareness raising and professional development. In-country and regional collaborations can generate the critical mass of expertise needed to promote, develop, and use NCA in policy and to have it broadly accepted by the public and private sectors. Finally, there is clearly a role for continued collaboration at the global level, building on the first NCA Policy Forum.

Developing practical guidance documents. There is clearly a global appetite for guidance on how to address increasingly complex policy challenges such as the SDGs. While generic interest in policy-relevant NCA has been growing, now is the time to supplement the detailed technical guidance on building accounts with guidance on NCA's many applications to policy. Much is needed—from briefing notes to full manuals. And there is now much shared experience to draw upon to develop guidance about what works, such as our synthesis of lessons above, and our tentative living principles for policy-fit NCA could be tested and reviewed. Guidance and associated capacity-building work could cover:

- Applying NCA to complex and comprehensive policy development and targeting, such as the SDGs, green growth, and NDCs;
- Using NCA as an integral mechanism to manage particular policy initiatives or instruments such as REDD+ or PES;
- Applying NCA to analytical tools such as input-output and scenario modeling and interpreting the results; and
- Communications work on NCA, and especially its results, using infographics, case studies, messaging, media work, and other tactics that create and maintain public attention and support as well as political appeal.

3.6 | References

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3.7 | Endnotes

1 See http://gggi.org/about-gggi/programs-plan-history/.
2 See http://www.naturalcapitalprSee oject.org/http://www.naturalcapitalproject.org/.

4 | From Accounts to Policy: Dutch Experiences with Natural Capital Accounting

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Summary

Environmental statistics and accounts can improve policy making in the area of sustainable natural resources' use, but this requires certain conditions to exist. Based on the development and use of statistics and accounts over the past 50 years in the Netherlands, we have drawn four lessons on enhancing the value of environmental statistics and accounts in policy making.

First, the process for making choices about the statistics and accounts to be collected must be transparent, involve users and decision makers, and ensure societal relevance over the long term. Second, information from environmental statistics and accounts can be used in all phases of the policy cycle, but the type and level of information required differs among the phases. Third, statistical data need to be translated into policy-relevant insights if maximum use is to be made of environmental statistics and accounts—but this requires expertise different from that needed for statistics development. The institutional relationships among those developing the statistics, conducting policy analysis, and preparing new policies strongly influence the uptake of natural capital accounting (NCA) information by policy makers. Different institutional channels are able to open statistics and policy interpretation for different audiences, increasing NCA's reach and the ability to format the results for specific audiences. Fourth, those setting up environmental accounts and/or conducting policy analysis should consider three factors that affect the applicability of the environmental accounts to the policy process: the scale of environmental problems, the level at which decisions are made, and the type of policy measures (generally applicable versus specific and location dependent). These lessons can help integrate environmental accounting into policy processes in other countries, leapfrogging decades of development by reducing the learning curve by designing an appropriate institutional setup, avoiding typical mistakes, and hopefully improving on it.

4.1 | Introduction

High-quality information on the value of natural capital and ecosystem services can help improve public policies that guide sustainable development. This paper explores the conditions necessary for environmental statistics and accounts to make such contributions, based on nearly 50 years of experience with environmental statistics and more than 20 years of experience with environmental accounts in the Netherlands (box 4.1). Today, information from these statistics and accounts is used in a broad range of policy dossiers. We discuss four lessons that can improve the contribution of environmental accounting to policy making (Oosterhuis, van der Esch, and Hoogervorst 2016; Ruijs, Oosterhuis, and Schenau 2017).[1]

Box 4.1: NCA in the Netherlands

The history of environmental statistics in the Netherlands goes back to 1969, when an environmental department was established within Statistics Netherlands. The emphasis was initially on statistics that described environmental pressures, such as emissions to air and water and waste production. Further environmental statistics began to be produced during the 1970s, covering a wider area. In the early 1990s, dissatisfaction with gross national product as a poor measure of welfare led to the development of a system in which "satellite accounts" are linked to the national accounts. This enabled the quantification of various trade-offs between economic growth and the environment. The National Accounting Matrix, including environmental accounts, was initially based on the policy drivers at that time, like climate change, ozone depletion, acidification, overfertilization, and waste. Over the past two decades, the number of environmental accounts expanded rapidly, supported by national government demand for data. In 2016, the following environmental accounts were produced:

- Physical supply and use accounts: Waste accounts, air emissions accounts, water emissions accounts, energy accounts (energy consumption by enterprises and households), water accounts, and material flows
- Stock accounts: Petroleum and natural gas reserves
- Monetary environmental accounts: Environmental taxes and charges, environmental goods and services sector, and environmental cost

Source: Oosterhuis, van der Esch, and Hoogervorst (2016).

4.2 | Lesson 1: Value of transparency and long-term vision

A first lesson from Dutch experiences with environmental statistics and accounts is that the process by which policy choices are made must be clear and transparent and ensure societal relevance over the long term. In the Netherlands, transparency over the data to be collected is assured through the Central Commission for Statistics. This office decides which environmental statistics and accounts are to be compiled and which are to be discontinued. Development is predominantly demand driven (Dijkerman 2010), with user consultation taking place through several advisory bodies, account teams, and a liaison between Statistics Netherlands and representatives from ministries and research institutes. Statistics Netherlands has the autonomy to make choices concerning data series to be compiled, but the available budget determines what Statistics Netherlands can carry out. Because the Statistics Netherlands budget is allocated from the budget of the Ministry of Economic Affairs, the ministry has considerable influence on its resources. Box 4.2 notes that the autonomous role of the Central Commission and of Statistics Netherlands has evolved over time and has, in the past, led to difficult and politically motivated choices.

Box 4.2: Environmental statistics and manure surplusess

Compared to its size, the Netherlands has a large livestock sector generating substantial surpluses of manure, which leads to significant eutrophication (that is, water pollution from excessive nutrients). Warnings of manure surpluses and their potential consequences for the environment were already being heard in the Netherlands at the end of the 1960s. Even so, a policy response was not formulated until about 15 years later, and only in 1984 were the first measures taken to mitigate the problem. Among other causes, progress was held back by a lack of statistical data on the extent of the manure surplus. Statistics Netherlands had carried out calculations in 1973, but these were not published because the ministry and agricultural experts could not agree on the thresholds that would define whether there was a surplus. Statistics on manure surpluses were published for the first time in 1982. The Netherlands Court of Audit (1990) showed that the attitude taken by the Ministry of Agriculture and Fisheries in the Environmental Statistics Advisory Committee was typified by lack of interest in calculations revealing manure surpluses. If Statistics Netherlands had calculated acceptable—if incomplete—surplus statistics as early as the second half of the 1970s, more timely interventions could have been made. What is striking is not just the political pressure that delayed publication of the results from Statistics Netherlands, but also the fact that the existence of manure surpluses could apparently only be shown convincingly if supported by Statistics Netherlands. It also suggests that a focus on overly precise data may not be appropriate to this phase in the policy cycle (see section 4.5).

Source: Oosterhuis, van der Esch, and Hoogervorst (2016).

The Central Commission is also responsible for considering long-term societal relevance in its decision making. In past decades, Statistics Netherlands has faced several budget cuts. In its choices, the Central Commission attempts to minimize the societal consequences of those cuts and tries to ensure that the statistics provide sufficient coverage of the various environmental domains, so that they remain relevant through the long term, and that they are able to provide sufficient links to adjoining domains, such as public health and economic sectors (Statistics Netherlands 2013). The long-term considerations are important because statistics can increase in meaning and value if they are collected over a longer period of time, because longer time periods enable the identification of trends and developments. The meeting of international obligations, such as European Union regulations, is also often given as an argument for continuing existing statistics. Next to this, political developments also play a role. For example, there is now a demand for data on green growth and on jobs in "clean tech" sectors. Such specific issues do not always correspond to the data available for past years. They may partly be constructed from existing series, but often also require more time before sufficiently long data series are available.

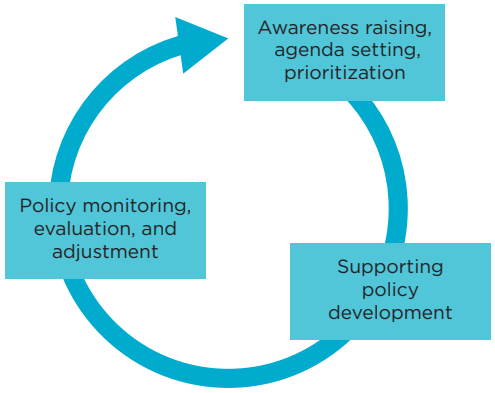
To guarantee transparency, Statistics Netherlands makes all its statistics publicly available, and currently all environmental statistics information is published online. Statistics Netherlands also produces thematic publications on various environmental topics, crucially providing context and interpretation that make the many environmental statistics digestible for policy makers and other users, helping them to relate raw data (such as the trends in certain emissions) to factors such as the size of polluting sectors, trends in society, and implemented policy. These reports also provide transparency over the choices, methods used, and assumptions made.

4.3 | Lesson 2: Accounts are useful in all phases of the policy cycle

A generally accepted conceptual idea on how policies come about is the policy cycle. In its simplest form, the policy cycle describes how a topic first has to make it high enough onto the political agenda (problem phase), followed by exploring and implementing policy instruments (implementation phase), and finally moves into a situation where the issue and policy response are monitored, evaluated, and tweaked, if necessary (monitoring phase); (figure 4.1).

Environmental statistics and accounting can play important parts throughout the policy cycle. However, the type of information required differs for each phase. Then the question for environmental account development is: how to best match the different demands for information throughout the cycle?

Figure 4.1: Policy cycle phases that use environmental accounts



Source: Authors' elaboration.

Experience in the Netherlands shows that environmental statistics and accounts are used intensively in all three phases (Schenau et al. 2009). First, the timely availability of environmental statistics and accounts can inform public debate and discussion on nascent environmental concerns. In this early phase of the policy cycle, the data supplied should be of sufficient quality for policy makers and the public to decide whether an issue presents an important challenge. This can come about through publication by the statistics agency or a government department, but also through the use of publicly available statistics by nongovernmental organizations (NGOs) or the news media. An example of timely availability is the quarterly publication of carbon dioxide (CO_2) emission figures at the same time as the quarterly estimate of gross domestic product (GDP). Coupling the two publications contributes to a broader insight that welfare is more than GDP growth alone.

Second, statistical information is often used to support the development of environmental policy, even though politics makes relatively little use of pure statistics—it rather uses studies that are based on the statistics and accounts. As it was succinctly put in one of the interviews conducted for this paper: no environmental statistics means no good environmental policy.

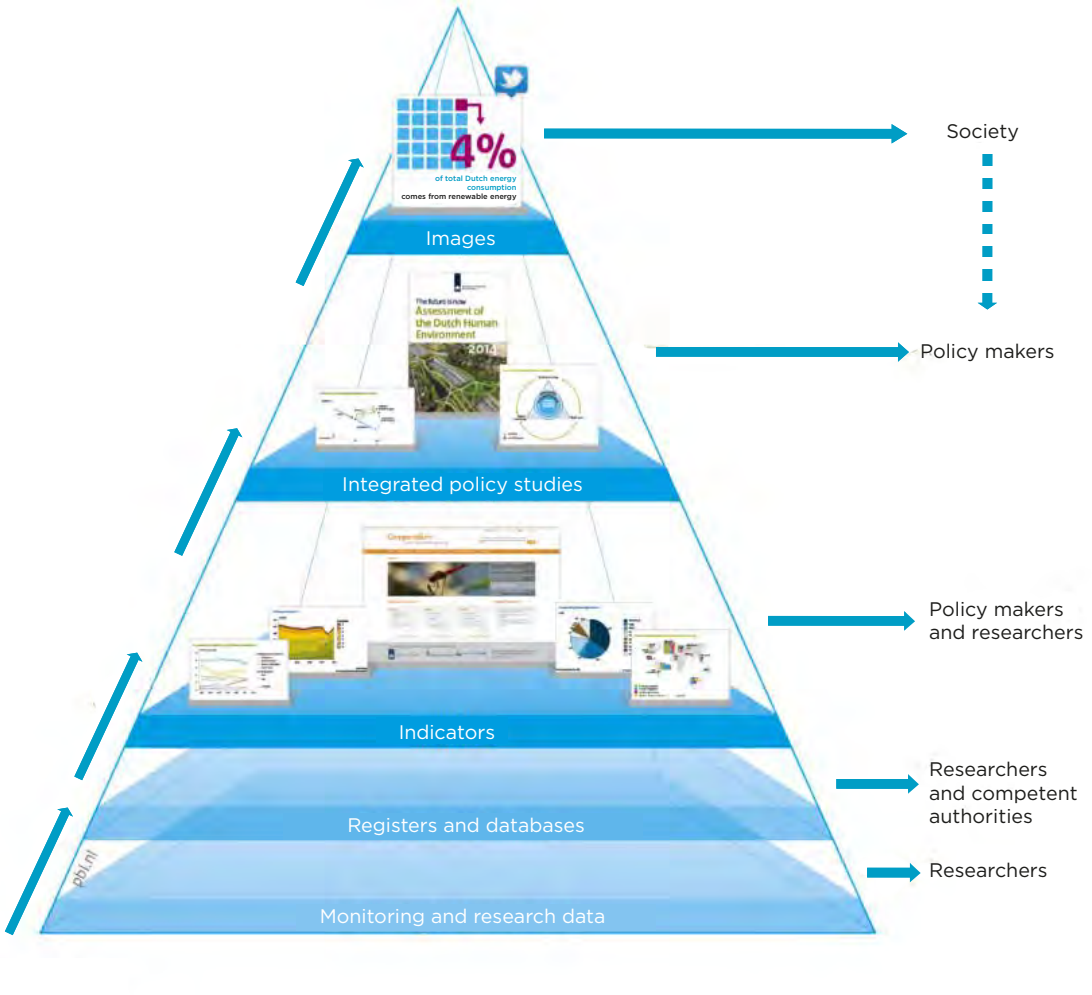
Environmental statistics certainly played an important role in the National Environmental Policy Plans (NEPP) of the 1980s and 1990s. The report "Concerns for Tomorrow" (RIVM 1988) was an important stimulus for the systematization of Dutch environmental policy, as it provided an overview of the environmental data available at the time. The use of environmental accounts is more restricted to particular types of analysis. One example is that of energy policy (see chapter 17). The National Energy Outlook (NEO) analyzes anticipated effects of new energy policies using a detailed energy-economy model that relies on the environmental accounts. It enables policy makers to understand the trade-offs between the environmental and economic effects of their policy choices (ECN et al. 2016). In this way, the accounts help to show the implications in terms of policy challenges, policy options, and their possible effects.

Third, monitoring and evaluation are two of the main applications of environmental statistics and accounts. However, the available information does not always provide a seamless response to policy demand. Monitoring and evaluation require inferences on trends, instrument effectiveness, and assessment of whether it is likely that the current policies will achieve the goal. This becomes easier with more precise information (for instance, spatial information, or information broken down per sector or by origin of the specific environmental pressure)—as well as by longer time series. For monitoring the Water Framework Directive, for example, the water accounts are used in a water-economic model to evaluate cost recovery and resource efficiency: this could not have been done without the accounts. Another example is the monitoring of the energy policies, for which the NEO uses model analyses based on the energy accounts to monitor goal achievement.

4.4 | Lesson 3: The need for an institutional structure to connect accounts to policy

The previous lesson shows that statistics and accounts are better able to inform policy if they are provided with context and interpretation, but that this goes beyond the mere presentation, or possible extrapolation, of historical trends. To make statistics and accounts useful for policy, one or more processing steps are often applied, for example, by aggregating data, converting them into indicators, or relating them to policy objectives or instruments in policy studies (figure 4.2). More complex processing can also be applied, for example, by using the data in modeling, scenario analyses, and future projections. The latter requires a considerable amount of work and expertise, including an understanding of the relevant systems and knowledge of policy instruments, evaluation methods, and environmental and economic models.

Figure 4.2: The information pyramid



Source: Oosterhuis, van der Esch, and Hoogervorst (2016).

This intermediary role between the compilation of statistics and its use in policy making involves distinct tasks. The role must be explicitly allocated, and resources and political support committed to it, if environmental statistics and accounts are to prove their value to policy. In the Netherlands, an institutional structure has been created step by step, comprising several separate institutes that specialize in strategic policy analysis and evaluation and that use the information from Statistics Netherlands—as well as many other sources—to provide policy advice. Separating the tasks of environmental statistics compilation and data quality control, on the one side, and their use in policy advice and evaluation, on the other, may create a greater sense of trust in the national statistical office and its independence. In practice, there is less discussion in society regarding the statistical methods of data collection and more discussion about the methods and assumptions that underpin policy analysis. Obviously, in such a constellation with a division of tasks, collaboration is necessary among the statistical agency, policy research institutes, and policy makers.

Furthermore, the ways in which information derived from environmental statistics and accounts is communicated greatly determine their value. There are various institutional channels in the Netherlands for publishing

environmental statistics that focus on policy advice and evaluation, each directed to particular audiences. The Environmental Data Compendium,[2] a joint activity by Statistics Netherlands, PBL Netherlands Environmental Assessment Agency, and Wageningen University and Research, is one example. This Compendium provides facts and figures on the environment, nature, and spatial planning in the Netherlands, together with a basic interpretation of trends and policy goals. It creates overall awareness and monitors environmental policies, yet its data are also used in several specific policy analyses. A more detailed analysis is conducted by, for instance, PBL Netherlands Environmental Assessment Agency, and published in reports, webpages, infographics, and videos. PBL has a statutory role to support policy making in the field of environment, nature, and spatial planning. It fulfills this by preparing outlooks, analyses, and assessments. Other channels are created through the public availability of data, with NGOs and newspapers being able to conduct independent analyses and bring them to the public. In addition, there are a number of think tanks, knowledge institutes, universities, and consultancy firms in the Netherlands (some related to the government) that receive regular commissions for assessment and advisory work. These, too, often rely heavily on publicly available environmental statistics.

4.5 | Lesson 4: Accounts are relevant for many policy fields, but not all

Our assessment of how environmental statistics and accounts have been used in the Netherlands has shown that those setting up environmental accounts and those doing policy analysis should consider three factors that seem to affect the applicability of the environmental accounting to the policy process: the scale of environmental problems, the level at which decisions are taken, and the type of policy measures deployed (generally applicable versus specific and location dependent). Before setting up accounts, it is advisable to assess whether the feasible level of detail for the accounts suits the policy issue at stake.

First, some policy measures rely on local data, whereas others require data at a higher level. A local water-quality problem usually needs a local solution, for which national-level water accounts may be of limited use to determine the appropriate policy measure. Currently, the Netherlands' water accounts are only of limited help for this. On the other hand, the national energy accounts fit the national energy policies—for which the location of an intervention is less relevant than the economic sector in which an energy intervention is taken.

Second, environmental accounts so far seem to be more relevant for top-down than for bottom-up decision-making processes. Dutch water policy processes have a tradition of bottom-up water management in which the measures taken are the result of streamlining a large number of bottom-up actions proposed by several actors at all levels of governance (state, provinces, water boards, and municipalities). Much of the information in the current water accounts does not match the geographic level at which decisions are made. On the other hand, energy policies have a more top-down tradition, in which national authorities make national-level policies that, generally, have no bearing on location. Moreover, they target households or firms whose activities are covered in the national accounts. The available accounting information is consequently better suited to address energy issues than to address the issues dealt with in the Water Framework Directive.

Third, some policy problems can be tackled with policy measures that are similar for all; while other problems need more tailor-made interventions. The Water Framework Directive has resulted in a rather diffuse, often location-specific, set of policy measures. The information required for analyzing these measures in many cases is not part of the environmental accounts, but it comes from local investigations and may have a qualitative character. On the other hand, the effectiveness of energy policies can usually be assessed in more general terms. The type of information needed for energy policy analysis is more fit to the type of information provided by the environmental accounts.

These three factors justify the conclusion that the setup and level of detail of the environmental accounts should depend on the policy problem at hand. This should be taken into consideration when the environmental accounts are compiled.

4.6 | Next steps

Policy making is often a "messy" process. Our discussion has shown that measuring the magnitude of environmental problems, and the (possible) effects of policy interventions, using information from environmental accounts can potentially make this process less messy. It supports evidence-based policy making and transparency, and it creates a clearer perspective on the trade-offs resulting from political choices. As a result, to a certain extent, the use of environmental statistics and accounts can depoliticize parts of the policy process. This requires an institutional setup and competencies characterized by:

- A demand-driven approach, tailoring the accounts to both the policy issue and the policy phase that needs to be supported,
- Cooperation, transparency, trust, and data sharing among statistical agencies, policy analysts, and policy makers in all phases of the policy cycle,
- Clear and recognized tasks at each phase for each of these organizations, and
- Multiple communication channels as a stable foundation for both accounts disclosure and for enabling their effective use.

By recognizing these issues, integrating environmental accounting information in policy processes can potentially be faster in the WAVES countries than what we have observed in the Netherlands. It took decades for the Netherlands to arrive at its current practice. In the WAVES countries, available resources may be more limited, while environmental accounts still often have to prove their added value to decision makers. In this light, WAVES could look for ways to leapfrog this long development process, saving on learning time while designing an appropriate institutional setup that is more cost-effective and avoids typical mistakes.

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4.8 | Endnotes

1 These lessons are based on literature review and interviews with key persons in Statistics Netherlands, related ministries and institutes working with the statistical and accounting data.

2 (www.clo.nl/en).

5 | Applying Natural Capital Accounting in Government Decision Making—Opportunities for New Uses and Collaborative Design

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Summary

Environmental accounting has progressed to the point where international standards were adopted in 2012 and a number of countries now regularly produce accounts. However, there has been a lack of corresponding progress in designing and using accounts to make better decisions, largely due to poor knowledge and understanding of how the accounts can be used. There are a number of potential uses for natural capital accounting (NCA), but only by collaboration between the account producers and users, much as product designers collaborate with clients and users, will the full scope of NCA for better environmental decision making be realized.

5.1 | Introduction

Environmental decisions often have to be made without enough information. Sometimes this is because of information gaps, and sometimes it is because the environment is only partly understood. It may be possible to close information gaps by commissioning research or seeking expert advice, but often the gaps are too large or time is too short to gather the information needed. There are also ways of compensating for a lack of information. Predictions can be made by applying judgment, or the precautionary principle can provide a reason to act even where information is inadequate. But surely these approaches are second best: environmental decisions need to be the best ones we can make—our future depends on it!

The history of environmental information in Australia has been a story of "two steps forward, one step back." Australian governments since the early 1970s have seen the need for better environmental information and have funded various programs over the years to address this issue. For a number of reasons, most of these programs have not lasted, even where they had significant potential. One reason for this is that environmental information programs rarely have significant public attention or appeal, and so are often the first to be cut or are the first proposals to be dropped when budgets are tight. Another reason is that proposals to fund environmental information programs sometimes lacked an organizing principle and were based simply on the need for more and better information. This kind of proposal is unattractive to finance agencies, because no matter how much new information is obtained, the need is never met. As a result, Australia's environmental information systems still have major gaps, a major example being the lack of long-term data on biodiversity. Further, even though Australia is producing environmental accounts, their use in decision making has been limited.

This paper, which is based on a presentation to the World Bank "Forum on Natural Capital Accounting for Better Policy Decisions" in the Netherlands in 2016, argues that environmental accounts provide the missing organizing framework for environmental information. But they offer much more than this. Accounts dovetail with a policy model that is finding much international support: that of maintaining the natural capital that produces the ecosystem services on which society depends. This paper therefore goes on to argue that accounts can only reach their full potential through collaboration between the account producers, usually national statistical offices, and users, including decision makers of all kinds as well as researchers.

5.2 | What can NCA do for policy?

Policy is a complex thing, and there are many definitions. But for those who make policy, the more important question is not what policy is, but what policy can do. Done well, policy decisions can solve significant social problems.

Metaphors can be helpful in exploring things that are not well understood. Solving problems through policy can be compared to taking a journey, from where we are to where we want to be. And a feature of something that is well known, even obvious, can provide insights into the thing that is less well understood. For example, it is obvious that one would not undertake a physical journey without a clear idea of the destination and the best way to get there. If the journey were long or difficult, planning would be important and it would also be important to have reliable transport and enough food and fuel. Unless the route was clearly marked and signposted, navigation instruments would be needed. Yet policy journeys are often attempted with only a broad direction in mind rather than clear destination, or without a navigation instrument for measuring progress.

Environmental accounts are an important new navigation tool for taking policy journeys. They are as significant for policy making as the newly invented chronometer and sextant were for ocean navigation in the 18th century. Before these instruments, navigation was mainly an exercise in "dead reckoning," which relied on the experience of ship captains. With the new navigation instruments, the captain was able to determine the ship's current position and the position of the destination much more accurately, and the navigator could chart a clear course between the two and keep the ship on course.

The story is the same with the "ship of state" and environmental policy. Before environmental accounts were developed (and standardized through the System of Environmental-Economic Accounts [SEEA]), it was difficult to know a country's environmental position with any certainty, particularly over time, because of the complexity of arranging all the necessary information in a consistent way and maintaining this consistency over time. In Australia, for example, *State of the Environment* reports, even though based on the carefully developed "pressure-state-response" model, have lacked that consistency. Another common approach to environmental information, the use of indicator suites, often lacked common standards, or if there were standards, they were not always followed. And even though Australia was an early producer of environmental accounts (from the early 1990s for some sectors, and generally from 2014) the use of accounts in decision making has been limited.[1] This may be the result of the bureaucratic "silo effect," an argument that different parts of government do not communicate because they are focused on their own particular roles, but irrespective of the reason, this is a lost opportunity![2]

Accounts address the problem of standardization. More than that, the "stocks and flows" model on which accounts are based provides a clear organizing framework for measuring the environmental assets or resources that we have (stocks of natural capital); how those resources provide benefits to humans (flows of ecosystem services); and how stocks of natural capital are replenished through natural processes or human investment. This same concept of human interaction with the environment as an integrated system, one that needs to be maintained if our way of life is to be sustained, underlies the leading approach to environmental policy, which means that NCA is the perfect tool for the job of informing good environmental policy.

So accounts tell us not just the state of the environment, but the state of the environmental-economic system on which we depend. By doing this, they also naturally direct the attention of policy makers to the question of whether that system is in good condition, that is, whether it has the resilience to continue providing a level of ecosystem services that will meet human needs, now and into the future. The result is that, over time, accounts can help articulate, in physical terms, not only a policy destination, even one as complex as sustainability, but also

the milestones on the path to that destination. The trends revealed by accounts would also reveal the effects of falling short of an intended policy path; for example, underinvestment might be reflected in accounts through an unexpected decline in the condition of natural assets. Even if the initial impact of the accounts only revealed gaps in information, this would help policy because it would point clearly to the research and monitoring needed to give a complete picture.

All this is fine in theory, but the crucial question is: what is the best way to use a tool that for most people remains new and unfamiliar? There are no rules as to where to start, so it may be best just to start a dialogue among interested parties. For example, the NCA Forum included a series of policy roundtables at which representatives of account producers, potential users, and a university discussed how to make use of accounts. This led to several projects, one of which is described in another chapter in this volume (Smith et al. 2017).[3]

5.3 | Finding design principles in existing systems and frameworks

What are the potential uses for the accounts? What opportunities do they provide for better decision making? The accounting standards in the SEEA set some of the parameters for accounts, but mostly for technical benefits such as consistency. From a user's perspective, the SEEA leaves a great deal of flexibility to design accounts to meet the needs of decision makers and other users.

Even with limited country experience, we can identify initial principles. What follows is a set of suggestions for design principles, built from one user's perspective on "what can accounts do to support better decisions?" They are not rules, but opportunities to explore!

5.3.1 | Function of accounts

We can draw several principles of account design simply from the function of accounts: they are not an end in themselves, but are intended to support better decision making. Clearly then, accounts should be *designed for policy relevance*, not just to meet accounting standards.

5.3.2 | Entrenched policy goals

From a user's perspective, the most obvious consideration in designing accounts is to support policy goals or objectives, particularly those that are entrenched and therefore unlikely to change, such as the 2030 Sustainable Development Goals (SDGs), or goals enshrined in domestic legislation. Other goals and objectives can change relatively quickly, while accounts as a policy-support system must be enduring. It would therefore be unwise to design accounts *only* around *existing* policy goals. So, accounts should also be flexible enough to *support policy goals, present and future.* Future goals might be accommodated simply by providing for regular review of account structures.

5.3.3 | SEEA concepts

The SEEA is based on a general environmental-economic model in which the economy operates within the environment; natural inputs flow from the environment into the economy, and residuals flow from the economy back into the environment. It is also based on concepts of stocks of environmental resources (natural capital) and flows of ecosystem services—and on certain accounting principles, particularly a spatially based approach and the combined presentation of financial and nonfinancial measures.

Some aspects of account design flow naturally from these concepts. First, accounts should, when fully implemented, *cover all aspects of the environmental-economic model, end to end*, from the generation of natural

inputs to the disposal of wastes. Second, a systemic view suggests that accounting units should in turn be *based on environmental systems*—ecosystems, water catchments, airsheds, and so on, rather than on political units or convenient geographical boundaries (although accounts could be combined to align with administrative boundaries). Even biomes such as the tropical savannah, which are otherwise based on ecological similarities, would generally not provide a good basis for an accounting unit, as the one biome can be found in different localities, providing ecosystem services to different populations. Biomes are not a single system. Finally, the "combined presentation" of financial and nonfinancial data in accounts underscores the fact that a key NCA objective is to support decisions that cannot be based on a single common measure, such as money. The difficulty of this integrative task suggests adopting not only the most relevant unit of measurement for any given environmental asset, but *all feasible units that will assist the integration task*. Water, for example, might be accounted for by quantity, quality, and market value.

5.3.4 | The state of scientific knowledge

The science related to some environmental assets and ecosystem services will be well known and can be reflected readily in account design. The science related to other account aspects is still developing. For example, scientific understanding of the interconnectedness of surface water and groundwater has evolved rapidly in recent decades and might mean that a river and adjacent aquifer should be accounted for in the same accounting unit, or at least in complementary units. Again, while the location-specific nature of biodiversity means that ecosystem accounts will also be location specific, science has identified some factors that are relevant to all biodiversity and that can be used as a checklist in account design. For example, it is important for biodiversity conservation to manage the entire landscape mosaic, not just the pieces that comprise it, which suggests accounting not just by landcover type, but also by species-specific habitat type and patch size (Lindenmayer et al. 2008). So it is necessary to *look at the science when designing accounts*.

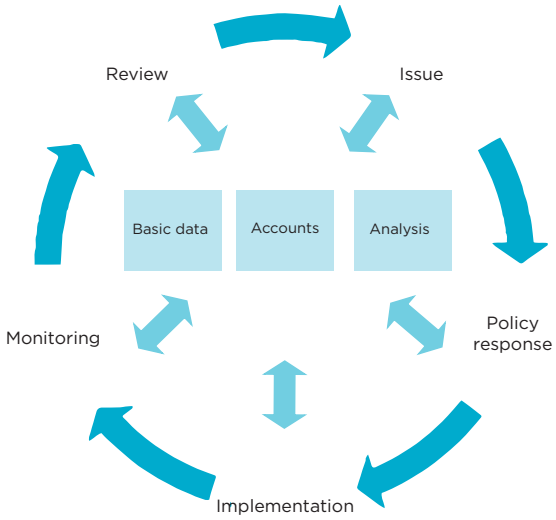
5.3.5 | The nature of the policy system

The policy system is usually represented as a cycle; attention moves progressively from the identification of a policy issue to policy response, passing through implementation, monitoring, and review, before returning to the issue in completion of the cycle. While it is not usual to reflect the role of information in this cycle, the information system can be placed at the center of the cycle and ideally will engage with decision making at all stages of the policy cycle, as shown in figure 5.1. It is clear from representing the ideal relationship between information and policy in this way that information systems, in this case accounts, should be designed to support decisions at each point in the cycle. Thus, for example, accounts should be designed as much to inform monitoring and review at later points in the cycle as they are to *support issue analysis and policy response.* And the information system should be capable of responding to feedback at any point in the cycle, for example, to vary the data that are collected to improve monitoring quality.

5.3.6 | The longitudinal nature of accounts

Properly designed accounts will form a high-quality time series. This is particularly useful to environmental policy, which is often dealing with long-term problems and long-term goals. The longitudinal nature of a good set of accounts will support two activities that are very important to good policy making. The first is to allow real data to be replaced with hypothetical data when considering future scenarios (that is, modeling). The second is to make it easier to update existing data with new or revised data. In other words, *accounts help us look forward and look back* to better see where we have come from and where we are going.

Figure 5.1: Information and the policy cycle



Source: Adapted from Vardon, Burnett, and Dovers (2016).

5.3.7 | The experience of other types of accounting

National accounting has been operating in its modern form since the System of National Accounts (SNA) was adopted in 1952. Modern business accounting is often dated back to Josiah Wedgewood's analysis of the books of his pottery business in the 1770s to identify cost components, match inventory to demand, and otherwise use accounting for the better management of his business. Environmental accounting is simply the newest application of accounting concepts and could no doubt learn much from these longer-standing forms of accounting, despite the significant differences involved, as national accountants work closely with economic policy agencies and business accountants have in many cases moved beyond simply preparing accounts to become business advisers.

5.4 | Accounting is an activity, a process of collaboration between account producers and users

The policy application of accounts is not just an issue of designing accounts, it is about the ongoing activity of accounting. Principles of design are theoretical and provide no more than a starting point. Most of the seven principles above could be implemented, to a degree, by the account producers alone. However, account producers do not have the expertise and experience of users. If the goal is for accounts to be used to their full potential, it makes sense for the experts in account production to talk to decision-makers as experts in account use, just as architects or product designers collaborate with their clients and seek feedback from users more generally. This is where experience has been lacking to date. We need to invent new forums and institutions to enable this collaboration. Perhaps it could start simply, like the policy roundtable mentioned earlier. As the issues become clearer with experience, this kind of engagement might become more structured, for example, through formal evaluations of accounts after they are produced, or through surveys of users.

5.5 | NCA is still in the experimental stages—the issue is how to minimize the inherent risks

Environmental accounting is relatively new, with the SEEA Central Framework having been adopted in 2012 and the SEEA ecosystem accounting still experimental. A number of countries have produced accounts, but none

are using them as an integrated element of an environmental decision-making system. This lack of experience, combined with novel features, such as combined presentation, makes it inevitable that moving in this direction will be, at least to some extent, a policy experiment, a process of trial and error.

There are several ways to minimize the adverse impacts of a trial and error approach. One is to learn from each other, sharing experiences, as in the World Bank Forum held in the Netherlands in 2016. Another is to learn from countries' experiences in related activities, in this case both national and business accounting. A third way is to move through the stages of trial and error as quickly as possible, to see the process as evolutionary. The stages of evolution cannot be skipped, but evolution can occur at a slower or faster rate, for example, by breaking a project into stages and applying the learning from one stage to the next. For example, a collaborative project described in another paper in this series involves the use of accounts to inform a *State of the Environment* report in the Australian Capital Territory. Because this is the first time this has been done in Australia (and possibly anywhere), the accounts will be released for comment as an "exposure draft" in advance of the main report, to correct any obvious errors and omissions before they are used to inform the analysis in the report itself.

With a new approach such as environmental accounting, there is no substitute for on-ground experience. To borrow Nike's slogan: "Just do it!™"

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5.7 | Endnotes

1 One of the few examples of account use in decision making in Australia concerned the use of water accounts in economic modeling to weigh up policies to recover water and reduce consumption. For more information, see the WAVES policy brief, "Australia's Water Accounts Inform Policy to Tackle Impact of Drought," http://www.wavespartnership.org/sites/waves/files/kc/NCAinAction_AustraliaWater.pdf.
2 For a discussion of possible reasons for the limited use of environmental accounts in decision making to date, see Vardon, Burnett, and Dovers (2016).
3 The details of this paper are in Smith et al. (2017).

6 | Natural Capital Accounting for State of the Environment Reporting in the Australian Capital Territory

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Summary

This paper discusses the initiative of the Office of the Commissioner for Sustainability and the Environment (OCSE) in the Canberra region (Australian Capital Territory, ACT) to develop and apply natural capital accounting (NCA) to the content, analysis, and recommendations of a forthcoming statutory State of the Environment (SoE) report (2019). The accounts have been developed using the international System of Environmental-Economic Accounts (SEEA), including experimental ecosystem accounting (EEA).

The primary reason that OCSE embarked on this reporting initiative was to add rigor, transparency, and authority to its work as it informs the recommendations that the OCSE makes in SoE reporting. These recommendations are tabled in the ACT Legislative Assembly, and a response from government is required. Environmental accounts can be a powerful mechanism for better policy outcomes by providing regular, consistent, and authoritative information that can be combined with the obligations of the OCSE.

This report describes the context and process of integrating NCA into SoE reporting. SoE indicators have been mapped against relevant accounts. Attachment 1 shows the first draft of this mapping exercise. In parallel with accounts production, work is ongoing to establish the commonalities and links between the accounts and ACT's key policy documents, which include the Nature Conservation Strategy (2013), the Planning Strategy (2012), and the Waste Management Strategy (2011). These strategies guide management decisions relating to the areas covered by the ACT SoE report including waste, transport, air quality, climate change, heritage, land, biodiversity, and water. Work has started to identify decoupling possibilities, trade-offs, and hotspots. To assist NCA project development, a manual will be developed for government, the community, and nongovernment organizations.

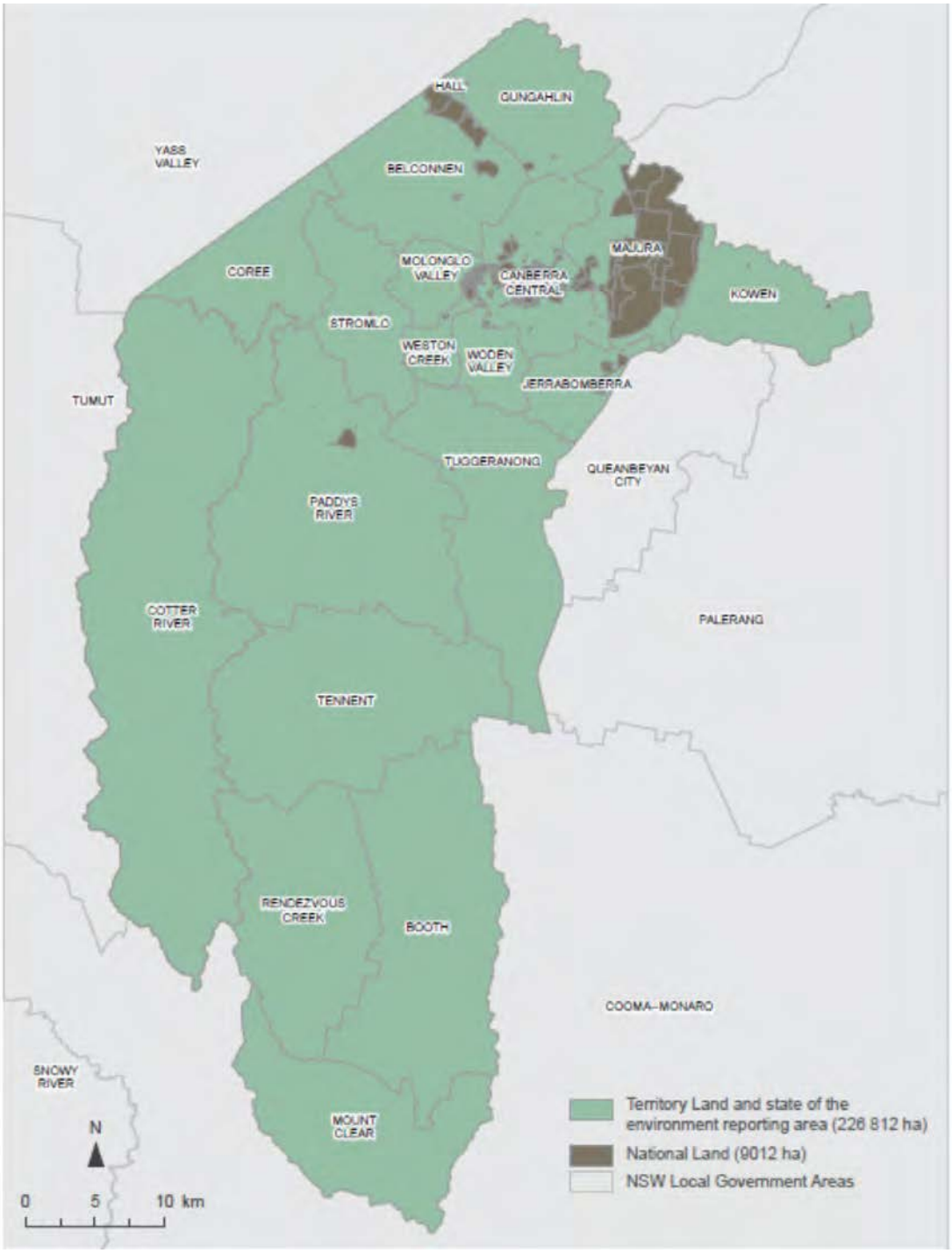
A first draft of the accounts, including information on land, water, energy, waste, and biodiversity, will be prepared by August 2017 for discussion with a range of stakeholders. In undertaking this work, the OCSE has drawn on the environmental accounting expertise of the Australian National University (ANU). The OCSE has been guided by the innovative work of the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) policy forum and an OCSE officer has attended the ANU environmental accounting course, originally designed for the WAVES program, and run in conjunction with the Australian Bureau of Statistics (ABS).

6.1 | Introduction

6.1.1 | Background

Canberra's people value its "bush capital" status. Approximately 56 percent of the ACT land area is protected under the National Reserve System (NRS). The extent of this natural capital provides a great opportunity to consider the application of an NCA framework to better inform policy. However, the picture is complex, with a variety of land covers and land uses in the ACT, and a population dependent on a range of imports from other Australian jurisdictions and the rest of the world.

Figure 6.1: The Australian Capital Territory

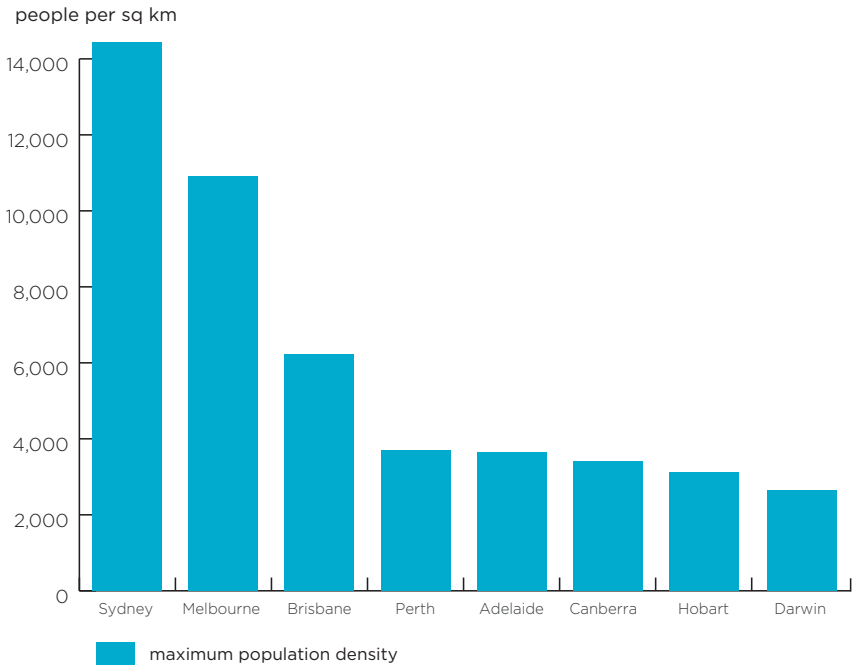


Source: ACT State of the Environment Report 2015 http://reports.envcomm.act.gov.au/actsoe2015/the-report/index.html.

The population of the ACT is 394,675. International comparisons of density are not favorable to Australian cities generally (Cloader 2015). On an analysis of population-weighted density, Canberra was calculated to have a ratio of 16 persons per hectare.

By national standards, Canberra is a low-density city (see figure 6.2, ABS [2015a]) with attendant environmental sustainability issues. For example, the ecological footprint of Canberrans is the highest of any Australian subnational government and much higher than many similar international land masses. It is a startling 8.9 hectares per person (ISARG 2015). Without significant policy intervention, this ecological footprint will continue to grow with the population.

Figure 6.2: Maximum population densities for all Australian capital cities



Source: ABS (2015a).

Canberra's population is expected to reach 500,000 by 2034 (Stewart 2014) and 600,000 by the 2040s (Barr 2015). A culture of greenfields development presents ongoing sustainability issues. While the ACT will meet its ambitious targets of 100 percent renewable energy target by 2020, it is recognized that transport and waste goals will stretch its capacity to deliver on sustainable goals (Minister's Report 2015/16).

It is critical that the ACT SoE report informs the policy decisions needed to support the environmental and socioeconomic sustainability of population growth and development pressures.

It is envisaged that the environmental accounts the OCSE is developing will provide a key tool for regularly "evaluating the adequacy and effectiveness of environmental management" in the ACT as outlined in the OCSE Act of 1993.

6.1.2 | The State of the Environment report and role of the OCSE

The OCSE is located in Canberra in the ACT. OCSE is an independent statutory body, established by the ACT government. Established by legislation in 1993, the OCSE reports on and makes recommendations for the ACT's environment.

The ACT SoE report must include the following:

1. An assessment of the condition of the environment, including an assessment of any of the following matters:
   i. the components of the earth, including soil, the atmosphere, and water
   ii. any organic or inorganic matter and any living organism
   iii. human made or modified structures and areas
   iv. ecosystems and their constituent parts, including people and communities
   v. the qualities and characteristics of places and areas that contribute to their biological diversity and ecological integrity, scientific value, and amenity
   vi. the interactions and interdependencies within and among the organizations, areas, and items mentioned in subparagraphs (i) to (v)
   vii. the social, aesthetic, cultural, and economic conditions that affect or are affected by the organizations, areas, and items mentioned in subparagraphs (i) to (v)

2. An evaluation of the adequacy and effectiveness of environmental management, including an assessment about the degree of compliance with national environment protection measures set forth by the National Environment Protection Council

The parliament in the ACT is required by legislation to respond to SoE report recommendations (Commissioner for Sustainability and the Environment Act 1993). The remit is wide, and the staff is small. SoE reports are produced every four years.

6.2 | The value of environmental accounts for SoE reporting

SoE reports were previously based on the DPSIR (drivers, pressures, state, impacts, and responses) model—the precursor of which was the pressure-state-response model. Contemporary SoE reporting is required to rigorously cover complex interactions to produce analysis that assists in policy development. A range of environmental reporting now recognizes the need for a reconsideration of the DPSIR model to enable reporting to better address increasing complexity, one reason being that DPSIR models may produce biased reporting outcomes that promote linear causal chains for inherently complex systems (Carr 2007). It is also claimed the DPSIR downplays "social diversity and local responses" (Carr 2007, 2010; Ness et al. 2010). Further, the simplicity of the DPSIR model may be unhelpful (Maxim, Spangenberg, and O'Connor 2009; Svarstad et al. 2007) and would be more useful if updated (Gari, Newton, and Icely 2015).

6.3 | Benefits of adopting an accounting methodology for the OCSE and ANU

Natural capital accounts, following the SEEA methodology, have been produced in Australia for the last two decades (Environmentcommissioner.act.gov.au, 2017). The Australian Bureau of Statistics (ABS) has been producing environmental asset accounts as part of the national balance sheet since 1996 (Obst and Vardon 2014) and has produced the Australian environmental-economic accounts annually since 2012 (for example, ABS 2014).

Since 2013, a number of environmental and experimental ecosystem accounts, based on the SEEA, have also been developed in Victoria (Varcoe, Betts O'Shea, and Contreras 2015; Eigenraam, Chua, and Hasker 2013; Keith et al. 2016) and for the Great Barrier Reef in Queensland (ABS 2015b).

Analysis of the environmental accounting efforts undertaken to date demonstrate that there are multiple advantages to using the accounts in reporting contexts. They include the following:

1. *Identification of existing data (and data gaps)*
2. *Consistency*—Of data, by conforming to an international standard (the SEEA)
3. *Continuity*—The capacity to generate reports at any desired interval (for example, annually)
4. *Scalability*—With the opportunity to examine impacts at different scales (local through to global)
5. *Comprehensiveness*—By recording transactions, accounts reveal
    - The use and replenishment of environmental resources (flows)
    - The classes of those using and replenishing
    - The corresponding draw-down or replenishment of environmental stocks

For the OCSE, the key benefit is that the accounts produced will form the basis of the ACT's SoE reporting requirements. These requirements are set out in the Commissioner for Sustainability and the Environment Act of 1993. Another benefit for the OCSE is that it will be actively engaging with the data providers in government to generate the accounts. This will encourage a rigorous conversation about the benefits of the accounting and reporting processes. The OCSE will be bringing the community into the discussion, informing it about trade-offs, gaps, and potentially good policy outcomes.

For the ANU, participation in the design and implementation of accounts for government use provides an opportunity to be involved in the practical application of research, as well as publishing of academic papers. It will also enhance the capabilities of the university staff and students, while contributing nationally and internationally to this rapidly developing field.

6.4 | Project process

The OCSE and the ANU, which has been involved in environmental accounting work for a long time, have entered into a collaborative arrangement to develop and present a set of environmental and ecosystem accounts (also referred to as NCA). The OCSE-ANU collaborative accounting project has been developed over a period of 18 months. It has had several key elements, which are described herein, and began with a roundtable discussion at the ANU in April 2015 to discuss potential applications of the accounts and the first draft of the paper "The Accounting Push and Policy Pull" (Vardon, Burnett, and Dovers 2016).

6.4.1 | Studying up

A key step in the process was the SoE reporting manager's attendance at the 2015 "Introduction to Environmental Accounting" course, which was conducted by the ANU and the ABS. This course is designed to assist with the implementation of the SEEA and was originally designed to meet the needs of the WAVES program. Participation in this course and an increased awareness of the extent of the applications of accounting nationally and internationally resulted in internal OCSE discussions about the potential for the application of the accounts to the reporting and policy recommendation process. As an independent office, the OCSE embarked on a scoping exercise that translated into partnership with the ANU.

6.4.2 | Establish the steering committee

OCSE and the ANU established a steering committee to facilitate the collaboration. This brought together a group of scholars and practitioners to discuss the process of account development. Three distinct needs were identified:

- Development of a draft project brief
- The establishment of a working group
- The need for a communications strategy

6.4.3 | Development of a draft project plan

The draft project brief was developed by the OCSE and the ANU and is the result of many iterations. It questions the need to consider changing the reporting methodology, outlines the reasons for undertaking the project, and provides an insight into the recommendations in the previous report. Noting that 7 of the 10 recommendations in the 2015 SoE report explicitly mentioned data, information, monitoring, and reporting of evaluation, the application of an environmental accounting mechanism became an important consideration for linking analysis and policy outcomes.

The project brief invited input from the expert working group to help identify a methodology consistent with the OCSE statutory responsibilities. In particular, OCSE was seeking input on the potential of environmental accounting to assist in several areas:

- Identification of data and information sets and the potential for development of sustainability indicators
- Identification of gaps and deficiencies
- Consider the potential benefits and feasibility through examples or case studies
- Use of spatial biophysical modeling
- Improvements in data collection and access for more integrated management
- Providing consistent and continuous information flow
- The potential to add to the broader digital agenda of the ACT government

6.4.4 | Nationwide workshop to review the project plan

The project brief was submitted to the expert working group for comment and suggestions, and discussed at a full-day workshop in Canberra in August 2016. The organizations represented included the ABS, the Bureau of Meteorology (BOM), Commonwealth Scientific and Industrial Research Organisation (CSIRO), ANU, Adviser to the Commonwealth State of the Environment report, Geosciences Australia, Chief Economist NSW, the lead author of a recent environmental accounting report relevant to Victoria, University of Sydney, and representatives from the Institute for the Development of Environmental-Economic Accounting. Observer status was provided from the federal Department of the Environment and Energy, and the OCSE communications officer attended.

The purpose of this workshop was to:

- Introduce the OCSE, the initiative, and the parameters of the work given statutory requirements;
- Encourage a robust and expert discussion of the risks and opportunities of advancing environmental accounts into the policy discussion through SoE reporting;
- Seek advice regarding account selection;
- Explore the link between indicators and accounts; and
- Consider the application of accounts to SoE reporting and decision making.

6.4.5 | Establishment of working group

Following this workshop, an environmental accounts working group was established. This group mapped the existing SoE indicators against relevant accounts. Attachment 1 shows the first draft of this mapping exercise. The work also involved mapping accounts against extant policy documents to prioritize and focus the development of the environmental accounts framework. This targeted mapping exercise will form the basis for the development and analysis undertaken in the first set of accounts, which the OCSE constructed.

6.4.6 | Use of the Generic Statistical Business Process Model

The Generic Statistical Business Process Model 2013 (GSBPM) will be used to guide the account production process in areas of:

- Data identification,
- Data access and retrieval,
- Account compilation,
- Data quality assessment,
- Data management, and
- The dissemination process.

6.4.7 | Early identification of challenges

Key challenges, which have already been identified as a function of this careful framing and robust assessment of the available material, are the subject of ongoing critical examination and analysis. The issues that the OCSE continues to examine include the selection of metrics and indicators for measuring the condition of ecological communities, such as Yellow Box— Red Gum Grassy Woodland and Natural Temperate Grassland.
There is currently no definitive measure of ecological condition in the ACT—there are a range of possibilities that need to be explored, including habitat hectares (Victorian State Government 2004), econds (Sbrocchi 2013), and biobanking (Office of Environment and Heritage 2014).

6.4.8 | A manual to assist NCA project development

Because this is the first time that accounting is applied to SoE reporting, there is no instruction manual for guidance. To assist the ongoing production of accounts in the ACT, and the more general application of environmental economic accounting to SoE reporting, a manual will be developed. Development of a manual will be one of the outcomes of the expert working group partnership. An accounts manual could assist a range of potential users by informing the:

- Choice of accounts,
- Scope of the accounts,
- Data sources and methods used in account production, and
- Use of the accounts for policy decision making.

6.5 | Alignment with key policy documents

In parallel with account production, the working group is continuing to establish the commonalities and links between the accounts and ACT's key policy documents:

- Nature Conservation Strategy 2013
- Planning Strategy 2012
- Waste Management Strategy, 2011

These strategies guide the management decisions relating to the following areas covered by the ACT SoE report:

- Waste
- Transport
- Air quality
- Climate change
- Heritage
- Land
- Biodiversity
- Water

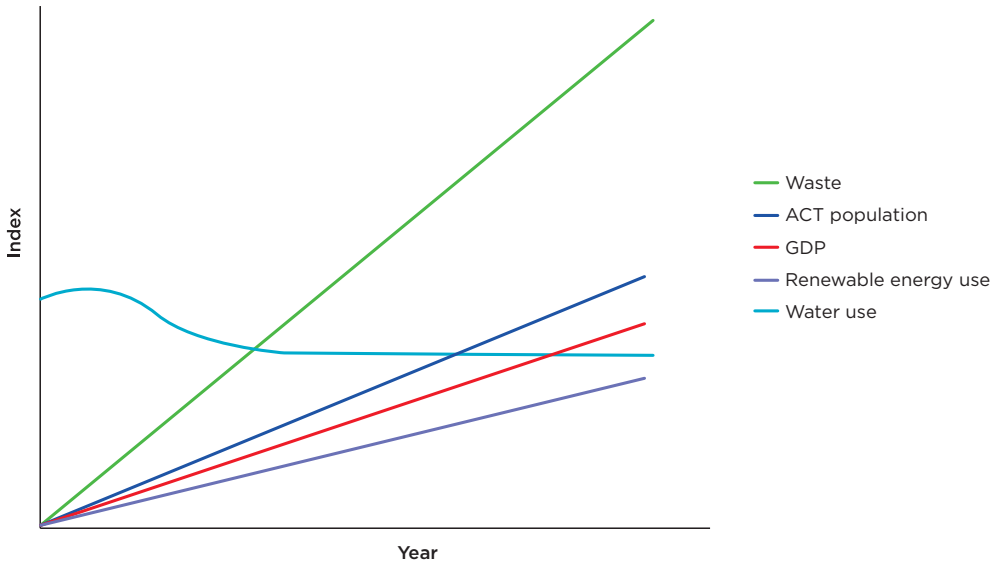
These, in turn, are connected to the environmental accounts that the OCSE is exploring.

6.5.1 | Identification of decoupling possibilities, trade-offs, and hotspots

The work resulting from the collaboration of experts, and in linking the conversation and analysis to current strategies, is critical to establishing the relationship between accounts and policy development, and, ultimately, decision making. By aligning accounts with key policy documents, we began the identification of:

- Areas that can be decoupled (figure 6.3);

Figure 6.3: Decoupling: ACT example trajectories



Source: OCSE.

- Areas where difficult trade-off decisions can be made, for example, in choosing to develop greenfield sites instead of the uptake of urban in-fill opportunities (OCSE 2015); and
- Addressing the question of hotspots, including the ACT's
    - o large ecological footprint,
    - o significant waste production, and
    - o urban development pressures.

6.6 | Communications strategy

The OCSE recognizes the importance of a communications strategy to promote a better understanding of this innovative reporting methodology.

We are witnessing a keen interest in the promotion of communications materials. Tools and infographics have been developed by WAVES and in the United Nations, the European Union, and the United Kingdom. Our interest reflects work underway in international and other science communication settings.

Strategy is being developed to address a number of goals:

- Ensure all stakeholders understand the accounts and the account development process.
- Provide government with rigorous analysis and reporting, with insights about the benefits of using accounts for transparent decision making, and the disadvantages of not doing so.
- Encourage data holders to recognize the importance of this methodology.

- Prepare and publish an SoE report for a broad audience and explain that accounts are not displacing current indicators, but showing data differently and with a renewed emphasis on the value of natural capital.
- Ensure that the accounts illuminate data gaps, and show that they assist in making decisions about monitoring and the use of resources for data collection.
- Explore the use of case studies to demonstrate applications of environmental accounts in policy settings—these case studies will be drawn from government, organizational, and community enterprises; and explore new media and technology to advance the discussion of an environmental accounting methodology.
- Continue to explore communication opportunities with WAVES communications experts.

6.7 | Just doing it!

6.7.1 | Exposure draft 2017

The OCSE has committed to producing an exposure draft of the accounts for SoE report discussions by August 2017. Table 6.1 lists the accounts currently in preparation for each SoE theme.

Table 6.1: Accounts for first exposure draft (August 2017)

Theme	Accounts
Land	Land use Land cover (ACT) Territory plan categories
Air	Greenhouse gas emissions Carbon stocks and carbon sequestration National Environment Protection Measure (NEPM) stardard
Water	Asset Supply Use Condition/quality
Enery	Supply Use
Environmental expenditure	Production of environmental services
Waste	Supply (material generated by industry, government, and households) Use (management, treatment, and disposal)
Experimental ecosystem	Listed threatened species Listed ecological communities Listed pest plants and animals Key ACT species Ecological condition Fire Ecosystems services

Source: OCSE.

Construction of the accounts is an iterative process involving

- Initial design of the account by the working group;
- Consultation with the relevant government managers and data holders regarding the categories and metrics used in the account and data availability;
- Populating a first draft of the account; and
- Obtaining feedback and modifying the account as appropriate.

Processes have been established for account production, as well as for engaging with the relevant stakeholders in government, community, business, and academia. These processes include

- Reviewing the technical components of the accounts through small, sector-specific workshops attended by metadata collectors and users;
- Distributing the first full set of accounts to the (second) expert workshop; and
- Meeting with this group to refine the accounts for public release as an exposure draft.

The accounts will be revised during 2018 and finalized as the basis for the SoE report in 2019.

6.8 | Final remarks

Environmental accounting is complex, and, in some jurisdictions, it is novel:

- Producing local or subnational environmental accounts adds a layer of complexity. Environmental accounting reporting requires a detailed analysis of data sets that have not been developed for that purpose.
- The SEEA methodologies and standards structure the reporting process, but also permit a degree of flexibility that requires careful exploration and analysis.
- The early development of a steering committee of critical friends is an important part of the process, positioning the reporting for expert input and peer review as the work develops.
- A thoughtful and thorough communication strategy is of paramount importance. The audience will include an array of regulators, administrators and the public, with interests in social, economic, environmental and cultural backgrounds, and responsibilities. To add value and carry authority, environmental reporting has to address these different levels of understanding and the needs of this multifaceted audience. Communication needs to respond to this diversity.

6.9 | Acknowledgments

We would like to thank Edwina Robinson for editorial assistance with the paper, Professor Stephen Dovers and Ann Lyons-Wright for their guidance and support in the setup of the project, and the participants of the workshop and working group formed to assist this project.

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Attachment 1: Indicators against tracked changes

Indicator	Account														Residual					
	SNA	Water	Water	Water	Water	Water	Land cover	Land use	Land condition	Ecosystem	Soil	Soil	Energy	Carbon	Air quality	Air emissions		Solid waste	Solid waste	Biodiversity	Non-accounting
		Asset (stock)	Asset condition	Asset (flow)	SUT	Emissions	Cover/eco extent	Use	Condition	Condition	Area	Condition	SUT	stocks		CO_2	Other	Stock	SUT	Species	
Emissions to the airshed																×	×				
Local ambient air quality															?						
Compliance—National Environment Protection Measures (NEPMs)																					×
Climate variability and climate change																					
Mean temperatures																					×
Extreme events																					×
Climate variables																					×
Greenhouse gas emissions														X	×	×					
Population growth and density																					×
Industry growth and consumption	×	×		×	×	×	×	×					×						×		
Consumption patterns and effects (including ecological footprint)	×				×								×						×		
Waste generation and management							×	×	×			×				×		×	×		
Soil condition							×		×		×	×									
Extent and condition of contaminated sites												×									
Development applications																					×
Greenfield versus in-fill development							×	×	×	×											
Water quality																					
Conductivity			×																		
pH			×																		

Indicator	Account															Residual					
Dissolved oxygen			x																		
Turbidity			x																		
Total phosphorous			x																		
Total nitrogen			x																		
Suspended solids			x																		
Faecal coliforms			x																		
Chlorophyll-a			x																		
Groundwater availability		x	x	x	x																
Groundwater quality			x			x				x											
Drinking water quality (includes all indicators per Australian Drinking Water Guidelines)			x		x																
Environmental flow releases					x																
ACT river discharge		x		x																	
AUSRIVAS O: E score			x							x											
Land use pressure (on water)		x	x	x		x	x														
Climate change pressure (on water)		x	x	x	x																
Water resource development		x	x	x	x	x	x	x													
Pest species										x										x	
Altered fire regimes							x		x	x											
Environmental offsets (direct and indirect)	x						x	x	x	x										x	
Number and condition of threatened flora and fauna species							x	x		x										x	
Number and condition of threatened ecological communities							x	x	x	x										x	
Connectivity of native vegetation							x		x	x											
Number and extent of protected areas								x													
Rare and insufficiently known species										x										x	
Climate change pressure (on heritage)																					?
Land-use change pressure (on heritage)								x													
Number of historic heritage places								x													
Number of aboriginal heritage places								x													

Source: OCSE.

7 | Water Accounts and Management in Botswana

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Summary

Botswana is one of the first five WAVES countries and has produced several natural capital accounts, including accounts for minerals, energy, and water. This paper focuses on water accounts and management. Botswana is a water-scarce country, and ensuring its efficient allocation and use is recognized at the highest levels of government as essential for sustainable development. Three water accounts have been produced so far, and they are informing the development of national water strategies and planning. In addition, water accounts are being investigated as potential tools for community-level catchment management and to assist land-use planning. Water accounting has been institutionalized, and the accounts will improve over time. Botswana is ready and able to contribute to African and global initiatives aimed at establishing communities of practice that will further the development of water accounts and their application in water management and planning.

7.1 | Introduction

Water is a major driver of economic growth and has been found to be the number one factor limiting development (Honorable Onkokame Mokaila, 2014 Water Pitso).[1] The 2017 Botswana budget speech stated that:

> *As one of the national priorities, sustainable use of national resources is part of a broader principle of sustainable development, which has been the hallmark of this country's development strategy. To achieve sustainable development, which entails expanding the economic base without sacrificing the environment, the country has been focusing on two broad areas of environmental protection and sustainable management of natural resources. A number of initiatives in these areas were undertaken during NDP[2] 10 and will continue going forward. A notable initiative is the Wealth Accounting and Valuation of Ecosystems Services (WAVES) programme whose main objective is to take stock of available natural resources and provide economic indicators for their use or depletion.*[3]

This message is backed up by the Honorable Minister of Land Management, Water and Sanitation Services, Prince Maele, Member of Parliament, who said when officially opening the 17th WaterNet/WARFSA/GWP-SA symposium on October 26, 2016:

> *My ministry is implementing a project on Water Accounting under the Wealth Accounting and Valuation of Ecosystems Services (WAVES) partnership program. With population growth, increasing demand for water, decline in available fresh water, there is a need to account for every drop of water that is available in the country.*[4]

The water sector has significantly benefited from the World Bank WAVES project, which has culminated in the formation of a Water Accounting Unit within the Department of Water Affairs (DWA). This is a major milestone for the institutionalization of water accounting within Botswana, following on the production of three water accounts and demonstrating an ongoing commitment to the production of the accounts. The main objective of the water accounting process in Botswana is to generate more credible information on natural capital for use in planning, policy, and decision making.

In addition to the three water accounts, key achievements included the production of four policy briefs, with data and supporting analysis made highly accessible to stakeholders and the public via the DWA website. The accounts are proving to be an important tool to assist and guide issues of water allocation efficiency and monitoring of compliance with safe water yields, as well as to create links with sustainable development goals and improve decision making.

In general, the water accounts enabled the identification of places and times of water scarcity and to better understand the economic importance of water to different industries. For example, water was shown to be important for the agriculture, mining, and energy production industries.

The water accounts in Botswana have also been used as a focal point for engagement with stakeholders. Feedback from the water accounts sensitization seminars indicated the information was of great value. In one case, stakeholder feedback highlighted the need to consider wildlife water use in water management. This led to an investigation that revealed wildlife to be a significant water user, accounting for approximately 10 percent of Botswana's previously estimated water consumption. The results of this investigation were presented to the London Group on Environmental Accounting,[5] with the suggestion that wildlife be considered in future water accounts, and a paper on the findings has been submitted to a journal.

7.2 | Institutional arrangements

The aim of natural capital accounting (NCA) in Botswana is to assist policy and planning in the central government. The secretariat of the WAVES program was deliberately based at the Ministry of Finance and Development Planning to support this goal. This ministry is responsible for coordinating all national development plans (NDPs) and a special unit (the NCA Unit) was established within the ministry to coordinate all accounting activity and ensure it meets government needs.

NCA implementation activities were carried out at the sectoral level by the Ministry of Minerals Resources, the Ministry of Green Technology and Energy Security, the Ministry of Land Management Water and Sanitation Services, and the Ministry of Environment Natural Resources Conversation and Tourism. These ministries developed natural capital accounts for water, minerals, energy, tourism, and macroeconomic indicators of sustainable development. The NCA Units in the implementing sectors are responsible for the actual development of the accounts. The deputy permanent secretaries within the relevant ministries chair the multisectoral technical working groups (TWGs), which assist in the timely supply of relevant data and provide technical input in the analysis of the results generated by various component accounts. The DWA's Water Accounting Unit was responsible for the production of the water accounts.

7.3 | Content of water accounts

The Botswana water accounts are a strategic-level document that provide credible and high-resolution data that are required for water resources management. Three water accounts have been produced covering four years (2010–11 to 2014–15) and all are on the DWA website.[6] The accounts provide the following information:

1. Total movement of water between the environment and the economy
    a. Water abstracted from the environment by each economic sector as well as water use and water consumption by each economic sector
    b. Distribution of water by the Water Utilities Corporation (WUC) and other water suppliers to other economic sectors

   c. Return flows into the environment by each economic sector (quantity and quality of water returned)
2. Total available stocks of water within the country
   a. Total inflows, abstraction, evapotranspiration, and closing volumes for Botswana's major dams; compliance to abstraction safe yields by WUC and other water suppliers
   b. Total flows, abstraction, and discharges into our shared rivers
   c. Total recharge rates, abstractions, and closing volumes for well-fields; compliance to abstraction safe yields by WUC, mining companies, and Botswana Power Corporation (BPC)
3. Monitoring of water use trends and projections for the future, especially with respect to growing demand
4. Monetary data and value-added link to national accounts
   a. Total operation and maintenance costs and capital expenditure on water by all economic sectors
   b. Total employment against water use by each economic sector
   c. Total gross domestic product (GDP) contribution against water use by each economic sector
5. The value of water as a natural resource and implications for achieving Sustainable Development Goals (SDGs) number 6 for Indicators: **6.4.1** Change in water use efficiency over time and **6.4.2** Level of water stress: freshwater withdrawal in percentage of available freshwater resources.
6. Quantification of waste water and its use

The water accounts in Botswana will become even more relevant with the upcoming planned improvements. These include the collecting better agriculture data by undertaking irrigation surveys, using better data and techniques to estimate livestock numbers, and including consideration of wildlife water use. Measures have been put in place to collaborate with the Botswana University of Agriculture and Natural Resources (BUAN) for the collection and analysis of irrigation data to assess the costs and benefits of expanding irrigation.

Through case studies of households not connected to water supply network, the accounts will also tackle issues of water access. The development of a comprehensive water balance or water asset account for Botswana will require development of groundwater asset accounts to compliment dam/reservoir stock accounts.

The DWA's Water Accounting Unit has been mandated to be the data center for all water data indicators and provide the links to SDG goal 6. The data on operation, maintenance, and capital costs within the water sector enable analysis on the planning of the development and maintenance of water supply infrastructure. This was highlighted by the DWA's Deputy Permanent Secretary, Dr. O. T. Obakeng, at the WaterNet Symposium in October 2016.

> *The main objective of the water accounting process is to generate more credible information on natural capital for informed planning and policy decision making. The accounts are deemed to be a critical tool to assist and guide in issues of water allocation efficiency, monitoring of compliance to safe yields, create linkages with sustainable development goals and better decision making. The water accounts enable assessing water scarcity, to better assess the availability, uses, and economic contribution of water.*[7]"

7.4 | Achievements in influencing policy or policy-related projects

In addition to the water accounts, four policy briefs have also been produced. These can be found on the WAVES Knowledge Platform[8] and cover water accounts summary results, water and agriculture, water and mining, and water and irrigation.

The water accounts and associated case studies have provided a range of credible data that have been used in several strategies, planning, and water management projects:

- National Spatial Plan for Botswana 2036
- National Water Master Plan (NWMP) Review
- Botswana National Water Conservation and Water Demand Management Strategy 2016–21
- The raw water abstraction strategy project
- Development of catchment management communities
- Botswana Integrated Water Resources Management & Water Efficiency Plan (IWRM-WE)

The National Spatial Plan for Botswana 2036 is led by the Ministry of Lands and Housing—Department of Town and Regional Planning (DTRP). The existing water accounts were enhanced through GIS processing to show total water use within the country as well as water consumption by livestock. These data have been used in the NSP project to show areas of water scarcity and to guide regional development (for example, industries that use large amounts of water should not be located in water-scarce areas).

The Botswana National Water Conservation and Water Demand Management Strategy 2016–21 is scheduled for release in mid-2017. Data on water use efficiency were taken from the water accounts for use in the strategy. Key messages from the accounts, like increasing utilization of effluent water, have been advanced in the strategy.

The Botswana NWMP was last reviewed in 2006, and one of the recommendations was for the establishment of a natural resource accounting (NRA) unit responsible for water. The review for the NWMP is currently at the terms of reference stage, and the accounts are being used to guide issues like per-capita water consumption and the economic cost of supplying water.

The raw water abstraction strategy project is a joint Stockholm International Water Institute (SIWI) and DWA project that looks at total raw water abstracted and the economic sectors abstracting the raw water and analyzes the price paid for the raw water. In some cases, the raw water is abstracted free of charge. The water accounts provide data on the amount of water abstracted by economic sectors and the value added per cubic meter for each sector. This information can be used for determining whether the fee structure is fair and whether those currently receiving free water are able to pay for the use of this water.

The development of catchment management committees is also a SIWI and DWA project that aims to develop a community-based strategy for protecting water resources at the catchment scale. The water accounts team has produced a concept paper on the potential of producing regional water accounts to support catchment-level community water management. This paper will be used as the foundation for further stakeholder consultation, formalization of the catchment management strategy, and to guide potential production of water accounts at regional scale in Botswana.

The Botswana Integrated Water Resources Management and Water Efficiency Plan was released in May 2013 and aimed at developing a more integrated solution for water as a driver of human development. The plan integrated all sectors and it is believed that, with appropriate and efficient water resources management, development and utilization, Botswana will be able to deliver adequate agricultural production and expand the number of people with access to water. The plan implicitly addresses the issue of water allocation efficiency, and accurate figures for this can be achieved through water accounting.

Apart for providing important information for government strategies and planning, there were other benefits from the water accounts:

- Establishment of better links among key stakeholders, namely Statistics Botswana, Ministry of Finance and Development Planning (MFDP), the Ministry of Agriculture, the WUC, Botswana Chamber of Mines, and the Ministry of Mining Energy and Water Resources (MMEWR)
- Shared understanding among stakeholders for the need to allocate and utilize water more efficiently
- Closer links with the Integrated Water Resource Management Water and Efficiency Plan[9]
- Better understanding of NCA in general, and water accounting in particular; seminars on water accounting were conducted jointly by the DWA Public Relations Unit and the Water Accounting Unit in all 10 DWA regional offices

The Integrated Water Resource Management Water and Efficiency Plan preceded the water accounts, but it recognized the importance of water accounting as a tool to monitor water allocation efficiency. The plan states that poorly managed and monitored water resources pose a big challenge to the development and protection of the environment. The combined sustainable yield from currently developed wellfields and dams is less than the projected near-term demand for Botswana.

7.5 | Community of practice for water accounting in Africa

Establishing regional collaborations will enhance the ability of countries in Africa to develop and use water accounting. Botswana has already benefited from hosting a delegation from Rwanda. To host the Rwanda delegation, the processes of account production and use in Botswana had to be systematically assembled and communicated. The Water Accounting Unit continues to informally discuss and assist colleagues from Rwanda on issues of data and coding of different industries.

We support establishment of a community of practice (COP) on water accounting to assist in the learning and sharing of approaches, experiences, and best practices among the countries. This can be done via south-south exchanges, dialogue between practitioners and decision makers on uses of water accounting and training opportunities, including both technical practitioners (account producers and analysts) and decision makers (account users).

Water accounting is closely aligned to IWRM and can assist in water allocation strategies for transnational river basin organizations, such as the Zambezi. Although this application is yet to be fully explored, it is an obvious area for further investigation by the COP.

Ideally, the COP should be coordinated by central regional body, for example, WaterNet, Gaborone Declaration for Sustainability in Africa (GDSA), or the World Bank WAVES regional activity. All should be aligned and the COP could efficiently assist all participating countries in developing roadmaps for water accounting with links to national priorities and identify a focal person for coordination.

7.6 | Final remarks

The water accounts in Botswana can play a role in sustainable water management. The accounts provide a national platform of credible data on water in the environment and the economy and have been used in national strategies and planning. Further uses at regional levels and for particular industries (for example, agriculture and wildlife tourism) are also being investigated.

The Hague Policy Forum on Natural Capital Accounting for Better Decision Making showed additional uses, such as indicators for climate change, sustainable development goals, and valuation of water that are yet to be fully explored in Botswana. An important area for Botswana and the NCA community in general is to produce messages from complex data that make sense to policy makers and analysts.

7.7 | Acknowledgments

The authors would like to thank WAVES World Bank for assistance with the development NCA and Botswana and for enabling O. B. Pule to participate in the November 2016 Policy Forum in The Hague. We would also like to thank Michael Vardon for comments on a draft version of this paper and for his guidance to the Water Accounting Unit whenever expert knowledge on NCA is needed.

7.8 | Endnotes

1 http://www.water.gov.bw/images/Water%20Pitso/waterpitso2014.pdf.
2 National Development Plan.
3 http://www.gov.bw/contentassets/95fd057dbf2b4f54801841329125487b/2017-budget-speech_final_-3february_2017.pdf.
4 http://www.waternetonline.org/articles/2016/10/26/17th-waternet-warfsa-gwpsa-symposium-official-openning.
5 https://unstats.un.org/unsd/envaccounting/londongroup/meeting22/BK_1.pdf.
6 http://www.water.gov.bw/downloads.html.
7 http://www.waternetonline.org/articles/2016/10/26/17th-waternet-warfsa-gwpsa-symposium-official-openning.
8 http://www.wavespartnership.org/knowledge-center.
9 http://www.water.gov.bw/images/Reports/IWRM%20WE%20Report%20Vol%201July%202013%20(Web-Optimised).pdf.

8 | The Use of Natural Capital Accounts in the Design of Public Policy in Colombia

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Summary

This paper discusses how the Colombian natural capital accounts provide useful inputs for public policy making in Colombia. The government's initiative to use the natural capital accounts as an input to make informed decisions and generate new knowledge that supports environmental policy has been gaining acceptance in recent years. This paper shows how Colombia's forest and water accounts have been used to monitor the effects of economic changes to natural capital. The accounts have been used to assess the environmental cost of the el Niño phenomenon in 2015, to quantify the environmental benefits to be gained by Colombia in a peacetime scenario, and to provide arguments to increase water use fees. While the use of natural capital accounting (NCA) is limited, its contributions to preserving, mitigating, and protecting the environment are huge, and there are ample opportunities to exploit them even further.

8.1 | Introduction

The National Planning Department (DNP), created by Law 19 in 1958, is a technical advisory body to the Colombian national government. It oversees the design and control of policies for the economic, social, and environmental development of the country, in coordination with ministries and local authorities. During 2014–18, the DNP produced the National Development Plan, "All for a New Country," which arranges Colombia's green growth strategy for sustainable and competitive development. This approach pursues long-term economic and social welfare as well as the protection and sustainable use of natural capital. For this, the National Development Plan has set three objectives: (1) to shift toward sustainable and low-carbon growth, (2) to protect and ensure sustainable use of natural capital and improve environmental quality, and (3) to achieve resilient growth and reduce vulnerability to disaster risks and climate change. For these objectives, goals and indicators have been formulated to monitor their progress.

Measuring Colombia's environmental assets will help identify whether human activities related to economic growth are environmentally friendly or, by contrast, are degrading the ecosystems and destroying the natural capital. This is particularly relevant because Colombia ranks second in the world for total biodiversity, after Brazil's Amazonian region, and is at the top of the list for the number of bird species and water resources. In 2015, the national government made stated as a key issue the use of environmental indicators to follow up the country's green growth strategy, which is part of Colombia's commitment to gain access to the Organisation for Economic Co-operation and Development (OECD). For this, indicators of the availability, depletion, productivity, and pollution of the country's assets should be developed. NCA is the tool to quantify the change in stocks of natural assets (DANE 2012) and provide the information to develop such indicators. In fact, those accounts "*measure [in the country] the effort of different economic sectors to preserve, mitigate, or protect the environment*" (DANE 2012).

NCA also provides detailed statistics for better management of inputs, like water or energy, in the economy. As such, the accounts are a planning instrument that bring information to policy makers and enable them to make better decisions (DANE 2012). Moreover, the processing of natural capital data could generate new knowledge that supports environmental policy at all levels, or help answer questions during the design or adjustment of public policies.

As part of the development of its NCA, Colombia was one of the first five countries interested in joining the WAVES Partnership. The WAVES National Steering Committee (NSC) and the WAVES National Technical Committee (NTC), which was organized in 2012, led the initiative process in Colombia. Both committees were made up of public staff of different levels from all the institutions involved in the environmental accounts process as producers and/or users. The fact that the committees are composed of personnel from public institutions promotes the use of NCA in decision making and policy creation.

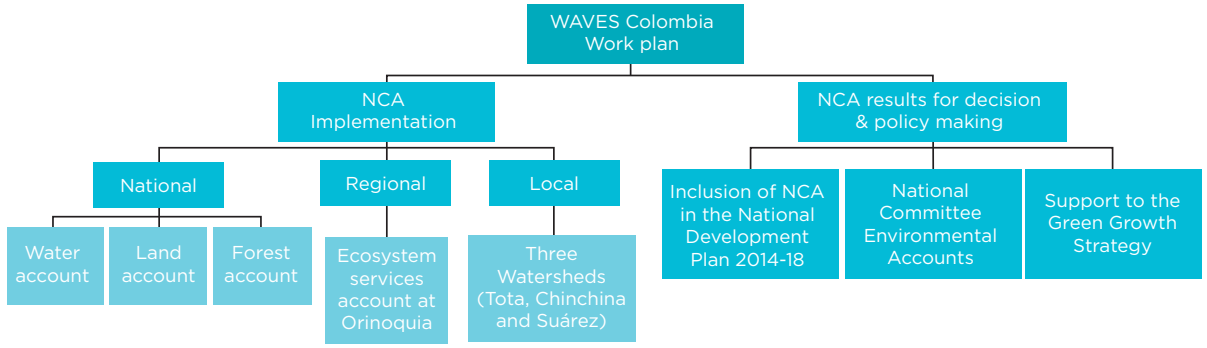
During the first phase of the WAVES Partnership, which started in 2011, results showed that rather than focusing on the technical development of environmental accounts, in which the country was relatively strong, WAVES´s support was more useful in closing the gaps between the production of environmental accounts and their use for priority decision-making processes, without leaving aside some technical implementation where gaps were found such as in forest and water accounting (WAVES 2016).

The implementation of the second phase officially began in July 2014, after the NSC gathered in June that same year and approved the main components of the WAVES work plan (figure 8.1). In the beginning, WAVES work in Colombia was focused on developing NCA for two pilot watersheds (Tota Lake and Chinchiná). Nevertheless, it turned out that the necessary information for the construction of national-level accounts was already available. Therefore, work on national forest accounts began in June 2014 and for national water accounts in 2015.

Additionally, work on ecosystem services accounts at the level of the Orinoquia River macro basin started in mid-2015. The NSC identified that, based on the current land cover and land use data for Colombia, it was possible to elaborate a national land asset account. A baseline scenario for the accounting was also developed for the Alto Suarez watershed. The two watersheds where chosen for NCA because of their relevance to national-level policies as well as local-level management issues.

Using NCA in planning, monitoring, management, and use of natural capital enables the design of macroeconomic indicators and strengthens institutional capacities in relation to their competencies and roles within the WAVES initiative framework and the Environmental Accounts National Committee (as stated in the National Development Plan 2014–18).

Figure 8.1: WAVES Colombia work plan, 2014–16



Source: WAVES (2016).

In June 2014, the general WAVES work plan was updated to include three main components, each one of them with a public policy priority, and with the main products to be achieved by the NCA related to these policies (table 8.1).

Table 8.1: Components of Colombia WAVES initiative and main products

Component	Public policy priority	Main products achieved*
Technical component of accounts	Promote protection and efficient management of water resources	Water accounts for two watersheds Water accounts at national level
	Promote conservation and sustainable use of ecosystems and their vegetation cover	Forest for two watersheds Forest account at national level Ecosystems services account at regional level
Public policy influence	Guaranteed use of environmental accounts for government tracking, management, and sustainable use of natural capital.	Preparation of road map 2020 for NCA
Institutional management	Strengthen institutions in regard to their competencies and roles within the WAVES initiative	Communications strategy and dissemination of results, coordination, and monitoring

Source: WAVES (2016).

The construction of natural capital accounts, the results already published, and the cross-institutional agreements have provided the analytical space for such accounts to inform recent policy priorities. There are many current uses of NCA at the national levels:

- *Lake Tota management*—Providing indicators for the Council of the National Economic and Social Policy (CONPES)[1] policy document, in addition to the beneficiary support and analysis for the design of a future payment for environmental services (PES) scheme
- *Chinchiná management*—Providing indicators for the Watershed Use and Management Plans (POMCA)
- *Green Growth Strategy*—Specific proposal from the DNP regarding indicators based on the accounts
- *Timber exploitation fee adjustment*—Used by Ministry of Environment, Housing, and Territorial Development (MADS) to analyze differences between administrative registers of timber use coming from regional environmental authorities, and the account at a national level
- *Peace dividends*—Impact on environment
- *Analysis*—Of the economic impacts of the water use fee (DNP and MADS)

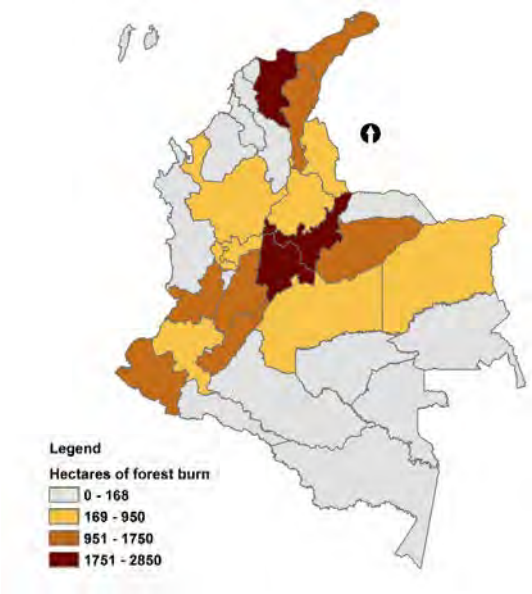
- *Green growth viewpoint*—Included in Colombia´s last National Development Plan (2014–18), therefore inclusion of NCA
- *Construction of accounts*—To strengthen Colombia's capacity for monitoring and evaluating its natural capital

The following sections give a few examples of how NCA has helped public decision making in Colombia. The forest and water accounts have been used to assess the environmental cost of the el Niño phenomenon in 2015, to quantify the environmental benefits to be gained by Colombia in a peacetime scenario, and to provide arguments to increase water use fees.

8.2 | NCA for analyzing el Niño

The el Niño assessment by the DNP in 2016 was based on information from the natural capital accounts. Colombia is highly vulnerable to hydroclimatic events and had, in fact, recently suffered from a natural disaster. The DNP estimated the economic cost of the forest fires caused by el Niño in 2015 in forest areas. Using the data of the Disaster Risk Management National Unit (UNGRD), the assessment shows that approximately 120,000 hectares were affected by el Niño (DNP 2016b). It also found that 19.5 percent of the total area affected corresponded to forest hectares. Figure 8.2 illustrates the departments where the loss of forest occurred and its intensity level. The departments with the greatest damage were located in the central eastern, Caribbean, and Pacific regions.

Figure 8.2: Hectares of forest burned, by department



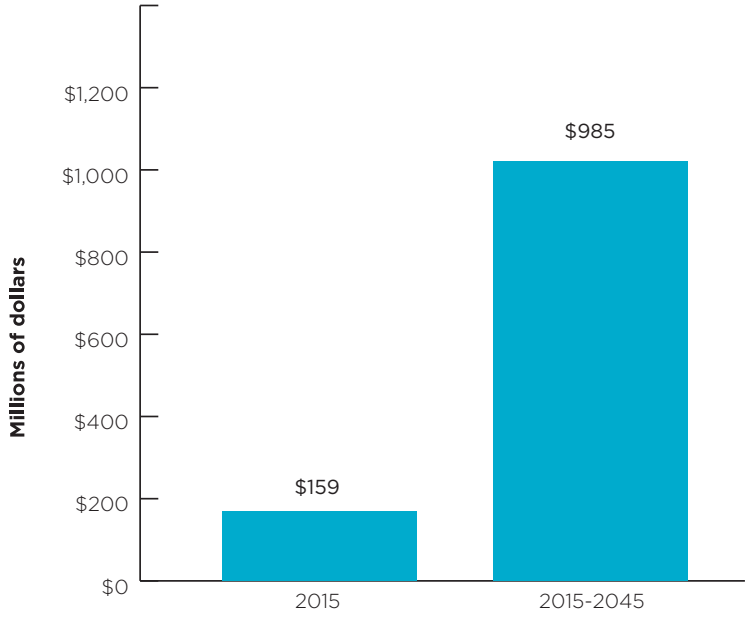
Source: DNP (2016b).

The economic cost of the forest fires was calculated, including estimations for the value of ecosystem services[2] that the forest would consequently stop providing in the future, including wood. Using a bottom-up approach, the economic cost was first estimated for municipalities, which were then aggregated to find the national cost.

Colombia's monetary loss due to el Niño was calculated based on this information from the national forest accounts and the value of the ecosystem services. The results show that, taking into account forest fires only, Colombia lost approximately US$160 million in 2015, or 0.063 percent of its GDP due to el Niño. Loss of wood supply accounted for 35 percent of this economic loss, and the remaining 65 percent was related to the economic

loss of other ecosystem services. The total economic costs for the Colombian economy are much higher, as it takes roughly 30 years for these ecosystems to recover. During this period, these annual losses only gradually reduce. The net present value of costs for 2015–45 is approximately US$985 million (figure 8.3).

Figure 8.3: Economic costs of el Niño



Source: Authors' elaboration.

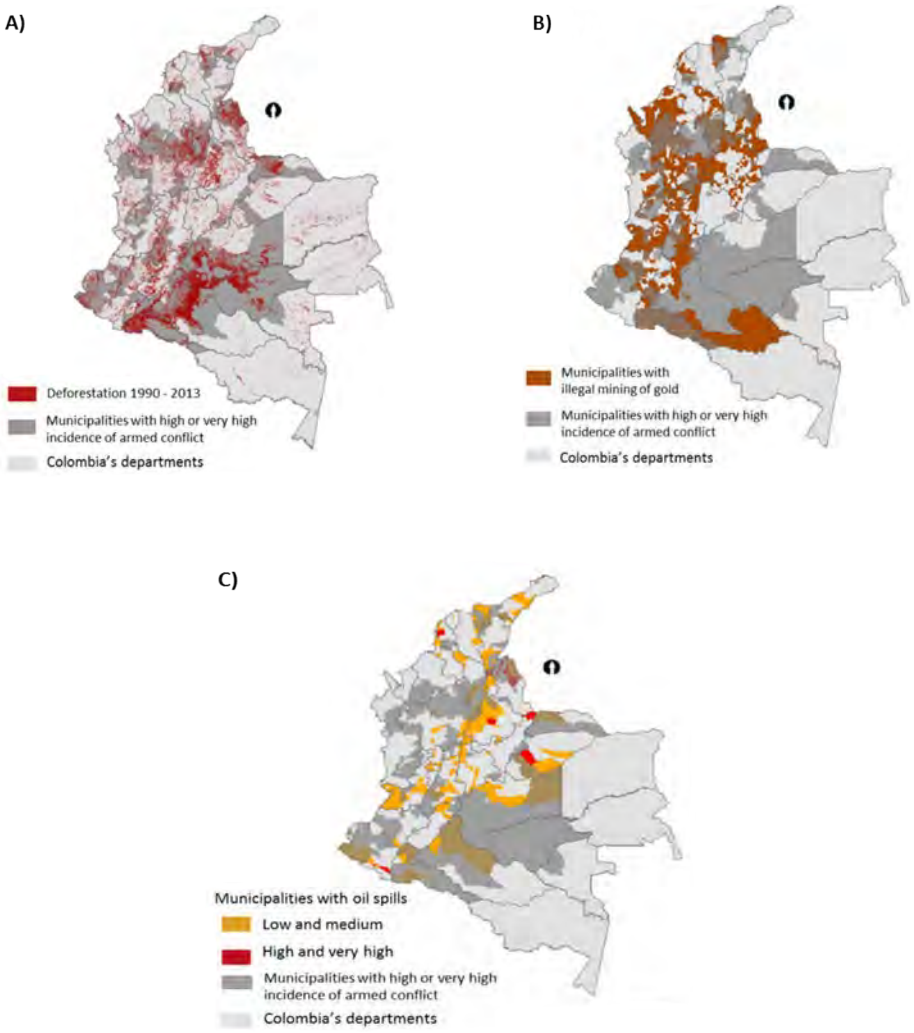
The findings of this assessment were given tremendous coverage on the media. Both the DNP and the national and regional media published news regarding the economic costs of el Niño. Consequently, local governments received information that enabled them to prioritize policies for climate risk management and include this topic in their development plan and their local projects.

8.3 | NCA for analyzing the peace dividend

Another public concern assessed by using the national forest accounts was the environmental benefits to be gained by Colombia in a peacetime scenario (Calderón et al. 2016). Before the peace agreement was signed, the DNP estimated the "peace environmental dividends." These dividends reflected the reduction in the environmental costs that would occur if armed conflict ended.

The armed conflict in Colombia has had not only economic and social consequences, but also environmental impacts. The annual deforestation rate is three times higher in conflict municipalities compared to the rest of country. Therefore, while the deforestation rate is 6.5 hectares for each 1,000 hectares in conflict municipalities, it is just 2.6 hectares in the other municipalities (figure 8.4a). Illegal gold mining also occurs in territories with armed groups (figure 8.4b). The environmental degradation related to mining is due to the use of mercury, which pollutes the river basins. In Colombia, illegal gold mining uses around 75 tons of mercury per year. Furthermore, the attacks on fossil fuel transport infrastructure have spilled 4.1 million barrels of oil in the last 35 years (figure 8.4c).

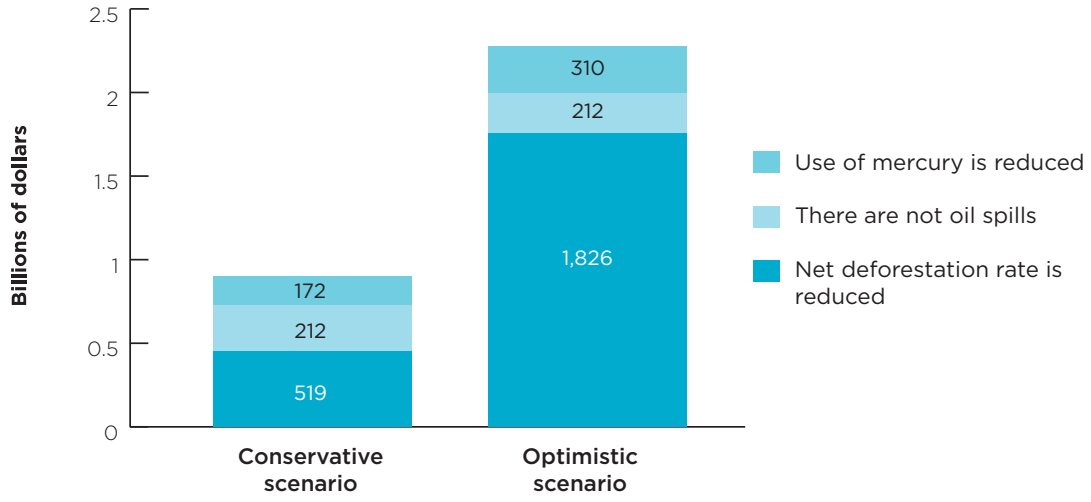
Figure 8.4: The impact of armed conflict on the environment



Source: Calderon et al. (2016).

We estimated the costs that society would no longer have to pay in a peace scenario, using the "avoided cost methodology." This methodology does not measure the environmental benefits of peace, but the costs potentially avoided from deforestation, illegal mining, and oil spills that are caused by the armed conflict. The environmental costs avoided included in the estimations are related to the recovering of hectares deforested, the value of CO_2 emissions avoided, the loss of forest, the costs of cleaning the soil and water, the costs in health due to the use of mercury, and the loss of oil and ecosystem services. Under this approach, two scenarios were generated: one conservative and one optimistic. The conservative scenario assumes that the municipalities in conflict zones will have a deforestation rate equal to the zones without conflict (2.6 hectares per 1,000 hectares), there will be no oil spills, and the use of mercury will be reduced to the Latin American average (33 tons per year). On the other hand, the optimistic scenario supposes that the municipalities in conflict zones will reduce their deforestation rate to zero, there will be no oil spills, and there will be no use of mercury. While in a conservative scenario the dividends would be around $903 million, in an optimistic scenario, the country could save approximately $2.4 billion in ecosystem services. Figure 8.5 shows the separate gains to be made by Colombia choosing peace.

Figure 8.5: Environmental dividends of peace under conservative and optimistic scenarios



Source: Authors' elaboration, based on Calderon et al. (2016).

In 2016, the DNP director disclosed the results of this analysis in a high-level event organized by the DNP, the United Nations Development Programme (UNDP), and the Buen Gobierno Foundation. The dividends were presented at a national level and by regions, and the importance of a state presence was emphasized, along with the development of a differentiated strategy for the territories and actions related to environmental restoration, agriculture reconversion, formalization of small-scale mining, the struggle against illegal mining, promotion of biocommerce and green businesses, and others.

8.4 | NCA for water policy

The national accounts have also been used as an input to build tools to analyze the possible effects of changes in water pricing or in water demand on the economy. Specifically, the national water accounts were deployed to build a social accounting matrix of water known as the SAM-Water (Álvarez et al. 2016). This matrix compacts in an easy way the circular flow of money and details the links among sectors, production factors (including water), and economic agents.

To build the SAM-Water, the following sources were used: the traditional SAM, the water accounts data for 2012, the National Study of Water (NSW), and the water use fee (WUF). The traditional SAM of 2012 was adjusted to include three types of water data (intermediate consumption, value added, and final demand) and to break down the agriculture sector by crops. From the national water accounts, water demand from all sectors, except agriculture, was obtained. The water demand from crops was obtained from the NSW, and the WUF figures were used to calculate the water demand.

The SAM-Water is the main input to develop a computable general equilibrium model for water. This last tool assessed how increases in the WUF in Colombia would impact the production level of economic sectors like agriculture-livestock, electricity, mining, industry-commerce, and services. The analysis considered a change of 0.8 Col$/$m^3$ to 3 Col$/$m^3$ for agriculture and of 0.8 Col$/$m^3$ to 10 Col$/$m^3$ in other sectors. The results showed, as expected, reduced production in sectors that consume more water and pay the water use fee. There is also a reallocation of water among sectors. The highest macroeconomic impacts would occur in the agriculture-livestock and electricity sector, with a change of output of -0.12 percent and -0.05 percent, respectively (table 8.2).

Table 8.2: Changes in the output of the different sectors

Sector	Change (%)
Agriculture/livestock	-0.12
Electricity	-0.05
Mining	0.09
Industry/commerce	-0.02
Services	-0.03
Others (use water)	0.04
Others (without information)	-0.02

Source: DNP (2016b).

The results were considered in the policy discussions that took place in 2016 among the different ministries and guilds regarding Colombia's WUF. The Ministry of Environment and Sustainable Development was the public entity that presented these results in the deliberation and decision meetings, given the new macroeconomic point of view.

8.5 | Final remarks

In Colombia, the central government has been the main user and beneficiary of incorporating the value of natural capital into its strategic policy making. Indeed, NCA has enabled policy makers at a central level to make decisions based on evidence, and they now have the arguments and data to find other strategies to protect Colombia's biodiversity.

Paying attention to the value of natural capital also contributes to improving its management and conservation. The recognition of this value, as well as insight into its changes and trends, can lead to better decision making regarding natural resource use in the economy, and in turn lead to better preservation of natural capital. Soon Colombia is going to implement a strategy to pay for ecosystem services. The NCA data will be useful to inform policy makers on the potential effects of such a strategy.

Finally, because policy-making processes require reliable information, using NCA in the environmental field is a convenient option to explore. NCA provides information about energy, forests, water, land, and others. NCA can act as a bridge to identify options that benefit social and economic development and biodiversity conservation. Considering natural capital accounts in the policy-making process will aid in making informed public policy decisions about preserving, mitigating, and protecting the natural capital of Colombia.

8.6 | Acknowledgments

The team especially wishes to thank Milena Niño and Andrea Corrales for their technical support, the editors for their feedback, and NCA forum participants for their comments.

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8.8 | Endnotes

1 The Council of the National Economic and Social Policy "is the highest authority of the national planning and serves as an advisory body to the Government on all matters relating to the economic and social development of the country. To achieve this, coordinates and directs the agencies responsible for the economic and social direction in the Government, through the study and approval of documents on the development of general policies that are presented at the meeting" (DNP 2016a).
2 These ecosystem services include greenhouse gas regulation, climate regulation, disturbance regulation, water regulation, water supply, erosion control and sediment retention, soil formation, nutrient cycling, waste treatment, pollination, biological control, refuge, food production, raw materials, genetic resources, recreation, and cultural services.

9 | Using Water Accounts and Modeling to Help Set Water Prices in Colombia

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Summary

The government of Colombia updated the water use fee (WUF) in 2016. The fee is used to fund the water resources management by national and regional authorities. As part of the decision-making process, the National Planning Department (DNP) built a Social Accounting Matrix (SAM) using the national water accounts to estimate the economic impacts of increasing the minimum fees. The goal was to inform discussions leading to the update of the fee. As expected, analysis showed that the sectors that consume more water pay more fees and would reduce the value of production. However, the analysis also showed the magnitude of the reduction was very low and would result in greater resources for water resource management. The analysis and water accounts were used in discussions leading up to the decision to increase water fees that are now with the president waiting to be signed into law. The experience shows that the accounts, in combination with analytical tools, can have direct input to government decision making. Regular updating of the water accounts will allow ongoing analysis of the impact of WUFs on the economy and facilitate similar modeling exercises in the future.

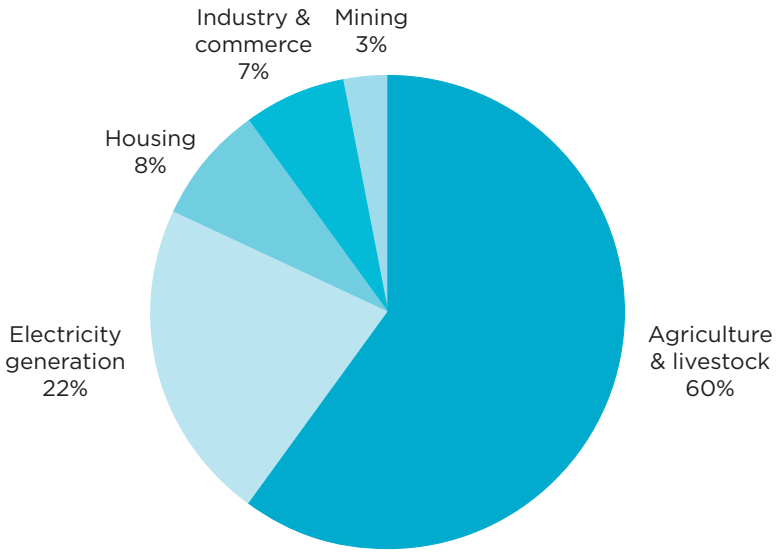
9.1 | Water policy in Colombia

In 2010, Colombia developed "The National Policy for Integrated Water Resource Management" (Política Nacional para la Gestión Integral del Recurso Hídrico, PNGIRH; MADS 2010), which sets the objectives, strategies, goals, indicators, and key actions for the management of water resources. This covers efficient water use as well as the prevention and control of water pollution over a 12-year time horizon. The national water policy was the culmination of a series of initiatives from the Ministry of Environment, Housing and Territorial Development (MAVDT), now the Ministry of Environment and Sustainable Development (MADS). The national water policy established unified guidelines for water management in Colombia, aiming to solve current problems while considering and harmonizing social, economic, and environmental objectives, and to preserve the natural wealth and welfare of future generations of Colombians.

In October 2014, the agencies involved in the Colombia Wealth Accounting and the Valuation of Ecosystem Services (WAVES) initiative agreed to advance the development of the water account at the national level, using the information already available in the national accounts and the environmental accounts produced by the National Administrative Department of Statistics (DANE) and the National Water Study (NWS), which is prepared periodically by the Institute for Hydrology, Meteorology, and Environmental Studies (IDEAM).

In Colombia, according to the national water accounts, the total water demand is about 36 million cubic meters (m^3; DANE 2016). Agriculture is the largest consumer of water (60 percent), followed by electricity generation (21 percent) and households (8 percent). A summary of water use by industry is shown in figure 9.1.

Figure 9.1: Water use by sector total and use permitted



Source: DANE (2016), national water accounts.

9.2 | Water use fees in Colombia

Historically in Colombia, the dominant view was that water resources were abundant. However, since the 1980s, relative water availability decreased in some small and medium-sized river basins, caused principally by erosion and massive deforestation (Gaitán 1996). To ensure effective water resources management, conservation and watershed restoration projects needed to be funded and hence potential financing mechanisms identified. Water abstraction charges and water pollution charges are instruments used in several countries around the world to finance water management, provide incentives for efficient water use, and reduce emissions of pollutants into water. Colombia uses its WUF to achieve these effects. The WUF is an indirect consequence of Decree 2811 of 1974,[1] which states:

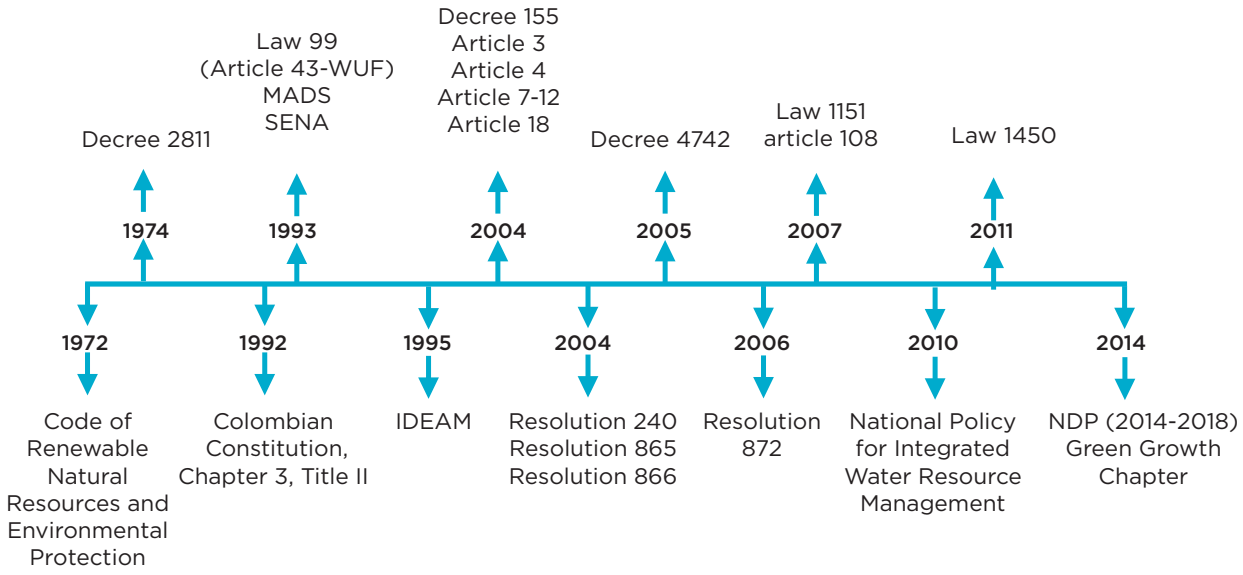
> *Waters are public, inalienable and under the State´s domain. Waters in the public domain are for public use and their administration and management is the responsibility of the State. The right to use the waters is acquired by ministry of law, by concession, by permission or by association.*

The WUF is explicitly declared in Article 43 of Law 99 of 1993,[2] which states: "The use of water for profit by natural or legal persons, public or private, will lead to the charging of fees set by the National Government to be used to pay the costs of protection and renewal of water resources (...)."

The WUF must be paid by "all those natural or legal, public or private persons, using water resources under a water concession" (Article 3, Decree 155 of 2004[3]). This fee is charged for each cubic meter of water abstracted, and each competent environmental authority, which in most cases are Regional Autonomous Corporations (CAR),[4] sets a different fee, based on a minimum rate fixed by the Ministry of Environment. It is important to know that the fee includes only the water abstracted charge and does not include water pollution charges, for which a separate fee is charged. The minimum WUF in Colombia is currently 0.78Col$/$m^3$.

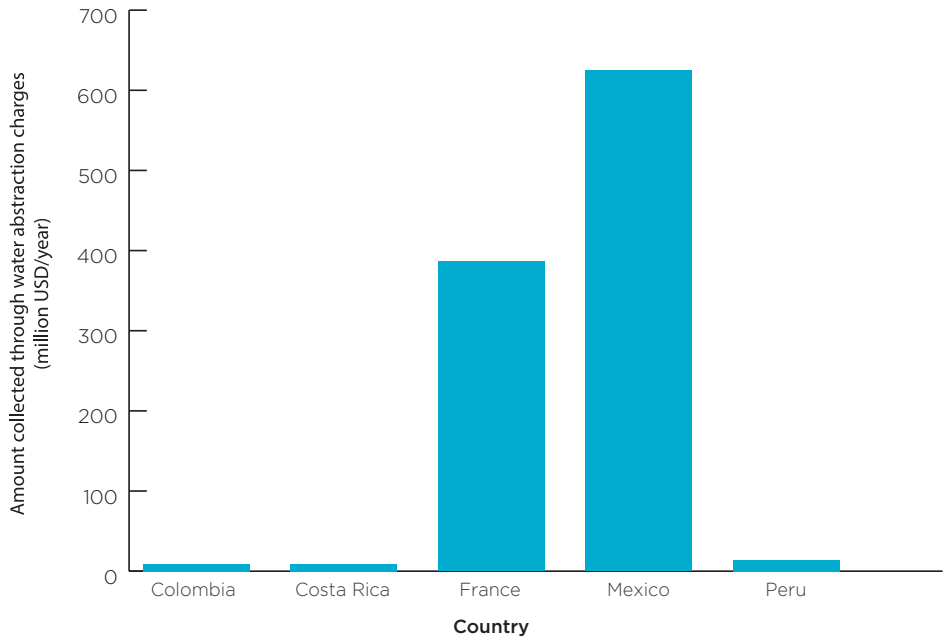
The development and implementation of WUFs over time in Colombia are summarized in figure 9.2.

Figure 9.2: Timeline of the WUF development in Colombia



In 2009 and 2010, the MADS conducted the Special Agreement on Scientific and Technological Cooperation 130-2008, which involved Javeriana University and IDEAM to adjust the WUF (MADS, PUJ, and IDEAM 2010). This analysis, conducted by Ministry of Environment in 2002 (Cruz 2002), considered the potential impact of the fee in different sectors of the economy, as well as the "Methodological Proposal Amending the WUF" (Propuesta Metodológica de Modificación de la Tasa del Uso del Agua), which was conducted by the United States Agency for International Development (USAID) in 2005 (USAID 2007).

Figure 9.3: Incomes collected from water abstraction charges in different countries, 2010



Source: GIZ and Ecosimple (2014).

Even though the charges in Colombia are updated annually in line with the inflation rate, compared to other countries, the water abstraction charges in Colombia are very low (figure 9.3). European countries like France collect an average of $375 million per year, yet Colombia raises only $2 million per year, a significant difference. Even Costa Rica, with a far smaller population than Colombia, collects $5 million per year, double that collected in Colombia, and the tariff is 5.2 Col$/$m^3$, close to five times the Colombia tariff. The comparisons among countries are not easy, because the charges vary according to type of use, source, location, and other factors (GIZ and Ecosimple 2014). For example, comparisons would ideally be adjusted by the number of people and businesses supplied with water.

The 87 percent of Competent Environmental Authorities (CEA) had implemented the appropriate billing fees, considering the cost of regional management factors in setting the minimum fee; the remaining 13 percent faced obstacles in implementation (GIZ and Ecosimple 2014). Nevertheless, in many cases the administrative cost to collect the WUF was higher than the fees collected. In 2012, the CEA was billed $11.7 million, but only $3.5 million was collected, which represents only 30 percent of the billed amount.

In 2010, the study "Rates of WUF, impacts on the cost of the residential water service and on industrial and agricultural profitability" was published (Patrimonio Natural, TNC, and WWF 2010). It was a partnership among Patrimonio Natural, The Nature Conservancy, and the World Wildlife Fund. The aim of the initiative was to analyze existing sources of public funding and propose a viable strategy for increasing the WUF to strengthen environmental and financial sustainability for the water supply (GIZ and Ecosimple 2014).

MADS received the Patrimonio Natural (2010) proposal and, using the technical arguments that were presented, began the political discussion to change the minimum tariff value of the WUF. Farmers' associations, unions, other ministries, and public service enterprises participated in the debate. While the data and analyses were good, they did not include any estimate of the impact on production and consumption at the macroeconomic level. For this reason, in 2016, the DNP decided to complement the analysis using additional information sources and extended modeling based on the national water account. It was believed that the accounts and modeling would give insight into the economic impacts of fee increases and incentives to reduce water use in agriculture.

9.3 | Using water accounts and modeling to set water fees in Colombia

Using information from the national water accounts, the DNP built a social accounting matrix, known as the WSAM-TUA[5], to model the effects of different levels of the WUF. The WSAM-TUA enabled understanding of the relationship between the economic production process and water flows by recognizing water as an input for each industry, as described in detail in Alvarez et al. (2016).

The WSAM-TUA was built with water accounts data (DANE 2016) and included seven industries: agriculture/livestock, electricity, mining, industry/commerce, services, others (use of water), others (without information)—plus "environmental government." The inclusion of "environmental government" allowed investigations of the use of the WUF to fund improvements to the environment via government. According to the law, the fees must be used for improving environmental conditions and water quality.

A proposal to increase the WUF was included in the general computable equilibrium model of the DNP using WSAM-TUA. The suggestion was to set different minimum fees for different sectors of the economy: Col$10/$m^3$ for all industries except for agriculture, which would have a minimum fee of Col$3/$m^3$. As expected, the sectors that consume more water and pay WUFs are the ones showing reduced production levels (table 9.1). Even though the increase in agriculture/livestock's fee was lower than that in other sectors, the impact was the highest from a

macroeconomic viewpoint (-0.12 percent in output). Negative effects also occur in the electricity (-0.05 percent), services (-0.03 percent), and industry/commerce (-0.02 percent) sectors. These results do not show the benefits that a higher fee collection would bring due to increased funding and expenditure for water management.

Table 9.1: Changes in production of the different sectors

Sector	Base scenario (US$, billions)	Alternative scenario (US$, billions)	Change (%)
Agriculture and livestock	24.59	24.56	-0.12
Electricity	9.05	9.05	-0.05
Mining	24.40	24.42	0.09
Industry and commerce	111.07	111.05	-0.02
Services	22.84	22.84	-0.03
Others (use water)	43.77	43.78	0.04
Others (without information)	158.92	158.89	-0.02

Source: DNP (2016).

A comparative static analysis was also conducted to know how much water the sectors should save to produce the same outcome that they produced before the WUF increase. This exercise was required because of the difficult political discussion with the different groups of the enterprises, particularly with the agriculture sector. The results showed that the agriculture sector should reduce its water consumption in 0.38 m^3 by million Col$ produced. Among crops, the incentive is heterogeneous. The palm crops would need to make the highest reduction (1.4 m^3 by million Col$ produced), while the oilseeds crops would make the lowest reduction (0.01 m^3 by million Col$ produced).

Table 9.2: Water used by crop and incentive of the WUF

Sector crop	Demand of water Hm^3/year	m^3 used by million Col$ produced	m^3 saved by million Col$ produced (incentive WUF)
Paddy rice	1,778.1	801.7	0.96
Cocoa	221.8	1,360.5	1.63
Sugar cane	1,476.2	1,028.7	1.23
Bean	39.6	44.5	0.05
Livestock	7,990.8	883.0	1.06
Oilseeds	1.1	7.6	0.01
Palm	1,793.6	1,164.7	1.40
Potatoes	221.2	110.9	0.13
Total agriculture	9,340.6	317.7	0.38

Source: DNP (2016).

The DNP's task was to provide information to MADS to inform a political discussion with the agriculture sector. The representatives of agriculture sector argued that an increase in the WUF would lead to the bankruptcy of some farmers, and that saving water would require high investments in technology. The results showed that both arguments were imprecise. The reduction in agricultural output was small (0.12 percent) and unlikely to send farmers into bankruptcy.

9.4 | Final remarks

Considering the value of natural capital contributes to improvements in its management and conservation. The visibility of this value, as well as insight into trends in changes, can lead to better decision making regarding natural resource use in the economy and in turn lead to better natural capital preservation. The national water accounts and analysis showed that an increase in the WUF leads to low levels of water savings and relatively small impacts on the value of production, but would result in greater resources for water resource management.

This analysis was conducted by DNP and based on a WSAM-TUA using the national water accounts to estimate the economic impacts of increasing the minimum fees. The construction of the computable general equilibrium model with water resources was only possible because of existing national water accounts. The WSAM-TUA can be updated with new water accounts and then be used to monitor the impacts of the recent fee increase, as well as in the setting of future fees. In this case, the analysis complemented the existing microeconomics and financial studies.

Water is a resource for which there is often a lack of high-quality data. Publishing the water accounts facilitates the building of social account matrices. Water accounts also assemble existing data on the value of water and volume of water used so they can be integrated with other information as well as SNA information. In the case of water, Colombia has shown how accounts, in combination with analytical tools, can provide a direct input to government decision making.

9.5 | Acknowledgments

The team especially wishes to thank Leidy Riveros for her technical support, the editors for their feedback, and NCA forum participants for their comments.

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9.7 | Endnotes

1 http://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=1551.
2 http://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=297.
3 http://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=13545.
4 The Regional Autonomous Corporations (CARs) are decentralized environmental management authorities and are the principle environmental authorities. They are responsible for all environmental management within their jurisdiction, including managing forests, basins, and granting and enforcing environmental licenses.
5 Water Social Accounting Matrix—Tasa por Uso de Agua (WSAM-TUA).

10 | Costa Rica: Influence of Natural Resources Accounting on Public Policy and Decision Making

Dr. Edgar E. Gutiérrez-Espeleta, Chair, WAVES, Costa Rica Steering Committee; Minister of Environment and Energy, Costa Rica

Summary

In recent years, Costa Rica has strengthened its interest in building statistics and indicators on some essential environmental resources. Under the leadership of the Ministry of Environment and Energy (MINAE) and the Central Bank of Costa Rica, the development of natural capital accounts has been promoted and institutionalized. The developed accounts (energy, water, and forest) have already provided important results.
The forest accounts have shown that the value of the forest to the economy is 10 times the value shown in the national accounts if forest-related activities and products, as well as the value of economic activities that make use of forest products, are included. The energy accounts will be used to evaluate the fulfillment of Costa Rica's sustainable development objectives. By showing the composition of the use of energy sources and the associated CO_2 emissions, these accounts provide essential elements to monitor policies related to climate change and mitigation of the emissions. Prospective policy opportunities for Natural Capital Accounting (NCA) include monitoring and implementation of Sustainable Development Goals (SDGs), climate change, and the Aichi targets, among others.

10.1 | Introduction

The wealth of Costa Rica and its economic growth depend on the management of its abundant supply of natural resources. Having 5 percent of global biodiversity confers an enormous heritage on which agriculture, electric energy, tourism, and the country's productive system in general (such as health, education, culture, well-being and quality of life) depends.

However, this wealth is not being adequately reflected in national indicators. The Wealth Accounting and Valuation of Ecosystem Services (WAVES) program has exposed the prevailing need to account for the country's natural resources to implement a more sustainable resource management path that balances Costa Rica's economic needs and conservation.

A country project for natural resources and ecosystem services accounting was established thanks to the strong participation, commitment, and involvement of the Ministries of Finance and Planning, and MINAE, along with the National Institute of Statistics and Censuses and the Central Bank.

This political support, along with the technical work, has been instrumental in promoting natural capital accounting as a cross-cutting tool to make economic contributions of nature visible to public institutions (national and local), the private sector, and civil society, and to make it a truly collaborative undertaking (WAVES-CR 2016).

There is a gap between statistics and economics in relation to natural resource accounting for the generation of public policies to improve the national budget. Data and their interrelations are key to obtain indicators and create a joint work schedule, as well as to determine a common language to communicate hard evidence for political decision making. Therefore, it is key that all actors know the importance of managing ecosystem services and using natural resources sustainably. This needs to be done through successful political communication, developing processes of institutionalization and advocacy.

Accounting for the environment helps improve natural resources management and ensure natural resources are reflected with greater relevance in public policies (WAVES-CR 2016c).

10.1.1 | Environmental accounts for reducing gaps between statistics and public policy

Environmental accounting is a statistical framework with consistent methodology that produces indicators that provide a country with the following:

- Aligned definitions and classifications of environmental data and their management
- Consistency in the combination of environmental and economic statistics
- Data that can be compared internationally and, in turn, used to better manage financial resources and national budget

Costa Rica has, with the support of WAVES, been working to do the following:

- Reduce gaps between researchers and policy makers
- Reduce the number of stereotypes that cause a "blockage" of the information flow between both groups
- Change the culture of public policy decision making so that this is not only a political process, but also promotes improvements in national economic policies, for example, using accounts in a practical way in adjusted net saving or ecological footprint metrics

10.2 | Costa Rica's development of environmental accounts

In Costa Rica, MINAE assumed leadership of the process for account preparation, while the Central Bank of Costa Rica (BCCR) is responsible for the technical work. Along with the National Institute of Statistics and Census (INEC), the Ministry of Finance and the Ministry of Planning and Economic Policy (MIDEPLAN), MINAE has taken on the challenge of leading the country toward more inclusive and sustainable development. This requires that the contribution of natural resource use to the economy through the natural resources accounting (NRA) is made explicit.

After a three-year effort, the Steering Committee for WAVES Costa Rica (WAVES-CR) produced the first natural capital account. The government of Costa Rica, in partnership with the WAVES program, officially published the natural capital accounts for water, forests, and energy in June 2016. BCCR generated tables of supply and use in monetary terms, fixed accounts of forest assets, water and physical use, and emissions of carbon dioxide under the energy account (WAVES-CR 2015–16).

10.2.1 | Water accounts

Water accounts have been compiled based on official data and estimates of the BCCR for the new base year 2012. The national accounting data sources include water statistics from the national accounts, water balances, water use and pollution, databases, and water services' financial statements.

Costa Rica receives abundant rainfall (annual average rainfall of 2,626 mm, among the highest rates globally). However, most (73 percent) falls between May and October. By contrast, the province of Guanacaste, in the northwest of the country, has an annual rainfall of 1,711 mm, with almost no rain between January and April.

Water- and sanitation-related businesses provide services to users and bill about 570 colones per cubic meter of water (US$1/$m^3$) supplied on average. The added value of the industry represents 0.5 percent of gross domestic product (GDP) in Costa Rica, and the net savings from operation is 24 percent of total production. About 50 percent of the water extracted by the industry is lost before it reaches the users.

Seventy-one percent of the country's electricity is produced by hydroelectric plants, which means they are entirely dependent on weather conditions, as they take advantage of the flows of rivers without being regulated. These flows can be diminished by other water uses. The Energy National Plan 2015–30 already mandates for a diversification of the electricity matrix.

The tables on water supply show that 75 percent of the water extracted in the country is for agricultural irrigation, 22 percent is for the supply of drinking water, and the remaining 3 percent is water extracted directly by the manufacturing, services, construction or mining companies, among others. The water supplied by the irrigation districts to users is billed at about 6 colones per cubic meter (US$0.01/$m^3$ on average), but government subsidies are needed to operate these irrigation districts.

In addition, in 2012, about 25.6 billion cubic meters of water were used in hydroelectric plants, which accounted for 71 percent of the gross energy production that year. Tables of origin and physical destination (System of Environmental-Economic Accounting for Water, SEEAW) also show losses by water companies and irrigation districts when the water is provided to end users. It also shows the wastewater (as defined by the SEEAW) generated after each use.

10.2.2 | Forest accounts

Forest accounts were compiled incorporating physical and monetary values. BCCR coordinated with the National System of Conservation Areas (SINAC-MINAE) and the National Forest Financing Fund (FONAFIFO-MINAE) to analyze the results of the new national forest inventory and to conduct a study of the carbon dynamics for the REDD+ (reduced emissions from deforestation and forest degradation plus) strategy.

The evolution of forest cover showed that the country's mature coverage stabilized after 1992, after which new forests began to grow. In Costa Rica, 52.4 percent of the total area is covered by forests, which has been reflected in the creation and implementation of laws and policies for conservation and reforestation.

The data show that, although the country's forest area has grown, its composition has also changed. Mature forests show reductions of 1.35 percent in 2008–11, and 0.53 percent in 2011–13, while other forest lands grew by 6.87 percent and 16.45 percent, respectively, resulting in a total increase in forest cover of 0.56 percent for 2008–11 and 3.23 percent for 2011–13.

Forest flow accounts based on source and destination tables estimate the value of the forest within the national accounts. The addition of forest-related activities and products improve this estimate. The forest industry accounts for 0.2 percent of GDP. But if accounting extends to other products that have wood components, resins, or some other material extracted from the forest for processing by industries, the share of the forest sector accounts for more than 1 percent of GDP.

Finally, if economic activities that are not classified as forest product extraction, but make use of forest products, are considered, the value of the "extended forest economy" accounts for more than 2 percent of GDP.

10.2.3 | Energy accounts

An early version of energy use and CO_2 emissions accounts for 2011, 2012, and 2013 has been compiled. The work is based on consolidating information on Costa Rica's energy resources and complementing national energy balances, with the preparation of accounts in physical and monetary units.

Estimates of input-output ratios are being developed with energy consumption and generation of emissions between industries, as well as quantification of energy dependence according to different sources. Preliminary results show that the electricity industry, the food industry, and the transportation sector are energy-intensive production activities in most parts of the country, while services contribute to higher value-added generation and employment. The energy intensity of the economy has declined in recent years due to the production of electricity from renewable sources. However, more than 50 percent of the total energy consumed in Costa Rica comes from nonrenewable sources. On the other hand, 70 percent of the CO_2 emissions are generated by the use of fossil fuels, particularly by the transport sector.

The emissions in the energy use sector depend on the economic growth of the country, its production structure, its energy intensity, and the amount of CO_2 emitted by each type of energy source used. Therefore, the identification of the composition of the use of energy sources and the CO_2 emissions associated to this use are essential elements in the monitoring of the policies related to climate change and mitigation of the emissions. It will serve as input to the evaluation of the fulfillment of the objectives of sustainable development.

From the energy account, estimates are obtained of the use of energy (in terajoules) depending on whether it is primary or secondary energy and by type of source. It is observed that more than 50 percent of the energy used per year corresponds to oil, fuels, and others, followed by renewable sources with 30 percent, used mainly for the generation of electric energy, as well as for final consumption in households and some industries (for example, vegetable waste and firewood), and finally electricity with the remaining 20 percent.

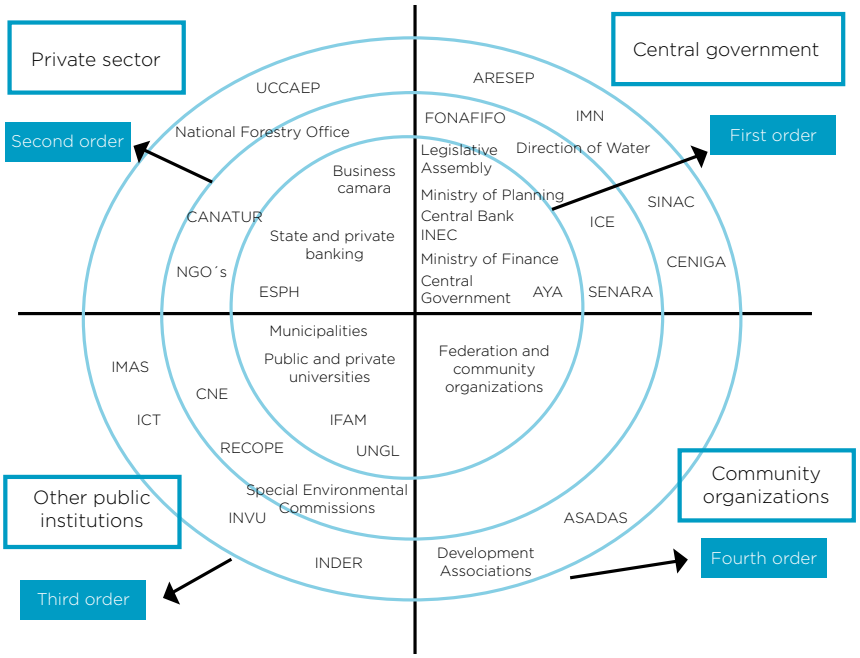
10.3 | The use of environmental accounts in Costa Rica for public policy decision making

10.3.1 | Social actors and agencies that influence policy and decision making

For Costa Rica, the process of selecting key players and decision makers is developed at various levels, with the aim of reaching all possible stakeholders who can influence the generation of public policies from their institutions, for example (figure 10.1):

- Representatives of the Legislative Assembly
- Representatives of the central government and its relevant public institutions
- Ministry of Environment and Energy and its different bodies, which are responsible for the theme and political lead of the process
- The BCCR, which is responsible for the preparation of environmental accounts
- Generating agencies and information providers
- Civil society, nongovernmental organizations, and other stakeholders who will benefit from the accounts

Figure 10.1: Stakeholders and their possible level of influence



Source: MINAE (2016).

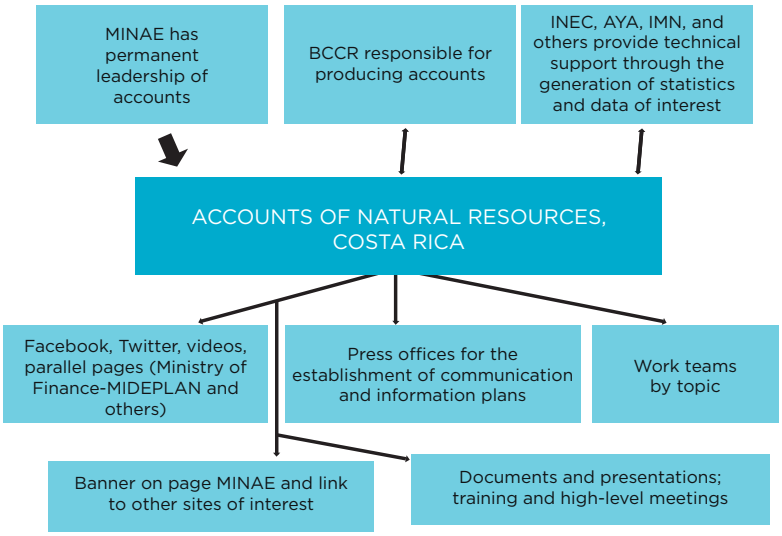
10.3.2 | Socialization and institutionalization efforts for public policy decision making

The WAVES-CR Project has exposed the prevailing need for natural resource accounting in a detailed and meticulous manner. This has contributed to greater commitment to actions established by the Steering Committee, which has promoted the participation, and involvement in the decision-making processes of HACIENDA, MIDEPLAN, and MINAE, along with INEC and BCCR.
In addition, some elements have been put into practice:

- Exploration of synergies and relationships of key players to establish commitments
- Consolidation of the institutional team that makes up the WAVES-CR Steering Committee
- For sectors and key actors, develop mechanisms of operationalization (forums, workshops, training, bilateral and high-level meetings, among others) for political advocacy and institutionalization of natural resource accounting

Moving forward, Costa Rica will implement its communication strategy (figure 10.2) to publicize the importance of environmental accounts, and the strategy will involve all stakeholders and social sectors to strengthen the sustainable development of the country.

Figure 10.2: Example of a scheme to establish a communication strategy



Source: MINAE (2015–16).

10.4 | Future of and opportunities for environmental accounts in Costa Rica for decision making

Costa Rica has recently intensified its interest in building statistics and indicators on some essential resources. However, in the future, Costa Rica hopes to empower itself in the accounting of its natural resources, not to give it a simple economic value, but to raise awareness about the values derived from these resources and how citizens can best use them in a sustainable manner.

Costa Rica is currently developing the ecosystem service account and the environmental protection expenditure accounts with the support of ECLAC (United Nations Economic Commission for Latin America and the Caribbean).

In addition, it is expected that in the coming years, biodiversity, marine and coastal resources, risk management, waste management, climate change, and wildlife, among others, will be selected by the institutions that make up the Steering Committee for the national environmental accounts.

The policy opportunities for accounting include the following:

- Improving the national environmental statistics system
- Incorporation with other systems: SDGs, climate change, Aichi goals, Organisation for Economic Co-operation and Development (OECD) green growth strategy, and others
- Better questioning about policy making—will not give all the answers, but provide better questions

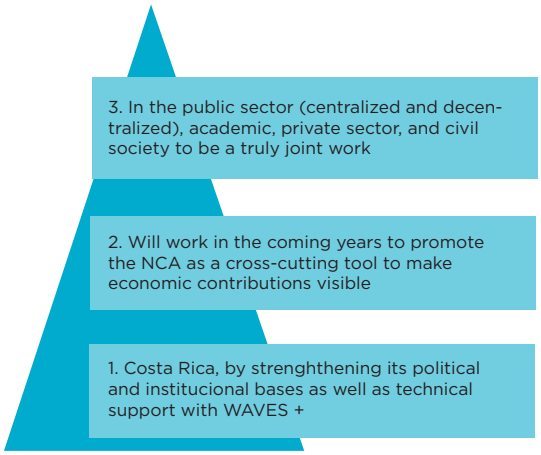
10.5 | Final remarks

The goal is simple: to make better decisions—better decisions that have a better impact on the well-being of populations. Better decisions that reflect Costa Rica's resources, wealth, weaknesses, and risks.
Achieving what is known as "sustainable development" is underpinned by this effort to value the environment to increase capabilities, reduce uncertainties, minimize weaknesses, and maximize benefits (WAVES-CR 2016a).

To this end, Costa Rica looks forward to the following:

- A national policy for the accounting of its natural resources
- A national strategy for natural capital accounting
- The strengthening of its national budget
- The creation of an environmental economics unit led by the Ministry of Environment

Figure | 10.3: Accounting opportunities



Source: MINAE (2016).

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11 | The Contribution of Energy and CO_2 Accounting to Policy in Costa Rica

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Summary

Energy accounting identifies in detail the main sources of energy and the economic activities that use that energy. This is particularly relevant for a country like Costa Rica, which aims to reduce its dependence on fossil fuels and create conditions for higher economic growth at the same time as using less petroleum and reducing greenhouse gas (GHG) emissions. In 2013, approximately 70 percent of gross carbon dioxide (CO_2) emissions due to energy use were from fossil fuel combustion, while the remaining 30 percent were from the use of other sources (geothermal, bagasse, coffee husks, other plant residues, and firewood). The food industries, transport activities, and electricity production used the most energy and were responsible for the highest shares of CO_2 emissions. Economic activities such as manufacturing of sugar and wood products are highly intensive in energy and emissions of CO_2 and have a relatively low contribution to total economic production in the country. The energy account provides a deeper understanding of the relationship of the energy sector with the environment and the economy than previous energy data by linking physical and economic information and specifying various interactions. While energy accounting is new in Costa Rica and has not yet been used in government policy and planning, the indicators from the accounts can assist the formulation of activities related to key national policies, such as the VII National Energy Plan and the National Climate Change Strategy. Primarily, the accounts would be a tool for monitoring energy use patterns, GHG emissions, productivity, and sustainability. Accounts could also be used in analyses to identify and test various options for attaining policy targets.

11.1 | Introduction

Costa Rica currently faces important challenges to its future development. A central issue is how to accelerate economic growth through the sustainable use of natural capital. Urbanization, increasing demand for energy, and agricultural growth are generating pressure on the country's natural resources. Land use conflicts in different regions are causing soil degradation, water pollution, and threatening coastal and marine resources (PEN 2015). In addition, climate variability is affecting many regions of the country, including its infrastructure and productive capacity (OECD 2013; Sancho, Rivera, and Obando 2015). The country's future development is projected by the government to rely on tourism growth, forest conservation, agricultural development, green industries promotion, renewable energy investments, and the decarbonization of the economy (MIDEPLAN 2014; OECD 2016).

Better knowledge and quantification of the main sources of national wealth and economic growth is needed, particularly the value of the Costa Rica's natural capital. This would help policy makers understand, for example, alternative uses of land, the economic implications of environmental degradation, the value of ecosystem services provided to industries, and the effectiveness of different policy instruments for a low carbon emissions development path.

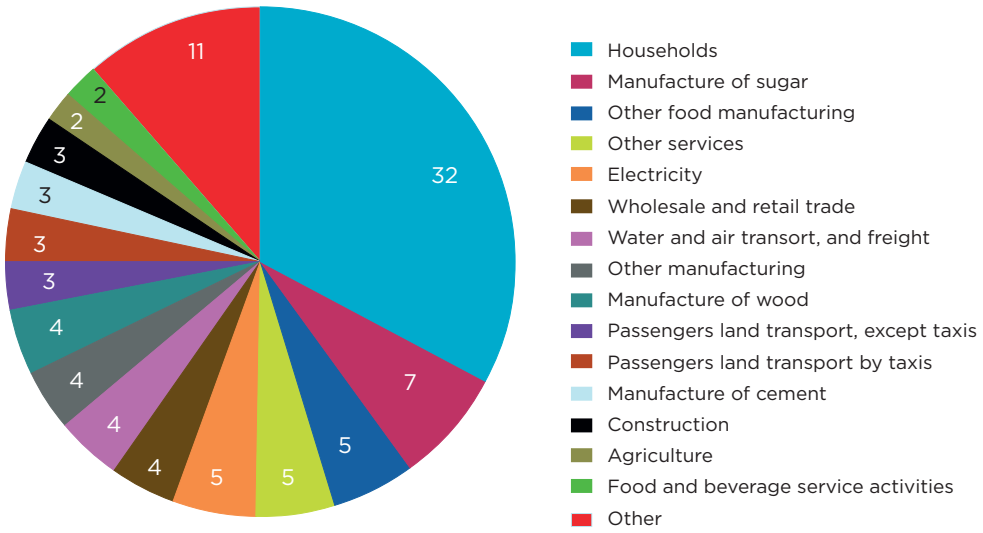
The Central Bank of Costa Rica (BCCR) led the technical work of compiling water, forest, and energy accounts with the support of the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) partnership, the World Bank, and the Ministry of Environment and Energy (MINAE). Based on the successful production of these

accounts and their potential usefulness for decision making, BCCR decided to institutionalize the compilation of environmental accounts by creating a new unit under the Department of Macroeconomic Statistics.

This paper focuses on energy use and CO_2 emissions because they are important policy areas for Costa Rica. The energy and CO_2 emission accounts help to better understand the relationship of the energy sector with the environment and the economy by specifying their interactions and showing their reciprocal influences. The accounts for Costa Rica were built using the System of Environmental-Economic Accounting Central Framework (SEEA-CF), which recognizes "the ever-increasing importance of information on the environment and the need to place this information in an economic context understood by central policymakers" (UN, European Commission, FAO et al. 2014).

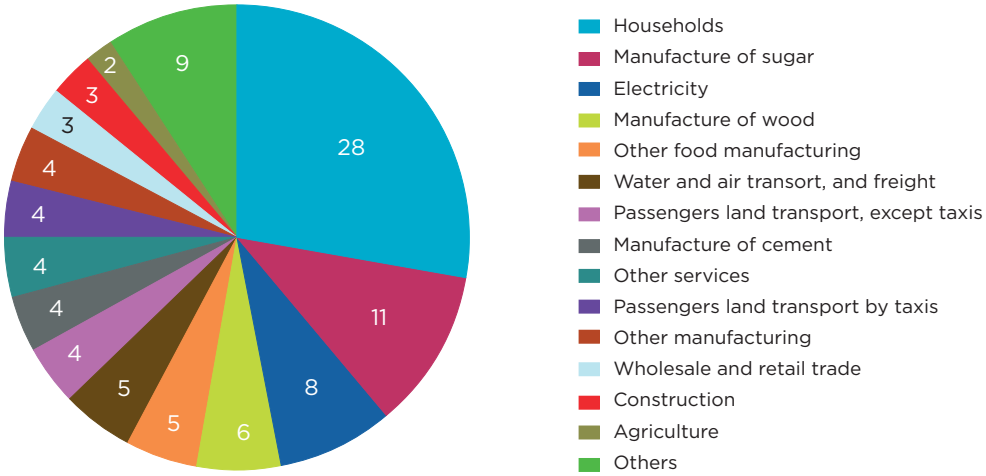
Energy use and CO_2 emission accounts were compiled for the years 2011, 2012, and 2013 (BCCR 2016). These accounts show the major energy using (figure 11.1) and CO_2-emitting economic activities (figure 11.2), as well as the sources of emissions (figure 11.3). At this stage, the time series is short, and we do not have all the information needed to fully explore the Costa Rican context. Still, the accounts produced have identified the industries that use the most energy and emit the most GHG gases, and it is logical to focus the government policy attention on these industries.

Figure 11.1: Costa Rica—share of energy use by economic activity and households, 2013 (%)



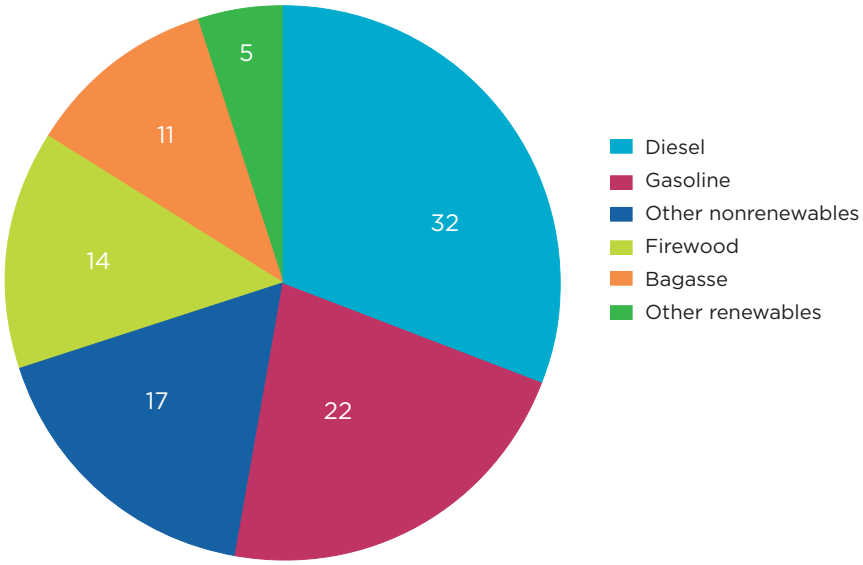
Source: Authors' elaboration with data from the energy accounts (BCCR 2016).

Figure 11.2: Costa Rica—share of CO_2 emissions by economic activity and households, 2013 (%)



Source: Authors' elaboration with data from the energy accounts (BCCR 2016).

Figure 11.3: Costa Rica—share of CO_2 emissions by energy source (2013) (%)



Source: Authors' elaboration with data from the energy accounts (BCCR 2016).

In Costa Rica, 90 percent of electricity generation is from renewable sources (predominantly hydroelectricity); however, the economy makes extensive use of fossil fuels (BCCR 2016). According to the Sectorial Directorate of Energy (DSE 2016), in 2015, the use of petroleum accounted for 63 percent of total energy use, followed by electricity (21 percent), and biomass (16 percent).

Energy demand is driven by transport activities (51 percent of total energy demand in 2015), manufacturing (24 percent), and households (13 percent; DSE 2016). The Biennial Update Report (BUR) on GHG inventory indicates that the country emissions from the energy sector grew by 22 percent from 2005 to 2012 (MINAE and IMN 2015). Currently, 64 percent of total GHG emissions come from energy use (MINAE and IMN 2015). This contrasts with a decrease in energy intensity (energy use per unit of gross value added) in the last decade (BCCR 2016). The evidence suggests that energy generation and use in the country is heterogeneous in terms of alternative sources and carbon intensity (Sancho, Rivera, and Obando 2015).

Energy accounting makes it possible to identify in greater detail which economic activities are the most intensive in the use of energy sources and to link this other economic and environmental information in a systematic way. The detail in the accounting tables enables quantification of energy dependence in Costa Rica's industries, by type of energy source, and to calculate relevant indicators like input-output ratios based on energy consumption. It also supports a variety of analytical modeling. Because of this, the energy account can inform the formulation of policies related to national plans and strategies, such as the VII National Energy Plan and the National Climate Change Strategy.

11.2 | NCA's contribution to better informed policies

Key questions for institutionalizing environmental accounting are how to create and strengthen demand for accounts use and how to ensure their continuous improvement. It is important to develop the *policy pull* to make natural capital accounting (NCA) a practical tool for decision making and policy design (Vardon, Burnett, and Dovers 2016). Through energy accounts, Costa Rica is developing better analytical and decision-making tools for sustainable development planning, while creating new institutional channels for interaction between account compilers and decision makers. Key opportunities for the energy accounts to influence government policy and planning are discussed below.

11.2.1 | National Strategy for Climate Change

Costa Rica has made considerable efforts in promoting sustainable environmental management and especially climate change mitigation at both national and international levels. The country has led discussions within the United Nations Framework Convention on Climate Change (UNFCCC), was a pioneer in the emerging carbon markets, and has established an ambitious National Climate Change Strategy (ENCC). The ENCC comprises six strategic areas (mitigation, adaptation, measuring, capacity building, awareness raising and public education, and funding), with the common objective of aligning policies for climate change with a long-term strategy for sustainable development. One of the main objectives of the strategy is to achieve a climate neutral economy by 2021. In line with this objective, Costa Rica submitted its intended nationally determined contributions (INDC) to UNFCCC on September 2015, with its long-term objectives of CO_2 emission reductions and development goals.

The main mitigation action of the ENCC is to reduce emissions from the priority areas of electricity generation, transport, agriculture, manufacturing, solid waste management, tourism, and land use change. Energy accounting is expected to monitor energy use and the related emissions from these areas as well as support the integrated analysis of energy use and macroeconomic data. Energy accounts can also be used to feed analytical tools such as computable general equilibrium (CGE), input-output, and other forecasting models. The account use in such models will strengthen the assessments of policy options, and hence policy design and implementation.

11.2.2 | National Energy Plan

The National Electricity Institute (ICE) has developed an expansion plan that aims for 98 percent of electricity generation from renewable sources within the next two decades (ICE 2014). This is part of the vision of the VII National Energy Plan (2015–30), where the overall objective is to reduce Costa Rica's dependence on fossil fuels and create conditions for higher economic growth and the reduction of GHG emissions. Moreover, the plan pursues clean energy production in a sustainable and environmentally friendly way, reducing oil imports by relying on domestic energy sources (ethanol, biodiesel, hydropower, geothermal, biomass, wind, and solar), consolidating an efficient transport system, and strengthening energy sector institutions (MINAE 2015).

Transport activities account for a large portion of national energy consumption. This is associated with a growing vehicle fleet and economic growth (Sancho, Rivera, and Obando 2015). The National Energy Plan 2015–30 includes a national objective for more energy efficient electricity generation, transmission, and distribution as well as for electric-powered devices. Furthermore, it aims for a national economy with a significantly lower level of GHG emissions by reducing its dependence on hydrocarbons, especially as source of energy for public and private transport, and by incorporating electric and hybrid vehicles into the vehicle fleet.

Energy accounting helps to identify relations between industries, their energy consumption and their emissions, not only from the supply (production), but also from the use (demand) perspective. Thus, there is more detail on which industries are growing and the extent of their energy demands and emissions. This provides a way for medium- and long-term monitoring of energy efficiency and productivity in the economy.

With its integrative approach, energy accounts contribute not only to energy policy analysis, but also to its interactions and feedbacks with industry and economic growth of the country. For instance, the DSE at MINAE is responsible for producing the national energy balances and is using the accounts to design energy efficiency plans targeted at the more energy-intensive industries. The accounts enable better estimations of potential policy effects on industries. Moreover, DSE and BCCR have established closer coordination for data collection and processing for the annual update of energy accounts. This contributes to better statistics development and the production of better indicators for policy monitoring and impact analysis.

11.3 | NCA and analysis

During the last decade, economic growth in Costa Rica has averaged 4.5 percent per year, recovering from the 2008–9 international financial crisis (table 11.1). In 2016, economic activity grew by 4.3 percent. This performance was mainly driven by the growth in services, especially those associated with professional and support services activities (7.6 percent), as well as financial and insurance services (13.8 percent) and wholesale and retail trade (4.6 percent) (BCCR 2017a). The historical dominance of agriculture has decreased significantly, from 12 percent of gross domestic product (GDP) in 1991 to 5 percent in 2016. The importance of the manufacturing industries also decreased, from 20.6 percent of total production in 1991 to 12.1 percent in 2016 (BCCR 2017b). Services have become the main driver of economic growth, both for the domestic and external economy—and consequently for the foreign direct investment of the country.

Table 11.1: Costa Rica—economic growth

	1992–2000 (%)	2001–10 (%)	2011–16 (%)
GDP	5.1	4.3	4.0
Agriculture, silviculture, and fisheries	4.6	2.3	1.5
Manufacturing industries	4.2	1.4	2.2
Construction	6.3	6.6	0.2
Services	5.4	3.5	5.9

Source: Authors' elaboration with data from BCCR (2017a).
Note: Calculations performed with a geometric growth rate.

A recent study by Adamson-Badilla et al. (2014) estimated the emissions embedded in international trade between Costa Rica and the rest of the world and concluded that Costa Rica is a net exporter of emissions. That is, the country's exports generate more emissions than imports. Although the level of total emissions is relatively low compared to international standards, it would be desirable for Costa Rica's exports to be less carbon intensive. This could be achieved, for example, by incorporating new technologies in production.

Costa Rica's BUR on GHG inventory indicates that total emissions in 2012 had increased by 15 percent since 2010, and 30 percent since 2005 (MINAE and IMN 2015). The use of energy and waste management are the country's main GHG emitters (table 11.2). A large share of these emissions is a result of the fossil fuels used in transport activities. Transport activities generate 70 percent of total emissions due to energy use, representing 45 percent of Costa Rica's total emissions.

Energy and CO_2 emission accounts could be used in standard economic models to estimate the costs, both in terms of investment and in lost production, and hence the relative benefits of different policy tools aimed at reducing energy use and CO_2 emission. For example, the effects of introducing energy or carbon taxes or subsidizing renewable energy developments could be shown using a CGE model.

Table 11.2: Costa Rica—greenhouse gas emissions (Gg of CO_2e)

Source	2005	2010	2012
Energy	5,922.1	7,027.6	7,213.8
Industrial processes	612.6	824.9	980.7
Agriculture and land use change	-228.6	224.7	1,119.4
Waste management	1,383.8	1,539.9	1,864.3
Total	7,689.9	9,617.1	11,250.2

Source: MINAE and IMN (2015).

A tool that is used frequently to explore aggregated determinants of emissions is the Kaya Identity. This identity uses information taken directly from the System of National Accounts (SNA). According to this identity, a country's emissions can be broken down into the product of four basic factors: CO_2 emissions per unit of energy, energy consumed per GDP, per capita GDP, and population. Table 11.3 shows the contribution of each component of the Kaya Identity for Costa Rica between 1980 and 2011. In particular, emissions during the 1980s and 1990s can be explained by an increase in energy intensity, national production, and population growth. Since 2000, energy intensity decreased while national production and population growth remained as main emissions drivers.

Because the Kaya Identity relies on information from the SNA, the energy and GHG emission accounts are a natural complement and could be used to further investigate the drivers of change within the identity. For example, one could investigate which parts of the economy are driving GDP growth (such as structural change) or are reducing energy use and CO_2 emission (such as technological innovation in production or switching of energy sources). Such information could help target policies at industries that achieve higher economic growth using less energy and producing fewer emissions.

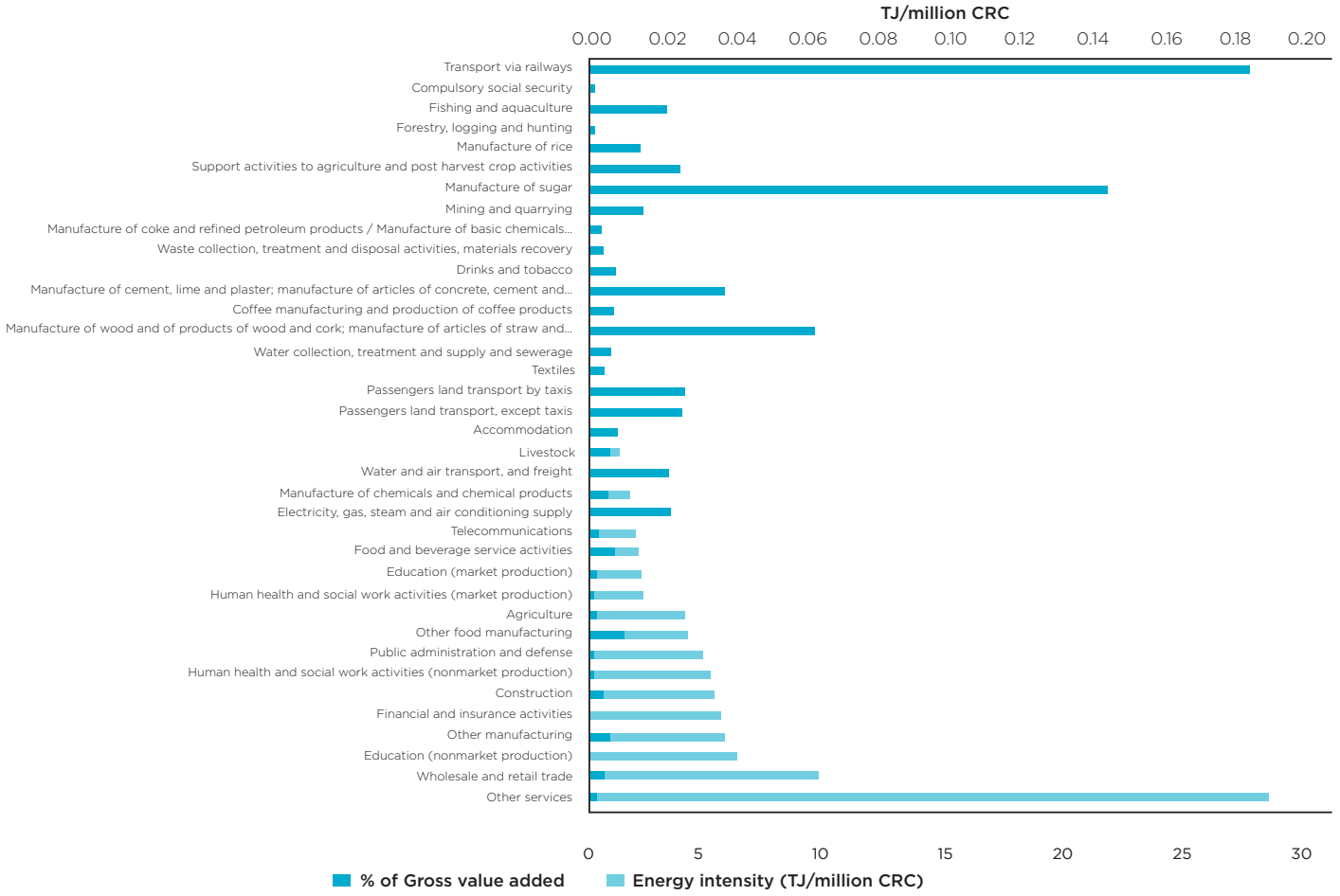
Table 11.3: Costa Rica—composition of emission changes due to fossil fuel use

Total change (CO_2 million tons)	Carbon intensity	Energy intensity	GDP per capita	Population	Total
1980–90	(0.26)	0.14	(0.09)	0.68	0.47
1990–2000	(0.14)	0.50	0.96	0.94	2.27
2000–2005	(0.04)	(0.31)	0.64	0.43	0.72
2005–11	0.07	(0.68)	1.04	0.52	0.95
Relative contribution	**Carbon intensity (%)**	**Energy intensity (%)**	**GDP per capita (%)**	**Population (%)**	**Total (%)**
1980–90	-56	29	-18	145	100
1990–2000	-6	22	43	41	100
2000–2005	-6	-44	89	60	100
2005–11	7	-72	110	55	100

Source: Authors' elaboration with data from the U.S. Energy Information Administration, based on Kaya (1990) and Bacon and Bhattacharya (2007).

Figure 11.4 shows the energy intensity and gross value added (GVA) of industries in Costa Rica. This shows that transport via railways, the manufacture of sugar, and the manufacture of wood and wood and cork products are the activities that have the highest energy consumption per million GVA Costa Rican colones. For example, the contribution of manufacturing of sugar and wood products to GVA is small (0.32 percent for sugar and 0.46 percent for the manufacture of wood products). This information is useful to policy makers because it shows where significant improvements could be made as well as estimates the level of incentives needed for industries to improve energy efficiency and emission reductions or for structural adjustment (encouraging a move out of particular industries).

Figure 11.4: Costa Rica—energy intensity and share of gross value added by economic activity, 2013



Source: Authors' elaboration with data from the energy accounts (BCCR 2016).
Note: Chained volume at previous year prices (year of reference: 2012).

11.4 | Final remarks

A regular and consistent information system, such as the energy and GHG emissions accounts, can contribute to better design, monitoring, and evaluation of key national policies related to energy, economic growth, and the decarbonization of Costa Rica's economy. The accounts can provide broad-level indicators identifying the industries that use the most energy and emit the most CO_2 alongside their contributions to the economy. The accounts can also be used in a range of analyses and models where their links to the SNA are useful for examining both environmental and economic impacts of different policy options. Accounts can also help obtain the information necessary for policy development and to better document the policy formation process.

The publication of the first energy accounts in Costa Rica in 2016 attracted the interest and institutional support from government agencies, and a continuous improvement process to update the energy accounts has started. The ongoing collaboration between the BCCR (compiler) and key government agencies responsible for energy policy (DSE, ICE) is critical for more proactive uses of energy and CO_2 emission accounts to occur. The publication of the first energy accounts was a significant milestone, and potential uses of the accounts have been identified—policy impacts are expected in the future.

11.5 | Acknowledgments

The compilation of the first energy and CO_2 accounts for Costa Rica was achieved with support from the World Bank through the WAVES partnership, particularly from Christian Peter and Juan Pablo Castaneda. Technical advice and guidance from Rocky Harris (UK Department for Environment, Food, and Rural Affairs) is gratefully acknowledged. Michael Vardon (Australian National University) provided valuable comments and suggestions on a preliminary version of this document. The views expressed herein are those of the authors.

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11.7 | Endnotes

1 Information from the DSE energy balances of 2014 and 2015 will be incorporated into the next energy accounts, which are due out in August 2017.
2 The GHG inventory cited in BUR (MINAE and IMN 2015) is based on the principle of territory, whereas the emissions resulting from the energy use reported in the emissions account are based on the principle of residence. Hence, this information is not comparable.
3 The mitigation and adaptation measures incorporated are aligned with key areas of the economy, such as tourism, electricity generation, forests, and the payment for environmental services, among other core areas seeking to consolidate a sustainable development strategy that strengthens the country's competitive performance and contributes to mitigating climate change.
4 http://www4.unfccc.int/submissions/INDC/Published percent20Documents/Costa percent20Rica/1/INDC percent20Costa percent20Rica percent20Version percent202 percent200 percent20final percent20ES.pdf.
5 The BCCR is currently working with the Inter-American Development Bank to construct a CGE model for Costa Rica that integrates the environmental accounts.

12 | Implementing Natural Capital Accounting in Developing Countries: Public-Academic Partnerships and Policy Uptake in Guatemala

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Summary

This paper presents key lessons from the implementation of natural capital accounting (NCA) in Guatemala using the System of Environmental-Economic Accounting (SEEA). The SEEA is compatible with the economywide frameworks that are regularly used to measure economic performance, and the System of National Accounts (SNA). Implementation, in the context of this paper, includes both producing the accounts and embedding them in the policy context of the country, and their influence in the overall policy dialogue and in different stages of the policy cycle. This paper reflects on experiences that could be useful in developing-country contexts, with characteristics like Guatemala, such as low levels of public resources, weak institutions, and especially very limited basic statistics (particularly environmental statistics). One consequence of underinvestment in data production and analysis is that few policy decisions integrate environmental information into the well-resourced economic data frameworks that dominate most policy discussions. Although there are problems, the experience from Guatemala shows that innovative institutional arrangements, including partnerships with academic institutions, can overcome resource constraints and provide credibility and rigor to the information used in the policy dialogue. This in turn sets the stage for a cultural shift in terms of data-driven decision making.

12.1 | Introduction

Countries have long kept a close watch on their income using the SNA to assess economic performance and the effectiveness of their development policies and plans. Yet conventional indicators based on the SNA, such as gross domestic product (GDP), do not provide information on whether growth is sustainable. Countries can grow in the short term by running down their assets, including their natural capital, but such growth cannot be maintained over the long term.

It is in a country's interest to monitor its national income and assets, including natural capital. By fully accounting for natural capital assets, such as minerals, fisheries, water, forests, and ecosystems, governments can provide more accurate information to policy makers and it is expected that this can lead to better decisions about development priorities and investments. This is especially important for developing countries, like Guatemala, with a predominantly rural population whose livelihoods critically depend on natural capital.

Facing the development challenges of an increasingly degrading natural capital base, in 2006, Guatemala started to compile natural capital accounts as part of a project funded by the Dutch Cooperation. The accounts were based on the SEEA, which is a framework developed by the international statistical community to organize information to describe the relationship between the economy and the environment as completely as possible. The SEEA has the same basic principles used in standard economic measurement, as reflected in the SNA. By doing so, the relevant environmental information can be effectively integrated and mainstreamed into government decision making.

This paper tries to answer the question: What were the key elements determining the relative success of the process that lead to NCA being used in or influencing key policy processes in Guatemala? To answer this question,

this paper presents the institutional arrangements that were used to build the accounts and some of the key policy uses that have occurred between the first publication of accounts in 2009 (BANGUAT and IARNA 2009) to the second iteration of accounts published and certified as official statistics in 2012 (INE, BANGUAT, and IARNA 2013).

12.1.1 | Overview of the Guatemalan natural capital accounts

Guatemala's history of developing NCA began in 2005 with the publication of a seminal paper by Castaneda (2006) that triggered a discussion in the academic sector, that in turn lead to the preparation of a project that was later funded by the Dutch Cooperation. Two sets of accounts have been produced, a first iteration covering 2001–6, and then a revised iteration for 2001–10. A full list and links to all account publications is found in the annex, and table 12.1 shows the scope of this work.

The Guatemalan Government and Rafael Landivar University jointly began the process of account development. There was relative clarity on the need to use an accounting framework that could integrate data and maintain well-defined relations among the data that would be useful for analytical purposes. The aim was to make optimal use of the micro data available to best serve the needs of policy analyses and create a maximum number of data checks. SEEA provided the ideal framework for this because its concepts and classifications are harmonized with the SNA, enabling analysis and projections to be linked to standard economic models.

The Guatemalan accounts present information about natural assets as well as the interactions between the environment and the more than 130 sectors of the economy. These interactions are analyzed using both an accounting and a thematic structure. In the accounting structure, the flows, assets, expenditures, and environmental transaction accounts are analyzed. In the thematic structure, the focus is on water, energy and emissions, forest, land and ecosystems, fisheries and aquaculture, minerals, and waste as well as a detailed analysis of environmental expenditures and transactions for the central state and municipal governments.

While the work is extensive, there are still gaps to be filled, including:

- Most of the work until now provides information in physical measures, focusing on SEEA Central Framework (SEEA-CF). Very few aspects of the accounts can be found in monetary terms. Thus, valuation of assets and flows of nonmarket ecosystem services are still undeveloped.
- Ecosystem accounts were never fully developed. With the guidance of the SEEA Experimental Ecosystem Accounts (SEEA-EEA), there is an opportunity to test an ecosystem accounting framework that is fully compatible.
- Some of the basic information for the accounts was estimated using the best available data at the time; however, new advancements in remote sensing and in basic economic statistics can be useful to obtain better measures. When updating the accounts, the estimations have a lot of space for improvement.

Table 12.1: Scope of the Guatemalan natural capital accounts

	Thematic Structure							
Accounting structure	**Forest**	**Water**	**Subsoil assets**	**Energy and emmisions**	**Land and ecosystems**	**Fisheries and aquaculture**	**Wastes**	**Expenditures and other transactions**
Asset accounts								
Natural resources	P+M	P	P+M			P+M		M
Ecosystems					P			M
Land and surface water	P	P			P			M
Flow accounts								
Natural resources	P	P	B			P		M
Ecosystem inputs				P	P			M
Products	P+M	P+M	P+M	P+M		P+M	P	M
Wastes and emissions	P	P	P	P		P	P	M
Expenditure and other transactions								
Environmental protection expenditure	M	M	M	M	M	M	M	
Natural resource management expenditures	M	M	M	M	M	M		
Aggregate indicators								
Depletion	M		M					
Intensity indicators	P+M	P+M	P+M	P+M	P+M	P+M	P+M	

Source: BANGUAT and IARNA (2009a).
Note: P= physial measures, M= monetary measures, P+M= physical and monetary measures.

12.2 | An approach to understanding NCA implementation in Guatemala

There is consensus that evidence is critical for effective policy making. Implementing NCA includes at least two aspects that are relevant for data-driven policy-making processes:

1. The producer side involves the design of effective institutional arrangements and a technical platform that will enable accounts to be built and produced year after year. The institutional arrangement requires resources and the necessary human capacity to build the accounts.
2. The user side considers how the evidence from the accounts connects to the policy process, how the accounts are embedded in the policy context of the country, and how they influence policy making and the actors involved.

The traditional way to study policy making is to break it down into stages. The stages are described in different ways by different people, but the basic ideas remain the same. Usual steps include identifying the problem or raising awareness to it (issue), selecting an alternative to tackle the issue of solve the problem (response), put the selective alternative into place and oversee its implementation (implementation), and evaluating the decision's effectiveness through time (monitoring and evaluation).

In Guatemala, the policy cycle is widely embedded in its planning instruments, which are developed under the guidance of the National Planning Agency (SEGEPLAN). It is through the lens of the policy cycle that SEGEPLAN assesses the effectiveness of some of the most relevant national policies, such as the National Development Plan (NDP), National Forest Policy (NFP), or the National Conservation Policy (NCP).

Natural account use in Guatemala is examined in this paper through the perspective of the policy cycle under the assumption that SEEA, as a multipurpose statistical framework, will or could inform the decision making at any stage of the cycle. For that purpose, a variation of the model proposed by Vardon, Burnett, and Dovers (2016) is used to understand the links among the uses of the accounts, the users of the accounts, and the policy cycle. In this variation, the policy cycle is simplified to show the four steps mentioned earlier.

There were several applications of the Guatemalan environmental accounts over the years. Three have captured the attention of the public, and the policy makers are listed here and described in more detailed in section 12.4.

- Integrated accounts and indicators. The integration of different thematic accounts allowed to explore the sustainability of the economic model in 2009 and help define a monitoring framework within a socioecological analytical framework.
- Forest accounts. The real contribution of forests to the economy is 2.5 percent of GDP versus the current 1 percent that is recorded in the national accounts. The forest stock is declining at a rate greater than 1.5 percent, with 96 percent of timber extractions uncontrolled. These results have been used as a key input in the new forest management strategy and in efforts to curb uncontrolled logging.
- Water accounts. The accounts revealed the situation at the national level and inspired analysis for specific regions, particularly for the metropolitan area of Guatemala City.

12.3 | Institutional setting

The Guatemala SEEA implementation process formally started in 2006 and was developed through a public-academic partnership that was fully funded until 2013. The reason for using this type of partnership was the limited capacity of government agencies to undertake account production, or even undertake some basic data collection activities, such as surveys.

Guatemala has a history of collaboration among government agencies and academic institutions on various topics. This usually helps overcome the challenge of limited resources and low capacity. For example, Rafael Landivar University has a long tradition of participating in the design of and offering general advice on household surveys that are part of the recurrent statistical operations of Institute of National Statistics (INE). Also, many agencies, such as the forest agency, Central Bank (BCG), and INE have representatives on the boards of universities.

For SEEA implementation, a partnership including INE, the Bank of Guatemala (BANGUAT), the National Planning Agency (SEGEPLAN), and the Ministry of Environment (MARN). Each of these institutions signed bilateral agreements with Rafael Landivar University and one of its research centers, the Institute of Agriculture, Natural Resources, and Environment (IARNA). These agreements included information-sharing commitments and the requirement of each agency to have a high-level official on the steering committee (SC). The agreements also assigned roles and responsibilities based on the project program that included aspects related to basic statistics, accounts, and policy.

To implement and monitor the accounts implementation, technical committees (TCs) were established for each thematic account (water, energy and emissions, forest, land and ecosystems, fisheries and aquaculture, subsoil resources, waste, and environmental expenditures and transactions) and were functional mostly prior to the publication of each iteration of the accounts. Later their role was not that clear, and they were never used as a platform to understand potential uses of accounts.

A key milestone of the process was the publication of accounts for 2001–10 as part of the official country statistics. The accounts were published after a 10-month process in which the agencies involved reviewed and certified the quality of the accounts using criteria such as relevance, accuracy, accessibility, interpretability, and other elements. A protocol was specifically designed for this purpose.

The sustainability of the process rests now on the institutional platform developed. However, the platform is still fragile and requires continuous funding, which was not secured when initial funding ended. IARNA continued to keep databases supporting the accounts stable and available, but government interest dwindled, until 2014, when the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) partnership began work in Guatemala.

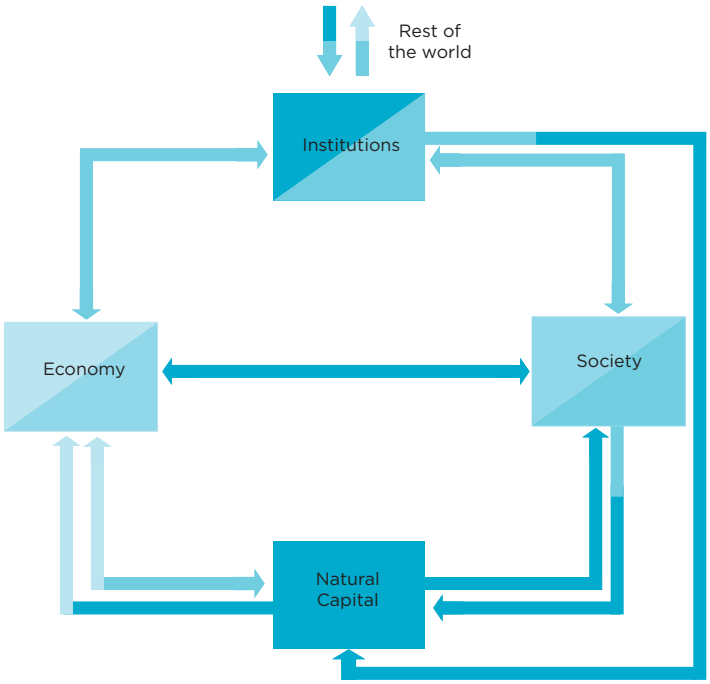
12.4 | Account findings and their use in the policy context

The accounts have been used to inform several issues, including sustainable development, as well as policies for forest and water management. These are described briefly below.

12.4.1 | Accounts inform sustainable development

In 2009, SEGEPLAN commissioned a study to understand the sustainability of the current development model and identify key indicators that could help monitor sustainable development (IARNA and SEGEPLAN 2009). Working with Rafael Landivar University and using the integrated SEEA accounts, a socioecological model was developed that informed key indicators that presented a first picture in terms of the state and trends of the system. The results of the analysis are presented in figure 12.1 in terms of the systems and relationships that should be prioritized (in darker lines). Figure 12.1 highlights the need to better understand and manage the relationships between the economy and the environment, especially the condition of the environment.

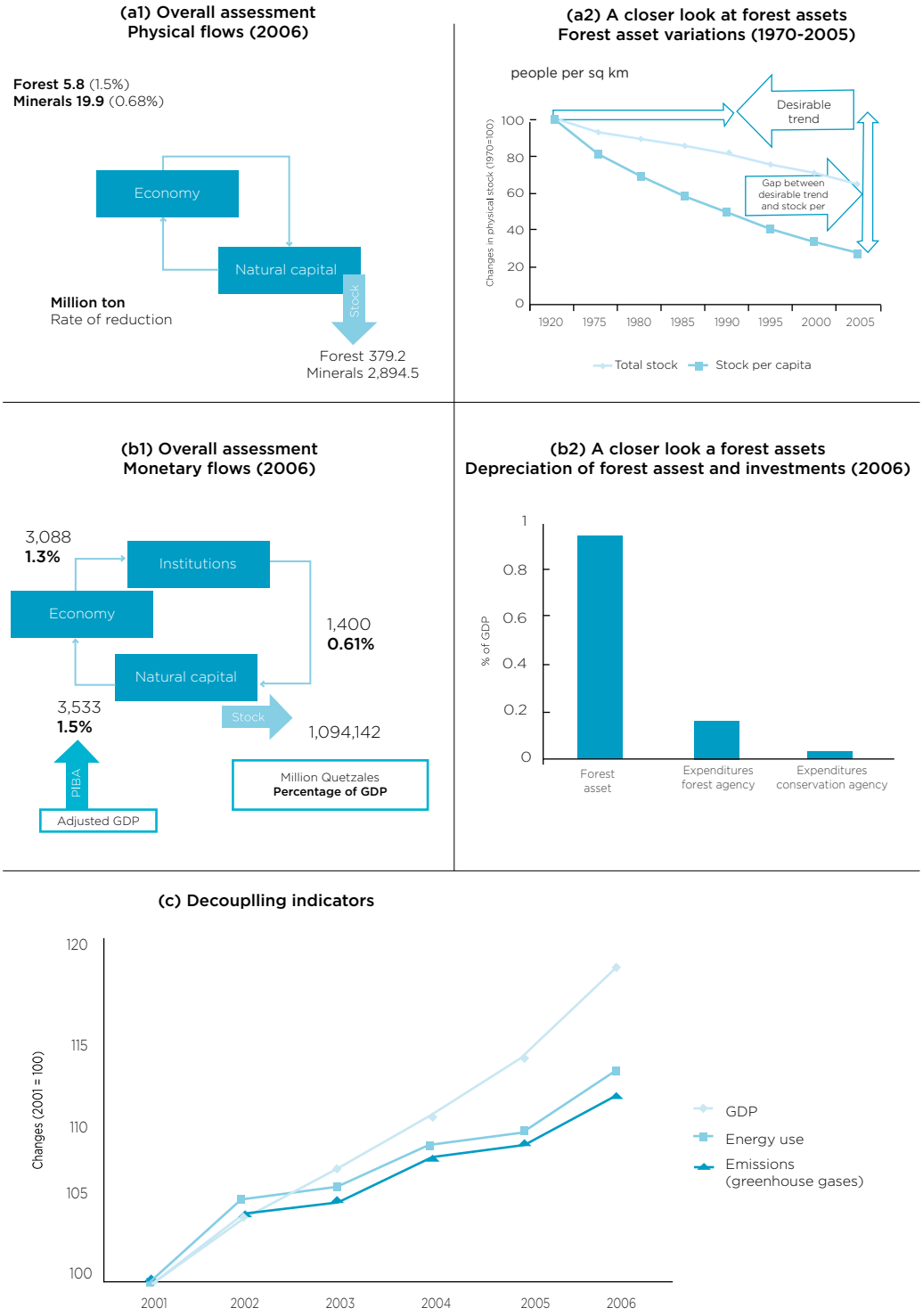
Figure 12.1: Priorities for the development of sustainable development indicators from NCA



Source: IARNA and SEGEPLAN (2009).
Note: Highest priorities are shown in darker lines.

This reality triggered the need for more information, and Rafael Landivar University again produced an independent report that reflected on these findings and linked SEEA to the socioecological system previously used (IARNA 2012). As shown in figure 12.2, three groups of indicators were used: physical stocks and flows, monetary stocks and flows indicators, and trends.

Figure 12.2: Examples of indicators of sustainable development from natural capital accounts in Guatemala



Source: Castaneda et al. (2009).

Five prominent conclusions from the report included:

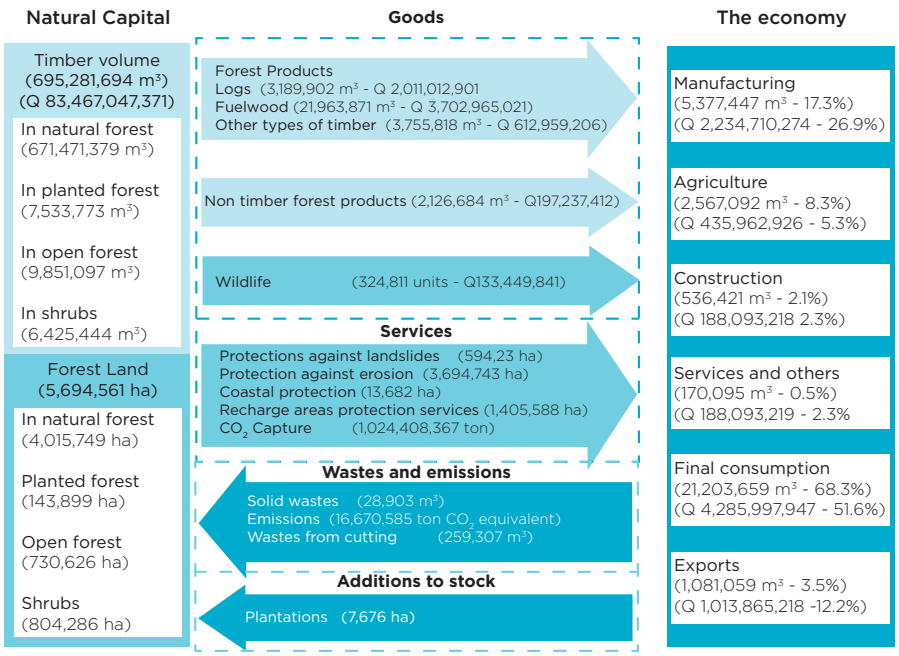
1. Natural capital is being reduced at a rate that it is undermining the total wealth of the country.
2. Flows from the environment to the economy exceed the regenerative capacity of stocks, causing degradation and exhaustion.
3. Flows from the economy to the environment cause further degradation of stocks.
4. Institutions are not reinvesting in natural capital or investment is limited.
5. The previous imbalances make the socioecological system unsustainable, and institutional responses are limited.

This new report generated internal discussions within SEGEPLAN and MARN and with other actors from civil society. Although these discussions did not lead to policy changes, there was at least a recognition that the economy does not operate in isolation of the environment and society and there is a need to analyze development issues according to the different pillars of sustainability.

12.4.2 | Accounts influence the forest strategies

In the 60 years leading up to 2010, Guatemala lost almost half its forest cover, equivalent to approximately 3.3 million hectares. The forest accounts measured the extent of deforestation and identified its main causes as agricultural expansion, urban development, uncontrolled timber harvesting, and the use of fuelwood. By making explicit the link between forests and the economy (figure 12.3), the accounts findings opened a lively debate between the stakeholders involved in Guatemala's forest sector, which led the government to strengthen the regulatory capacity of public agencies responsible for forests.

Figure 12.3: Links between the forest and economy revealed by the Guatemala forest accounts



Source: BANGUAT and IARNA (2009b).

The accounts revealed the extent of uncontrolled logging, which takes place outside institutional regulatory frameworks, and some of it is illegal. It also revealed households' high dependence on fuelwood: 64 percent of the population relies on fuelwood for their main source of energy, with high dependence in rural areas. And while the percentage of the population using fuelwood fell between 1964 and 2006, the actual amount of fuelwood used in cubic meters increased.

Data from the accounts were used to model the relations among deforestation, fuelwood, and energy security in the long term, and the results became headline news (Banerjee et al. this volume chapter 13). In response, the government presented a proposal to congress for a new public/private strategy for the sustainable production and efficient use of natural resources, including fuelwood and soils. The strategy combines policies and incentives for forest protection, rehabilitation, and reforestation, with the intention to create over 20,000 direct and 60,000 indirect jobs and ensuring fuelwood as well as timber supply for small and medium sized industry.

12.4.3 | Accounts inform local water instruments

The information provided by the water accounts is helping to foster dialogue across sectors and is also informing research. For example, a study led by the Guatemalan Municipality looked at the intensity of water use in metropolitan areas of Guatemala. The detailed information is helping municipalities prepare their long-term goals for water security. Demand is linked to better hydrological models that predict water supply and the effects of different land uses and climate change on water availability. A complementary study indicated that restoring natural forests in the water recharge areas around Guatemala City could help increase resilience to climate change, slowing down runoff, and improving infiltration into the soil and groundwater.

Alongside this research and analysis, a policy that manages extraction permits that aims to match the supply and demand of water and prevent conflict was investigated. The study included some measures of households' willingness to pay for conservation and reforestation of these. The Metropolitan Water Conservation Fund Area (FONCAGUA) emerged from this dialogue, bringing together local authorities, the municipal water company, civil society, nongovernmental organizations (NGOs), and other stakeholders.

12.5 | The road ahead

To achieve full implementation of NCA in Guatemala, information that is derived from accounts must contribute to existing policy processes and initiatives that have strong support from different actors (public and private). In a review commissioned by the current SC, the policy priorities to which the accounts can contribute were grouped in four broad, thematic areas:

1. Inclusive green growth and poverty reduction

2. Food security

3. Climate change, risk, and economic growth

4. Economic and environmental sustainability

These areas are related to the overarching country's national development plan, "K'atun: Our Guatemala 2032." There are multiple connections and links among these issues, and the accounts that could inform them, in Guatemala.

12.5.1 | Inclusive green growth and poverty reduction

In general, NCA can help to better understand the impact of the economy on the environment and the contribution of the environment to the economy, and to identify opportunities for innovation and promote activities that could lead to inclusive green growth. Flows and assets can also help inform the national development plan and the competitiveness strategies, which are part of the current discussions in Guatemala. By exploiting the analytical potential of these accounts through modeling tools, the accounts can also provide the basis for the assessing the effectiveness of current or proposed policy instruments, such as those related to protected areas, the forest sector, and energy.

12.5.2 | Food security

At the national level, NCA can inform issues on food security and food sovereignty. These are critical for future development, and poverty reduction is a primary concern of the National Development Plan. Current scenarios of climate change indicate a potential undermining of the country's capacity for food production and thus there is a need for a clear understanding of the relationship between agriculture activities and the ecosystems that support these activities. Such understanding can allow better decisions on alternative land uses and ensure that sufficient ecosystem services are preserved for agricultural production. Agriculture-environment accounts, such as those being proposed by the United Nations Food and Agriculture Organization (FAO), could provide more information for strategic decisions on issues of food security and sovereignty.

12.5.3 | Climate change, risk, and growth

NCA can deepen the analysis of strategic natural capital to meet economic and social priorities. This can improve policy responses to climate change by managing threats to particular industries (for example, agriculture and water supply) and preserving key natural capital for realizing the potential of tourism in the country. Ecosystem accounts in selected areas could inform decisions at both the country level as well as in the specific areas of study.

12.5.4 | Economic and environmental sustainability

From a macroeconomic perspective, NCA indicators can send the right signals to decision makers to reduce the negative externalities and promote green growth. The current macroeconomic indicators could be complemented by NCA indicators to better assess the sustainability of the current trends.

12.6 | Final remarks

Although the technical aspects of the accounts were developed rigorously, gaining international recognition, the country now faces huge challenges. Funding has been reduced and 10 years of NCA experience is at risk of ending abruptly. The last challenge is the development of clearer links among the natural capital accounts and policy, which in turn will help to institutionalize NCA into the public sector. WAVES can greatly contribute to facing these challenges soon.

The Guatemalan case shows that the formalization and institutionalization process is gradual and that the starting point is not necessarily in the public sphere. Bringing together technical and financial capabilities from nonpublic institutions can enrich the process and give it more credibility at the national level, especially when it is intended for the findings to influence the policy cycle.

Some final key messages:

- Public-academic partnerships are possible and effective in developing-country contexts.
- Accounts were produced and credibility and rigor were added by the presence of academic institutions.
- Institutionalization is about establishing clear and systematic ways to produce and use the accounts. Involving key stakeholders, especially academia, can help confront resource constraints and provide stability to the process.
- The objective nature of the accounts enables collaboration on certain aspects of compilation and capacity building, and other aspects will be left to be developed as per the roles of the agencies and academic institutions.

12.7 | Acknowledgments

The authors would like to acknowledge the leadership of Rafael Landivar University and the Institute of Agriculture, Natural Resources and the Environment (IARNA) for their past work and continued efforts to develop methodologies and implement natural capital accounts in Guatemala. We are thankful to the editors for their helpful comments, especially Michael Vardon. Work on SEEA accounts in Guatemala was funded by the Dutch cooperation from 2006 to 2012. This paper was funded by the World Bank in the context of the WAVES implementation program in Guatemala.

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13 | The Integrated Economic-Environmental Modeling Platform: An Application to Guatemala's Fuelwood and Forestry Sector

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Summary

This chapter presents the Integrated Economic-Environmental Modeling (IEEM) platform. IEEM advances the state of the art in decision-making frameworks, enabling policy makers to understand the full range of economic and environmental implications of public policy and investment alternatives. IEEM utilizes data organized under the international System of Environmental-Economic Accounting (SEEA), which is compatible with the economywide frameworks that are regularly used to measure economic performance. While conventional economic impact analysis quantifies the effects on standard indicators, such as gross domestic product, income, and employment, IEEM goes one step further, capturing impacts on indicators reflecting stocks of environmental resources, environmental quality, and wealth, such as genuine savings. While a country's natural capital accounts present a snapshot of past natural capital use, IEEM is the first forward-looking platform that integrates natural capital accounts and enables us to ask "what if" questions to estimate how the economy and environment will be impacted. To demonstrate IEEM capabilities, we apply it to Guatemala's fuelwood and forestry sector, where fuelwood accounts for 57 percent of the nation's energy consumption, and its current levels of unsustainable use are causing deforestation and environmental degradation.

13.1 | Introduction

Computable general equilibrium (CGE) models are powerful tools that provide insights on policy impacts on economic indicators such as gross domestic product (GDP), income, and employment. The recent publication of the first international standard for environmental-economic accounting, the System of Environmental-Economic Accounting Central Framework (SEEA-CF; UN et al. 2014), amplifies the analytical strength of this approach. This chapter describes the Integrated Economic-Environmental Modeling platform (Banerjee et al. 2016, 2017), a decision-making platform that provides a quantitative, comprehensive, and consistent framework for analyzing public policy and investment impacts on the economy and the environment.

IEEM embodies three innovations that exist in no other decision-making platform: first, IEEM captures economy-environment interactions by integrating rich environmental data based on the SEEA. The SEEA, which is the core database for IEEM, is consistent and compatible with the System of National Accounts (SNA), which countries traditionally use to measure economic performance. Second, IEEM includes specific environmental modeling modules for different economic sectors. For example, the forestry or fisheries sectors' production structure, constraints, and policy issues differ from those of the automobile manufacturing sector. Each of IEEM's environmental modules was designed to capture the specific dynamics of a particular sector using environmental resources as inputs. And third, IEEM generates indicators that go beyond GDP, for example, IEEM is the first forward-looking modeling platform that generates indicators that reflect changes in human well-being and wealth, such as genuine savings and variations of the inclusive wealth index.

For the first time in an ex ante economic analytical framework, IEEM captures how depletion and degradation of the natural resource base and emissions affect national wealth and prospects for future economic growth. Wealth may be understood as the aggregate value of manufactured capital, natural capital, and human and social capital. Nobel Laureate Joseph Stiglitz argued that a firm's health and potential are assessed based on both its income and its balance sheets. Prior to the SEEA, countries mostly reported income flows, while information on environmental resources, and thus a key dimension of national assets and the national balance sheet, was seldom reported. The SEEA provides a framework for accounting for environmental resources in the national balance sheet, which, integrated into IEEM, enables the ex ante assessment of the impacts of public policies, investments, and exogenous shocks on both income and wealth.

The section that follows describes the main features of the IEEM database. Section 13.3 provides an overview of the modeling framework. Section 13.4 applies an IEEM developed for Guatemala to the issue of fuelwood scarcity and the forest sector. The chapter closes with future directions and applications of the IEEM platform.

13.2 | The SEEA and the IEEM database

In 2012, the United Nations Statistical Commission adopted the SEEA-CF as the first international standard for environmental-economic accounting. A critical contribution of the SEEA is in the extension of the asset boundary to include environmental processes that do not have a defined owner or receive compensation. In monetary terms, the asset boundaries of the SEEA-CF and the SNA are the same. In physical terms, however, the boundary of the SEEA is broader and includes all natural resources and areas of land of an economic territory, not limited to only those resources with a market value. SEEA makes it possible to track natural capital inputs to the economy, the output of residuals in the form of emissions and effluents from the economy back to the environment, and changes to natural capital stocks. Moreover, a particularly useful feature of the SEEA for integrated modeling purposes is its ability to combine physical and monetary quantities in a single accounting framework.

The various steps in developing the integrated database that underpin IEEM are detailed in Banerjee et al. (2016, 2017). In essence, the first step is to generate an Environmentally Extended Supply and Use Table, which draws on data from both the SNA and the SEEA. This extended table accounts for environmental inputs into the productive processes of economic sectors; the waste and emissions that result from these processes; and the waste and emissions arising from household consumption.

In the second step, based on the Environmentally Extended Supply and Use Table, an Environmentally Extended Social Accounting Matrix is constructed for the country or region. A social accounting matrix tracks the circular flow of income among economic sectors, households, government, and additional accounts that include the savings and investment and export/import accounts. The environmental extension to a standard social accounting matrix includes satellite matrices to track stocks and flows of environmental resources in physical units.

13.3 | The Integrated Economic-Environmental Modeling Platform

IEEM uses a standard recursive dynamic CGE modeling framework as its starting point and integrates environmental modules that are specific to each environmental resource. Similar to the SEEA, IEEM was designed to enable flexible and modular implementation with environmental modules that may be switched on or off depending on whether SEEA data are available. The IEEM for Guatemala (IEEM-GUA) includes features, dynamics, and policy issues specific to forests and deforestation, land, water, energy and emissions, mineral resources, aquatic/fisheries resources, waste, and residuals.

The forestry and deforestation module accounts for the natural growth rate of forest resources. Deforestation occurs when the rate of timber extraction is higher than the natural growth rate of forests and reforestation efforts combined. In the land module, the treatment of agricultural land is similar to that of other factors, such as capital and labor, but its availability may be fixed or flexible in supply. The water module allows for the modeling of water used in agricultural activities. The energy and emissions module is structured to include emissions generated through production processes or the use of goods and services by households and other final uses. The dynamics of the mining sector are determined by the size of known recoverable reserves, where the smaller the remaining stock, the higher the marginal cost of extraction (Ghadimi 2007). This dynamic is modeled by reducing total factor productivity when new resource discoveries do not compensate for extraction. The fisheries module captures stock dynamics as a function of the quantity of fish harvested, the intrinsic growth rate of the resource, and the carrying capacity of the environment. The module includes a catch-per-unit-effort production function that assumes the catch-per-unit-effort is proportional to the existing stock (Conrad 2010).Finally, the waste and residuals module tracks the production and use of waste and residuals (for example, hospital, paper, glass, rubber waste, and so forth). For the purpose of policy simulations, in each module, resource use can be bounded, efficiency levels can be set higher or lower, or price boundaries can be set.

13.4 | IEEM-GUA applied to Guatemala's fuelwood and forestry sector

Sixty-seven percent, approximately 2.1 million, of Guatemalan households use fuelwood as a primary source of energy, with fuelwood accounting for 57 percent of the country's overall energy use in physical terms. Fuelwood is primarily used in cookstoves for cooking food and heating homes, and it also serves cultural purposes (Bielecki and Wingenbach 2014). Increasing demand for fuelwood is resulting in rapid deforestation and forest degradation (INAB, IARNA-URL, and FAO 2012), fuelwood scarcity (the current fuelwood deficit is over 10 million m^3/year), and greater demands on time for collection, especially that of women and children. Moreover, the use of open cookstoves is well known to have detrimental health effects, increasing the probability of respiratory illness by 31 percent (SEGEPLAN 2010), the premature death of over 5,000 people per year, and productivity losses of approximately 1 percent of GDP (Global Alliance for Clean Cookstoves 2014).

The National Strategy for Sustainable Production and Efficient Use of Fuelwood (2013–24; INAB 2015) was developed to address this issue by establishing forest plantations and promoting efficient household fuelwood use through more efficient fuelwood cookstoves, thereby aiming to reduce the fuelwood deficit by 25 percent. Additionally, the PROBOSQUE strategy provides incentives for reforestation, including reforestation for energy purposes, and is one of the largest such programs in Latin America and the Caribbean. The IEEM-GUA platform can help explore the economic, environmental, and wealth impacts of both strategies.

13.4.1 | Scenario design

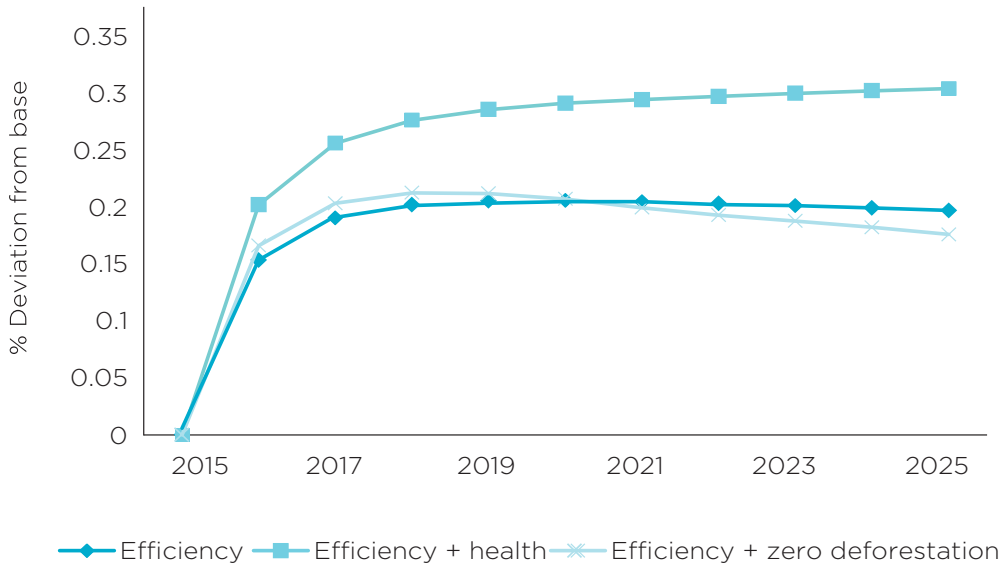
Three scenarios were developed to explore the impacts of Guatemala's fuelwood strategy and PROBOSQUE (Programa de Incentivos para el Establecimiento, Recuperación, Restauración, Manejo, Producción y Protección de Bosques) from 2016 to 2025. All three scenarios are compared to the baseline "business-as-usual" scenario, which assumes that past trends will continue to 2025. The "efficiency" scenario imposes a 25-percent increase in household fuelwood consumption efficiency through the use of a more efficient cookstove. The "efficiency + health" scenario includes the same policy measure as the efficiency scenario, but incorporates the anticipated positive health impacts that would arise with increased household fuelwood efficiency. These positive health impacts are reflected in greater productivity of household members.[1] Based on the work of García-Frapolli et al. (2010), the number of hours saved due to improved efficiency of household fuelwood use was estimated and show a conservative increase of 0.125 percent in rural labor productivity. A final "efficiency + zero deforestation"

scenario includes the same policy measure as the efficiency scenario, along with an enforced policy of zero deforestation.

13.4.2 | Results and analysis

Figure 13.1 shows private consumption as a proxy of household welfare. The improvement in fuelwood efficiency would have a positive impact on well-being of approximately 0.2 percent, with respect to the baseline, by 2025. The efficiency + zero deforestation scenario would also have a positive impact, though to a slightly lesser degree. This difference would be driven by a decrease in wages as a result of the constraint on deforestation, given the decrease in the output of agriculture, which is a labor-intensive sector. The efficiency + health scenario would have the greatest positive impact, equivalent to 0.3 percent in 2025. It is noteworthy that, in all cases, increased household consumption has implications for rates of consumption of environmental resources, as well as levels of waste and emissions returning to the environment. The consideration of wealth impacts later in this section is thus important for assessing both positive and negative aspects of increased household income and consumption. GDP impacts are positive across scenarios: 0.18 percent deviation from the baseline by 2025 in the efficiency scenario, 0.16 percent in the efficiency + zero deforestation scenario, and 0.31 percent in the efficiency + health scenario.

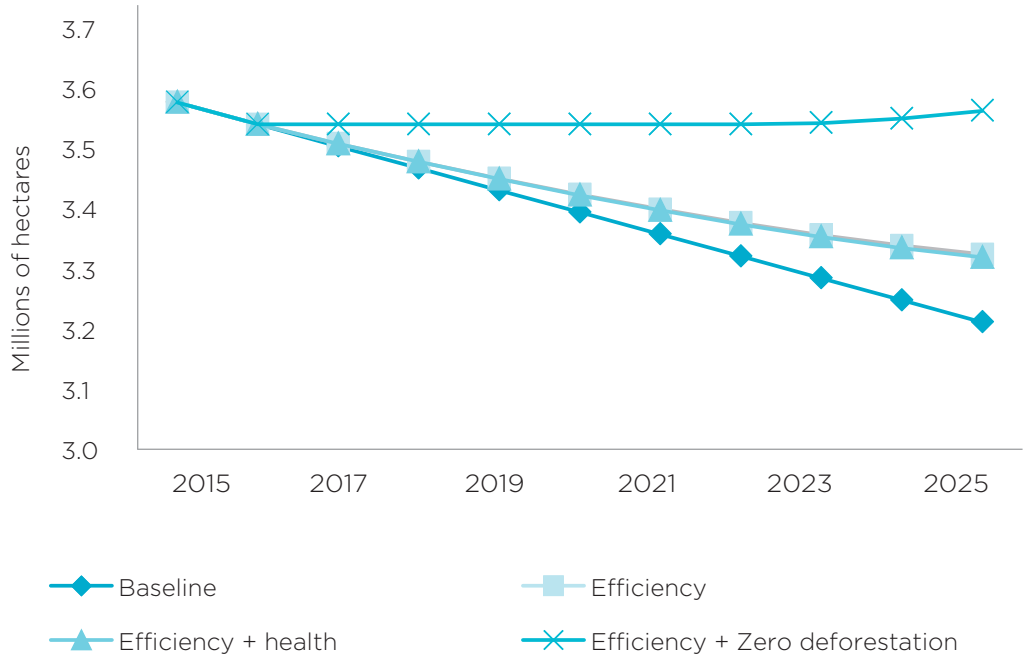
Figure 13.1: Household private consumption



Source: Authors' own elaboration.

An interesting effect of the change in fuelwood consumption efficiency is the rebound effect we see in household energy consumption. The efficiency scenario would result in a 12 percent decline in the value of fuelwood consumption, which would be much less than the 25 percent increase in fuelwood use efficiency. In terms of energy used, the increase in efficiency would also induce a behavioral change in response to increased fuelwood efficiency by cooking more and heating the homes to a higher temperature and/or for a longer period of time. The scenario would also result in small increases in the consumption of other forms of energy, with an overall increase in the total energy consumption bundle. This effect is driven by the decrease in the cost of the energy bundle as well as an income effect due to the savings on fuelwood consumption arising from the fuelwood efficiency shock.

Figure 13.2: Hectares of standing forest

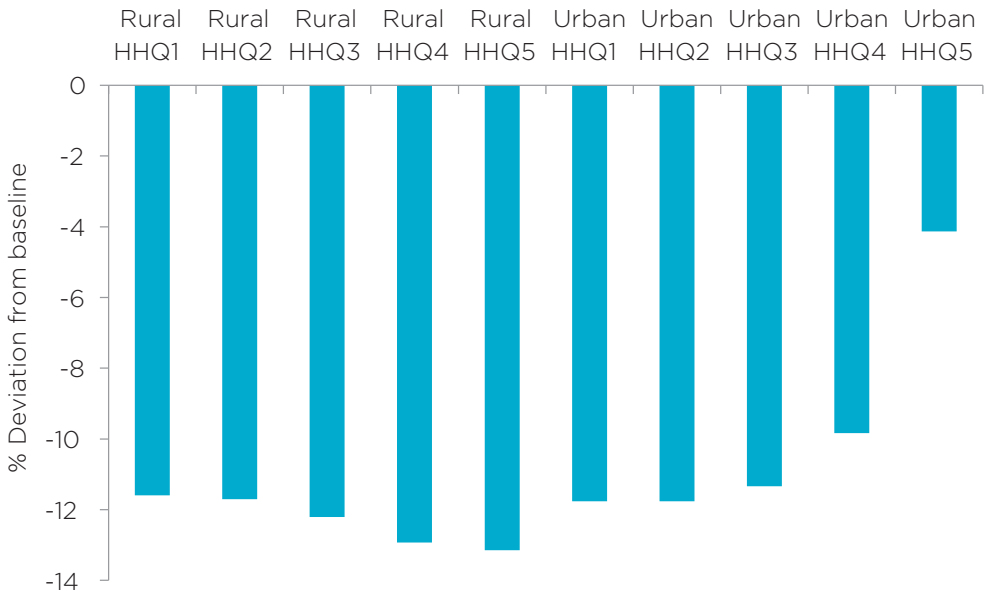


Source: Authors' own elaboration.

The three scenarios have a clear impact on the stock of forest resources. Figure 13.2 shows that the efficiency and efficiency + health scenarios would result in a reduction of the loss of forest area by 100,000 hectares, while the efficiency + zero deforestation scenario would maintain forest cover at its 2016 level.

Figure 13.3 demonstrates that those households consuming a greater share of fuelwood, particularly the poorer rural households, would experience the greatest shift in their emissions profile in all scenarios. With the poorest households spending the greatest share of their income on fuelwood (up to 15 percent), they also benefit the most from the fuelwood strategy in terms of income savings and health benefits. In terms of sectoral emissions, the electricity sector and food processing sectors are currently the greatest emitters of greenhouse gases, followed by nonmetallic mineral production and transportation services. Overall emissions for the Guatemalan economy are -6.8 percent, -9.2 percent, and -12.1 percent lower in 2025 when compared to baseline emissions.

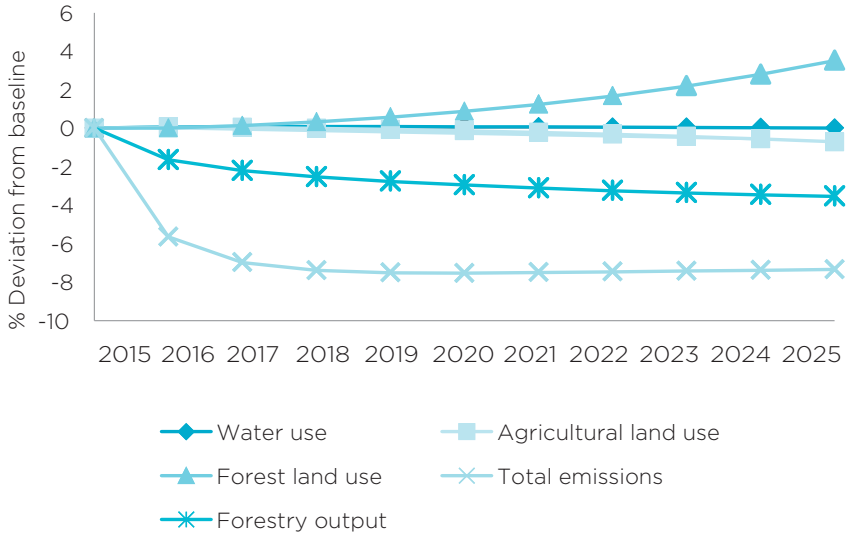
Figure 13.3: Disaggregated household greenhouse gas emissions in 2025



Source: Authors' own elaboration.

Figure 13.4 illustrates some of the indirect impacts that, prior to IEEM, would require more than one model to capture. Under the efficiency scenario, there would be a decline in agricultural land use with a concomitant increase in the stock of forestland as deforestation slows. Forestry output would decline with the fall of fuelwood prices. Water use would remain similar to baseline consumption despite the small decline in agricultural output. Total greenhouse gas emissions would fall as a result of efficiency improvements.

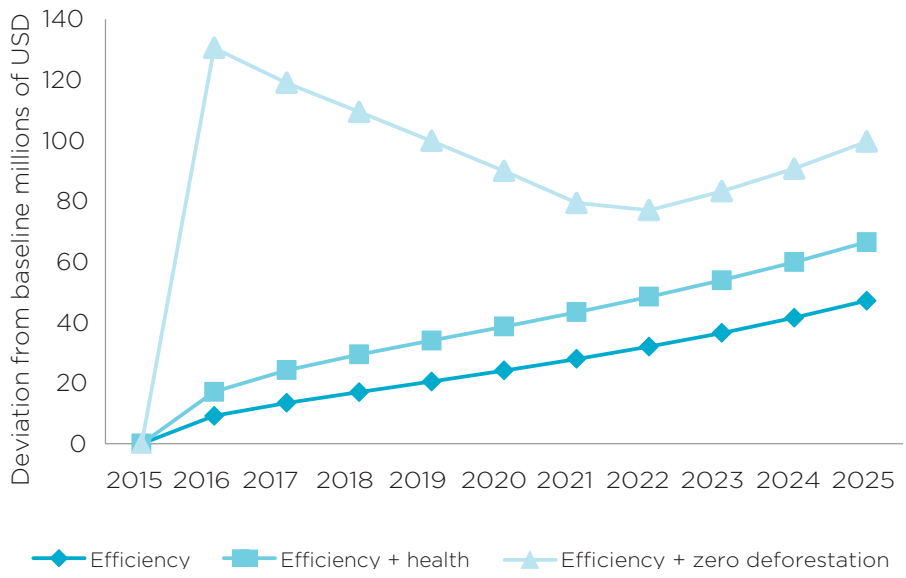
Figure 13.4: Multiple impacts of household fuelwood use under the efficiency scenario



Source: Authors' own elaboration.

To focus on IEEM's environmental dimension, genuine savings is estimated without including investment in education as a proxy for human capital; it is calculated as gross national savings, less forest depreciation, mineral depreciation, and the cost of emissions.[2] Figure 13.5 shows the impacts on genuine savings. The efficiency and efficiency + health scenario would result in a steady increase in genuine savings following implementation of the fuelwood strategy. The efficiency + zero deforestation scenario would have the most wealth-enhancing impacts. Once both fuelwood and zero deforestation strategies are implemented, there would be a sudden increase in genuine savings, greater than in the efficiency + health scenario. This is the result of the full halt of deforestation. The drop and subsequent rise of savings is explained by the sudden increase in forest stock that would follow from the implementation of PROBOSQUE and the movement toward equilibrium between the natural rate of forest growth and the legal forest harvest.

Figure 13.5: Scenario impacts on genuine savings until 2025



Source: Authors' own elaboration.

13.5 | Concluding remarks

The IEEM platform enables the analysis of policy impacts on the economy and the environment in a quantitative, comprehensive, and consistent framework, explicitly considering how economic activities critically depend on the environment, both as a source of inputs and as a sink. Prior to the SEEA, national accounting focused on national income flows. With the SEEA, countries are empowered to report on the environmental dimension of their national balance sheet. In the application of IEEM to the fuelwood and the forestry sector of Guatemala, the environmental impacts of two strategies to improve fuelwood availability and reforestation would be positive in general, with reductions in fuelwood use, deforestation, and harmful greenhouse gas emissions. The reduction in greenhouse gas emissions, in turn, would have positive health impacts, especially on rural poor households, contributing to improvements in labor productivity and higher incomes. For the first time in an ex ante economic analytical framework, IEEM estimates the impact of these policies in terms of national wealth. From this perspective, both the fuelwood strategy and the forest incentive policy would enhance Guatemala's underlying wealth, and thus its prospects for future economic growth. This analysis provides evidence in support of the

fuelwood and forest incentive policy for reducing deforestation and improving livelihoods, particularly for rural areas.

IEEM can provide critical input into the public policy cycle, particularly in the formulation stage. Indeed, economywide models have long been considered the "workhorse" of public policy analysis (Jones 1965). IEEM as a forward-looking framework can be used to ask "what if" questions, test alternative policy approaches, and assess impacts and trade-offs for the economy and the environment. IEEM can be applied to the prioritization of policies and specific lines of action for the allocation of scarce public resources, and in some cases, can substantiate a business case for public policy and investment decisions. Furthermore, scenario analysis with IEEM can provide a common basis for dialogue among diverse stakeholder groups and interests.

In the absence of IEEM, in conventional policy analysis, including partial equilibrium analysis, a policy may seem positive for a specific economic sector or for economic growth overall. Consideration of the entire economy and the environmental dimension, however, adds significant value to the analysis by shedding light on potentially perverse impacts on other sectors and on the environment. Many of the indicators generated by IEEM are the ones of most interest to policy makers, such as GDP and employment. IEEM further enriches policy debate with the environmental-economic indicators it provides, such as impacts on stocks of natural capital and environmental quality. While decisions are likely to always have some political underpinnings, the power of the IEEM approach is that it is evidence based, providing objectivity and transparency to the decision-making process. IEEM thus enables policy and decision makers to understand the full range of economic and environmental implications of public policy and investment alternatives before implementation.

13.6 | Acknowledgment

This work was funded by the BIO Program of the Inter-American Development Bank.

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13.9 | Endnotes

1 There are a handful of studies that have used measurements from improvements in household air quality arising from the more efficient use of fuelwood to estimate the economic benefits of improved fuelwood use efficiency. For example, García-Frapolli et al. (2010) account for the number of work hours lost that were attributable to sickness arising from open cookstoves.

2 Genuine savings reflects policy impacts on national wealth and the national balance sheet and is calculated as national savings adjusted for depletion of the underlying environmental resource base and pollution damages, with the addition of expenditure on education as a proxy for investment in human capital (UN et al. 2005). More specifically, adjusted genuine savings in IEEM is calculated as follows. Depreciation is the reduction in the value of an asset through time due to wear and tear; depreciation of the forest stock is calculated using IEEM results as the product of the annual volume of deforestation and the output price of timber in that year. Similarly, depreciation of mining stocks is calculated using IEEM results as the product of the annual volume of mineral extraction and the output price. Emissions damages are calculated based on IEEM results as the product of annual greenhouse gas emission and the value used by the World Bank in its estimation of adjusted net savings estimations, which is equal to US$20/ton of carbon dioxide equivalent (World Bank 2011).

14 | Linking Natural Capital Accounts and Development Policy: The Case of Indonesia's Intended Nationally Determined Contribution

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Nissa Cita Adinia, WAVES Indonesia and Universitas Indonesia

Summary

This chapter discusses the government of Indonesia's (GOI) efforts to develop Indonesia's Intended Nationally Determined Contribution (INDC) to reduce greenhouse gas (GHG) emissions by factoring in better natural resources data. This chapter also presents a system dynamics model that reveals the relationships among natural resource wealth, the well-being of the Indonesian population, their economic activities, and GHG emissions. Improving the collection, availability, and access to information on natural resource stocks and flows is critical to understanding the causal relationships within the system dynamics modeling.

GOI has incorporated natural capital accounting (NCA) into national accounts for several years—the Integrated System of Environmental Economic Accounting (SISNERLING) is Indonesia's approach to NCA. Efforts to "bridge" the existing NCA and development policy have not been systematic, but rather have been tackled on a case-by-case basis. As this chapter further discusses, there is both a need and good scope for better aligning a stronger SISNERLING and climate change policy, and in the process, improving the latter.

The chapter concludes with a discussion of the challenges of and efforts for upgrading SISNERLING. One way to improve the system, and accelerate demand-driven NCA, would be through cooperation between SISNERLING and the Indonesia WAVES (Wealth Accounting and the Valuation of Ecosystems Services) program.

14.1 | Introduction

This chapter describes how natural resource data have been used to develop Indonesia's intended nationally determined contribution (INDC) to reduce greenhouse gas emissions, how NCA may further improve climate change policy, and the challenges that remain.

Addressing climate change issues is one of the GOI's main national development priorities, recognizing this is a significant part of achieving the Sustainable Development Goals (SDGs). In 2009, Indonesia committed to voluntarily reduce GHG emissions by 26 percent by 2020 relative to business as usual (BAU), and to a higher target of up to 41 percent with international support. This commitment was confirmed in Presidential Decree No. 61, Year 2011, on the National Action Plan for Reducing Emissions of Greenhouse Gases (RAN-GRK). RAN-GRK provides a framework for central and local governments, as well as other stakeholders, to implement the GHG emissions reduction activities planned for 2010–20.

In 2015, as part of the government's long-term Conference of the Parties (COP21) negotiation in Paris 2016, the commitment was restated in its INDC—an unconditional reduction in GHG emissions of 29 percent below BAU emissions by 2030. The government issued this revised commitment based on detailed BAU baseline and mitigation scenarios developed and modeled as part of the ongoing implementation of the RAN-GRK review by the Ministry of Development Planning (Bappenas) and associated stakeholders. This kind of dynamics modeling depends on significant data collection and major calculations across sectors, demanding quality data on stocks and flows of natural resources, and other social and economic parameters.

14.2 | The need for NCA to make better development decisions—by bridging missing links between data and policy

Indonesia is facing increasingly severe environmental degradation and risks of natural resources scarcity, all of which are being exacerbated by the challenges of climate change. A recent World Bank study estimated that the country's 2015 forest fires alone cost the country more than US$16 billion in economic disruption (World Bank 2016).

Over the past 10 years, the demand for information on natural resources, such as national assets, has increased in Indonesia. Improved information is a legal mandate in Indonesia (Law No. 32/2009 on Environmental Protection and Management [UUPPLH 32/2009]), requiring all departments to develop an inventory of all natural resources and use methods such as NCA. The State's Supreme Audit Agency (BPK), in its review report on the transparency of central government fiscal implementation in 2012–13, recommended that the government should document natural resource conditions and values (Irawan 2017), including legal ownership and economic values, in a comprehensive report. In 2014, the House of Representatives endorsed this requirement, calling on the government to take systematic action in presenting information on natural resources, thus improving the state's internal financial management. Meanwhile, the Corruption Eradication Commission also focused on natural resource sectors in the prevention and eradication of corruption, covering energy security and environment (energy, oil and gas, mining, and forestry). The commission has initiated a series of monitoring and evaluation activities through the National Movement to Save Indonesia's Natural Resources to accelerate how the state records natural resource quantities, conditions, and values (KPK 2017).

Following the United Nations Framework Convention on Climate Change (UNFCCC) COP13 event in Bali, the GOI truly prioritized its climate change actions. Its commitment to emission reductions was complemented by work to develop a robust policy on climate change. In support of this, the GOI developed a dynamic modeling framework that utilizes information on natural capital stocks and flows as per the NCA framework. As the model was developed, the GOI realized the crucial need to assess information on the cross-sectoral interlinks between natural resources and human and physical capital stocks and flows. Although the GOI has long incorporated natural capital into national accounts, problems arise because line ministries (which produce their own data) and Indonesia's statistical agency (BPS, the sole national agency mandated to produce natural capital accounts) are not systematically linked to each other. For example, forest inventory, agriculture statistics, and energy statistics are not yet aligned with asset accounts produced by the statistical agency.

Problems also occur because Indonesia's existing NCA (the Sistem Neraca Lingkungan/SISNERLING) has not yet directly fed into development policy decisions. SISNERLING was constructed without clear links to development policy and thus, at the moment, there is a disparity between development policy decisions and the information currently provided by the SISNERLING. Efforts to "bridge" the information divide have not been systematic, but rather have been implemented mostly on a case-by-case basis. A good example, however, which we can learn from, are the inputs to developing climate policy through INDCs.

14.3 | Developing Indonesia's INDC

Prior to the COP21 climate conference in Paris, countries around the globe agreed to publicly outline what post-2020 actions they intended to take under a new international climate agreement, their INDC. These INDCs will form a foundation for climate action post-2020 when the new agreement will go into effect. As an active party to the UNFCCC, Indonesia has already prepared its INDC. Because the INDC must be integrated deeply into national

development plans and actions, Indonesia put significant efforts into a comprehensively informed preparation process.

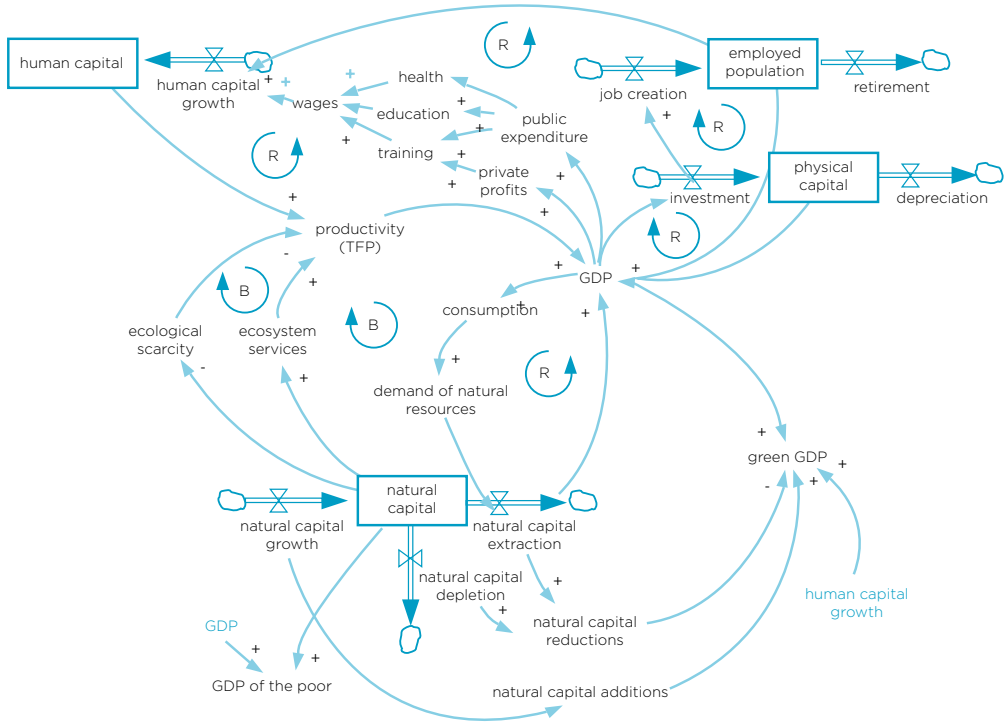
Indonesia's INDC was built on a robust series of reviews of the existing national GHG emissions reduction action plan (RAN-GRK).[1] This plan aims to provide a clear overview of GHG emission-reduction achievements, evaluate the strengths and weaknesses of national efforts to address climate change, and thus produce valuable insights and guidance for developing and implementing future national climate policy.

The RAN-GRK review covers data collection, the identification of calculation and projection methods, and the development of tools used to establish emission baselines and mitigation scenarios and targets for each of four sectors (land-based, energy, industry, and waste management). Developed by Bappenas in collaboration with six line ministries and the Bandung Institute of Technology (ITB), the RAN-GRK review employs a system dynamics model that generates emissions pathways that can be used in decision support for climate policy.

The system dynamics model focuses on causal relationships among stocks (for example, natural resources, population, technologies) and flows (for example, demand for water and energy, resulting emissions). These relationships can be used to show how a system evolves over time, and it can also be used to model rates of change, feedbacks, and time lags. It can explore "what-if" scenarios that describe what could happen under certain assumptions about the future (emissions scenarios do not predict the future, but rather present a set of projections and analysis to see which drivers and decisions would have most impact).

The model covers the links among the wealth and well-being of the Indonesian population, their economic activities, and their associated GHG emissions. Figure 14.1 illustrates the interactions modeled to achieve the INDC, notably those among natural capital, human capital, and physical capital and population.

Figure 14.1: Stocks, flows, and causal relationships among natural capital and other forms of capital



Note: The causal loop was established for Indonesia Green Economy Model (IGEM) which has a similar objective with Indonesia INDC. R refers to a reinforcing system or loop where linked components have positive relationships. For example, increased consumption increases demand on natural resources; increased natural resources demand leads to natural resource extractions. B refers to balancing loops where each component has negative relationships.

Source: Bappenas (2014).

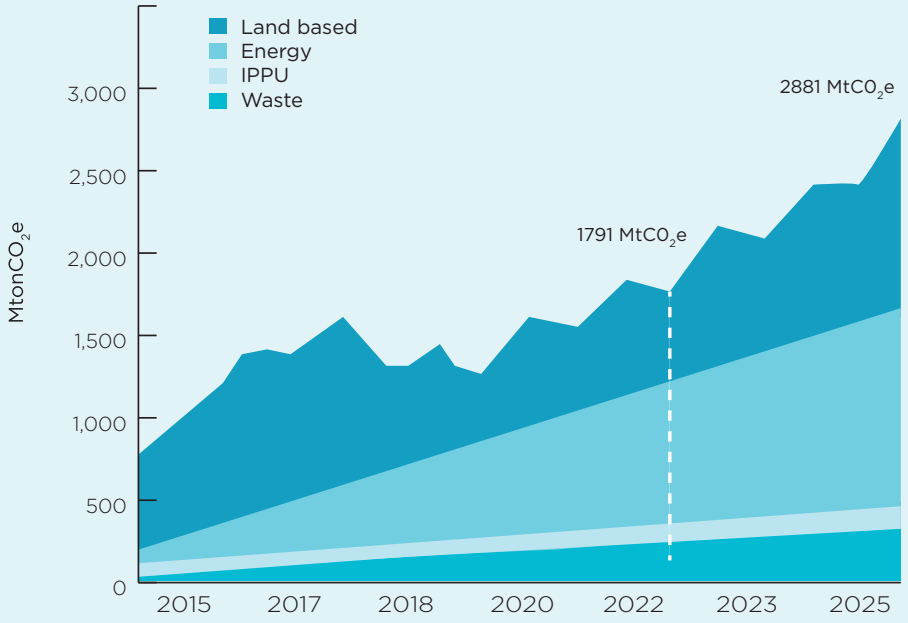
Information on natural resource stocks and flows is important and must be available to run the INDC model. For building the INDC model, only secondary data on stocks and flows have been available thus far, with most of the data having been provided by line ministries.

Box 14.1: Calculating Indonesia's baseline emissions

For the purpose of the RAN-GRK model, to make emissions projections, economic activities are clustered in four broad sector categories: the land-based sector, the energy sector, industrial processes and product use, and the waste sector.

Running the model, total GHG emissions under a BAU scenario are projected to reach 2,881 $MtCO_2e$ by 2030. The figure below shows the contribution of the four sectors between 2000 and 2030. The energy sector is projected to grow the fastest from 2015 onward and is the largest emitting sector by 2030, accounting for 50 percent of national emissions. Emission from the land-based sector, by contrast, grows at only 1.6 percent per annum, and its share of total emissions falls from over 50 percent in 2015 to less than 40 percent in 2030.

Indonesia's baseline emissions by sector



Source: Murniningtyas et al. (2015).

14.4 | Ways forward: upgrading SISNERLING and the role of the WAVES program

While climate change policy is the focus of this chapter, it should be noted that Indonesia's NCA has also had an impact in improving information for policy in a number of areas. For example, NCA has contributed to improving Indonesia's spatial planning (Law No. 26/2006 on Spatial Planning) by helping to institutionalize classification standards for land cover and utilization.

Indeed, Indonesia has been regularly expanding and updating its approach to environmental accounts. In 1997, Indonesia's Statistical Agency (BPS) adopted the System of Environmental-Economic Accounting (SEEA) and has produced annual publications through SISNERLING. Until recently, SISNERLING used the older SEEA-1993 framework to develop annual asset accounts for forest resources, minerals, and energy. However, BPS

has been updating SISNERLING to meet the 2012 SEEA standard, starting from the SISNERLING published in 2015. Asset accounting for energy, minerals, and timber resources are now also included in SISNERLING, in both physical and monetary terms. In 2016, BPS began experimental physical asset accounts for land in Sumatera and Environmental Protection Expenditure Accounts/Environmental Goods and Services Sector (EPEA/EGSS) in-depth studies in 17 provinces. In 2017, BPS will continue to develop the same accounts and will also develop land accounts for Java and Kalimantan.

The Indonesia WAVES program will support GOI as it strengthens and expands its system of natural capital and environmental accounting, as represented by SISNERLING. Moreover, Indonesia WAVES will help GOI institutionalize its use, so that development planning and policy analysis are better and more routinely informed by natural capital information. The program development objective is to enable GOI to regularly and systematically (1) implement natural capital accounting and (2) use the developed accounts in policy analysis and development planning.

Bappenas is currently mandated by the president of Indonesia to provide the analysis for Indonesia's long-term development vision of 2045 and 2085. Furthermore, the institution is also expected to establish the next National Medium-Term Development Plan for 2020–24, which will be accompanied by a sound Strategic Environmental Assessment (SEA). These policy developments will be pursued back-to-back and conducted on a scientific basis. A policy modeling exercise, similar to the pioneer INDC exercise above, will employ information on stocks and flows to capture salient elements of the development and carrying capacity of natural resources and environment.

This is a good opportunity for SISNERLING to be developed in ways that are aligned with and better serve the development policy process. Both BAPPENAS and BPS, as well as related line ministries, should coordinate to design the relevant SISNERLING data that could support the modeling exercise. WAVES, which has an approach of fostering improved data collaboration, could support this process and ensure stronger linkages between NCA and policy development.

14.5 | Challenges and opportunities

How to create construct institutional links between NCA and development policy processes in Indonesia remains challenging, especially in the context of many barriers. These barriers include data reliability, willingness to share data among line ministries, and understanding of the modeling tool.

The process of preparing the factual basis for the INDC submission, and the ongoing review of the RAN-GRK, offer some strong pieces of the "bridge" that needs to be built between natural resource information providers and the policy users of such information in Indonesia. It also highlights the importance of integrating development and climate change, and the importance of cross-sector collaboration in formulating mitigation objectives and policies. Through the establishment of valid and robust natural capital accounts on relevant physical and monetary values, a streamlined system could be achieved for tracking indicators and reporting international and national targets, such as Sustainable Development Goals, SEAs, government financial statistics, and the INDC.

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14.7 | Endnote

1 The RAN-GRK review is mandatory (Presidential Regulation, article 9).

15 | Measuring Green Growth for Environmental Economic Policies in the Netherlands

Sjoerd Schenau, Statistics Netherlands

Summary

Green growth is an important policy theme. Progress toward green growth can be monitored using indicator frameworks, including the Organisation for Economic Co-operation and Development (OECD) monitoring framework for green growth. Many indicators from the green growth monitoring framework can be directly obtained from the accounts of the System of Environmental-Economic Accounting (SEEA) Central Framework. In the Netherlands, green growth is an important policy theme and has been monitored for several years. The government requires data input for policy evaluation and policy making. Overall, the Dutch economy has become "greener" since 2000. However, this progress takes place gradually and is yet to occur for all aspects of green growth.

15.1 | Introduction

Green growth strategies focus on ensuring that natural assets can deliver their full economic potential on a sustainable basis. In 2011, Statistics Netherlands proactively published the first edition of Green Growth in the Netherlands (Statistics Netherlands 2011). In 2012, the government asked Statistics Netherlands to monitor green growth on a regular basis and to develop consistent monitoring frameworks for sustainability and green growth for the purpose of monitoring and evaluating Dutch government policies, such as the climate policies, circular economy, bio-based economy. In response, Statistics Netherlands compiled data that was reported in the Sustainability monitor, which featured a chapter on green growth (Statistics Netherlands 2015b), as well as the publication Green Growth in the Netherlands (Statistics Netherlands 2015a). These reports provided an update of the green growth indicators in the Netherlands that were first reported in 2011 as well as provided international context and detailed thematic aspects. Data from the environmental accounts play a key role measuring green growth.

15.2 | Policy relevance

In 2011, the OECD green growth strategy was adopted by the OECD Ministerial Council (OECD 2011a). It emphasizes that governments must embed environmental challenges in the heart of economic policy making. The OECD green growth strategy provides a policy strategy for implementing this economic transformation along with a monitoring framework and a proposed set of indicators. The ambitions and effectiveness of the OECD green growth strategy have been evaluated since its launch four years ago (OECD 2015). The report shows that one-third of OECD countries have started to implement a monitoring framework for green growth and that most OECD countries have started to implement green growth policy instruments, such as pricing pollution and offering incentives for efficient resource use.

In the Netherlands, green growth is high on the political agenda. The government sees green growth as an essential part of maintaining the ability to grow in the future, while reducing the environmental impact and dependency on scarce resources (Tweede Kamer 2013). "Green" can also be a source of economic growth

and stimulate innovation to tackle global challenges in global markets. The government's Green Deal Program, established in 2011, aims to involve the private sector in the green transition (Ministry of Economic Affairs 2015). In its interim report on the green growth agenda (Ministry of Economic Affairs et al. 2015), the government focused on eight domains (energy, bio-based economy, climate, from waste to resource, circular economy, built environment, food, and mobility) and on creating the conditions and opportunities to realize green growth and minimize the impact on the environment. Green growth has a kind of "umbrella" function in a sense that it incorporates several environmental policies of the government. For each of these policy domains, specific policies have been developed. Several government agencies are implementing and evaluating these policies, namely the Ministry of Economic Affairs, the Ministry of Environment and Infrastructure, Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland), and the Netherlands Environmental Assessment Agency (PBL).

15.3 | The OECD measurement framework for green growth

The concept of "greening the economy" is still relatively new. Two major recent initiatives focus on the economic and ecological aspects of sustainability, namely the green growth strategy of the OECD and the green economy of the United Nations Environmental Programme (UNEP). Although both initiatives broadly encompass the same topics, there are some conceptual differences.

According to the definition formulated by the OECD (OECD 2011a), green growth is about "fostering economic growth and development while ensuring that the quality and quantity of natural assets can continue to provide the environmental services on which our well-being relies. It is also about fostering investment, competition and innovation which will underpin sustained growth and give rise to new economic opportunities." UNEP defines a green economy as one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP 2011). Statistics Netherlands has chosen to apply the OECD framework to measure green growth (figure 15.1), because it currently provides the more detailed measurement framework.

Indicators for green growth focus on the economic-environmental nexus, that is, the extent to which economic activity is being "greened." The conceptual framework for measuring green growth developed by the OECD is based on the setup of the production sphere of a macroeconomic model, whereby inputs are transformed into outputs (OECD 2011b). Accordingly, the indicators describe the following:

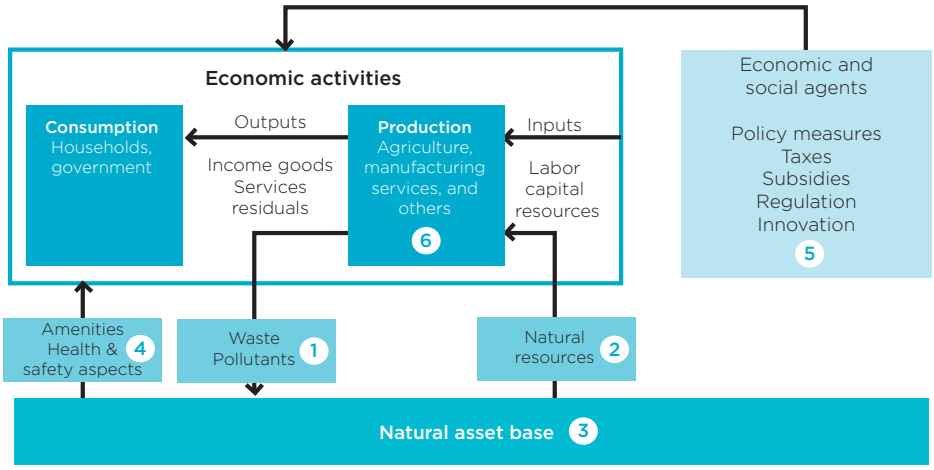
- Natural asset base (natural capital) that provides crucial inputs into production
- "Greening" of production processes, in terms of improving the environmental efficiency
- Outputs, which refers to the broad notion of well-being that also captures aspects not reported by conceptual macro-economic measures (for example certain environment-related services, environment-related health problems, and amenities)

The OECD notes that the production function approach should be supplemented by indicators on government policies and economic opportunities.

In the OECD measurement framework for green growth, the indicators are broken down into four themes (OECD 2011b):

- The environmental and resource productivity of the economy
- The natural asset base
- The environmental quality of life
- Policy responses and economic opportunities

Figure 15.1: OECD measurement framework for green growth



1. Indicators monitoring environmental efficiency
2. Indicators monitoring resource efficiency
3. Indicators monitoring the natural asset base
4. Indicators monitoring environmental quality of life
5. Indicatos monitoring green policy instruments
6. Indicatos monitoring economic opportunities

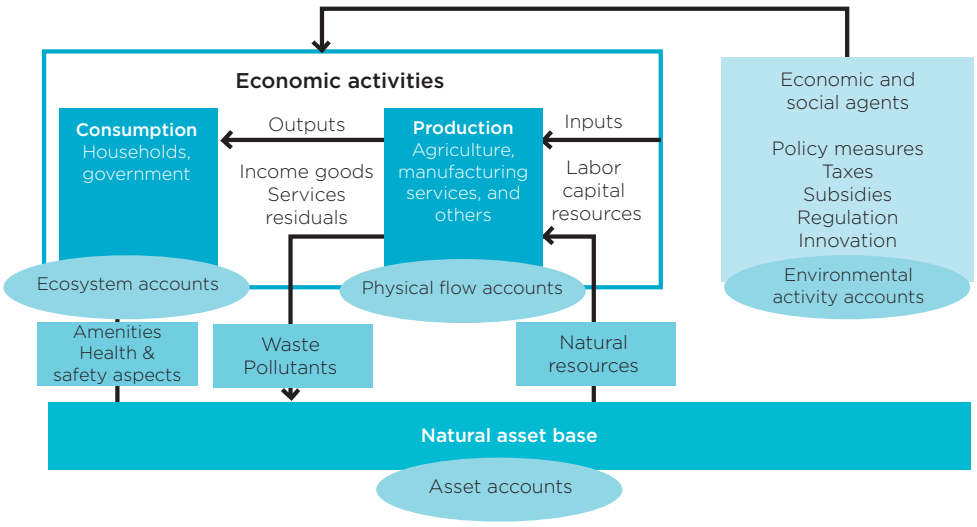
Sources: OECD (2011b); Statistics Netherland (2015a).

15.4 | Environmental accounting and monitoring green growth

The SEEA provides a consistent, coherent, and comprehensive measurement framework for green growth, as it integrates economic and environmental statistics (UN et al. 2012). Both UNEP and the OECD advocate that environmental accounting is used as the underlying framework for deriving indicators of green growth. The OECD explicitly advocates that measurement efforts should, where possible, be directly obtained from the SEEA framework (OECD 2011b).

Many indicators from the OECD green growth monitoring framework can be directly obtained from the accounts of the SEEA Central Framework (figure 15.2). For example, indicators for environmental efficiency and resource efficiency can be derived from the physical flow accounts. Combining physical information with monetary indicators from the System of National Accounts (SNA) provides information on the interaction between environmental pressure and economic growth. The asset accounts of SEEA provide the basis for indicators related to natural resources. Environmental activity accounts provide useful information on the application and efficiency of various policy instruments, such as environmental taxes and subsidies. Data from the environmental goods and service sector (EGSS) provides information for evaluating economic opportunities that may be initiated by green growth policies. Finally, ecosystem accounting provides information on both natural capital (asset base) and flows on ecosystem services.

Figure 15.2: The SEEA accounts and links to consumption, production, and policy measures



Source: Statistics Netherlands. 2015a.

15.5| Selection and scoring of the indicators

The point of departure for the Dutch green growth indicator framework is the indicator list composed by the OECD (2011b). The first Dutch green growth edition described 20 indicators (Statistics Netherlands 2011b). In 2012, the indicator set was revised, and a new set of 13 indicators was selected, based on the following criteria:

- *Coverage.* All themes of green growth must be covered sufficiently by indicators. Several new indicators were sought for the third theme of environmental quality of life.
- *Interpretability.* Indicators should be clearly interpretable in relation to green growth.
- *Data quality.* Indicators should meet general quality standards, namely analytical soundness and measurability.
- *Consistency with other indicator sets.* Where possible, indicators should be coherent with the macroeconomic indicators from the national accounts. Also, consistency with indicators of the Dutch Sustainability Monitor should be achieved.
- *Relevance for the Dutch situation.* Not all indicators from the OECD list are relevant for the situation in the Netherlands. For instance, the OECD indicator "access to sewage treatment and sanitation" is irrelevant for the Netherlands, as (almost) all households have access to these amenities. So, this indicator was omitted in favor of highly relevant indicators that were not included in the OECD list, such as indicators on water quality.

Indicator selection was discussed with several stakeholders, including the Ministry of Economic Affairs, the Ministry of the Environment, and the PBL.

A key aspect of measuring green growth is assessing and interpreting the indicators. The scores are based on the evaluation of trends in greening growth. For example, when the share of renewable energy rises or the waste recycling percentage increases, this change is scored as "positive." If the trend is stable, such as a stable exposure to air pollution, the indicator is assessed as "neutral." If the trend deteriorates, such as a decline in biodiversity or

a decrease in energy reserves, the indicator is assessed as "negative." The scores for environmental and resource efficiency indicators are based on the relationship between environmental pressure and economic growth. When economic growth exceeds the increase of the environmental indicator over a given period, it is called decoupling. Decoupling can be absolute or relative. Absolute decoupling occurs when the environmentally relevant variable is stable or decreasing, and, accordingly, the indicator has been assigned a positive score. Decoupling is said to be relative when the growth rate of the environmentally relevant variable is positive but less than the growth rate of the economic variable. Relative decoupling is assigned a neutral score. No decoupling is scored as negative; there is simply no decoupling.

15.6 | Progress toward green growth in the Netherlands[1]

Overall, the Dutch economy has become "greener" since 2000. However, this development has occurred gradually and but it has not been observed for all aspects of green growth. This is evident when looking at the different themes of the green growth framework as shown in the figure 15.3. The Netherlands green growth performance is average compared to other OECD and EU countries, and there has been no improvement in ranking against other OECD or EU countries in recent years.

Figure 15.3: Summary of the trends for the Netherlands' green growth indicators and an international comparison of the Netherlands with EU/OECD countries

Source: Statistics Netherlands (2015a).
Note: Gray cells indicate missing data.

The direct environmental pressure of the Dutch economy has decreased. All environmental efficiency indicators for emissions and waste generation overall score "green." This means that the pressure decreased in absolute terms, while the economy grew (absolute decoupling). Only the carbon footprint, that is, the amount of greenhouse gas emissions that result from Dutch consumption, was stable. Despite the national progress toward green growth, the Netherlands scores are average (or low) in an international context. The international position for this group of indicators is stable with respect to other countries in the OECD and EU.

The resource efficiency indicators show that the Netherlands is very resource efficient in the use of material resources. It has a very small domestic material use per capita compared to other EU countries and in the past decade, the Netherlands has improved more in this regard than other countries. The Netherlands also has the highest rate of waste recycling.

Along with efficient use of material resources, the efficient use of energy is also essential for a green economy. Most of the energy use in the Netherlands is from fossil fuels, leading to significant levels of greenhouse gas emissions. The share of renewable energy is increasing over time; however, in the EU, the Netherlands still ranks among the lowest in terms of renewable energy use. A positive sign is that employment and value added in the sustainable energy industry has increased, indicating green growth potential for the Dutch economy. Total energy use has been increasing since 2000, but at a slower pace than the economic growth, and hence there is relative decoupling.

The Netherlands has a high population density, indicating that its natural asset base could be easily affected by emissions and resource use. Positive signs for the natural resource base is that fish stocks in the North Sea have grown and timber stocks have also increased, while the global biodiversity footprint has decreased over time. However, compared to international rates, large amounts of land are still being converted into built-up areas, which puts pressure on biodiversity. Including biodiversity losses abroad due to Dutch consumption (modeled as an area where all biodiversity has disappeared) is also an issue.

Dutch environmental quality of life shows both signs of improvement and deterioration over time. Exposure to air pollution decreased over time, which is positive. On the other hand, only a few water bodies meet the quality standards of the European Water Framework Directive. There has been some improvement in the ecological water quality between 2009 and 2012, but the chemical quality has deteriorated. The Dutch people are less worried about the environment and are also less willing to pay for environmental products. The latter may be related to the recent economic crisis.

The share of environmental taxes and fees in total taxes and social contributions in the Netherlands, an important indicator for green policy instruments, has been falling in recent years. No major new initiatives for environmental tax reform have been undertaken since 2000. While there has been a decrease, the Netherlands still scores high for this theme internationally. "Greening the economy" has led to economic opportunities over the last 15 years. As an example, during the last decade, employment in the environmental goods and services sector increased to 126,000 full-time equivalent jobs at a growth rate that was much higher than in the rest of the economy.

Green growth data are published in Green Growth in the Netherlands (Statistics Netherlands 2015a). In addition, data for most indicators can be directly obtained from Statline, the electronic database of Statistics Netherlands. In 2012, Statistics Netherlands developed an interactive infographic to inform policy makers and the general public on the status of green growth in the Netherlands. The infographic "Green Growth" on the Statistics Netherlands' website was updated in November 2015.[2] It is an interactive tool that enables users to find detailed information on green growth. The infographic consists of two parts. In the left column of the infographic, there are four dashboards, each representing one of the four themes of green growth. Consecutively, each dashboard contains

a number of related indicators, represented by pie charts. The colors in the pie charts illustrate the trends of the indicators toward or away from "greening growth."

15.7 | Final remarks

The Netherlands has implemented the green growth strategy adopted by the OECD. A range of policies have been applied to achieve green growth, including climate policies, circular economy, bio-based economy, and the so-called "green deals" that involve the private sector in the green transition. Data supporting the monitoring of these policies has been collected, organized using the SEEA, and published by Statistics Netherlands. These data show the Netherlands has made progress toward achieving green growth and provides an opportunity for the policies aimed at achieving green growth to be reviewed and improved.

In addition, the Dutch experience has shown that the SEEA provides a consistent, coherent, and comprehensive measurement framework for green growth. It does this by integrating economic and environmental statistics and providing a large number of the indicators for monitoring green growth. The production of reports specifically addressing green growth and the creative use of infographics for communicating the results to general audiences have led to greater awareness and acceptance of the environmental accounts.

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15.9 | Endnotes

1 This summary is taken from Statistics Netherlands (2015a).
2 CBS.nl Statistics Netherlands, 2012, "Green growth: Brief explanation 'Green growth,'" June 20, http://www.cbs.nl/en-GB/menu/themas/dossiers/duurzaamheid/cijfers/extra/groene-groei-visualisatie.htm.

16 | The Use of Water Accounts for Water Policy in the Netherlands

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Summary

Integrated water resource management has been a key feature of water policy in the Netherlands since the 1980s, and its importance was reinforced after 2000 with the implementation of the European Union (EU) Water Framework Directive (WFD). The core objective of the WFD is to achieve a "good status" for surface waters and groundwater. Member States should prepare river basin management plans (RBMPs), programs of measures (PoMs), and monitoring programs; conduct an economic analysis of water use for each river basin district; and ensure that all water users contribute to recovering the costs of water services.

Since 2001, Statistics Netherlands (CBS) has prepared a National Accounting Matrix including Water Accounts (NAMWA) to provide indicators for supporting and evaluating integrated water policy. NAMWA makes it possible to relate each sector's water use to its economic activity (thus offering insights into resource efficiency and pollution intensity), assess the sector's contribution to cost recovery, and analyze water-related financial incentives.

These properties of water accounts have been used to support WFD implementation, albeit mainly in a descriptive way. They are used to show the state of and trends in specific water indicators, to convey information on the use of water resources and water services (including emissions to water) by economic sectors, and to show their financial contributions to cover the costs of their water use.

However, water accounts have had more limited use in analyzing scenarios, policies, and measures. Their anticipated usefulness for the selection of cost-effective measures based on modeling the economic impacts of water policy measures has not materialized. This may be due to a lack of awareness of this potential use, but also to a mismatch between the policy maker's information needs and the information in the accounts (which is only quantitative and has insufficient geographical and sectoral detail). In other water policy areas (notably marine policy), water accounts might play a more significant role.

16.1 | Introduction

This chapter addresses[1] the use of environmental accounts in water policy in the Netherlands, with a focus on inland waters (both surface and groundwater). The key policy developments in this area over the past 15 years were related to the implementation of the EU WFD. This chapter presents the main features of the WFD and its implementation, introduces the main environmental accounts with potential relevance for water policy in the Netherlands, and addresses the actual policy role that these accounts (could) play or have played and tries to explain why this role has been limited in some respects. This chapter concludes with some considerations about the usefulness and limitations of environmental accounts for water policy making.

16.2 | The Water Framework Directive and its implementation

16.2.1 | WFD objectives and requirements

The EU Water Framework Directive establishes an integrated legislative basis for water protection. The core objectives of the WFD are to achieve a "good status" rating for surface waters and groundwater by 2027, if not sooner. For surface waters, this rating is subdivided into "good chemical status" and "good ecological status" (or,

for artificial and heavily modified water bodies, "good ecological potential"). For groundwater, a differentiation is made between "chemical status" and "quantitative status" (that is, no over-abstraction of groundwater).

To achieve these objectives, EU Member States must prepare Programmes of Measures (PoMs) that specify concrete actions and regulations, monitoring programs, and River Basin Management Plans (RBMPs). Some specific provisions of the WFD present potential demand for water accounts, including the following:

- The requirement for Member States to prepare an economic analysis of water use for each river basin district
- The obligation to ensure that all water users contribute to the recovery of the costs of water services and that water-pricing policies provide adequate incentives for users to use water resources efficiently.

16.2.2 | Policy process and policy documents

The WFD introduced an integrated approach toward water policy in the EU and its Member States. This integration has several aspects. The WFD addresses both groundwater and surface water, both water quantity and water quality (chemical and ecological), relationships within and among river basins, as well as the various functions and uses of water. The WFD also deals with the economic aspects of water and water use.

Meanwhile, in the Netherlands, an integrated approach toward water management has been applied for some decades. The importance of such relationships as between quantitative and qualitative water management, and between groundwater and surface water, was acknowledged in the 1980s. During the 1990s, integrated water resources management (IWRM) and a water systems approach became key concepts of the institutions responsible for water management.[2]

The implementation of the WFD reinforced the Dutch approach after 2000, culminating in the Netherlands National Water Plan and the first set of RBMPs in 2009. The 2010s have seen the implementation of these plans and preparation for the next phase. The resulting new National Water Plan and RBMPs cover 2016–21. The RBMPs are based on the plans and programs of the various authorities responsible for water management at the national, regional, and local levels.

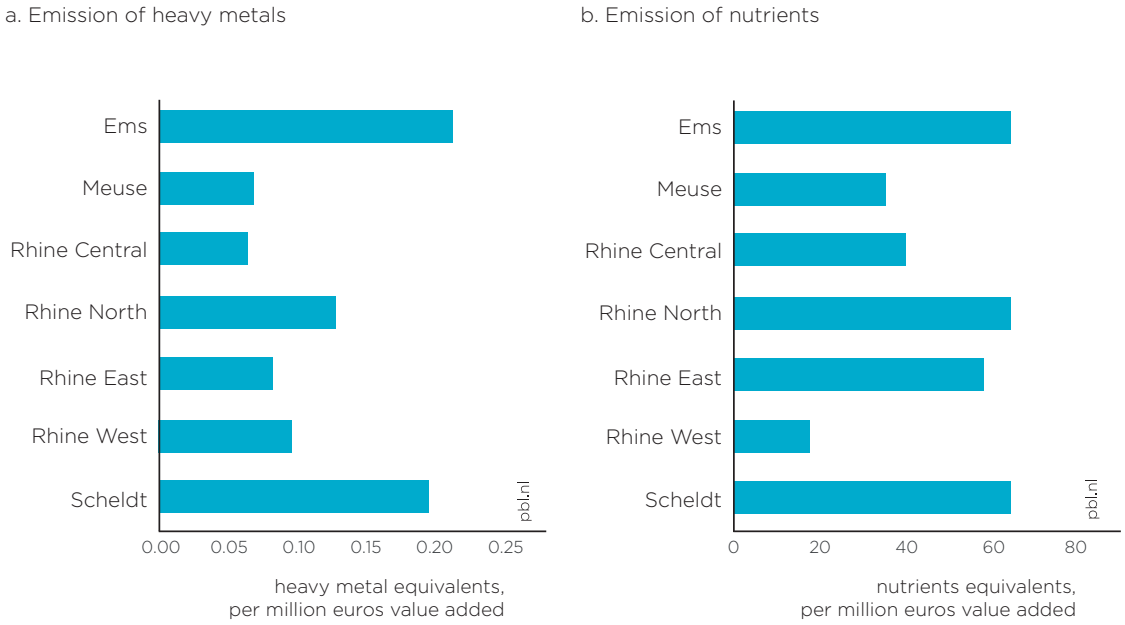
16.3 | Water accounts for water policy

The System of Environmental-Economic Accounting for Water (SEEA-Water) provides a conceptual framework for monitoring progress toward national and international water policy objectives. Statistics Netherlands started working on water accounts as part of environmental accounts in 2001. A first full so-called NAMWA (National Accounting Matrix including Water Accounts) was prepared for the year 1996 at the request of the Dutch national water authorities. The objective of NAMWA was to enable the determination of indicators for supporting and evaluating the IWRM. NAMWA consists of the following accounts:

- Economic accounts (with detailed data on water-related transactions and more aggregated data on other transactions)
- Water emission accounts (based on the national emission registration system)
- Water flow accounts (based on data from water supply companies and environmental annual reports of large manufacturing companies).

Initially, NAMWA was constructed at the national level, but the WFD's river basin approach necessitated the regionalization of the water accounting system. A regional NAMWA was therefore developed for each river basin district in the Netherlands: Rhine (with four sub-districts), Meuse, Scheldt, and Ems. The establishment of regional water accounting systems made it possible, for instance, to present river basin level data on the "emission intensity" of the economy (emissions per euro of value added) (see figure 16.1).

Figure 16.1: Emission intensity per river basin, 2007



Source: Statistics Netherlands (2011).
Note: Emissions of copper, chromium, zinc, lead, cadmium, mercury and arsenic are converted into heavy metal equivalents and are subsequently added up. Likewise, emissions of phosphorus and nitrogen are converted into nutrient equivalents. The conversion into equivalents takes into account the harmfulness of the metal/nutrient for the environment. The Statistics Netherlands publication does not specify the weights used to calculate the equivalents.

Subsequently, NAMWAs have been prepared for several years, thus allowing for a time series analysis and the identification of trends. NAMWAs were also conducted to help with the economic description of the Dutch part of the North Sea, as a contribution to the reporting requirements of the Marine Strategy Framework Directive (MSFD).

Since 2005, further detailed water supply and use tables have been developed for the Netherlands. These tables show detailed information on the exchange of water between the environment and the economy, both the abstractions from the environment and the return flows, including losses flowing back to the environment, and the exchange of water among the sectors within the economy. Initial attempts have also been made to determine economic values for Dutch water resources within the SEEA framework.

Policy relevance has been an important consideration behind these developments. Nevertheless, direct policy involvement in the supply side of environmental accounts is limited, as Statistics Netherlands has a certain degree of autonomy in collecting, compiling, and presenting statistical information.

Apart from WFD and MSFD implementation, water accounts now play a role in the monitoring of "green growth" in the Netherlands. With the help of environmental accounts, indicators are constructed showing whether there is a decoupling of economic (gross domestic product [GDP]) growth from environmental burdens and from

resource use (emissions, resource depletion). For example, the accounts show that real GDP between 2000 and 2012 increased by some 15 percent, while heavy metals emissions to water decreased by about 50 percent and groundwater abstraction decreased by 7 percent. In the agricultural sector, the total value added increased over the same period by some 10 percent, but nitrogen surpluses decreased by 40 percent and phosphorus surpluses by more than 80 percent.

16.4 | The role of environmental accounts data in policy development

NAMWA's role in supporting WFD implementation is mainly through describing the economic development of river basins in the RBMPs. In terms of policy analyses, however, NAMWA data play a relatively minor role. Neither the first (2009) nor the second (2016) RBMPs and PoMs contain any significant trace of analysis based on the water accounts. To find an explanation for this, two areas where the water accounts, in principle, could have played a role were examined: the selection of cost-effective measures for water quality improvement and the issue of cost recovery.

16.4.1 | Selecting cost-effective measures

Even though NAMWA was not intended to support cost-effectiveness analyses for water policy, it was expected that information in the water accounts could also be used for this purpose. The preparation of the first set of Dutch RBMPs was accompanied by a large research program (Water Economic Modelling for Policy Analysis [WEMPA]), aimed at developing an Applied General Equilibrium (AGE) model for water economics. This model, which was based on NAMWA, would in principle enable policy makers and decision makers to select the most cost-effective policies and measures to achieve a certain objective (for example, a certain amount of additional emission reduction) and to calculate the direct and indirect economic impacts of each option.

In practice, however, neither the AGE model nor the NAMWA itself were used for these purposes. The role of NAMWA in the economic analysis required by the WFD was limited to information provision. It was not used to estimate or simulate the impact of policy measures on water and economy. The first set of RBMP costs and benefits of the measures have been assessed, but without any use of, or reference to, NAMWA and the WEMPA work (which at that time was still ongoing).[3] In the second round of RBMP preparations, NAMWA was used again for the economic description of the river basins, but no NAMWA-based modeling was used and no cost-benefit analyses were performed. Socioeconomic reports, written as background information for the new 2016–21 RBMPs, do contain some NAMWA-based information, but are (again) mainly descriptive. (In addition to the water accounts, they use several other data from Statistics Netherlands and other research institutes.)

A possible reason for the limited use of water accounts for policy analysis is that the selection of WFD measures was (and is) not conducted in a top-down manner by a single optimum-seeking decision maker. Instead, it is the result of gathering and streamlining a large number of bottom-up actions proposed by several actors at all levels of governance (state, provinces, water boards, and municipalities). Apparently, neither the available NAMWA-based information nor the WEMPA model match the needs of this specific policy-making and decision-making process. The details of this mismatch could not be investigated in the present study, but it seems that information on the possible environmental and economic impact of water policy measures will be used only if it is presented in a way that closely links to the concrete decisions that the responsible authorities and actors have to make.

Another explanation for the modest role of water accounting could be that many of the measures needed to achieve the WFD objectives have a qualitative rather than a quantitative character. In particular, the achievement of a "good ecological status"[4] depends on measures relating to the design and structure of the water system,

not just measurable parameters, such as the quantity of emissions released or water consumed. Neither the environmental nor the economic impact of such measures (which are usually site-specific) can be readily measured or analyzed within the quantitative framework of the water accounting system.[5]

16.4.2 | Cost recovery for water services

Cost recovery is another topic where water accounts could in principle provide the information needed to support the requirements of the WFD. The WFD obliges Member States to ensure "an adequate contribution of the different water uses, disaggregated into at least industry, households and agriculture, to the recovery of the costs of water services." Essentially, this means that water use is not subsidized (the polluter/user pays principle) and that there are no significant cross-subsidies among the main categories of water users.

In the two reports on cost recovery (Rijkswaterstaat, 2005 and 2013), five water services were distinguished. Table 16.1 shows the calculated cost-recovery rates for each of these services for the years 2000 and 2012.

Table 16.1: Cost-recovery rates for water services in the Netherlands, 2000 and 2012

Water service	2000	2012
Water production and supply (%)	100	100
Collection and transport of rainwater and waste water (%)	80	100
Waste water treatment (%)	100	100
Groundwater management (%)	95	100
Regional water system management (%)	100	100

Source: Rijkswaterstaat (2005 and 2013).

For most of the identified water services, cost-recovery rates of (close to) 100 percent were calculated, with the exception of "collection and transport of rainwater and waste water" in the year 2000. At that time, some municipalities did not yet levy a sewerage charge, but were financing their sewerage systems from their general budget.

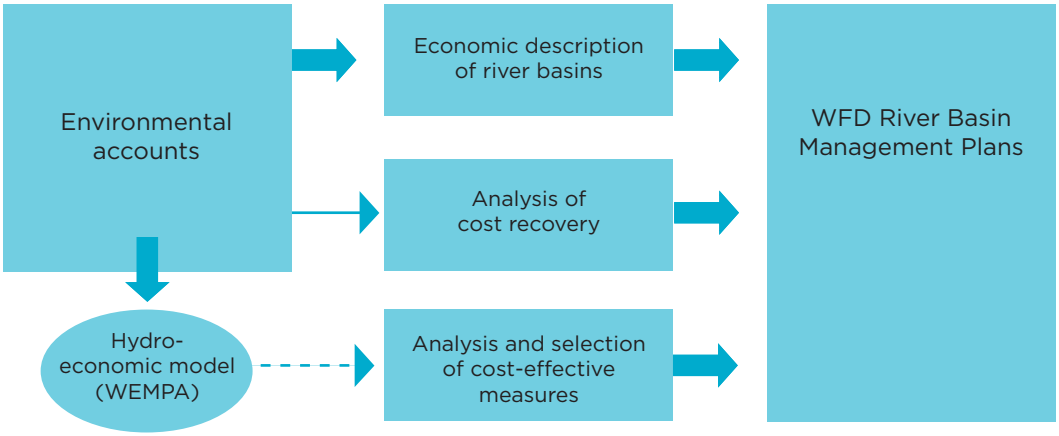
In both of the cost-recovery reports, the water accounts (NAMWA) were used as one source of information. In some cases, they served as a cross-check on estimates from other sources. In other cases, NAMWA was the only available data source, for example, because other statistical data on water supplies to industry are confidential. In addition to NAMWA, other elements of the Environmental Accounts—such as the water use accounts, accounts of the revenues of environmental taxes and charges, and accounts of the net environmental costs of industries—were used for calculating cost-recovery rates.

But cost-recovery estimates were made at the national level only. Even though water accounts were available at the river basin level (NAMWARiB), apparently the information they contained was insufficient to allow the calculation of cost-recovery rates at this level. Attempts to do so in the first report were not based on NAMWARiB and relied on a lot of assumptions.

16.4.3 | Synopsis

Figure 16.2 illustrates the role of environmental accounts in the WFD implementation in the Netherlands. It shows that these accounts have played an important role in the economic description of the river basins, as well as a smaller role in the analysis of cost recovery. The envisaged role in the analysis and selection of cost-effective measures, with the help of an integrated hydro-economic model (WEMPA), has not materialized (as indicated by the dashed arrow).

Figure 16.2: The role of environmental accounting in WFD implementation in the Netherlands



Source: Ruijs et al. (2017).

16.5 | Lessons—usefulness and limitations of environmental accounts for water policy making

16.5.1 | Important, but limited, role

Statistics on water use, water pollution, and water quality have been collected and analyzed in the Netherlands since the 1970s. National accounts have an even longer history. The integration of national accounts with water accounts since 2000 has made it possible to monitor the use of water resources at the level of economic sectors, to relate water use to sector economic activity, and to assess sector share in the recovery of the costs of the water services provided. This kind of information would not have been available without water accounts.

In principle, water statistics and water accounts have a variety of possible applications in water policy, in all stages of the policy cycle. This chapter focuses on the implementation of the WFD, which has been a main part of Dutch water policy over the past 15 years. That experience suggests that water accounts in the Netherlands play an important role in supporting water policy, but the accounts do not fulfill all of their potential roles.

16.5.2 | Water accounts for cost-recovery estimates and economic descriptions

Information from the accounts is currently used mainly for descriptive purposes, to show the present state of specific indicators and to monitor the trend in their development over time. The water accounts have been successful in conveying information on the use of water resources and water services (including emissions to water) by the various sectors of the Dutch economy, as well as the financial contributions made by these sectors to cover the costs of this resource use and services. By comparing water use data with economic activity data (GDP and value added by sector), indicators of progress toward resource efficiency and decoupling can be constructed. This information is widely used in the Netherlands and also at the international level. With respect to implementing the WFD, the water accounts have been useful mainly for the economic description of the river basin districts and to some extent for assessing the rates of cost recovery for the various water services.

16.5.3 | Data need and data supply do not always match

Thus far, however, the accounts have had limited use in analyzing future scenarios and the possible impacts of policies and measures. In principle, economic-environmental analyses would enable the selection of cost-effective measures, the assessment of (direct and indirect) economic impacts of WFD policies and measures, and the

analysis of long-term scenarios for water sector development. The limited use of the accounts for these purposes may, to some extent, be due to poor awareness among policy makers of the information that these accounts offer—and especially how this information can be used in the bottom-up policy—and decision-making processes that characterize Dutch water policies. There may also be a mismatch between available information and the needs of the policy makers for sufficient detail (geographically and by sector).

Measures for WFD implementation are, to a large extent, initiated and executed at the regional level (water boards). At this level, experts are mainly concerned with the technical feasibility and cost-effectiveness of concrete measures, and not so much with the (direct and indirect) links between environment and economy to which the environmental accounts relate. A substantial part of the measures (and their impacts) have a qualitative rather than a quantitative character. In particular, the realization of a good ecological status depends on measures relating to the design and structure of the water system, which are not shown in the water accounts, rather than to measurable parameters such as amounts of emissions or water consumption, which are part of the water accounts. Furthermore, economic-environmental analysis at this low geographic level would require the availability of data at the same low level of aggregation. This is often not possible for confidentiality reasons.

16.5.4 | Water accounts are expected to be useful for the marine strategy

Despite the restricted role of the water accounts in the WFD, it is expected that their role may be more important in the implementation of the Marine Strategy Framework Directive (MSFD). Here, the scale and level of policy have a better match with those of available statistics. In this case, implementation is mainly at the national level and the underpinning economic analyses are for the entire part of the North Sea that is under the jurisdiction of the Netherlands (Dutch Continental Shelf). The "NAMWA for the North Sea" is used not only for the economic description, but will also play a role in assessing the impacts of North Sea economic activities on the environment and ecosystems. Finally, it should be noted that water accounts are also used in other water-related policies in the Netherlands that were not investigated in this study.

16.6 | Acknowledgments

The author gratefully acknowledges useful contributions and comments from Sjoerd Schenau and Cor Graveland (Statistics Netherlands); Rob van der Veeren (Rijkswaterstaat), Stefan van der Esch, Arjan Ruijs, and Frank Dietz (PBL Netherlands Environmental Assessment Agency); and Steve Bass (IIED).

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16.8 | Endnotes

1 This chapter is based on A. Ruijs, F. Oosterhuis, and S. Schenau, The application of natural capital accounting in the Dutch energy and water policies: From Statistics to Policy – Part II (chapter 2), PBL publication 2559, PBL Netherlands Environmental Assessment Agency, The Hague, 2017. This report also contains a full list of references.
2 In the Netherlands, the various water management responsibilities are divided among the regional water boards, municipalities, provinces, and, at the national level, Rijkswaterstaat.
3 Indirectly, data from the national accounts and other environmental accounts (for example, environmental taxes) may have been used.
4 Annex V of the WFD contains the criteria for "good ecological status" of the various types of water bodies.
5 An example of such a measure is the reconstruction of the natural features of a stream, such as meanders and gentle banks.

17 | Environmental Accounts in Dutch Energy Policies

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Summary

The Dutch economy, compared to that of other European Union countries, is characterized by a relatively energy-intensive industry and a large share of fossil fuel in the domestic energy supply. In 2013, the Dutch government entered into an Energy Agreement for Sustainable Growth with 46 partners that all agreed to share responsibility and commitment to achieve overarching objectives related to energy saving, energy supply, and the reduction of greenhouse gas emissions (GHGs). This chapter[1] examines how environmental accounts and statistics have played, and continue to play, a role in the agreement as well as Dutch energy policies more generally.

Evidence clearly shows that for the Dutch energy policies, and for the energy agreement in particular, use has been made of the environmental accounts and statistics. These data were used to create awareness of the magnitude of the problem, prepare policy measures, and monitor progress toward agreed objectives. The accounts and statistics are specifically used in several reports to monitor progress of the energy agreement as well as in models that assess the future effects of policy measures proposed during the preparation phase.

The energy agreement provides a clear example of the policy impact of environmental statistics and environmental accounts during policy development, implementation, and monitoring. The environmental accounts are especially useful for energy policies as they relate to a national policy problem for which the activities of the actors (governments or businesses) are reflected in the accounts and for which generic policy measures can be adopted. A key lesson is that cooperation and trust among statistical, analytical, and policy agencies is essential for effectively applying accounts to policy process, and this trust takes time to develop. It is hoped that the Netherlands' experience may inspire Wealth Accounting and Valuation of Ecosystem Services (WAVES) partners and other countries to more readily develop mechanisms and institutions that mainstream the uptake of information from the natural capital accounts into policy-making processes.

17.1 | Introduction

17.1.1 | Energy accounts and the energy agreement

In the Netherlands, energy statistics and energy accounts have informed policy makers working on energy and climate policies for years. Research agencies, nongovernment organizations (NGOs), and several ministries used this information to raise awareness about the policy problems, as inputs to many energy models, and to monitor the energy policies. In 2013, the Dutch government entered into the Energy Agreement for Sustainable Growth (SER 2013) with 46 partners that all agreed to share responsibility and commitment to achieve overarching objectives related to energy saving, energy supply, and GHGs.

This chapter examines how the environmental accounts and statistics have played, and continue to play, a role in this energy agreement, specifically, the role of environmental accounts in the different policy phases. This chapter also assesses which institutional structures have emerged that enable translation of the data from the energy statistics and accounts into useful information for policy and distil some general lessons from this experience.

17.1.2 | Brief overview of energy accounts in the Netherlands

Environmental statistics and environmental accounts have a long history and important role in the Dutch energy policies. Since the 1970s, Statistics Netherlands (or CBS) has published statistics on energy production, use, and saving. Related statistics include greenhouse gas emission data from the Pollutant Release and Transfer Register and climate change–related monetary data, such as data on environmental investments, expenditures, and taxes. Detailed energy statistics are released monthly, and a national energy balance is published annually, providing detailed data on energy production, supply, and use.

Statistics Netherlands has compiled energy-related environmental accounts since the 1990s. Year by year, more energy-related accounts have become available. Today, accounts are available for the following areas:

- Physical energy supply and use tables that show power generated and used by both households and businesses
- Air emissions accounts that relate air emissions to the source of production and consumption by households
- Physical and monetary asset accounts for oil and natural gas reserves
- Monetary environmental account modules, such as accounts for environmental taxes, environmental protection expenditures, and the environmental goods and services sector.

Choices on the data to be compiled by Statistics Netherlands are made by an independent commission and depend on demand from policy makers and research agencies. Demand grows over time as more data become available or new methods are developed.

Until 2013, Statistics Netherlands annually published Dutch environmental accounts (for example, Statistics Netherlands [2011]). Since 2011, the various modules of the environmental accounts were included in the publication *Green Growth* in the Netherlands. Between 2011 and 2013, Statistics Netherlands also published the *Economic Radar for the Sustainable Energy Sector*, and since 2003, the publication *Renewable Energy* in the Netherlands (Statistics Netherlands 2012). Since the Energy Agreement was executed, Statistics Netherlands, PBL Netherlands Environmental Assessment Agency, Energy Research Centre of the Netherlands (ECN), and the Netherlands Enterprise Agency (RVO.nl) annually publish the *National Energy Outlook*, which is used for monitoring progress of the Energy Agreement (ECN et al. 2014, 2015, 2016). These reports include predictions of future goal achievements as well as most of the statistical and accounting information first published in other energy reports from Statistics Netherlands.

17.2 | Policy process for the energy agreement

Energy policies have always been sensitive in Dutch politics. The Netherlands is characterized as having more energy-intensive industries compared to many other European countries. This is due to the large number of refineries, chemical, horticultural and transport industries in the Dutch economy (Statistics Netherlands 2015a; De Nederlandsche Bank 2016). However, a broad range of energy saving policies has gradually decreased energy intensity of the Dutch economy. Yet, the Dutch economy remains very dependent on fossil fuels and emits relatively high amounts of greenhouse gasses compared to many other European countries. In addition, the share of renewable energy in the total gross energy consumption is relatively small compared to that of other European countries, and in 2013 the Netherlands was ranked among the last of the European Union nations (EU-28; Statistics Netherlands 2015a).

In the early 2010s, energy policies were less prominent on the political agenda. There was widespread and growing unease among societal organizations and businesses that energy and climate policy was politicized and capricious. Moreover, despite international agreements on climate policy and several European energy and climate policies, the government did not provide a clear vision, long-term perspective, or direction for energy policy. This was needed by the business community for investment security. Furthermore, since the start of the financial crisis, there was a period of doldrums in Dutch energy and climate policy. As a result, progress toward internationally agreed objectives was slow.

In 2011, parliament broadly accepted a motion that called on the government to create a national energy transition agreement (House of Representatives, 2011–12), that is, an agreement to hasten the transition to an energy system that emits less carbon. In response, the Minister of Economic Affairs requested advice from the Social and Economic Council (SER) about the threats and opportunities for the Dutch economy in the light of climate change, rising energy prices, and growing global demand for fossil fuels (SER 2012). The SER advised the government to reach a broadly accepted energy agreement with the employers' organizations, trade unions, and environmental NGOs. At the end of 2012, the SER started a process that resulted in the national energy agreement. Over eight months, representatives from government, employers' associations, trade unions, and environmental organizations had intensive negotiations in four theme-based policy roundtables—industry, built environment, transport and mobility, and renewable energy—to discuss targets and instruments for the requested energy agreement.

In September 2013, the participating organizations signed the energy agreement and set the following objectives (SER 2013):

- An average final energy efficiency improvement of 1.5 percent per year, and a reduction of final energy use of 100 Petajoules (PJ) by 2020
- A 14 percent share of renewable energy in the Netherlands' total final consumption of energy by 2020 and 16 percent by 2023 (4.5 percent in 2013)
- Creating at least 15,000 additional jobs by 2020, of which a significant number are to be created in the next few years.

The signatories also agreed to evaluate the agreement every three years and established a standing committee for the energy agreement. This committee oversees the implementation of the agreement, supports and advises the stakeholders, and updates measures as necessary. The standing committee and the ministries involved also requested that key environmental and energy research institutes of the Netherlands PBL, ECN, Statistics Netherlands, and RVO.nl annually publish a National Energy Outlook to monitor the progress of the agreement.

The energy agreement deliberately focused on energy saving, energy efficiency, renewable energy, and jobs growth instead of the reduction of GHGs. This approach was deemed to be more acceptable to a broader range of stakeholders and hence more politically palatable than previous climate change policies and related targets for GHGs.

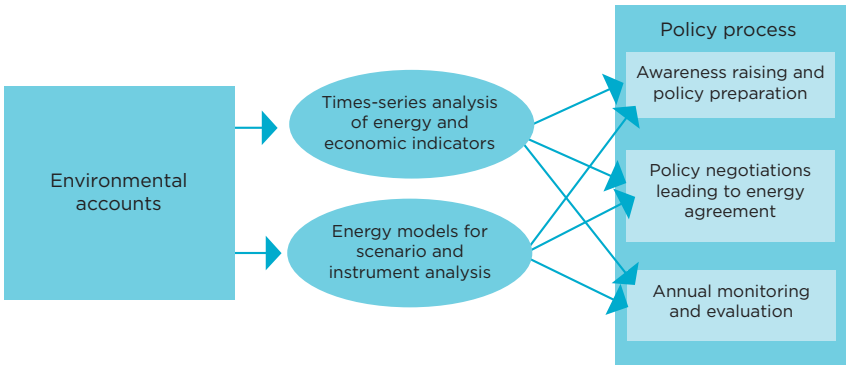
Since 2013, positive progress has been made, with, for example, the share of renewable energy in Dutch final energy consumption increasing from 3.9 percent in 2010 to 5.8 percent in 2015 and final energy consumption decreasing from 2,223 PJ in 2010 to 2,076 PJ in 2015. The latest projections show that the share of renewable energy is expected to reach 15.8 percent by 2023, just below the goal of 16 percent, and that energy saving will reach 68 PJ by 2020, which is below the goal of 100 PJ (ECN et al. 2016).

17.3 | The role of energy statistics and accounts in the energy agreement

17.3.1 | Environmental statistics and accounts in three phases of the policy process

The energy statistics and accounts played an important role in the process before and during the negotiation process of the energy agreement, and they continue to be important for monitoring the agreement's progress. Figure 17.1 shows the types of analyses and the roles of the environmental accounts in the phases of the policy process.

Figure 17.1: The role of environmental accounting in the policy process leading to the energy agreement in the Netherlands



Source: Ruijs et al. (2017).

Awareness of Dutch energy use and energy policies is created by the regular reports on energy use and energy policy. The statistical and account data showing changes in energy use, energy saving, GHGs, and growth of the environmental goods and services sector are used by the energy research institutes and several environmental organizations and consultancy firms. They project future energy use, GHGs, and the effects of government policies, but they also use these data to update the Environmental Data Compendium[2] or to show the public and the authorities how the country is progressing in this domain as compared to other countries.

An interesting feature of the energy agreement is the role played by two key energy policy research institutes—ECN and PBL—in the policy negotiation process. They played an advisory role, providing evidence and answering questions, and made an ex ante evaluation of the agreed measures (ECN and PBL 2013). The conclusions of this ex ante evaluation resulted in several changes in the final agreement, resulting in setting more realistic objectives. The ECN and PBL participation was highly appreciated, and the results from their analyses were accepted without much debate.

Another interesting feature is the cooperation among ECN, PBL, Statistics Netherlands, and RVO.nl, who monitor progress toward the goals in the energy agreement, and report on the progress in the annual National Energy *Outlook* (see ECN et al. 2014, 2015, 2016). The *Outlook* combines historical statistical information and indicators from Statistics Netherlands and RVO.nl with forward-looking model results from ECN and PBL. Moreover, it includes an interpretation of how the policies agreed upon contribute to the changes observed. By presenting a combined multiagency perspective of the progress toward the targets in the energy agreement, it provides a powerful message to policy makers and businesses about the steps to be taken. On the basis of this report, the parties involved in the agreement discuss annually whether new policy measures are needed. The accounting data presented in the *Outlook* are also used as a basis for global and international reporting commitments to the

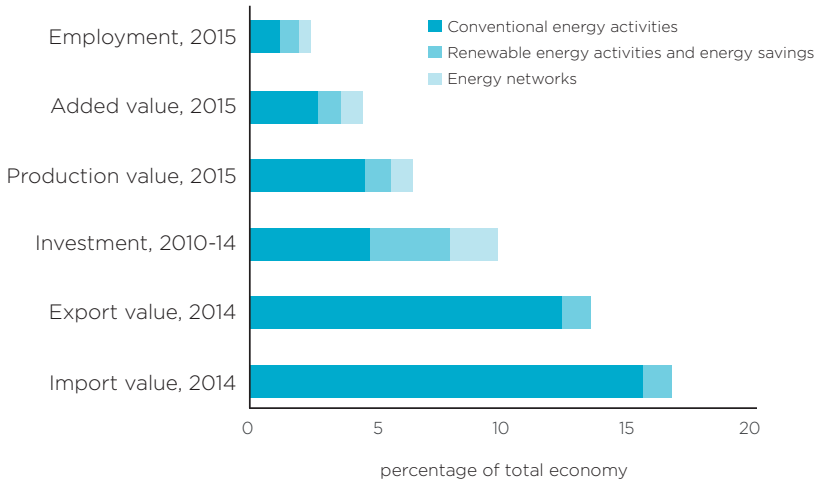
European Union and the United Nations Framework Convention on Climate Change (UNFCCC) on the emission of greenhouse gases and air pollutants.

17.3.2 | Environmental accounts for looking backward and forward

The National Energy *Outlook* makes extensive use of the energy statistics and environmental accounts for looking at the progress made in the energy transition to date and for looking forward to the expected future effects of policy measures. For this, the time series of the energy statistics (for example, the Energy Balance and Statistics Renewable Energy; Statistics Netherlands 2015b, 2015c), the environmental accounts and the national accounts of Statistics Netherlands as well as data from the Pollutant Release and Transfer Register (PRTR 2015) are used. For forecasting and ex ante policy evaluation, ECN and PBL use additional information and economic theory to build and use models.

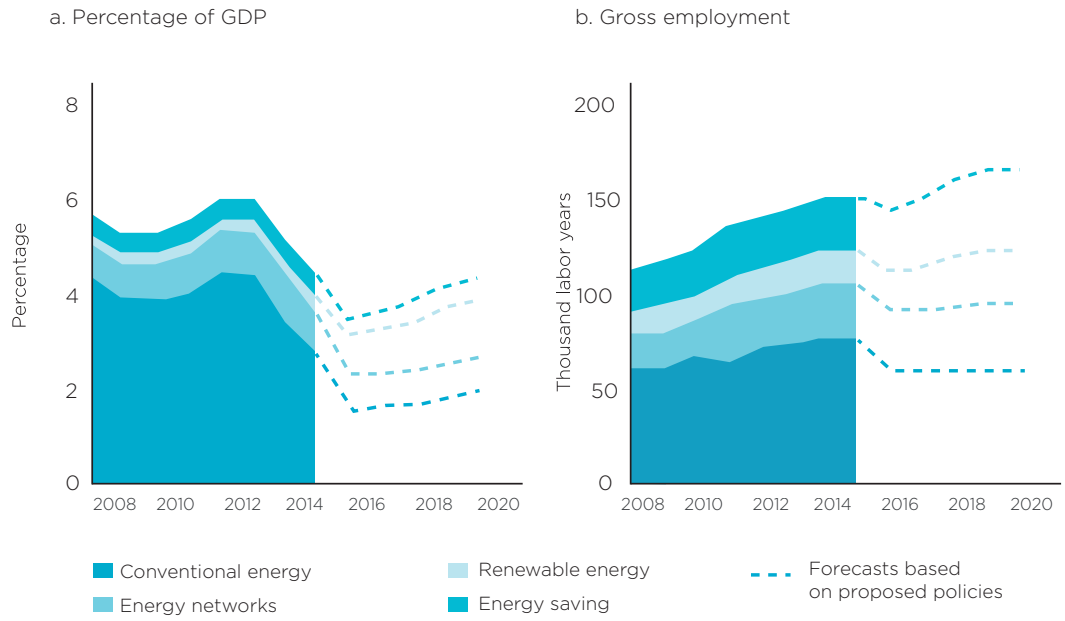
For looking back at the progress of the energy transition, several new indicators have been developed in the last decade. For example, to provide detailed data for the energy transition, Statistics Netherlands has developed indicators on production value, (gross) value added, exports, investments, and employment for renewable energy production and energy saving, disaggregated according to their production profiles (for example, solar, wind, biomass) and process profiles (for example, manufacturing, installation, consultancy, research, and development). These indicators are built with data from the national accounts as well as energy accounts, and this enables many comparisons and analyses of the Dutch economy. For example, an evaluation of the shares of the energy supply activities in the Dutch economy (figure 17.2) and developments in the contribution of energy supply activities to the gross domestic product (GDP) and to gross employment (figure 17.3; see also ECN et al. 2016).

Figure 17.2: Share of the energy supply activities in the Dutch economy per economic indicator, 2015



Source: ECN et al. (2016).

Figure 17.3 Contribution of energy supply activities to the Dutch economy and to gross employment



Source: ECN et al. (2016).

For looking forward, ECN and PBL have developed coupled energy-economy models that are calibrated using the energy accounts and statistics. These large-scale simulation and optimization models are used to evaluate the projected effects of policy interventions on future energy use and production. This modeling is used in the National Energy *Outlook* to assess about 70 policy measures in the energy agreement. See ECN et al. (2016) for more details about the models and model inputs.

17.4 | The added value of environmental accounts

From reviewing the role of environmental accounts in Dutch energy policies, three key lessons emerge:

- Accounts are important at all phases of the policy cycle
- Accounts are suitable for analyses and models used to inform energy policy
- Collaboration among those involved in account production, policy analytics, and policy design and implementation is important.

17.4.1 | Energy accounts and statistics are important in all policy phases

The energy agreement is a good example of a situation in which environmental statistics and environmental accounts have had a clear impact on government policies. The data were highly relevant to raise awareness, prepare policy, and monitor the Energy Agreement. The energy statistics and accounts fed into several energy models and policy analyses that provided relevant inputs for the negotiation process and forced the participants to propose workable measures and objectives. Moreover, the annual monitoring of the progress provides information to review and, if necessary, improve the measures proposed. The environmental statistical and accounting data, in combination with the modeling results and projections, provide an agreed set of facts and

defuse the political debate, not only among different political parties, but also among government, employers' organizations, trade unions, and environmental organizations. For the research institutes, the accounts, and the models to play such a role, undisputed trustworthiness is required.

17.4.2 | The environmental accounts are suitable for the analysis of energy policy

Ruijs et al. (2017) argued that three factors affect the applicability of the environmental accounting data in the policy process:

- The scale of the environmental problems
- The level at which decisions are made
- The type of policy measures (generally or nationally applicable versus specific and location dependent).

Environmental accounts are especially useful for national-level problems that are influenced by decisions made by representatives from the economic sectors represented in the accounts and the government can design generally applicable policy measures, independent of location and context. The Dutch energy policies, and especially the energy agreement, appear to score well for all three factors. The energy agreement was national in scope, with the economic sectors all represented in negotiations as well as in the environmental accounts. The energy-related accounts provide relevant physical (for example, emissions and energy input and output), employment, and monetary (for example, taxes and expenditures) information by economic sector that is directly linked to the economic information in the national accounts and hence can be used to tailor policy responses.

17.4.3 | Accounting, energy policy analysis, and modeling is a collaborative effort

In the energy agreement, the environmental accounts were used in several energy and simulation models. Building suitable models and conducting relevant policy analysis is complex both technically and organizationally. Technically, this work requires detailed knowledge of the system to be analyzed and analytical and modeling skills. Organizationally, the process leading to the energy agreement shows that energy policy evolves step-by-step and has resulted in a division of tasks among

- The institutes collecting and compiling (and sometimes also analyzing and interpreting) the statistics and environmental and national accounts (that is, Statistics Netherlands)
- The institutes using this information for (among other things) policy analysis and model building
- The policy makers using this information in their policy proposals.

The division in tasks among the different agencies requires cooperation among the agencies, and such cooperation is still growing in the Netherlands. The annual *National Energy Outlook*, in which monitoring and forward-looking scenario and instrument analysis are combined, is an excellent example of this cooperation. The experience is not restricted to energy, and Statistics Netherlands cooperates with many other institutes (for example, see Oosterhuis, van der Esch, and Hoogervorst [2016]).

17.5 | Final remarks

It has taken time for the different institutes to trust each other in the policy processes related to energy. In addition, it was a time-consuming process to prepare the environmental statistics, accounts, and models that

are relevant for the policy process. Step-by-step, more detailed information was requested from Statistics Netherlands, and the new information provided allowed for new and improved types of analysis. In parallel, policy makers also learned step-by-step which questions were most important and what types of information and analysis were needed. Through cooperation and transparency, all stakeholders learned from each other. The division of tasks required close dialogue among policy makers, policy analysts, and statisticians, and this enabled the evolution of data, indicators, analysis, and modeling to better suit the needs of policy.

While policy making is often a "messy" process, the experience of the Netherlands has shown that the energy accounts and statistics, along with the results from the energy models, have facilitated the policy process of the Energy Agreement for Sustainable Growth. Empirical evidence and transparency have, to a certain extent, depoliticized the policy process and separated fact from fiction. This could not have been realized if the statistical agency, policy analysts, and policy makers operated independently, not cooperating and sharing data and insights. This is perhaps the most important lesson from the Netherlands, which the WAVES partners and countries can learn from, and potentially make faster progress than in the Netherlands.

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17.7 Endnotes

1 This chapter is based on Ruijs and Schenau (2017), chapter 3.
2 www.clo.nl.

18 | Use of Mineral Asset Accounts in the Philippines

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Summary

The Philippines produces both precious metals, gold and silver, and base metals, such as copper, nickel, and iron. Even though the mining sector's contribution to the economy is fairly small, it is an important part of the economy. However, there are a number of policy issues involving the mining sector. Social and environmental impacts of mining operations are not fully addressed, despite existing laws and institutionalization of mechanisms to govern the protection of the environment. The government collects a fairly low share of revenues from mineral resources, and the allocation of its share across national and local government is debated. Valuing the natural resources and compiling a natural capital account is one of the methods that has been identified to help guide the policy and decision makers in this important area.

The trade-off between establishing a mining operation and other land uses may be better weighed given the availability of natural capital accounts. The process and output of development of accounts also enable the assessment of impacts of mining on the economy, environment, and human well-being as a whole. Executive Order 79 mandates the inclusion of the results of resource accounting and the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) project as a source of information in developing the necessary policies to protect the environment and promote responsible mining. The Department of Environment and Natural Resources (DENR) is planning to use natural capital accounting (NCA) as part of the process to assess the impacts of mining activities or other activities.

NCA will also provide a basis in determining the sharing scheme of revenues in mining activities. A bill on minerals (Bill No. 5367) that was filed in the House of Representatives in 2015 proposed a new fiscal regime and revenue-sharing arrangement between the government and the mining contractor for large-scale metallic mineral mining operations. The bill was not passed. However, the mineral asset account can be used to assess the sharing scheme that is proposed in the bill and provide information to the lawmakers as basis for approving it. In addition, information from the accounts about the mineral reserves and how much of these reserves were extracted over a period of time will provide better knowledge on the rate of extraction that may be undertaken in the future.

18.1 | Introduction

Mineral resources refer to any concentration of minerals—naturally occurring inorganic substances, except energy materials, such as coal, petroleum, natural gas, radioactive materials, and geothermal energy—that may be of potential economic value (Mining Act of 1995). In terms of economic contribution to the country, the important metallic minerals found in abundance in reserves in the Philippines are gold, copper, chromite, nickel, iron, cobalt, platinum, silver, mercury, manganese, molybdenum, and zinc (Phil-WAVES 2016, 8). According to the Oxford Business Group (2009), the Philippines ranks third in the world in gold ore reserve in terms of occurrence per unit area, fourth in copper reserves, and fifth in nickel ore reserves.

For the mineral resources to be utilized by its intended end user, several processes must be completed, beginning with exploration, then extraction, beneficiation, up until refining. Regardless of the minerals produced, the scale of mining operation, or the location, mining is an impact-intensive industry. Waste in the form of barren rocks, tailings, leach piles, and the like are released to the air, terrestrial, and aquatic ecosystems (Yap 2015).

Despite these issues, there are still a number of active mining operations in the Philippines because of the demand for both metallic and nonmetallic minerals. In 2016 alone, the Philippine mining industry produced about ₱45.8 billion worth of precious metals: gold and silver. According to a report of the Mines and Geosciences Bureau (MGB 2017), the base metals in the form of copper concentrate, mixed nickel-cobalt sulfides, nickel direct shipping ore, chromite, and iron ore produced the same year were valued at about ₱54.8 billion. However, the mining sector's contribution to the economy is small. For instance, during the third quarter of 2016, the mining sector contributed 0.06 percent to the Philippine gross domestic product (GDP) (MGB 2017).

18.2 | Policy issues

The mining sector in the Philippines faces several issues. First, the social and environmental impacts of mining operation are not fully addressed, despite the laws and institutional mechanisms that have been established to protect the environment. For instance, Executive Order 79 mandates that no mining activities shall be implemented in areas that are critical to maintaining the integrity of the ecosystems or negatively affect the indigenous peoples. These areas include: (1) protected areas categorized and established under the National Integrated Protected Areas System; (2) prime agriculture land, including plantations devoted for valuable crops, zones for strategic agriculture and fisheries development, and declared fish refuge and sanctuaries; (3) tourism development areas identified under the National Tourism Development Plan and island ecosystems; and (4) impact areas of mining, as determined by current and existing mapping technologies.

The government receives a low share of mineral resources utilization. Under the Philippine Mining Act of 1995, the government collects fees, royalties, and taxes from the utilization of the mineral resources. Republic Act No. 7729 stipulated that excise tax rates on metallic and nonmetallic minerals and quarry resources are: (1) for coal and coke, 10.00 pesos per metric ton; (2) for nonmetallic and quarry resources, 2 percent based on the actual market value of the annual gross output; and (3) for metallic minerals, approximately 2 percent of the actual market value of the annual gross output.[1] In 2011 alone, almost ₱8.3 billion in taxes, royalties, and fees was collected by the Philippine government from mining companies. However, this accounted for only 0.61 percent of the total tax revenue collected in the national level (IMF 2012). Considering that mining is highly extractive and the use of the resource of that industry means foregoing other uses, like water provision, timber, etc., this share in government income is still insufficient. Executive Order 79 (2012) mandated a moratorium on new mineral agreements until legislation rationalizing existing revenue-sharing schemes and mechanisms takes effect.

Revenue allocation across national and local governments is disputed. Of the taxes and royalties collected from mining operation, local governments or the host communities receive only 40 percent, if the mining activity is operated by a private sector entity. If it is operated by a government-owned and -controlled corporation, the local government or community receives 1 percent of the gross revenue or 40 percent of the mining taxes, whichever is greater. Among the local government units, the community, or barangay, receives a 35 percent share; the city/municipality, 45 percent, and the province, 25 percent. Most local government units argue that the host community should receive the largest share.

Valuing the natural resources and compiling a NCA are some of the methods that have been identified to guide the policy and decision makers in addressing the issues discussed.

18.3 | Natural capital accounting in the Philippines

The development of NCA in the Philippines started in the 1990s when the Department of Environment and Natural Resources, with funding from the U.S. Agency of International Development (USAID), embarked on the

implementation of the Environmental and Natural Resources Accounting Project (ENRAP). ENRAP aimed to (1) develop mechanisms for examining economy-environment interactions; (2) generate improved information on specific sectors of the economy of importance to natural resource and environmental policy; and (3) provide better measures of a nation's growth and development as recommended by the Philippine Agenda 21 (delos Angeles 2000). Physical and monetary estimates at the national level were compiled to include metallic minerals, particularly gold and copper, for the period 1988–99, nonmetallic minerals for the period 1988–96, and environmental degradation caused by small-scale gold mining for the period 1988–98. There were also efforts to pilot the accounts at the regional and provincial levels. The physical and monetary accounts of mineral resources, particularly gold, copper, and limestone, were compiled to cover the period 1990–98 in the Cordillera Administrative Region. The accounts for nickel, in ore and metal forms, and sand and gravel in the province of Palawan were also compiled (Talento 2013).

In 1996, the Philippine Agenda 21 was adopted, which included as one of its targets the initial institutionalization of Environmental and Natural Resources Accounting (ENRA). In 1997, Executive Order 406 (1997) was signed, which institutionalized the Philippine Economic-Environmental and Natural Resources Accounting (PEENRA) System. PEENRA units in the DENR, the National Economic Development Authority (NEDA), and the National Statistical Coordination Board (NSCB) were created to ensure the implementation of the system. However, this endeavor was not sustained due to resource limitation, the lack of political will, and the prioritization of the agencies involved (Talento 2013).

The Philippine Wealth Accounting and Valuation of Ecosystem Services (Phil-WAVES) project that started in 2013 takes off from the initiatives of the ENRAP toward development of NCA. For this project, four priority areas were identified: mineral accounts, mangrove accounts, and two ecosystem accounts in Southern Palawan and the Laguna de Bay Basin (WAVES 2016).

18.3.1 | The mineral asset account

One of the accomplishments of the Phil-WAVES project in terms of its mineral accounts component is the completion of preliminary physical and monetary asset accounts for gold, copper, nickel, and chromium for the period 2000–2012, produced by the Philippine Statistics Authority (Phil-WAVES 2016). Through the project, physical accounts for gold, copper, nickel, and chromite were compiled and estimated. Monetary accounts were computed based on the physical accounts estimated using the net present value. The System for Environmental-Economic Accounting Central Framework (SEEA-CF) 2012 was used as the accounting framework. Although the resulting accounts are still limited compared to the wide range of mineral resources found in the country, the output contributes to the development of macroeconomic indicators for computing adjusted net national income, adjusted net national savings, and comprehensive wealth (Phil-WAVES 2016, 5). The accounts may also provide input in the planning and policy making of various agencies, such as NEDA and DENR, to name a few.

The Philippine Statistics Authority (Phil-WAVES 2016) suggested improvements in the production of mineral accounts, including the following:

- Localize the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources (UNFC-2009), which was adopted during the production of the mineral accounts. Currently, the MGB uses the Combined Reserves International Reporting Standards Committee (CRIRSCO).

- Expand the mineral asset accounts for gold, copper, nickel, and chromite to include other metallic and nonmetallic minerals to provide a more holistic picture of the mineral resource/reserves of the country.

- Explore the enhancement of the methodology for monetary accounts to include compensation of employees, depreciation, resource rents, and others, which were not included in the previous accounts.
- Compile mineral accounts at the subnational and provincial levels so they may be more relevant to local government units (LGUs) for planning, decision making, and policy formulation at the micro level.
- Improve the generation of administrative data by developing a system that (1) facilitates data storage and retrieval, (2) includes the integrated annual reports submitted to MGB in the Designated Statistics, a mechanism to identify and generate of crucial statistics for administrators, planners, policy makers, and decision makers in the government and private sectors, (3) addresses problems, such as data gaps, duplication, delayed release, and inaccessibility of important sets of statistics, and (4) has a framework for setting priorities in data production.

18.4 | Use of mineral accounts in policy and decision making

The growing awareness of the importance of NCA in policy and decision making provides an opportunity to use the mineral asset account compiled under the WAVES project. The DENR is considering the use natural capital/ resource accounting in programmatic environmental impact assessment of mining projects. Executive Order 79 mandates the inclusion of results of resource accounting and the WAVES project as a source of information in developing necessary policies to protect the environment and promote responsible mining. Capacity building and improvement on data management and access are needed to transfer the experience of the Phil-WAVES project in areas outside the pilots and to compile NCA at subnational levels.

To engage decision makers and stakeholders to address the issues related to mining, a strong sense of ownership must be fostered for the policies and decisions. This may be achieved by conducting public awareness campaigns, capacity building, and consultations throughout the policy and decision-making process.

The mineral accounts provide a holistic and comprehensive view of the mineral assets as a basis for development. Comprehensive information about the mineral reserves and how much these were extracted over a period of time provides better knowledge on the rate of extraction that may be undertaken in the future. It will also provide a more analytical and scientific basis for new policies or improvement of the existing ones.

The trade-off between establishing a mining operation and other land uses may be better weighed given the availability of the accounts. The process and output of development of accounts also enable the assessment of impacts of mining on the economy, environment, and human well-being as a whole. The accounts will provide direction as to the kind of alternatives that should be employed if mining activities cause more harm than benefit to the environment and the people. The accounts will also be used as a basis for enhancing the mitigating measures in balancing the impacts of mining activities. The pronouncement of the DENR to inject NCA as part of the process of assessing impacts of mining activities or other activities is a step toward protecting the environment and sustaining the natural resources.

Existing policies may be better evaluated using the accounts that will lead to better and more relevant policies across all levels of the government.

The use of NCA in the Philippines is a new development to improve the policy- and decision-making process, particularly in promoting evidenced-based actions. Institutionalizing this into the organization of DENR with full human resource and budgetary support could result in using NCA as part of the policy process. The experiences

and lessons from previous undertakings and the positive results from the Phil-WAVES project show that NCA plays a major role in policy and decision making.

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18.6 | Endnote

1 For copper and other metallic minerals, 1 percent on the first three years, 1.5 percent on the fourth and fifth years, and 2 percent on the sixth year onward, and for gold and chromite, 2 percent.

19 | Natural Capital Accounting in Rwanda: The Process and Potential Applications

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Summary

Rwanda uses natural capital accounting (NCA) as a tool to enhance the sustainable management of the environment and natural resources. Based on domestic priorities, the NCA work began with land and water accounts, with some preliminary work on minerals. These three sectors are identified as the key pillars of economic development and sustainable growth in Rwanda. Land is the basis for agriculture, and it contributes to 31 percent of gross domestic product (GDP) and provides 50 percent of total employment. Eighty percent of Rwanda's population is rural, and the majority of these areas rely on agriculture for their livelihood. Land availability is already a constraint not only to agriculture growth but also to urbanization. Water in Rwanda is under pressure due to rapid population growth and economic development (6.9 percent GDP growth in 2015). For the land accounts, information was compiled using the physical asset accounts, land use, land cover, and monetary accounts. The water accounts focused on the physical asset accounts, the physical flow accounts, and the monetary accounts. Findings show that about 70 percent of the land is for used for agriculture and forestry, and that fragmentation increased slowly from 2014 to 2015. The area of dense forest declined by half over a 20-year period, and the area of settlement doubled. Agriculture and livestock uses had their highest transacted area, but with low value per hectare.

For water, agriculture was the largest consumer (68 percent) for the period of 2012–15. The value of water as an input to agriculture differs by region and the timing of water availability. The quality of water and the reliability of its supply are also important determinants of the value of water. More analytical work might be needed and additional tools should be used for a deeper analysis. The process of developing the accounts is complex; thus an appropriate structure should be established for a regular update on NCA data.

19.1 | Introduction

This discusses the potential use and application of NCA for land and water in Rwanda. Although the development of land and water accounts is ongoing work, the current information available enables some analysis to start informing policy makers.

As one of the signatories of the 2012 Gaborone Declaration, Rwanda committed to integrate the value of natural capital into the development and business practice. As an early commitment, Rwanda established a National Steering Committee in 2013 to assess priorities and the key actions to be mainstreamed. In line with its medium- and long-term strategies—especially the Economic Development for Poverty Reduction Strategy (EDPRS) and the Green Growth and Climate Resilience Strategy (GGCR)—the land, water, mineral, forestry, and energy accounts were found to be priority sectors. A scoping study in 2014 revealed that it would be feasible to develop the land and water accounts and do preliminary work on minerals.

During the process of developing the accounts, capacity was strengthened and the Technical Working Group (TWG) team appointed to learn about the NCA process has become increasingly comfortable with developing the accounts. In addition, the Steering Committee has been providing advice, and its involvement shows a strong ownership.

19.1.1 | Why land, water, and minerals?

Rwanda is one of the most densely populated African countries, with an area of 26,338 km^2 and a population of about 12 million. Furthermore, considering that the country has few natural resources to exploit and that its population largely relies on small, semi-subsistence rain-fed agriculture, land is already a constraint to agricultural growth. This means that to achieve food security, agricultural productivity must be increased. However, the high population density leads to plot fragmentation, land scarcity, and land degradation, which is somewhat alarming. Moreover, rapid urbanization results in land being converted from other uses to residential use. As the country is now implementing its green growth strategy, the zoning of green areas is another high priority.

Rwanda is a naturally water-rich country. However, the water resources are under pressure from high population growth and rapid economic development. Urban water supply is uncertain, and rural households often rely on less hygienic sources.

Rwanda's minerals sector is small, but it represents an important share of export revenues and is growing rapidly. However, the sector still relies on less efficient processing technology and low-skilled labor. Furthermore, even if the value of output contributes to the gross domestic product (GDP) and foreign exchange earnings, rent capture by the government is limited, and the level of employment and environmental effects are not yet well understood.

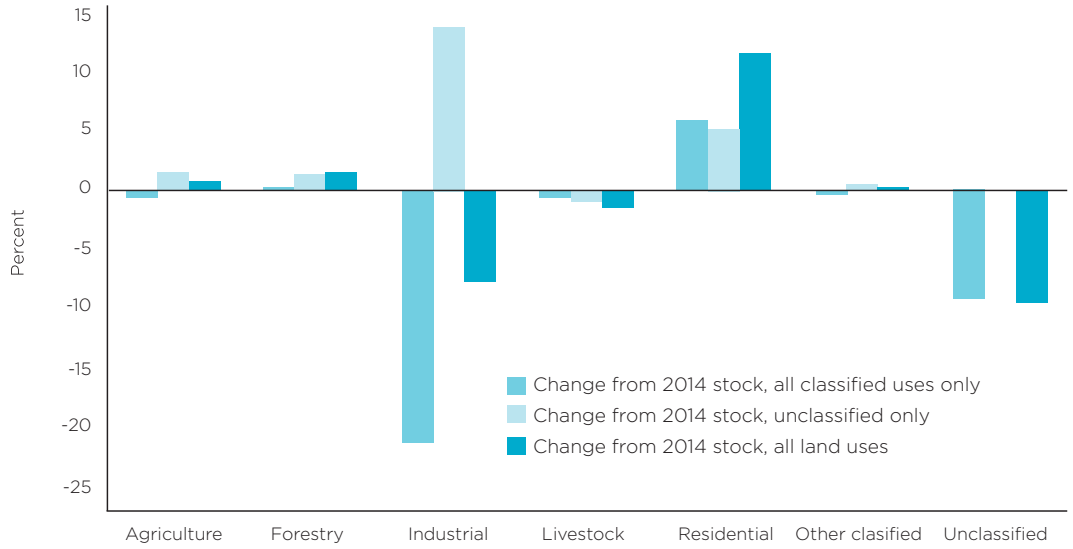
19.2 | Land accounts: process and results

Rwanda has the advantage of having an established and comprehensive database on land ownership and use: the Land Administration Information System (LAIS). For the monetary information, LAIS provides a systematic data set that can advance the understanding of land transaction values in Rwanda. However, some comparisons could be contemplated to assure the robustness of LAIS data. For example, LAIS values per hectare could be compared with mortgage values, as collected by the banking system and Revenue Authority.

19.2.1 | Land use and land use change

Using data extracted from LAIS, land assets accounts have been developed for 2014–15. Results show that about 70 percent of land is in agriculture and forestry uses. The data for 2012–15 were considered in the development of the land accounts, but due to differences in the precision of early records from the period when LAIS was initiated, the years 2012 and 2013 were not included because of the numerous discrepancies and inconsistencies in the data. Figure 19.1 shows that most recorded changes are not physical shifts from one land use to another, but administrative moves from an unclassified state to a known land use category.

Figure 19.1: Land accounts: land use change by sector, 2014–15



Source: Authors' elaboration.

19.2.2 | Land cover accounts

Using remote sensing information, land cover accounts for the period 1990–2010 were developed to monitor and analyze changes in land cover and land use to understand land dynamics in Rwanda. Rwanda, a member of the Regional Centre for Mapping of Resources for Development (RCMRD),[1] and the government of Rwanda worked together with them to create land use and cover maps for 1990, 2000 and 2010. The Wildlife Conservation Society, Science for Nature and People Partnership, and United States Geological Survey effort to develop ecosystem accounts has already relied on these land-cover datasets developed for Rwanda.

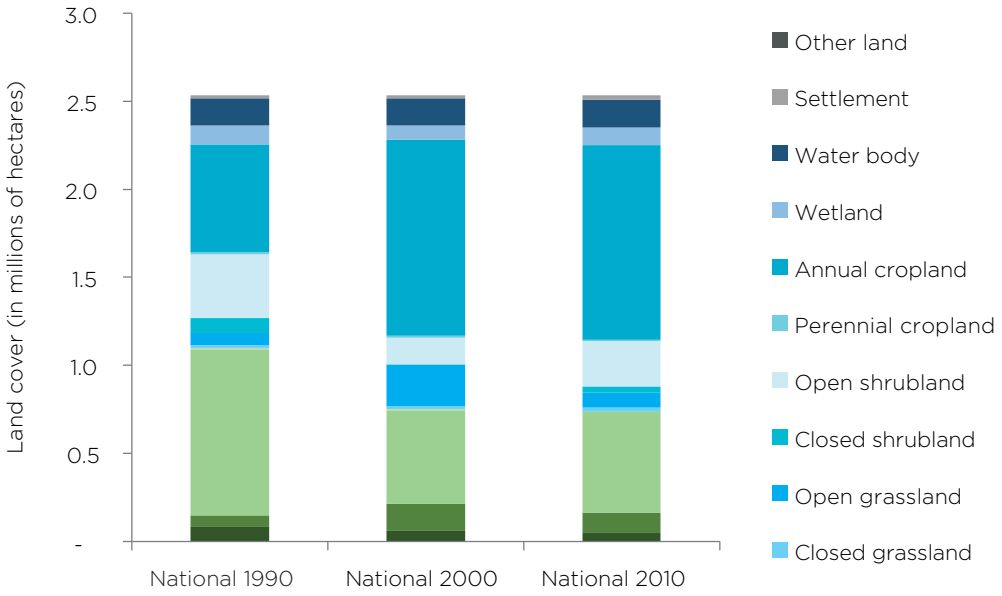
The results in figure 19.2 show that since 1990 there has been a decline of woodland and an increase in cropland in Rwanda. This change is most noticeable from 1990 to 2000, which includes the period during the genocide events and the land use changes associated with movements of people and repatriation of refugees. While the area of dense forest has declined by half over the 20-year period of this analysis, the area of sparse forest has increased, particularly after 2000. The area of settlements has doubled over this same period, but remains a very minor feature of the landscape, at about 1 percent of Rwanda's overall area.

19.2.3 | Land transaction values and comparisons: monetary accounts

LAIS contains information on the land transactions and values. These data were used in an initial step to develop the monetary land accounts. The transaction values for 2014 have been analyzed. For 2015, there is a need to look further at data quality and consistency. Results show that the value of transactions in the capital city is higher compared to those of the other provinces.

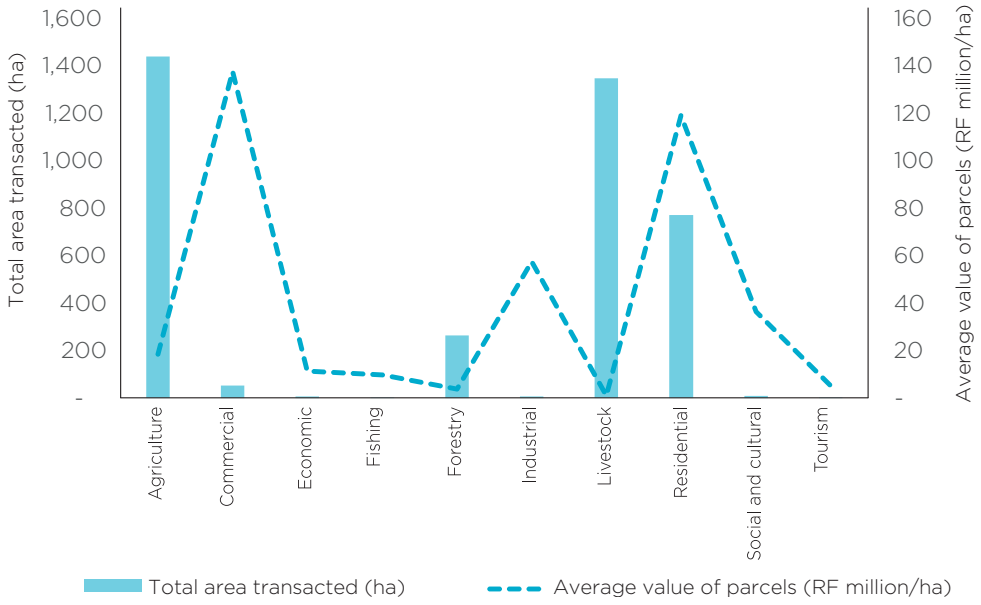
The data show that most transactions involved agriculture, livestock, and residential land uses. For transaction values across sectors, figure 19.3 shows that agriculture and livestock land uses have the highest transacted area but are of substantially lower value per hectare than commercial, residential, and industrial land uses.

Figure 19.2: National land cover comparison, 1990, 2000, and 2010



Source: RCMRD, (1990, 2000, 2010).

Figure 19.3: Summary of area and value of parcel transactions in Rwanda, by LAIS land use, 2014



Source: LAIS (2014).

19.3 | Water accounts: process and results

In Rwanda, water accounts are policy relevant due to the high pressure on water resources. Water supply is uncertain and part of the rural population relies on less hygienic sources. Water is a key input to production, and

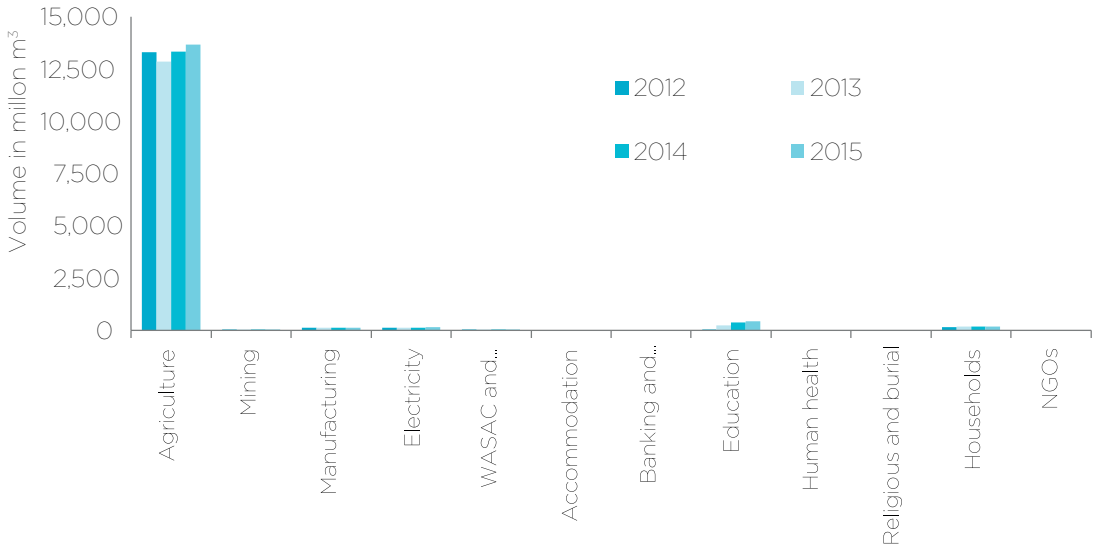
scarcity could constrain growth in key sectors (agriculture, urban development) if it is not sustainably managed. Statistics show that Rwanda's water resources are severely degraded (MINIRENA 2013), primarily due to land degradation resulting in siltation of water bodies; pollution from point and nonpoint sources, including agricultural chemicals, inappropriate human settlements, and poor urban and industrial waste management. Rwandan statistics do not currently allow any detailed estimates of the quantities of water used by different economic activities, which would be needed to assess how water could be managed and used more efficiently.

19.3.1 | Water assets and water use accounts

Using the SEEA water accounts, physical water accounts based on currently available data in the National Water Resources Master Plan (WRMP) and additional information have been developed. Compared to the process in compiling the land accounts, developing the water accounts has been a complex exercise. For the water sector, data are scattered among different institutions and compiling the data requires a format that harmonizes data from different sources. A better way to update these accounts in the future, beyond the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) program, must be planned and developed.

Preliminary results in figure 19.4 show that agriculture is the largest consumer (68 percent) for the period of 2012–15. The value of water as an input to agriculture differs by region and water availability, the quality of water and the reliability of its supply are also important determinants of the value of water. More analytical work will be needed, and additional tools should be used for a deeper analysis.

Figure 19.4: Trends for water consumption in Rwanda for 2012–15 (mm³)

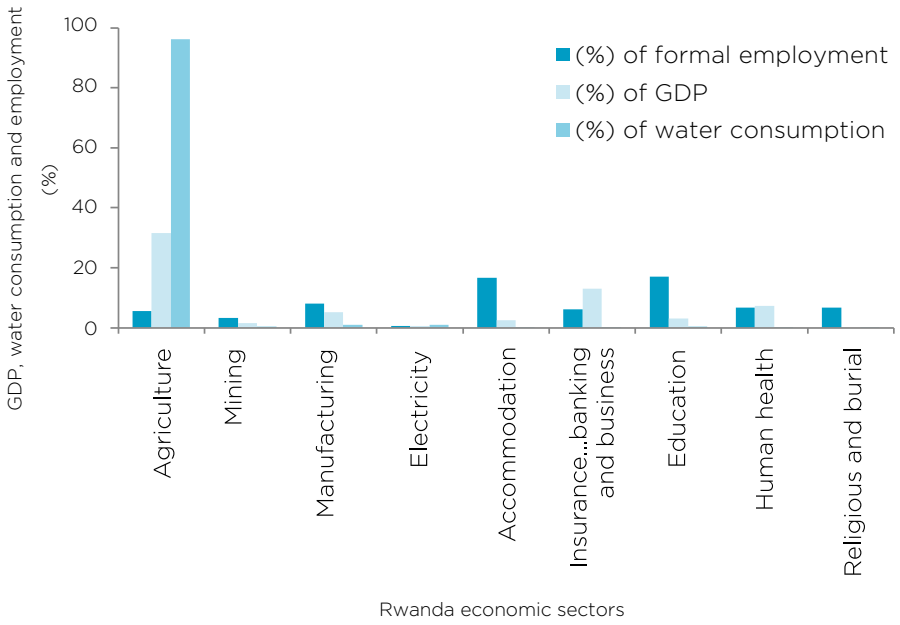


Source: Authors.

19.3.2 | Economic water accounts

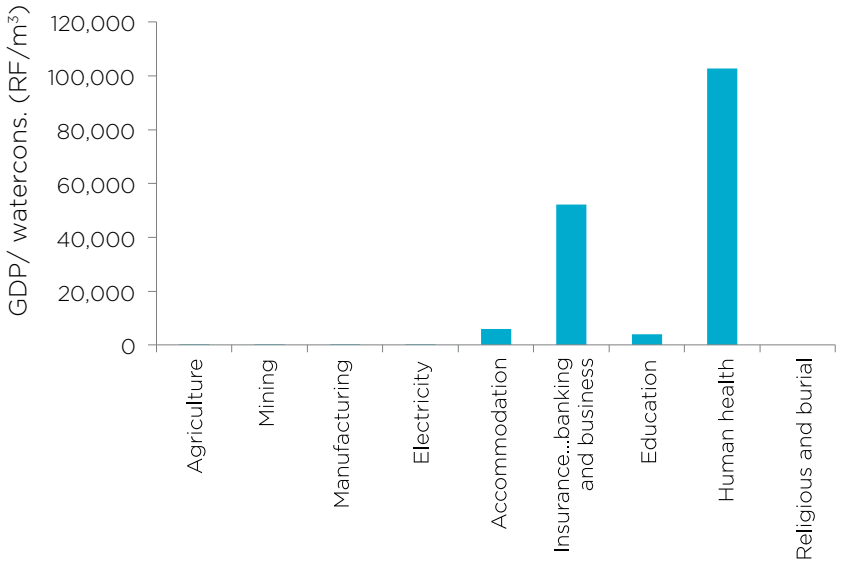
The water accounts are not finalized, as the data is not fully assessed yet. However, some preliminary findings can be gleaned. Figure 19.5 shows that agriculture sector as the bigger water consumer, contributes to GDP at 31 percent and to 50 percent of total jobs. Figure 19.6 shows that water productivity is higher in the service sector than in agriculture.

Figure 19.5: Water consumption, GDP, and employment (as a percentage), 2012



Source: Authors, based on information from PSUT and the National Account in NISR.

Figure 19.6: Water productivity and efficiency (RF/m³)



Source: Calculations made using data from NISR for GDP and data from water consumption table.

19.4 | Mineral accounts: process

The development of the mineral accounts started recently and will include physical flow and monetary information. The data used covered the years 2012, 2013, 2014, and 2015. Preliminary findings reveal that this sector is under severe pressure and is susceptible to sector wide volatility, leading to hedging with inventories, and

so forth. Data on the mineral accounts could enable the government to set appropriate mining taxes or fees to determine trends in production, value addition, and employment in different mineral sectors.

19.5 | Potential uses of accounts

19.5.1 | Uses of land accounts

The second economic-development and poverty-reduction strategy recognizes that land is a limited resource requiring proper management to contribute to rural development and productivity.

Under EDPRS2, the rural development objective aims to continue to reduce poverty by increasing the productivity of agriculture. It also places priority on human settlements and focuses on land-use allocation for development. Land scarcity, high population growth, and rapid economic growth have exerted stress on competing land uses in the country, and although sectoral planning exists, better information is needed to ensure that sector policies target tensions or competing demands for the same land.

Land accounts can inform policies to address these issues by contributing to the understanding of how sectors compare in terms of land use per value of output or intensity of use, as well as longer term projections of productivity, resource use, or potential bottlenecks in land availability for national development objectives. Land accounts can also clarify and compare economic values generated by land in competing uses and how changes in land use may affect land value. In addition, these accounts enable comparisons of market values for land in different regions or for different uses, which could inform the expropriation policy and compensations.
When linked to water accounts, land accounts can offer insights in the analysis of the impact of land-use changes on productivity of key commercial crops or water resources. These accounts could also inform planning on potential implications for water use or food production due to changes in land uses.

19.5.2 | Uses of water accounts

The EDPRS2 strategic plan for the water supply and sanitation sector has the ambitious target to reach a 100 percent coverage for water supply and sanitation services. Water availability could constrain growth in some regions or key sectors (agriculture, urban development) or deter investment in some kinds of commercial activities.

On completion, water accounts will enable the government and responsible agencies to understand where water is being used most, its productivity, and trends in efficiency or intensity of use. These accounts will also allow estimation of water use and value for different economic activities, both absolute and relative to their contributions to employment and growth. Monetary water accounts will help to clarify and compare the economic value of water in competing uses and how it is changing over time. The accounts will also enable the comparison of water prices being paid by different sectors and population groups to inform investments and infrastructures needs in each sector.

19.5.3 | Uses of mineral accounts

Though small, Rwanda's mineral resource sector contributes to a significant share of export revenues and can contribute toward the EDPRS2 aim of economic transformation, rural development, productivity, and youth employment.

Mineral accounts are expected to help provide more accurate data for government management and oversight as well as setting appropriate mining taxes or fees and determining trends in production, value addition, and employment in different mineral sectors. The mineral accounts will also inform the government on how to optimize resource rents from mining and utilize these through re-investment in physical, human, and social capital. The utilization of the mineral accounts could further inform the hopes and plans of increasing investments and production from the mining sector and consequently its contribution to GDP and foreign exchange earnings.

19.5.4 | Observations to date

In the course of developing the accounts, the major observations include the following:

- The preparation of water accounts has involved a process and platform for improving data exchange, institutional coordination, and measures for dealing with intersectoral trade-offs. The water accounts development process has also helped to improve the quality of data used for management, pricing, and allocation and to address questions of cost recovery and investment needs.
- In developing the land accounts, key agencies were involved, which has strengthened existing collaboration in land data exchange and management. The process helped to inform land-use planning, and agencies recognized the need to harmonize the data collection system. Current results are being used to examine how land-use and land-cover changes conform to the recommendations in the Land Use Development Master Plan, as well as how market values of land in different regions can be used to inform the expropriation policy and compensations.
- There is a need for better data collection and management formats among partner agencies to improve the input into the accounts building process. While most of the partner agencies have the required information, a number of them lack the data in specific formats or do not collect it. This information, however, was relayed to the agencies, and now most are collecting the data in the required formats.
- There is also need for increased data sharing across government institutions to improve the efficiency of account construction. This data-sharing issue largely rests with those institutions that may have the information necessary for the accounts building process, but bureaucracy slows down the process of accessing the information.

19.6 | Lessons learned

Developing the accounts has been a complex and demanding process. It was important to assess existing data at the earlier stage and be able to understand the gaps. Because data were not in one place, compiling data scattered among different institutions was not an easy task: people had to be convinced of the relevance of compiling the accounts. In the absence of any memorandum of understanding for data sharing, getting access to data was complicated.

Existing raw data were mostly in a format that required additional work before they could be useful as information for analysis. Then the dataset needed to be crosschecked to eliminate inconsistencies to ensure accurate estimates.

In the beginning, it was difficult for institutions to discuss the NCA concept. However, after sharing preliminary findings, institutions were more involved in the process and the results on accounts were viewed as a means to increase awareness. Stakeholders continue to provide feedback and offer recommendations on how best to improve the results.

For effective implementation, the NCA concept needs to be well understood. In the beginning, the level of commitment was low, but through learning by doing, the staff involved became increasingly more engaged.

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19.8 | Endnote

1 RCMRD, based in Kenya, was established in 1975 as an intergovernmental organization to supply spatial analysis and mapping and capacity building services to member countries, which includes Rwanda. Its mission is to promote sustainable development in the member states through the generation, application, and dissemination of geo-information and allied information and communication technologies (ICT), products, and services.

20 | How Environmental Accounts in Sweden Are Driven by Changing Policy Need

Nancy Steinbach, Environmental Accounts and Natural Resources Unit, Statistics Sweden

Summary

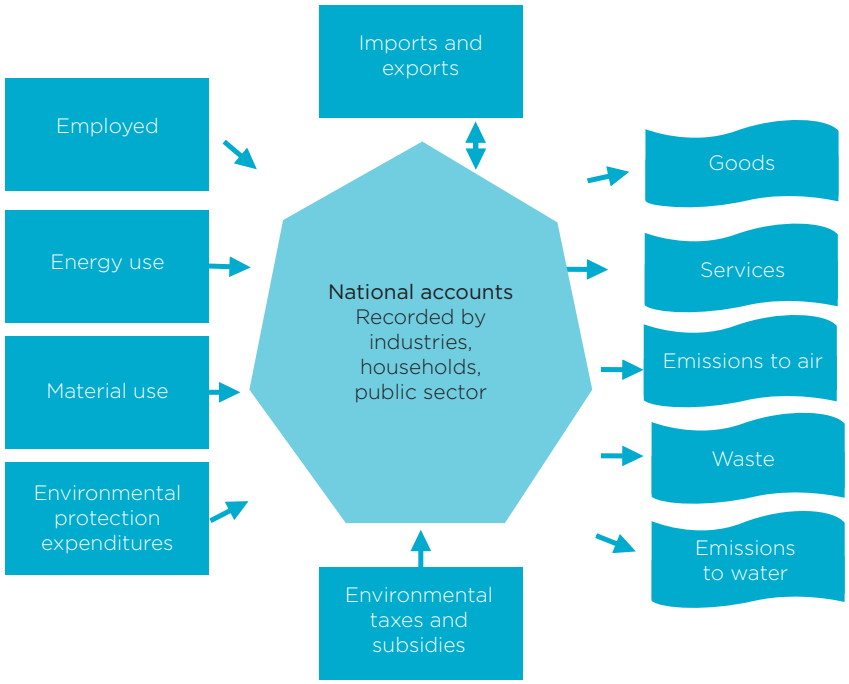
This chapter provides an overview of how Sweden's environmental and economic accounts system was developed and is used today. The work to develop the accounts began the government tasking Statistics Sweden with development of a single system combining economic and environmental data. The assignment was inspired in the early 1990s by international and national discussions on the lack of common data systems that could describe the relationship and mutual effects of the economy the environment. This chapter notes the importance of discussions with national policy and research actors in shaping what the accounts cover, and the significance of international and European policy commitments in driving continuing demand for environmental economic analyses and basic data. By involving the stakeholders, Statistics Sweden has gradually expanded the knowledge base as well as provided opportunities to promote account use.

This chapter discusses the use of accounts information by different government agencies. The accounts are used for purposes that range from monitoring the emissions of greenhouse gases in the economy, to assessing the impact of Swedish consumption on the global climate, the environmental pressure of housing and planning activities, and investigations of maritime activities, to assessing the size of the bio economy. It also points to emerging topics for further developing the environmental and economic accounts system, notably being able to provide an integrated analysis of particular aspects of sustainable development.

20.1 | Background

The components of the environmental economic accounts are described in the international System of Environmental-Economic Accounting Central Framework (SEEA-CF 2012). SEEA began development in the early 1990s. The purpose of the system is to show how the economy and the environment interact. By integrating environmental and economic accounts' data, use of the SEEA-CF framework can help describe the environmental contribution to the economy (for instance, the use of raw materials, water, energy, and land by different sectors) and the impact of the economy on the environment (for instance, emissions to air, land, and water). Figure 20.1 depicts a statistical system with the aim of describing the contributions of the environment to the economy and the impact of the economy on the environment. In the heart of the framework are the national accounts, which are depicted as the central element. The environmental accounts also distinguish activities relevant to the environment in the economy (environmental goods and services sector) and associated *economic transactions* in the national accounts (environmentally related instruments and expenditures for environmental protection).

Figure 20.1: The environmental economic accounts system



Source: Statistics Sweden.

20.2 | Early calls for better environmental-economic information

In 1993, the government tasked Statistics Sweden, the National Institute of Economic Research, and the Swedish Environmental Protection Agency to create a system to describe the relationships among the economy, the environment, and natural resources in terms of monetary and physical flows, as well as the state of the environment. This assignment was a result of the government investigation Räkna med miljön från 1991 (SOU 1991, 37–38) ("Count on the Environment" from 1991), initiated by the Ministry of Finance. The backdrop to this investigation was the call from the international community, the United Nations (UN) and the Organisation for Economic Co-operation and Development (OECD) to look beyond a nation's gross domestic product (GDP) and to assess the impact and interrelationship of the economy on the environment. There was significant debate on sustainable development in Sweden during that time, and *Our Common Future* by the Brundtland Commission had recently been published in 1987. This publication provided a foundation for new discussions on aligning and unifying economic and social systems with basic ecological and natural science principles.

While the National Institute of Economic Research was assigned to develop a "green GDP" measure at the macro level (an assignment which the institute was later released from) and to build an environmental economic model, the Swedish Environmental Protection Agency was assigned to follow the state of the environment. Statistics Sweden was tasked to manage a statistical system for the environmental economic accounts. The National Institute of Economic Research established the Environmental Medium-Term Economic Model (EMEC), which is an equilibrium model based on, among other things, information from Statistics Sweden's environmental accounts. EMEC is still in use today.

20.3 | Environmental economic accounts for Sweden today

The initial focus has been on stocks and flows of natural resources, such as forests, land, and water, together with development of some air emissions accounts, input-output analysis, and environmental protection expenditures. Thereafter, the full suite of "flow accounts" followed, covering further types of air emissions, energy use, and environmental economic instruments. Each area was evaluated by users and statisticians alike, and as a result, today, the primary focus remains on the flow accounts. The user community expressed less interest in stock accounts. Currently the demand for new statistics from users, such as the Swedish Environmental Protection Agency and the Ministry of Environment and Energy, relates to consumption-based environmental impacts and ecosystem accounting.

At Statistics Sweden, a team of about six persons works full-time on different aspects of the environmental economic accounts. Statistics Sweden produces the following statistics annually:

- The environmental goods and services sector (annual, official statistics)
- Environmentally related subsidies (annual, official statistics)
- Environmental taxes (annual, official statistics)
- Environmental protection expenditures (annual, official statistics)
- Air emissions by industry (quarterly, regional, and annual, of which the annual data are official statistics)
- Energy fuel use by industry (annual)
- Material flows (annual, official statistics)
- Chemicals indicators (annual).

20.3.1 | Assignments and special requests

The assignments are based on the regular production of environmental accounts and extend them. They serve several agencies and organizations, including the Ministry of Finance, the Ministry of Environment and Energy, the Ministry of Enterprise and Innovation, the Swedish Agency for Marine and Water Management, the Swedish Environmental Protection Agency, and the Swedish National Board of Housing, Building, and Planning. The results are, for the most part, disseminated via websites (that of Statistics Sweden or the assigned agency) for the general public to explore and use the information:

- Consumption-based greenhouse emissions (annual)
- Water accounts (irregular, most recently in 2013)
- Ecosystem accounts (ongoing development work with focus on land types and ownership)
- Environmental technology (irregular, most recently in 2016)
- Forest accounts (annual to Eurostat, otherwise irregular)
- Bio and ocean economy (first pilot on bio economy conducted during 2017; pilot on ocean economy was conducted during 2012, with a second assignment finalized 2017).

20.4 | Demand-driven development of the environmental economic accounts

Many areas within the area of environmental economic accounts are desirable for development. Direct demands from policy authorities drive development, but there is also increasing interest from the research community to obtain more data linking the economy to the environment. Researchers are also playing indirect roles in the policy process.

20.4.1 | Environmental impact of consumption

This demand relates to globalization and Sweden's role in the world. The Swedish generation goal, part of the Swedish system for environmental objectives[1] set out by the government, provides guidance on what values need to be protected and the change in society that is required to achieve better environmental quality. Annual data on consumption-based greenhouse gas emissions (GHGs) are provided to the Environmental Protection Agency. In addition, a research project exploring additional impact, areas such as chemicals, land and other areas, is underway.[2]

20.4.2 | Environment-related subsidies

Statistics on environment-related subsidies such as environmentally motivated are categorized by industry. Ad-hoc studies have been done on subsidies that are potentially damaging to the environment as well. The demand reflects both the new sustainable development goals (SDGs) and the evaluation of how Sweden is reducing fossil-based dependence and improving efficiency in the use of natural resources. The interest of the data falls under the Swedish environmental objectives, but is also required by the Ministry of Finance.

20.4.3 | Ecosystem services and related land use

One of Sweden's environmental objectives includes a milestone target "that no later than 2018 will the significance of biodiversity and the value of ecosystem services be common knowledge and integrated into economic arguments, political considerations and other societal decisions where relevant and appropriate." This demand has led to three specific projects for identifying and developing new statistics and accounts that can help achieve this milestone.

20.4.4 | Marine- and water-related environmental economy

The European Water Framework Directive has long been a driver to develop and publish better statistics and accounts on the impacts of the economy on pollution in the lakes, streams and oceans, but also on the impact of using water and consequences of economic instruments. The Swedish Agency for Marine and Water Management has in turn begun the economic analysis of evaluating the impact and contributions made by the Swedish maritime activities in our coastal areas.

20.4.5 | Inclusion of social issues in the environmental accounts

Another demand is to include social issues in the environmental accounts system to obtain a complete accounting system for sustainable development. After the financial crisis in 2009, more voices called for an integrated analysis of the economy, as well as social and environmental impacts on Swedish society. Within the European Union (EU), the Beyond GDP initiative[3] influenced the Nordic environmental ministers, which led to a report discussing these aspects (NCM 2016). In addition, the indicators of the UN SDGs are currently being evaluated at Statistics Sweden, and further work in this area is anticipated.

20.4.6 | Measurements of the bio economy

Measurements of the bio economy is a recent type of activity within the environmental accounts, with the interest coming from the Ministry of Enterprise and Innovation. The EU is setting a path for a resource-efficient economy

and has developed a strategy for the bio economy. The action plan points to developing new technologies, processes, markets, and competitiveness, and breaking down silos between policy makers to enable closer cooperation.

20.5 | Going forward

If the environmental economic accounts system is to be used in a broader context—for example, to explore wider social development or marine issues—new cooperation projects must be initiated. Establishing new projects is possible, but it requires financing over a longer period, financing that is not yet available to Statistics Sweden.

The environmental economic accounts team at Statistics Sweden views international initiatives as an important driving force of demand, notably the EU, OECD, and the UN discussions on managing the environment and the economy, as well as the EU strategy for a resource-efficient Europe. These needs include information on material flows and for ecosystems, as well as for land use linked to economic actors and economic instruments.

After the UN's 2015 agreement on SDGs, environmental accounts are frequently being requested as a basis for reporting on the proposed SDG indicators. For example, Statistics Sweden is in the process of evaluating the proposed set of indicators from the UN. The recent work performed by Statistics Sweden, along with United Nations Environmental Programme (UNEP) and the Ministry of Environment in Chile, has been especially useful for assessing indicators from the environmental accounts related to the sustainable consumption and production SDG (Statistics Sweden MIR 2016, 5). There has also been a strong and continuing demand from OECD and from researchers for analyses of the environmental impact of consumption nationally. Now that the EU's strategy for environmental economic accounts requires yearly reporting of air emissions by industry, the quality of the analyses should improve, as the environmental data availability for many important trading partners will become available.

Approximately 18 assignments on average per year are handled by the environmental accounts group. These assignments are requested by national as well as international organizations. The main assignments are from the public sector in Sweden and international organizations, although assignments from private enterprises are uncommon.

The Swedish National Board of Housing, Building and Planning, along with the Royal Institute of Technology (KTH), has assigned the environmental accounts to develop environmental indicators for buildings and factory premises. This has resulted in several publications and the visualization of indicators at the Swedish National Board of Housing, Building and Planning.[4]

The Swedish government has displayed two main areas of interest over the years: The Ministry of Enterprise and Innovation's interest in environmental technology and bio economy and the Ministry of Environment and Energy's interest in ecosystem services. In both cases, the environmental accounts tested and produced new statistical methods to generate new statistics and analyses in these areas (Statistics Sweden MIR 2017, 1 [forthcoming]; MIR 2015, 6; and MIR 2015, 2).

International clients include the EU (both Eurostat and the rest of the Commission), the European Environment Office, the Nordic Council of Ministers, and private institutions and consultants in Europe. Through research, Eurostat has contributed to the national development of both statistics and environmental economic accounts. For several years, Statistics Sweden has been conducting national studies for air and energy accounts and

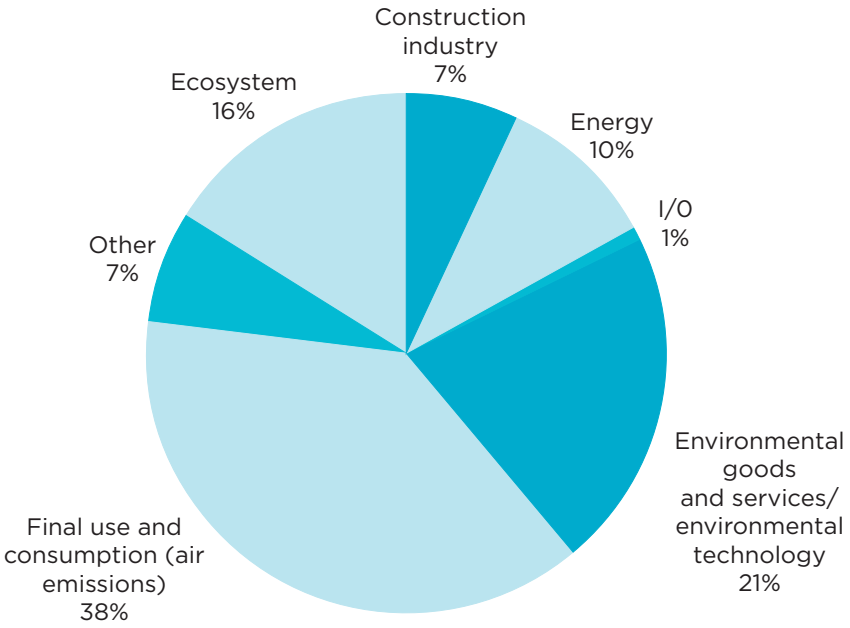
developing environmental economic accounts on behalf of Eurostat. These studies were later used to help other countries further develop the statistics and provide Eurostat with examples for analysis.

The Nordic Council of Ministers assigned Statistics Sweden and the Ministry of the Environment and Energy, in cooperation with their Nordic counterparts, to develop indicators for supplementing welfare measures, beginning with environmental aspects. The results of the work of this ad hoc group was endorsed by Nordic environmental ministers in 2015, and the project is now in the process of making the indicators available online.

Areas identified for further development are water, air, energy, and material flow accounts; the development of statistics for climate adaptation costs at the EU level; and the development of web presentation techniques to communicate the impact of consumption on climate.

The six largest areas of demand from the environmental accounts, in terms of funding, for 2014 are shown in figure 20.2.

Figure 20.2: Areas of demand from the environmental accounts, in terms of funding, 2014



Source: Statistics Sweden.
Note: I/O refers to input-output related assignments regarding employment and value added.

20.5.1 | Upcoming initiatives

The Swedish government is due to present an analysis of welfare and sustainable development in conjunction with the annual spring budget. This analysis will include a discussion of the Swedish policy implications of including consideration of the effects of consumption-based greenhouse gases emissions in the government processes.

It is worth noting that all work on environmental accounts in Sweden began with an open instruction, but also a regular budget, from the government: Develop, in accordance with UN and international guidelines, new accounts linking the economy to the environment. This considerable trust has been nurtured by Statistics Sweden through the generation of annual, quarterly, and regional data precisely on such links and then moving beyond to explore complementary policy themes. It is not uncommon to receive additional open calls to develop new statistics,

for example, the work on ecosystem accounts has been conducted in a similar spirit. One good example is the quarterly air emission accounts that the team developed and its results are now published regularly, due to improved account production processes that have been able to save the time and money to enable re-investment. The impact of this quarterly data has been significant in the media and among the user community.

20.6 | References

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20.7 | Endnotes

1 For more information on Sweden's environmental objectives, go to www.miljomal.se/sv/Environmental-Objectives-Portal/Undre-meny/About-the-Environmental-Objectives/.
2 For more information, on the Prince research project, go to www.prince-project.se/. This project is a three-year assignment, in cooperation with the Royal Institute of Technology (KTH), the Stockholm Environment Institute, Chalmers University of Technology, the Norwegian University of Science and Technology, and TNO/CML (Netherlands Organisation for Applied Scientific Research/Institute of Environmental Sciences Leiden University [CML] of the Netherlands).
3 To learn more about the European Commission's Beyond the GDP initiative, go to www.ec.europa.eu/environment/beyond_gdp/index_en.html.
4 http://www.boverket.se/sv/om-boverket/publicerat-av-boverket/oppna-data/miljoindikatorer/.

21 | Natural Capital Policy in the United Kingdom

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Summary

About 10 years ago, the United Kingdom (UK) became interested in the concept of natural capital. In particular, the critical role that the natural environment plays in prosperity, the economy, and well-being, and the growing risks to the flow of benefits a nation receives from it (such as clean air, flood protection, clean water).

A natural capital approach views the environment and a nation's prosperity as being inextricably linked rather than mutually exclusive aspirations that are in conflict with one another. The UK government has started to adopt a natural capital approach to managing the environment, focusing on the benefits of the environment to people.

As part of this new approach, the government made two serious commitments. First, it established a Natural Capital Committee to advise it on whether it was on a sustainable path, and if not, what could be done about it. Second, it devised a program for fully incorporating natural capital into the national accounts, and on this, the government is half way through delivering this commitment.

This chapter investigates the reasons for the UK's success to date in incorporating natural capital into environment policy, chief of which is the government's adoption of the Natural Capital Committee's main recommendation: to develop, as its flagship environmental policy, a long-term (25-year) environment plan based on natural capital.

21.1 | Background

The UK government became interested in the concept of natural capital about a decade ago. Reports like the 2011 (UK) National Ecosystem Assessment[1] (NEA) were making the government increasingly aware of the following:

- The critical role that our natural environment plays in prosperity, the economy, and well-being
- The growing risks to the flow of benefits we receive from it (such as clean air, flood protection, and clean water).

The solution encompassed was to adopt a framework that views the environment and prosperity as inextricably linked, which is a core tenet of a natural capital approach. This led to the government producing a major environment policy paper in 2011, the Natural Environment White Paper[2] (NEWP). This policy paper committed to the following:

- Establishing what was thought to be the world's first Natural Capital Committee, set up by a government to advise it
- Incorporating natural capital into the national accounts
- Championing a natural capital approach to managing the environment.

With the establishment and focus of this committee, the UK government saw an opportunity to place greater emphasis on natural capital, which more explicitly recognizes the benefits of the environment to people. This specific emphasis on environmental benefits will underpin changes to environmental policy as the natural capital approach is implemented.

21.2 | The Natural Capital Committee

The Natural Capital Committee was established in 2012, with a fixed three-year term, as an independent advisory body to the UK government.[3] The committee reported to the Economic Affairs Committee, which is a ministerial committee chaired by the Chancellor of the Exchequer (the UK's main finance minister). The main remit of the Natural Capital Committee was to advise the government on the following:

- Determining when, where, and how natural assets are being used unsustainably
- Recommending how the government should prioritize action to protect and improve natural capital so that public and private activity is focused where it will have greatest impact on improving well-being in society
- Researching priorities to improve future advice and decisions on protecting and enhancing natural capital.

Environment policy is devolved in the UK, to England, Scotland, Wales, and Northern Ireland. The Natural Capital Committee's remit covers only England.

The members of the committee were chosen for their expertise in one or more of the areas of science, economics, accounting, and business. The committee was chaired by Professor Dieter Helm, an academic from Oxford University, with seven additional members. The committee met monthly, with additional ad hoc meetings to discuss various aspects of its work program. It produced annual *State of Natural Capital* reports to the government, alongside various technical reports that it commissioned and wrote.[4] Among these additional reports, there was one on corporate natural capital reporting[5] and one on improving cost-benefit analysis guidance[6] to inform its advice on how to improve the UK government's policy appraisal guide (the Green Book[7]).

The priority recommendation, first outlined in its 2015 report[8] to the government and reiterated in the 2016 report,[9] was for the government to develop a long-term (25-year) plan to improve the environment. The Conservative Party adopted this idea as one of its 2015 election manifesto commitments in early 2015,[10] and again in its 2017 manifesto, and so it became government policy following both elections. Other tenets of the party's manifesto commitments were to extend the life of the Natural Capital Committee to the end of the Parliament (2020) and to work with the committee to develop the government's 25 Year Environment Plan (25 YEP).

In 2016, the Natural Capital Committee was re-established for an additional fixed period, 2016 to 2020, again as an independent advisory body. The Chair, Dieter Helm, was reappointed along with three previous members. The purpose of the overlapping membership was to retain the core experience and expertise of the first committee. In addition, three new members (academics with experience in policy delivery) have been appointed to bring more practical natural capital user and promotion experience. These changes reflect a new phase of the committee with the focus moving from research and development toward the practical application and implementation of natural capital approaches to government and business decision-making processes.

The current work program of the Natural Capital Committee is focused on the following four areas:

1. Providing advice to the government on

- The 25 YEP and how to best test the natural capital approach it contains in four pilot/pioneer areas across the country
- Appropriate governance structures to best deliver the 25 YEP at both the local and national levels

- The incorporation of natural capital into the national accounts and making this policy relevant
- The role of valuation in improving policy-making effectiveness.

2. Assessing annually the government's progress against its commitment to develop a 25 YEP. Since the Natural Capital Committee was re-established, it published its first annual report in January 2017.[11]

3. Producing a natural capital "how to" manual,[12] providing a step-by-step guide to local authorities and other organizations that focuses on how to develop a place-based plan to systematically improve the environment in a particular area. This manual covers a range of issues, from the need to develop natural capital accounts, establish baselines, and understand how natural assets are changing through time, to the need to have effective local environmental governance.

4. Helping mainstream natural capital across all decision makers (government, business, and others) by working with a range of organizations to encourage them to embed natural capital into how they operate.

21.3 | UK National Environmental Accounting

In 2011, the UK committed to incorporate natural capital into its national accounts, a program led by the Office of National Statistics (ONS) and the environment ministry (Defra). These two offices published a roadmap in 2012, updated in 2015,[13] describing how they would implement this. Since 2011, work has been underway to systematically measure, value, and account for each major broad land cover type. In particular:

- Initial accounts have been produced for woodland, farmland, and freshwater ecosystems, with scoping studies completed for coastal margins, marine ecosystems, and peatlands (all available on the ONS website[14])
- Ecosystem accounts for urban ecosystems are currently being developed, with further work planned for seminatural grassland, mountains, moorlands, and heaths
- Projects are underway to develop and improve the monetary estimates of the value of air pollutant absorption and to improve the enclosed farmland account
- A summary of the latest estimates of the overall value of natural capital in the UK was published by ONS on 30 November 2016.[15]

The development of these accounts has benefitted from a strong working partnership between Defra and ONS. This has helped to provide access to data sources and scientific advice and to ensure policy relevance.

The Natural Capital Committee's role in the development of the accounts has largely been twofold. First, to encourage the UK's Office of National Statistics and Defra to maintain their commitment to this natural capital accounts program. Second, to promote the importance of the accounting approach and the policy relevance of the accounts, and to raise the profile of the accounts by communicating them to a wider audience and highlighting the results.

21.4 | A Natural capital approach to managing the environment

After considerable work and challenges, natural capital is recognized as the best framework for developing policy on how the environment is managed (in England). Using natural capital as a framework for identifying environmental problems and opportunities and for helping to design actions to resolve issues is advantageous for a number of reasons.

First, the natural capital framework is based on a stock concept as opposed to only flows, so it encourages a long-term sustainability view. Focusing purely on annual or short-term flows reveals little, if anything, about how sustainable those flows are. A robust natural capital accounting approach can help capture this longer-term perspective, which is useful for informing appropriate policy responses and helping overcome any risk of a short-term focus.

Second, this type of framework encourages actions based on the understanding of the environment being an interconnected system, as opposed to traditional silo thinking, which separately considers individual elements of the environment (for example, air, land, water, biodiversity). Changes to one aspect of the environment, say cutting down trees for a development, has multiple impacts. Cutting down trees would cause an immediate loss of biodiversity, but there could also be changes to water and air quality, as well as changes to amenity values in the surrounding area. A systems view, which also extends into environmental-economic interactions, encourages a broader assessment of all the costs and benefits that arise, allowing for more efficient actions.

Such a system view, where all the costs and benefits to people from the environment are incorporated, can also help identify a wider range of solutions to problems. For example, it enables natural solutions to flooding to be properly considered and compared to traditional concrete infrastructure flood solutions. Natural capital accounts can reflect the significance of nonmarket services in the system which might otherwise be neglected.

Third, natural capital drives the better use of resources by identifying and prioritizing the actions that can be taken which give the highest net benefits. This allows greater environmental improvement to be obtained for each dollar spent. Accounts are central to this prioritisation, helping identify assets which are, for example, particularly beneficial or are declining and hence which warrant policy attention.

Fourth, natural capital talks the language of Treasury (finance ministries), which is finance and economics. By integrating environmental information on “assets” and “services” and their values, value for money of environmental interventions, including their contribution to supporting the economy and well-being can be determined and the case made for public spending on the environment compared to other uses of finite funds.

Finally, the results from the experimental natural capital accounts can and have been used as an education tool to demonstrate to ministers, senior decision makers, and the public how the environment provides a large range of valuable benefits that are often ignored in markets. For example, the latest monetary estimates for the UK’s natural capital demonstrate that the nonmarket services of recreation, air filtration, and carbon sequestration together account for two-thirds of the overall value (which includes oil and gas reserves).

Accounting results have also supported the argument why better management of the environment is economically sensible. For example, the systematic approach to accounting for natural capital has been adopted at a subnational level for England’s Public Forest Estate[16] to raise the visibility and importance of natural capital alongside the financial accounts. These accounts show that the value of the services delivered by England’s woods and forests is estimated to be £11.9 billion. Over 95 percent of this value is determined on the basis of the

benefits the woods and forests provide to society, for example, through recreation and climate regulation. This value is not captured in traditional financial accounts.

21.5 | Final remarks

The Natural Capital Committee has had a powerful effect in promoting the concept and use of a natural capital approach and in shaping environmental policy in England. The main recommendations of which have been to advise the government to develop a long-term (25-year) comprehensive plan to improve the environment based on a natural capital approach and to continue its program of incorporating natural capital into the national accounts. The UK government is pursuing both of these recommendations.

There are a few key ingredients to the Natural Capital Committee's success in influencing policy and mainstreaming the concept of natural capital within and beyond the government, including: the independence of the committee, presenting clear examples of analysis incorporating natural capital, reporting to central government rather than agencies, and having an influential chairperson. The Natural Capital Committee positioned itself as an independent body that is prepared to give frank advice to the government on what needs to be done, while avoiding becoming a pressure group.

Furthermore, the committee was able to effectively make the case to the government to include natural capital in policy. The committee conducted and presented robust economic analysis to demonstrate how investment in the environment compares favorably to nonenvironmental interventions, such as building new transport infrastructure (even when not all the environmental benefits can be monetized). For example, the committee's 2015 report demonstrated how the returns from investing in natural capital projects, such as woodland planting, peatland restoration, and wetland creation, are up to nine times the costs of these projects, even for large-scale projects. This compares to the average cost-benefit ratios of about four to one for road schemes and between two and three to one for rail schemes in the UK.

Finally, reporting into the Chancellor of the Exchequer at the center of government, rather than via more distant government bodies, has meant that more notice is taken of the committee's advice. The committee's profile was strengthened by having a very influential chairperson, who is known and respected by politicians from all parties and who is supported by multidisciplinary experts, who can provide compelling advice on the benefits of taking a natural capital approach, including of compiling accounts.

21.6 | Endnotes

1 http://uknea.unep-wcmc.org/.
2 https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature.
3 https://www.gov.uk/government/groups/natural-capital-committee.
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22 | Assessing Strategies to Achieving the Sustainable Development Goals: An Integrated Economic-Environmental Modeling Approach

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Summary

In effect, since January 2016, the 17 Sustainable Development Goals (SDGs) are a universal call to action to end poverty and protect the environment. The government of Guatemala is currently engaged in a prioritization exercise, defining specific lines of action and developing estimates of costs of implementation. This chapter applies the Integrated Economic-Environmental Modeling platform for Guatemala (IEEM-GUA) to evaluate the economic, environmental, and wealth impacts of implementing strategies to make progress toward achieving the SDGs. In particular, this chapter evaluates specific lines of action to meet the second SDG to achieve food security and promote sustainable agriculture and the sixth SDG to achieve water and sanitation coverage for all. The evaluation revealed that significant new investment in these areas would be required to meet these SDGs and that the overall pace of economic growth is critical. IEEM applied to the SDGs lends transparency and structure to the prioritization and agenda-setting process. It sheds light on the potential need for complementary policies to reconcile lines of action that can inadvertently move progress toward specific SDGs in opposite directions. Finally, an advantage of applying an integrated framework, such as IEEM, is that it can highlight trade-offs, potential win-wins, and links among SDGs, where one line of action can result in progress toward multiple SDGs simultaneously.

22.1 | Introduction

The post-2015 development goals are embodied in the 2030 Agenda for Sustainable Development.[1] In effect since January 2016, the 17 SDGs are a universal call to action to end poverty and protect the environment. To mainstream the SDGs in national processes, many countries are aligning their national development plans with the SDGs. In the case of Guatemala, the nation is now better positioned to make progress toward achieving the SDGs when compared with the previous Millennium Development Goals, where it achieved only 25 percent of the targets. This limited progress was in part due to the absence of a national framework for development planning that could guide the investments of the Guatemalan government and ensure policy consistency (CONADUR 2014).

Guatemala recently approved its National Development Plan K'atun: Our Guatemala 2032, and the Council of Urban and Rural Development is now prioritizing SDGs, aligning them with strategic actions set out in Plan K'atun,[2] and creating a statistical mechanism to monitor progress (CONADUR, 2016, UNDG, 2016). With the United Nations supporting both the design of Plan K'atun and the socialization processes of the SDGs with Guatemalan society, 90 percent of the thematic areas addressed by Plan K'atun and the SDGs are closely aligned (Moir 2016).

This chapter discusses the application of the Integrated Economic-Environmental Modelling platform for Guatemala to evaluate the economic, environmental, and wealth impacts of implementing strategies to make progress toward achieving the SDGs in Guatemala. IEEM is a powerful framework for analyzing complex policy

goals, with its ability to highlight trade-offs, potential win-wins, and links among SDGs, where one line of action can result in progress toward multiple SDGs simultaneously.

This chapter focuses on the second SDG of ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture, and the sixth SDG of ensuring availability and sustainable management of water and sanitation for all. For the second SDG, this chapter concentrates specifically on doubling agricultural productivity and incomes of rural producers (target 2.3), while for the sixth SDG, the focus is on equitable access to drinking water and sanitation for all (targets 6.1 and 6.2). Scenarios are developed based on Plan K'atun, published government policy directives, strategies, specific lines of action, and cost estimations.

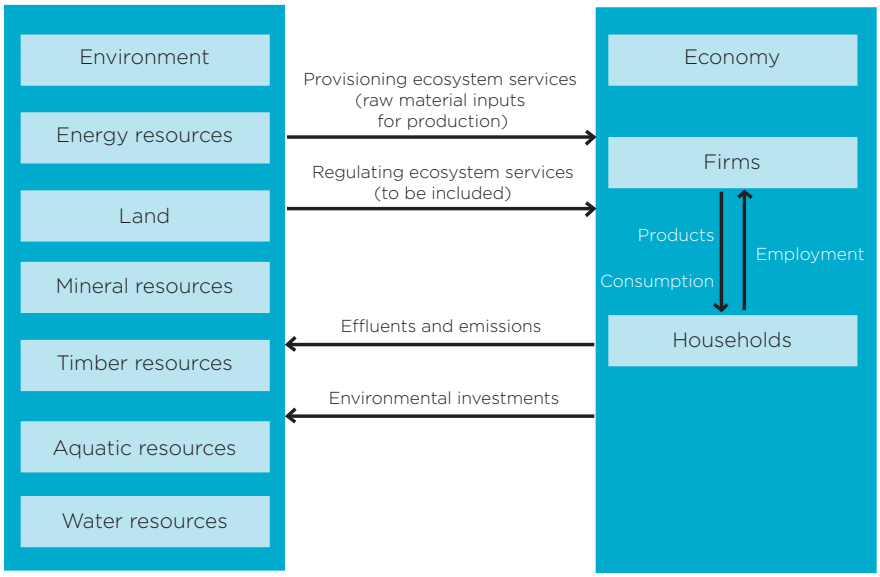
This chapter is structured as follows: Section 22.2 provides a brief overview of the methodology. Section 22.3 describes the specific lines of action the government of Guatemala may pursue to make progress toward the second and sixth SDGs and the scenarios to be implemented with IEEM-GUA. Section 22.4 presents results and analysis. Section 22.5 offers conclusions, while the final section provides a discussion of the key findings and the advantages of using an integrated framework such as IEEM for analysis of SDGs and other complex policy challenges.

22.2 | Methods

This analysis uses the IEEM platform described in Banerjee et al. (chapter 13 of this publication). IEEM is a decision-making platform that provides a quantitative, comprehensive, and consistent framework for analyzing public policy and investment impacts on the economy, the environment, and wealth (Banerjee et al., 2017). At the core of IEEM is a dynamic computable general equilibrium model, calibrated with data based on the System of National Accounts and the System of Environmental-Economic Accounting (SEEA; United Nations et al. 2014). Economy-wide approaches can generate policy insights into a broad area of inquiry and thus are well suited for evaluating the complex and multisector policy issues presented by the SDGs (Lofgren et al. 2013). What sets IEEM apart from other decision-making frameworks is its: (1) integration of rich environmental data based on the SEEA, (2) customized environmental modeling modules that capture the dynamics of environmental resources and their use, and (3) the indicators generated by IEEM capture policy and investment impacts not only on measures of income flows such as gross domestic product (GDP), but also on wealth which is the foundation of the economic development prospects of a country.

Figure 22.1 shows how environment-economy interactions are modeled within IEEM. On the left side of the figure, the environment is represented by the environmental accounts contained in the SEEA, namely energy, land, minerals, timber, aquatic resources, and water. The right side of the figure shows the economy, represented by firms that use labor, capital, and other factors of production, and intermediate inputs to produce goods and services that are consumed by households, the government, and exports markets. IEEM captures the two-way interactions between the economy and the environment, with the environment serving as an input for productive processes in the form of provisioning ecosystem services. Through production and consumption, emissions and waste are generated and returned to the environment. To mitigate environmental damage and improve environmental quality, investments are also made in the environment. The data structure that underpins IEEM captures these interactions quantitatively.

Figure 22.1: Environment-economy interactions embodied in IEEM



Source: Authors' own elaboration.

With our focus on the SDGs, the impacts of public policy and investment on household-level poverty and inequality are particularly important. The IEEM platform has a built-in microsimulation module which considers the impacts on the population living in poverty and on economy-wide measures of income concentration, such as the Gini coefficient. IEEM uses Guatemala's nationally determined poverty line, which is $2.83 per person per day in 2010 prices (INE 2013).

22.3 | Lines of action for achieving the SDGs and scenario design

Considering SDG target 2.3, a key strategy for improving agricultural productivity and incomes of the rural poor in Guatemala is expanding irrigated agriculture. Irrigated agriculture has the potential to increase crop yields by 150 percent, as well as increase the income earned due to improved quality and seasonal availability of produce (Amezquita 2012). The area apt and available for irrigation is considerable, with just 29 percent of the potential 850,120 hectares (ha) irrigated. While current irrigation focuses on export crops, productivity and value gains are greatest with higher value crops such as tomatoes, peppers, onions, and carrots, among others (MAGA 2013). Two scenarios that can make progress toward SDG target 2.3 are undertaken, drawing on: Guatemala's Great National Agriculture and Livestock Plan 2016–2020, which sets out lines of action for enhancing agricultural productivity and competitiveness of the sector (MAGA 2016); the Irrigation Development Policy (2013 to 2023), and; the National Irrigation Diagnostic (MAGA 2013; MAGA 2012).

The third scenario (WTSN) simulates lines of action for making progress toward SDG targets 6.1 and 6.2. Guatemala's Water and Sanitation National Policy outlines the priorities, strategies, and objectives for water and sanitation. Household survey data from 2011 show that the water and sanitation coverage was 75.3 percent and 55.96 percent, respectively, indicating that 3 million people lacked access to water. A key goal of the policy is to increase water and sanitation coverage to 95 percent and 90 percent, respectively, by 2025 (SEGEPLAN 2013).

The consequences of limited access to quality water and sanitation are grave. The availability and quality of water and sanitation impact infant mortality and maternal mortality at a rate of 30 and 140 persons per 100,000,

respectively, and lack of access is the main cause of death for children under five years of age. Improved access and quality of water and sanitation reduces the frequency of gastrointestinal sickness by 32 percent in the case of sanitation and 25 percent and 31 percent for water availability and water quality, respectively, demonstrating the potentially large gains from investing in these areas (SEGEPLAN 2013; UNICEF and WHO 2008).

The fourth and final scenario simulates the joint impact of IRRIG2 and WTSN.

IRRIG1. The first scenario (IRRIG1) simulates a key component of the country's plans for irrigated agricultural expansion which focuses on investments in rehabilitating and modernizing existing irrigated water supply systems and infrastructure. These plans are expected to increase the total irrigated area by 6,399 ha at a cost of $6,045,780, distributed over a five-year period (MAGA, 2013).

IRRIG2. The second scenario (IRRIG2) considers additional investments proposed under Guatemala's Great National Agriculture and Livestock Plan for increasing irrigated agriculture. The plan aims to increase irrigation on an additional 100,000 hectares at a cost of $1.95 million over five years. In this scenario, this policy is implemented together with the IRRIG1 scenario for a total investment of $7,995,780 and a total increase in irrigated areas of 106,399 ha.

WTSN. In the third scenario (WTSN), investment in water and sanitation is simulated, increasing water coverage from 75.3 percent to 81.5 percent and sanitation coverage from 56 percent to 66 percent. This is less ambitious than the SDG target of full coverage, though it is more realistic given current budget allocations. The cost for increasing water and sanitation coverage is $1.6 billion and $70.2 million, respectively, for a total investment of $1.67 billion between 2017 and 2030 (SEGEPLAN 2013). The WTSN scenario also implements a 0.44 percent increase in rural agricultural labor productivity to reflect productivity gains from healthier household members who get sick less frequently (Kiendrebeogo 2012).

COMBI: The fourth simulation (COMBI) simulates the joint impact of IRRIG2 and WTSN scenarios.

22.4 | Results and analysis

Table 22.1 shows the scenario impacts on macroeconomic indicators in terms of difference from baseline values in 2030. The IRRIG2 scenario would tend to drive positive impacts on all macro indicators and private consumption would increase by $797.9 million. In the WTSN scenario, the impact would be less, equal to $74.5 million. The COMBI scenario shows the overall GDP impact would be $1.185 billion.

Table 22.1: Macroeconomic indicators, difference from baseline by 2030 (US$, millions)

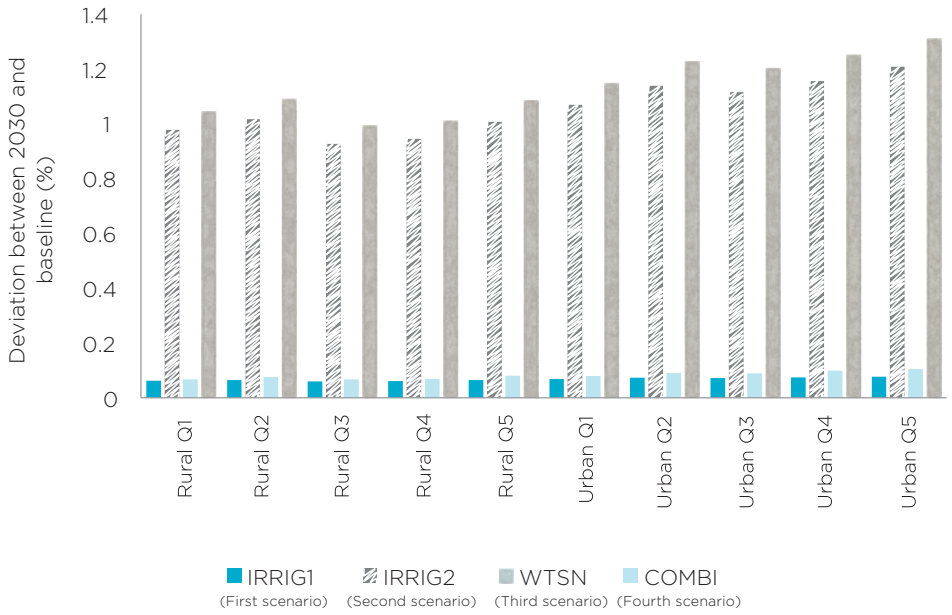
	IRRIG1	IRRIG2	WTSN	COMBI
Absorption	69.2	1,078.0	108.1	1,1184.7
Private consumption	51.1	797.9	74.5	871.4
Fixed investment	18.1	280.1	33.6	313.3
Exports	34.2	533.6	60.2	593.2
Imports	23.5	368.3	38.5	406.5
GDP	79.9	1,243.3	129.8	1,371.4
Genuine savings	36.5	563.1	33.7	595.4

Source: Authors' own elaboration.

Focusing on the COMBI scenario, by 2030, the impact on agricultural output would be $181.1 million. In the baseline in 2030, output of nonexport agricultural crops is 52 percent greater than in 2017 compared with 59 percent in the COMBI scenario, indicating that additional investment and productivity enhancements would be required to meet the second SDG and close the gap of 41 percent to double agricultural output by 2030.

Figure 22.2 shows that urban wealthier households experience the greatest increase in income, equal to 1.31 percent in the COMBI scenario compared to 1.05 percent for the poorest rural households. When baseline growth is taken into account, per capita income increases between 9 percent and 18 percent across rural and urban households and income quintiles. When overall economic growth is taken into account, in the COMBI scenario, there remains a gap of 83 percent between reaching SDG target 2.3 of doubling incomes.

Figure 22.2: Percentage of the deviation in per capita income between 2030 and baseline, rural/urban households and income quintiles



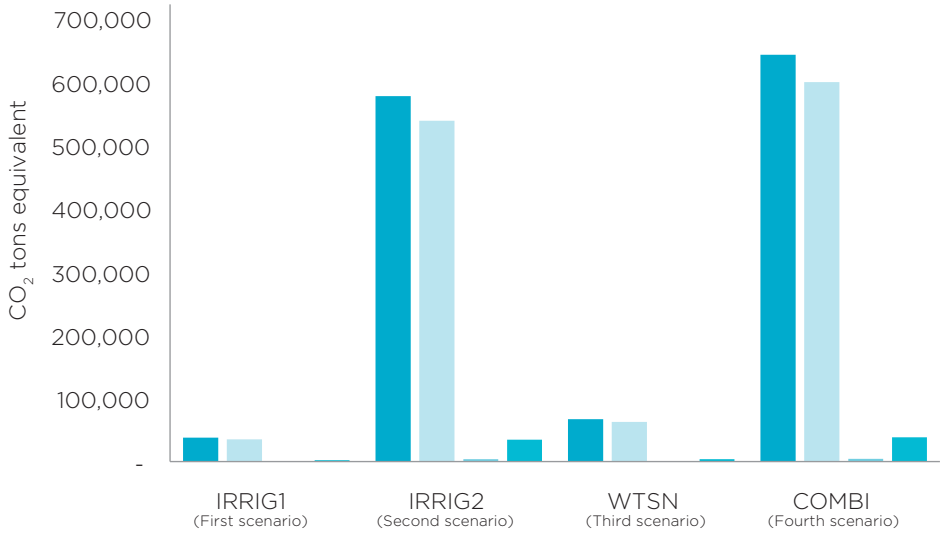
Source: Authors' own elaboration.

Considering equivalent variation, a welfare measure, by 2030 Guatemalan households would be better off by $747 million in the COMBI scenario. In the baseline, the population living in poverty is 44.77 percent. When we consider the impact of business-as-usual economic growth and the COMBI-scenario impacts, over 2.42 million people would be lifted from poverty while income inequality gap would also decline. All investments would be wealth enhancing in terms of impacts on genuine savings, with an increase of $595.4 million in the COMBI scenario. While deforestation and emissions would increase in all scenarios, the increase in household savings drives the increase in genuine savings. The net present value is calculated using a 12 percent discount rate and results in net present values of $126.7 million, $2.1 billion, negative $718.5 million, and $1.3 billion for the IRRIG1, IRRIG2, WTSN, and COMBI scenarios, respectively.

In the baseline, the total forested area in Guatemala is over 3 million ha and cumulative deforestation would be 36,528 ha by 2030. The IRRIG2 scenario would result in an additional 9,209 ha of deforestation compared to 657 ha in the WTSN scenario. Water consumption per capita, considering all water uses including irrigation, would

increase by 1,860 ML/capita in the COMBI scenario. Overall, greenhouse gas emissions would increase to 642,346 tons of CO_2 equivalent in the COMBI scenario. Figure 22.3 shows total and disaggregated CO_2, CH4, and N2O emissions for each scenario.

Figure 22.3: Difference between 2030 and 2017 cumulative emissions, CO_2 tons equivalent



Source: Authors' own elaboration.

22.5 | Final remarks

This chapter discusses the implementation of IEEM-GUA to simulate lines of action for achieving the second SDG of ending hunger and promoting sustainable agriculture and the sixth SDG of ensuring water and sanitation for all. Results showed that reaching these goals would require substantial investments. Where investment in agriculture and water and sanitation are considered together in the COMBI scenario, along with business-as-usual economic growth, over 2.4 million individuals would be lifted out of poverty. Yet, the baseline developments plus the investments as proposed in the COMBI scenario increase agricultural output by 59 percent. To reach the objective of doubling agricultural output by 2030, additional investments would be required to increase agricultural output by the remaining 41 percent. Also, the goal of doubling incomes cannot be reached with the COMBI scenario alone. An income gap of 83 percent remains.

All investments evaluated in this analysis would be wealth enhancing, increasing genuine savings by $595 million, despite the increase in deforestation and emissions. This result is driven by the investment impacts on household savings, while increases in the value of standing forest and the costs of emissions damage would reduce this value. The $1.67 billion investment in water and sanitation would generate a $69.5 million welfare gain, though the net present value of the investment would be negative. This analysis shows that such investment is unlikely to occur without a strong government commitment. There are important reasons for the government to undertake this investment, including one of basic human rights as reflected in the 2010 United Nations Resolution 64/292.[3]

IEEM generates results that can be used to substantiate compelling cases to government institutions, particularly ministries of finance, where such institutional support is critical for budget allocations to achieve the SDGs. Impacts expressed in terms of GDP, income, and employment continue to rank high on policy makers' agendas. The estimated economic return of investing $1.37 billion in agriculture and water and sanitation, for example,

communicates a powerful message. IEEM also generates results in terms of wealth and natural capital impacts; these indicators are increasing in relevance and provide policy makers with a broader evidence base upon which to formulate policy and engage with their constituents. As highlighted in this application of IEEM, investment in agriculture has important impacts on water consumption and emissions, which may require complementary or mitigating policies for ensuring sustainable economic development as well as delivering on international agreements.

22.6 | Discussion

The results of this IEEM-GUA modeling exercise demonstrate the importance of considering specific lines of action both individually and in an integrated way. Analysis of individual lines of action is important for transparency and can contribute to prioritization exercises and the agenda-setting phase of the policy cycle. Through individual analysis, some investments may reveal a business case that could be appealing to the private sector as illustrated with the investment in irrigated agriculture. In these instances, it may be appropriate for the government to concentrate efforts on creating an enabling environment for private sector investment. These types of findings are fundamental inputs into the policy formulation stage of the policy cycle. In the case of Guatemala, an application of this finding would be the creation of a legal framework for water management that would set the stage for private investment in irrigated agriculture.

On the other hand, an integrated analytical approach sheds light on how individual SDGs can be mutually supportive to achieving the overall Agenda for Sustainable Development. IIEM-GUA has shown that improvements in water and sanitation would increase agricultural labor productivity, which in turn would increase agricultural output and contribute to target 2.3. While the specific lines of action considered here targeted the second and sixth SDGs, both positive and negative spill-overs on other SDGs were found to arise. All investment scenarios would contribute to achieving the first SDG of ending poverty in all its forms as well as the eighth SDG of promoting inclusive and sustainable economic growth, and employment. The investments evaluated would grow GDP by $1.37 billion, diversify the agricultural sector, and create jobs. A portfolio approach to the SDGs is appropriate to capitalize on these types of win-wins, and in cases where some lines of action generate greater returns to investment, compensating for those that do not. Aristotle's reflection, "the whole is greater than the sum of its parts," holds true in terms of the SDGs.

Yet, investments in agricultural expansion and in water and sanitation also lead to trade-offs. The expansion of agriculture is not without its consequences for the environment, with an increase in deforestation of 9,820 ha, in addition to the business-as-usual deforestation of 36,528 ha. This increase in deforestation disfavors making progress toward the 15th SDG, which aims to promote the sustainable use of forests, and in particular, indicator 15.1.1, which is the forest area as a proportion of total land area. The 13th SDG calls for action on climate change, though the expansion of agriculture and increased deforestation gives rise to greater emissions, particularly when forests are burned and replaced with agriculture. All scenarios generate faster economic growth, which also increases emissions across all economic sectors. Determining how increased emissions affect Guatemala's commitments to the Paris Agreement and the 13th SDG will require a careful consideration of the potential trade-offs.

SDG target 6.5 calls for the implementation of integrated water resources management, and target 6.6 aims to protect and restore water-related ecosystems, both of these tasks are closely related to water consumption, which would increase in all scenarios. Certainly, to ensure policy consistency among SDG lines of action, it will be important to monitor how increased water usage affects water availability and quality and potential negative

externalities, such as salinization, in drought-prone areas. Integrated landscape management for the production of a variety of ecosystem services such as water provisioning and climate regulation can aid in making progress toward the 6th, 8th, and 13th SDGs discussed in this chapter. Furthermore, these natural systems are critical for sustaining rural livelihoods and thus also critical to the first and second SDGs.

The IEEM platform enables consideration of public policy and investment impacts on multiple sectors and complex integrated economic-environmental objectives. Without such an integrated framework, some of the synergies and trade-offs among different SDGs may have been missed. IEEM sheds light on these interactions and generates evidence that can inform and elevate the discourse on the most effective strategies for achieving the SDGs and identify "low-hanging fruits" and potential win-win situations. As seen in this application, IEEM's language is grounded in economics, generating results that speak to policy makers with clear points of entry into the policy cycle, while quantifying and recognizing natural capital's contribution to economic development and the challenges posed by the SDGs.

22.7 | Acknowledgments

This work was funded by the BIO Program of the Inter-American Development Bank.

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22.9 | Endnotes

1 http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.
2 The National Development Plan is structured on five principle tenets: (1) inclusive economic development, (2) improved governance for ensuring human rights, (3) sustainable urban and rural development, (4) the environment, and (5) human welfare. The plan establishes 36 priorities, 122 results, 80 goals, and 730 directives that are to be monitored.
3 http://www.un.org/es/comun/docs/?symbol=A/RES/64/292&lang=E.

23 | Developing Pilot Ecosystem Accounts in the European Union: Potential Policy Applications

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Summary

The European Union (EU) has started work to develop EU-level pilot ecosystem accounts by 2020. The KIP INCA project (EC, 2016c) aims to design and implement an integrated accounting system for ecosystems and their services in the EU, to serve a range of information needs. The aim is to pilot a set of accounts across a range of ecosystems and ecosystem services and to test how they can support a number of EU policies.

This short paper outlines a number of potential policy applications of ecosystem accounting, with particular reference to EU policies. This includes the development of macro-level physical and/or economic indicators that are consistent with the National Accounts and thus could complement gross domestic product (GDP). Ecosystem accounts can also support environmental and sectoral policies, for example through better quantifying the contribution of ecosystems to di erent sectors, assessing synergies and trade-offs of different measures, or better targeting measures and investments. In the corporate sector, natural capital accounting can provide a concrete framework for business performance reporting, to help measure opportunities and dependencies on natural resources, in both physical and monetary terms. The development and practical testing of ecosystem accounting in an EU policy context can also provide useful input to the further development of international guidelines such as System of Environmental-Economic Accounting – Experimental Ecosystem Accounting (SEEA EEA); (UN, 2014 a). This in turn can provide a consistent basis for measuring progress at international level, and provide opportunities for synergies in reporting under the 2030 sustainable development agenda.

This initial outline of potential policy applications should contribute to prioritizing the prototyping and testing of selected ecosystem accounts in the EU.

23.1 | Introduction

One of the objectives of natural capital accounting (NCA) is to help integrate natural capital, and in particular ecosystems, into socioeconomic decision making. National accounts currently underpin many socioeconomic decisions but do not fully take the contribution of ecosystems into account. A broad range of economic activities are dependent upon ecosystems. Natural assets are nite and are under threat of depletion and degradation as a consequence of unsustainable patterns of consump- tion and production. The incorporation of ecosystems into standard accounting frameworks can help mainstream nature and biodiversity in decision making, and to promote more resource e cient and sustainable choices.

In the context of EU environmental policies, the EU 7th Environment Action Programme (EC, 2016) and the EU Biodiversity Strategy (EC, 2011) include objectives to develop natural capital accounting with a focus on ecosystems and their services. At the EU level, important results have been achieved under the initiative on Mapping and Assessment of Ecosystems and Services (MAES); (EC, 2016b), as well as on categorising ecosystem services through the Common International Classification of Ecosystem Services (CICES). The European Environment Agency has piloted land and water accounts, whilst the Joint Research Centre (JRC) has gained relevant experience and important knowledge on modelling ecosystem services. The European Commission's

Directorate-General for Research and Innovation (DG RTD) has funded relevant research and innovation projects such as OPERAs (OP- ERAs, 2017) OpenNESS (OpenNESS, 2017) or the Horizon 2020 action ESMERALDA (ESMERAL- DA, 2017).

EU Member States have made progress in implementing many of the thematic accounts of the SEEA-Central Framework (UN, 2014 b). These include accounts for water, energy, minerals, forests, sh and environmental protection expenditure. Moreover, some EU Member States are developing ecosystem accounting. For example, the Netherlands produced a comprehensive pilot study on ecosystem accounting for the Limburg province (de Jong et al., 2016), and is planning to extend the approach in 2017 and 2018 to the whole country. The United Kingdom developed pilot thematic eco- system accounts, and publishes broad monetary valuation estimates at national level (ONS, 2017). Other Member States, including France, Germany and Finland, have also started experimenting with ecosystem accounting.

The KIP-INCA project aims to build on these experiences to establish an accounting system for ecosystems and their services at the EU level, primarily using EU-wide data sources, to support a wider range of Member States in developing ecosystem accounts at national or subnational level. The foundation of the system is a common data platform of geo-referenced information on ecosystems and their services. KIP-INCA builds on the rst phase of MAES work on ecosystems and their services in the EU.

Significant work needs to be done in order to develop comprehensive EU ecosystem accounts, in particular on developing ecosystem condition accounts, and to link them explicitly to ecosystem services. In addition, it is important to test and evaluate the development and use of such accounts in various policy areas. The remainder of this paper outlines some of the potential policy areas of application of ecosystem accounting in the EU policy context.

23.2 | Macroeconomic policies and indicators at EU level

Accounting can make the contribution of natural capital to economic development explicit alongside produced or manufactured capital and human capital. In this way ecosystem accounting provides important input to macro-level decision making. Examples include:

- Input to macroeconomic priorities such as the green economy, growth and jobs, annual EU Growth Surveys:
- Highlight the economic values of natural capital, e.g. monetary values of the goods and services related to ecosystems that are produced in a speci c year or in a speci c sector, alongside other economic information.
- Identify opportunities and trade-offs between economic, social and environmental priorities, at a number of levels.
- Evaluate investment and policy options in a way that explicitly takes into account externalities and better re ects true costs to society and the economy of ecosystem degradation.
- Provide concrete information to underpin processes such as the Greening of the European Semester and the implementation of the Sustainable Development Goals (SDGs) in the EU.

23.2.1 | Development of macro indicators alongside GDP

- Accounts provide a systematic basis on which to develop macro indicators of natural capital either in physical or monetary terms, ensuring consistency, reliability and comparability with other types of capital (e.g. fixed and financial assets) and understanding the contribution of natural capital to total wealth.
- By measuring the flows of ecosystem services and accounting for the depletion and degradation of ecosystems, ecosystem accounting can lay the foundations for the development of new macro indicators that can inform decision making alongside, or in combination with, GDP or other macro indicators.

23.3 | EU environmental and climate change policies

Ecosystem accounting can contribute to the better understanding, articulation, and accounting of the range of services that ecosystems provide (provisioning, regulating and cultural) in specific sectoral policies. These services need to be explicitly taken into account alongside those typically accounted for, such as the provision of timber or food (e.g. forestry and agricultural policy).

Some benefits cut across several sectoral policies due to the nature of the ecosystem service, or have co-benefits from one policy area to another (e.g. peri-urban forests might, in addition to providing air and water puri cation services, also contribute to climate change mitigation and adaptation). Ecosystem accounting can help identify these synergies, as well as potential trade-offs within ecosystem services, and between ecosystem services and industrial production, and across time and space. An example of this is the distribution of costs and bene ts of ecosystem services, and the challenges and opportunities of designing payment for ecosystem services schemes. In this context, ecosystem accounting could demonstrate potential new income sources for land owners (for example in the forest sector).

Importantly, accounting can also provide indications of levels of sustainable use of ecosystems, for example through accounts of ecosystem condition or ecosystem capacity. This is essential in order to indicate whether ecological assets are being used in a sustainable manner or not.

Finally, accounting can contribute to the development of consistent and streamlined forms of reporting across a range of policies and at di erent stages of the policy cycle: planning and development, monitoring and review, and at a range of di erent spatial scales, including at regional, national or at EU level.

23.3.1 | Environmental policies

Because ecosystem accounts explicitly account for a comprehensive range of ecosystem services, and demonstrate in physical and monetary terms the benefits of improving the condition of ecosystems, and the sustainable management of resources, they can demonstrate the benefits of a range of environmental policies. They also provide a common reference to help assess progress towards targets related to ecosystem restoration, for example, the EU 2020 Biodiversity Strategy target to restore 15% of degraded ecosystems, and to support a strategic approach to nancing green infrastructure throughout Europe. They can also support the implementation of and help streamline reporting under EU legislation that has an ecosystem approach, in particular the Birds and Habitats Directive, the Water Framework Directive, and the Marine Strategic Framework Directive.

Box 23.1: Macro indicators of natural capital

Macro indicators for natural capital are yet to be fully developed and are not yet in widespread use, in particular related to ecosystems. However, some national-level macro indicators for ecosystem perfor- mance have been developed. For example, Scotland has developed the Natural Capital Asset Index (Scottish Government, 2015). Similar approaches exist in the Norwegian Nature Index (Norwegian Institute, 2017).

23.3.2 | Climate change policies

Ecosystem accounting provides quantitative estimates of the contribution of ecosystems to climate mitigation through carbon absorption from oceans, peatlands, and forest. These can be used to help estimate the costs, bene ts and investment opportunities at local, regional or national levels of nature-based solutions for climate adaptation strategies. For example, coastal or flood protection schemes may include the restoration of wetlands and ood plains instead of resorting to traditional grey infrastructure solutions (e.g. building large concrete barriers) which are often more costly. This can help provide a more informed approach for investment decisions by public authorities or insurance companies. Related to this is flood risk management (See Box 2), accounts also provide a framework to monitor land use and the ecosystems' ability to perform services over time and to ag areas for potential concern.

Box 23.2: NCA and flood risk management

The European Environment Agency (EEA 2015) considered the role of forests in helping to manage flood risk. Through retaining excess rainwater forests provide ecosystem services that can reduce the impacts of floods. In comparison with water basins with forest cover of 10%, total water retention is 25% and 50% higher in water basins where the forest cover is more than 30% and 70%, respectively. It is clear that the extent and density of forest cover would form part of NCA information that would inform flood risk management.
The study also found that the ability of a forest ecosystem to retain water depends on characteristics including: tree composition, tree density, age of forest, length of vegetation growing season and number of layers of vegetation cover. This suggests NCA systems also containing data on key characteristics of any forest would provide additional information to inform flood risk management.

23.4 | EU sectoral policies

A range of EU sectoral policies may be supported by NCA. This includes forest management, agricultural, regional and marine polices, each of which is discussed below.

23.4.1 1 | Forest management

Accounting can support the implementation of the EU Forest Strategy, and forest land use planning and management decisions, in particular by providing tangible and systematic information reflecting the true value of forest ecosystem services beyond wood production (Beyond Wood, 2016) such as: carbon sequestration, water filtration, air puri cation, soil retention, flood control, and recreation (see inset Box 3). They can also identify potential new income sources through 'Payment for Ecosystem Services' schemes for land owners.

23.4.2 | Agricultural policies

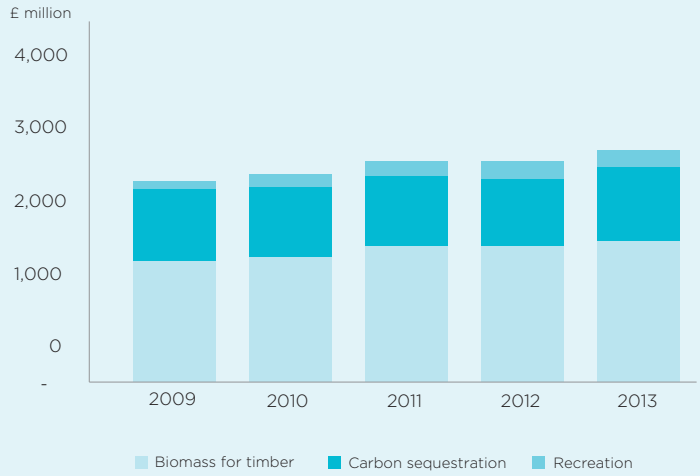
Accounting can provide information in a systematic manner for future policy reviews, such as the Common Agricultural Policy in the EU. For example, the accounts may provide quantitative estimates of the risks to agricultural production from environmental degradation and a reduction in ecosystems services (e.g. pollination) and can help to assess the benefits of investing in more sustainable forms of farming, connecting landscapes and increasing biodiversity.

23.4.3 | Regional policies

Accounting can provide a sound basis for targeted analyses at regional or more local scales, and support authorities in identifying synergies and trade-offs between diferent ecosystem services and help to implement green infrastructure approaches to regional development. It can help to better target investment in projects or measures by including a wider range of values related to ecosystems in decision making.

Box 23.3: The value of a tree: ecosystem services in UK woodland

The UK Office for National Statistics (ONS Woodlands, 2015) studied the values of UK woodland ecosystems. The study considered three ecosystem services (timber production, carbon sequestration and recreation), calculating monetary ows for them. The results are presented in the graph below. Similar work carried out in Germany, Spain and by EU-funded research projects indicate similar orders of magnitude.



Sustainable urban development and land-use planning is another area accounts can contribute to by recognising, for example, the ecosystem services provided by green spaces in urban areas such as air and water purification and recreation, and associated health benefits.

23.4.4 | Marine policies

Accounting can contribute to the development of a systematic approach for presenting information about marine assets and the state of the oceans, such as in the context of the EU initiative on Ocean Governance. It can also quantify the contributions of ecosystems to blue growth in a systematic manner, including through economic valuation. This can include a range of marine ecosystem services including: provisioning services, such as fish provision or the development of medical products, coastal resilience and protection, carbon sequestration, and cultural services such as recreation. For example, UK Natural Capital Accounts (ONS, 2015) provide estimates for marine carbon sequestration of around 2 million tonnes of carbon annually.

Accounts can also support better planning in marine areas, for example, targeting the design of marine protected areas, restoration measures, and the implementation of blue and green infrastructure. Pointing to opportunities and trade-offs in marine socio-economic decision making, for example through the impact of marine economic activities such as mineral extraction, transport, and tourism, is another area where accounts could be useful.

23.5 | Corporate accounting and reporting

Corporate NCA can provide a concrete basis for business reporting by explicitly mapping out the impacts and/or dependencies on natural resources and placing a monetary value on them. This provides companies clarity on

how much they depend on nature to generate revenue and a common metric to embed sustainability in business decision making. Reporting, disclosure and transparency on corporate impacts and dependencies on nature are central to enhancing corporate environmental responsibility.

NCA also informs investors about risks and opportunities of their placements directly or indirectly related to natural resources. For some companies, increasing risks related to environmental change (climate change, loss of natural capital) means that impacts and dependencies on nature are increasingly regarded as strategic risks. Finance departments recognize that the disclosure of risks to natural capital are key to companies' investors relations. In the longer term, NCA also means that business accounting can be compatible with national accounts so they can inform each other.

A number of approaches for corporate NCA have been developed internationally and in the EU, including in the context of the launch of the Natural Capital Protocol (see Box 23.4). Ongoing work in the EU Business and Biodiversity platform (B@B, 2017) aims to identify available approaches and best practices and to explore synergies between corporate and national accounting methodologies.

Box 23.4: The Natural Capital Protocol

The Natural Capital Protocol (Natural Capital Coalition, 2016) provides a framework designed to help generate trusted, credible, and actionable information for business managers to inform decisions. The Protocol aims to support better decisions by including how a company interacts with nature, or more specifically natural capital

Corporate NCA accounting can in particular help to:

- Provide a consistent basis and reference for business accounting and reporting on nature and environmental related assets and investments. This in turn can transform business strategies and plans, contributing to the better management of risks, as well as highlighting investment opportunities by directly seeing costs/values related to nature.
- Facilitate business reporting, in a way that is consistent with national accounting, in particular in the context of the EU Disclosure of Non-financial Reporting and Accounting Directives.
- Further inform investors about risks and opportunities.

23.6 | EU contributions to international theory and practice

At international level, the EU is a leading contributor to the development of accounting standards, such as through the European regulation on environmental accounts (Regulation (EU) 691/2011), which provides a legal framework for a harmonized collection of comparable data from all EU Member States and EFTA countries (Eurostat, 2011), and in contributions to the SEEA EEA. The EU contribution to the development of global indicators and standards for accounting for ecosystems and their value will assist reporting at international level, such as for the SDGs and in the long term alternative macro-economic indicators.

In addition, by supporting NCA projects in developing and middle income countries, the EU is enhancing the capacity for sustainable decision making processes in these countries as well as helping to guide and increase the effectiveness of EU development aid and other investments in these countries.

23.7 | Conclusions

There are a number of potential applications of ecosystem accounting in the context of EU-level policies that need to be trialed and tested in the context of the KIP INCA project. As with the development of many tools and information systems the involvement of end-users in specific policy areas is essential to ensure that the initial objectives are fulfilled. This is an integral part of the KIP INCA project approach and aims. The initial mapping of policy areas outlined in this paper can lay the basis for prioritizing the prototyping and, testing a first set of accounts in a number of specific policy contexts in the project. This should support the further development of natural capital accounting in a number of specific policy areas in the EU in the years to come and the experience and knowledge gained will be important for the further development of global accounting standards.

23.8 | Acknowledgments

Much of this text was taken from the KIP INCA phase 1 report, as referenced in the introduction. The authors would like to thank all the KIP INCA partners in the European Commission and the EEA for useful discussions on these issues.

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24 | The Aichi Targets and Biodiversity Conservation– The Role of Natural Capital Accounting[1]

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Summary

Natural capital accounting (NCA) has been identified as a vehicle to accelerate the mainstreaming of biodiversity into decision making and development policies in a systemic manner. NCA includes a wide range accounts, including those for biodiversity, which is one of the least developed areas of accounting.

Accounting for biodiversity poses several theoretical and practical challenges, including the need for a wide range of professions to work together to address the topic. All have different entry points and aims for biodiversity conservation and sustainable use, as well as their own terminologies and ways of working. These differences can make discussions challenging. More clarity and precision are needed in the discussions regarding how accounting can address biodiversity conservation.

To assist collaborations among diverse groups of professionals in the application of accounting to biodiversity conservation, the Aichi Targets have been mapped to the System of Environmental-Economic Accounting (SEEA; table 24.1). Aichi Target 2, which is to "integrate biodiversity values into national and local development strategies and *plans and national accounting systems as appropriate*," is the principal entry point. To achieve this target, diverse agencies and professions will need to work together. In addition, a range of recent examples and literature– with a focus on land, ecosystem and species accounts– have been introduced to suggest specific ways of applying accounting to biodiversity conservation. This work is in the beginning stages, and new ideas and incorporation of further practical experience are being sought.

This chapter summarizes a range of practical and theoretical issues associated with biodiversity accounting and its application to biodiversity conservation and is intended to provide a starting point for countries and agencies looking to begin work in this important area.

24.1 | Introduction

There is considerable success in mainstreaming development issues in recently revised National Biodiversity Strategies and Action Plans (NBSAPs)[2] and some reciprocal recognition of biodiversity in national development strategies or sector plans. The latter has depended on close collaboration of biodiversity, finance, and development authorities, increasingly recognized as joint drivers of effective biodiversity mainstreaming who recognize NCA as a vehicle to accelerate mainstreaming[3] of biodiversity into development planning in a more systematic way (Weber 2014; UNEP-WCMC and IEEP 2014). The December 2016 Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) recognized the importance of mainstreaming biodiversity use and conservation in the forest, agriculture, fishery, and tourism sectors (COP Decision XIII 3, paragraph 17d).[4]

Collaboration among a wide range of professions (for example, accountants, ecologists, economists, and land and sea managers, etc., and the public and private sector) is important for turning the promise of environmental-

economic accounting into practical information that can be used by decision makers in the public and private sectors (Vardon et al. 2016). Politicians do not understand that public funds invested in biodiversity can deliver high returns.[5]

A range of accounting work related to biodiversity has emerged, such as how NCA in general can be applied biodiversity conservation and as well as specific biodiversity accounting initiatives. Several projects have used the System of Environmental Economic Accounting-Experimental Ecosystem Accounting (SEEA-EEA) (UN et al. 2014) to develop accounts related to biodiversity conservation or include aspects or measures of biodiversity that are relevant to accounting (for example, ABS [2015], Burns et al. [2014], Driver et al. [2015], Eftec [2015], Keith et al. [2016], Remme et al. [2014], Remme et al. [2016], Schröter et al. [2015], UNEP-WCMC [2016], Varcoe et al. [2015]). This includes turning existing biodiversity data and endangered species lists into accounts, as well as the use of habitats-based approaches to infer biodiversity status. The corporate sector has also addressed accounting for biodiversity in the past (for example, TEEB for Business) and more recently (for example, Jones [2014]).

The growing body of work has brought to light many practical issues concerning the data sources and methods needed to generate accounts. More importantly, it has also shown that the accounts must be tailored to be relevant sources of reliable information for management and policy decisions relating to biodiversity conservation.

This note aims to generate discussion about the potential uses of accounting for biodiversity conservation. Three applications of accounting are considered: (1) the Aichi Targets, (2) land-use planning and protected areas management, and (3) biodiversity offsets and payments for ecosystem services. These are clear uses within the biodiversity conservation community, with some experience to suggest that countries could apply accounting to these issues as a first step toward a more comprehensive or extended use of accounting.

Additional applications of accounting to biodiversity appear possible and could be elucidated in the future. This potentially extends to a more holistic and integrated land-use planning regime that better considers biodiversity and the impacts of management on biodiversity and the ecosystem services that are derived from biodiversity. Such planning and management would be a significant improvement from traditional land planning regimes and could help land-use planners build the bridge that is often missing between them and the economic and development planners.

24.2 | Applying accounting to biodiversity conservation: The Aichi Targets

The CBD established 20 biodiversity targets, known as the Aichi biodiversity targets.[6] Aichi Target 2 aims to place biodiversity into the mainstream decision-making frameworks of policy makers (Rode, Wittmer, and Watfe 2012). It also makes explicit that biodiversity is to be incorporated into national accounting (that is, the System of National Accounts [SNA]; see EC et al. [2009]). The SNA is one of the chief sources of information for governments and others about the functioning of the economy and has a central position in the economic analyses, feeding into government and corporate decision making.

By integrating biodiversity information into the SNA, biodiversity can be considered in the mainstream economic policy, resource allocation, and fiscal and planning tools used in government decisions. To achieve Aichi Target 2, an obvious path is to join existing ecological and economic understanding to the accounting concepts and structures of the SNA via the SEEA. The number of countries implementing natural resource accounts, excluding energy, within the SEEA is included as an operational indicator to attain Aichi Target 2, as welcomed in Decision XIII/28 by the Conference of the Parties for the Convention on Biological Diversity in December 2016.[7]

Many of the Aichi Targets may be addressed via the accounting described in either the SEEA Central Framework or SEEA EEA. Table 24.1 shows which accounts that could inform each of the Aichi Targets. For example, a national balance sheet showing the value of natural resources, such as protected areas and wildlife, along with the values of other assets could support the integration of biodiversity aspects into national and local development and poverty-reduction strategies. Improved understanding of expenditures on biodiversity could help maximize the conservation benefits from the activities designed to meet many of the targets.

The land account is an important base account and can support the development of accounts for ecosystem extent. In combination, these accounts can play a role in achieving and monitoring Aichi Targets 4, 5, 7, 10, 11, and 15. The land account is also a fundamental building block for terrestrial ecosystem condition accounts that are linked to Aichi Targets 8, 9, 14, and 19 (see table 24.1). Basic land accounts can generally be prepared with existing data sources and may be updated regularly with remotely sensed data. Accounts of ecosystem extent can, for example, be derived from the maps of the distribution of vegetation classes combined with information on land cover. How these and other accounts can be applied to some specific issues with land planning and endangered species is discussed below.

Table 24.1: Links between Aichi Targets and environmental and ecosystem accounts

Aichi Target	Relevant environmental-economic and ecosystem accounts	Example indicators
1. By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	—	
2. By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	All SEEA—National balance sheet showing values of natural resources along with the values of other assets (SNA and SEEA-CF); ecosystem service accounts showing both physical levels and monetary values of services (SEEA-EEA); national development plans (or regional or State level)	Natural resources (land, fish, and timber) as a proportion of total wealth Ecosystem services as a proportion of GDP
3. By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out, or reformed to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the CBD and other relevant international obligations, taking into account national socioeconomic conditions.	Environmental activity accounts—these accounts cover environmental protection expenditure, taxes, subsidies, and so forth (SEEA-CF)	Level of subsidies to industries (forestry, fishing, mining, and fossil fuels) impacting biodiversity Public expenditure on biodiversity conservation as a proportion of all public expenditures Level of payments for ecosystem services

Aichi Target	Relevant environmental-economic and ecosystem accounts	Example indicators
4. By 2020, at the latest, governments, business, and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of the use of natural resources well within safe ecological limits.	Physical asset and supply-use accounts for water, timber, aquatic resources, minerals, and energy (SEEA-CF); ecosystem extent and condition accounts (SEEA-EEA)	Proportion of ecosystems with improving condition Harvest levels as a proportion of regrowth rates (for renewable resources)
5. By 2020, the rate of loss of all natural habitats, including forests, is at least halved and, where feasible, brought close to zero, and degradation and fragmentation are significantly reduced.	Land cover/ecosystem extent accounts (SEEA-CF/SEEA-EEA); ecosystem condition accounts (SEEA-EEA)	Proportion of ecosystems with declining extent Proportion of ecosystems with declining condition
6. By 2020, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally, and applying ecosystem-based approaches, so that overfishing is avoided; recovery plans and measures are in place for all depleted species; fisheries have no significant adverse impacts on threatened species; and vulnerable ecosystems and the impacts of fisheries on stocks, species, and ecosystems are within safe ecological limits.	Physical asset and supply-use accounts for aquatic resources (SEEA-CF); ecosystem condition account; biodiversity accounts species accounts (SEEA-EEA)	Trend in harvest levels as a proportion of regrowth rates Trend in the number of species threatened by fishing
7. By 2020, areas under agriculture, aquaculture, and forestry are managed sustainably, ensuring conservation of biodiversity.	Emissions accounts (SEEA-CF); land cover/ecosystem extent and land use accounts (SEEA-CF/SEEA-EEA); ecosystem condition account; biodiversity accounts - species account (SEEA-EEA)	Levels of emissions Proportion of native vegetation cover on land used for agriculture, aquaculture, and forestry Proportion of land managed for biodiversity conservation used primarily for agriculture, aquaculture, and forestry
8. By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	Ecosystem condition accounts (SEEA-EEA)	Trend in pollution loads
9. By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	Possible links to ecosystem condition and biodiversity accounts (SEEA-EEA) and environmental activity accounts (SEEA-CF)	Trend in the area of distribution of alien species Trend in the expenditure on control of alien species

Aichi Target	Relevant environmental-economic and ecosystem accounts	Example indicators
10. By 2015, the multiple anthropogenic pressures on coral reefs and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.	Water emissions account (SEEA-CF); ecosystem extent account of coral reefs and vulnerable ecosystems (Secades et al. [2014]); ecosystem condition account (SEEA-EEA); ecosystem services account (SEEA-EEA); biodiversity account—species diversity/population/extinction risk trends in coral and reef fish (adapted from Secades et al. [2014])	Trend in pollution loads Trend in water quality Percentage of ecosystems in declining condition
11. By 2020, at least 17 percent of terrestrial and inland water and 10 percent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative, and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	Land cover/ecosystem extent and land-use accounts (SEEA-CF/SEEA-EEA); ecosystem condition account and ecosystem services account (SEEA-EEA); biodiversity accounts—species diversity/abundance accounts (SEEA-EEA)	Percentage of ecosystems in protected areas Percentage of ecosystems managed for conservation (that is, private conservation areas) Number of species found in protected areas
12. By 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	Biodiversity accounts—species diversity/abundance accounts (SEEA-EEA)	Number of threatened species Area of distribution of threatened species
13. By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socioeconomically as well as culturally valuable species, is maintained, and strategies have been developed and implemented to minimize genetic erosion and safeguard their genetic diversity.	Biodiversity accounts (SEEA-EEA)— genetic diversity account; not described in SEEA-EEA, practically difficult, but theoretically feasible	—
14. By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods, and well-being are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	Ecosystem condition account and ecosystem services account (SEEA-EEA)	Trend in ecosystem service levels (for example, water provisioning and water filtration services)
15. By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including the restoration of at least 15 percent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	Land cover/ecosystem extent account (SEEA-CF/SEEA-EEA); ecosystem condition account; ecosystem services account carbon asset account (SEEA-EEA)	Trend in carbon sequestration Trend in total carbon stocks

Aichi Target	Relevant environmental-economic and ecosystem accounts	Example indicators
16. By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	Biodiversity accounts—genetic diversity account; not described in SEEA-EEA, but feasible; ecosystem services account (SEEA-EEA)	—
17. By 2015, each party has developed, adopted as a policy instrument, and commenced implementing an effective, participatory, and updated national biodiversity strategy and action plan.	Possible role for a biodiversity account (SEEA-EEA) in NBSAPs	—
18. By 2020, the traditional knowledge, innovations, and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity and their customary use of biological resources are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the CBD with the full and effective participation of indigenous and local communities at all relevant levels.	—	—
19. By 2020, the knowledge that the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared, and transferred and applied.	Possible roles for ecosystem condition account; ecosystem services account (SEEA-EEA)	—
20. By 2020, at the latest, the mobilization of financial resources to effectively implement the Strategic Plan for Biodiversity 2011–2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by the parties.	Environmental activity accounts (SEEA-CF)	Trend in expenditure on biodiversity conservation

Source: After Vardon et al. (2015).

24.3 | Using ecosystem accounting in threatened-species and protected-area management

Threatened-species and protected-area management are cornerstones of conservation policies, laws, and practices. However, most scientists and public officials involved in threatened-species and protected-area management have little knowledge of accounting and how it could be useful for them. There are few examples of ecosystem accounting being applied directly to protected-area or species management. However, two examples of accounting applied to these issues are available from Victoria, Australia: (1) the economic benefits arising from protected areas were estimated (Varcoe et al. 2015) and (2) used to feed a debate on expanding protected areas in Central Highlands of Victoria (Keith et al. 2016.).

The two Victorian studies show the economic benefits of biodiversity conservation and, in particular, the large value of cultural and recreational services that is obtained from some ecosystems. Keith et al. (2016) also shows the economic benefits from competing land-use activities and enables decision makers to know what would be lost and gained via a change in land uses. In this case, net economic benefits are expected from expanding the national park network, entering the carbon market would, and ceasing native forest logging.

Accounting can target areas, habitats, or species in need of assistance and assess the likely costs of remedying deficiencies. For example, the identification of habitats underrepresented in the protected-area network (Aichi Target 11) and possible cost-effective solutions for increasing the area of these habitats by expanding the protected-area networks or implementing schemes for the protection of habitats on private lands. The land accounts might identify that only 5 percent of wetlands occur in protected areas, well short of the 17 percent identified in Aichi Target 11, as well as identify the industries owning the land on which the rest of the wetlands occur. This would enable government planners to assess the likely cost to government of expanding the protected-area network to achieve state targets as well estimate the likely impact on economic production. This would help find solutions that maximize the area of the wetland protected and minimize the cost to government and industry.

For threatened species, information from the environment protection expenditure accounts helps assess the efficiency of expenditures. The expenditures should result in increases to species distribution and abundance (and hence lower its risk of extinction and threat status), and the accounts through the regular data can be used to identify the types and locations of expenditures that achieve the best results. Such analysis of the accounts would over time allow generalizations about the optimum time and place of interventions (for example, waiting until near extinction to act is likely to be costlier than action taken when declines are first apparent). This effort can be linked to Aichi Target 3.

24.4 | Applying accounting to biodiversity offsets and payments for ecosystem services

Payments for ecosystem services and offsets are economic instruments used in many countries to implement conservation and biodiversity policies. There are more than 300 programs (experiences) for payments for ecosystem services (Blackman and Woodward 2010) with a combined value of payments exceeding US$6.5 billion (OECD 2010). Biodiversity offsetting is used in many countries (for example, Gibbons et al. [2015], ICMM and IUCN [2012], Madsen [2011]).

Biodiversity offsets are defined by the Business and Biodiversity Offsets Programme (BBOP 2012) as:

> *Measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development.*

In accounting terms, biodiversity offsetting represents a trade-off between assets in time and space. For example, an ecosystem may be lost in one area due to a development but can be replaced by the protection and management of another ecosystem asset in another area, with no net loss of biodiversity over a defined time (see Curran et al. [2013], Gibbons et al. [2015], and Reid [2011] for more on the theory and practice of offsetting). In the area of biodiversity, both accounting and offsetting can benefit by working more closely together. Accounting can benefit offsetting by linking the exchange of assets to changes in the flows of ecosystem services and hence enable a more complete assessment of what is lost and gained from particular transactions. Accounting benefits as the values of the exchanges obtained via

biodiversity offsetting can be used in ecosystem accounting and hence be used to estimate the value of biodiversity to economic production and consumption, as well as human well-being more generally.

For example, a developer may build houses on land occupied by a forest. To offset the loss of forest and related biodiversity on the housing site, the developer purchases and manages another of piece of land, which has a similar forest type. In terms of assets, it is a fair exchange. However, the services derived from the assets are different. The original site was on the edge of a town and was used for recreation as well as provided water and air filtration services. The new site is distant from populations and not used for recreation and no water or air filtration services are derived. The accounting would show that the exchange of services was not equal, even if the exchange of assets was. Furthermore, the accounting would show the revealed value of the biodiversity to society for the site lost, and this value may apply to other locations and hence be used to assess other trade-offs in land use.

24.5 | Where to start?

The Aichi Targets provide a useful entry point for applying accounting to biodiversity conservation. Target 2 is the most broadly stated target and may be a means by which other targets are made possible. Target 2 certainly provides an impetus for cross-agency and multidisciplinary collaboration. If achieved, it could have a profound impact on macro-economic decision making, as biodiversity has not previously been visible in the national accounts. As an initial step toward target 2, countries could convene the relevant agencies to design a suite of accounts to meet this target and chart a path towards their creation. Part of this would include an examination of the existing economic and environmental information. This effort would help determine what accounts might be feasible in the short term and to which targets these accounts could be applied. Specific accounts in the SEEA framework are discussed below.

Land accounts: Many targets can be addressed via the land accounting (table 24.1), especially if combined with data on protected areas status (for example, from the International Union for Conservation of Nature Protected Area Classification[8] and the World Database on Protected Areas[9]). For targets 5 and 11, land accounts can measure progress toward these targets. Moreover, they can identify additional areas in countries that could be added to the protected-area network, how much this might cost to governments, and which industries and communities would be affected (positively and negatively) by the establishment of additional protected areas. Accounts for the Central Highlands of Victoria, Australia (Keith et al. 2016) have been used in this way.

Ecosystem accounts: At least some of the value of biodiversity is captured as part of the production of ecosystem services. As such, the ecosystem service accounts, in combination with other accounts, provide another means to integrate biodiversity into national accounting (Aichi Target 2). It is certainly possible to examine the value of past uses and hence what might be lost if land management was changed (for example, the accounts could be used for scenario modeling).

Species accounts: These accounts provide a mechanism for explicitly considering and managing the contribution of biodiversity to service delivery. This is relevant for specific groups of species that underpin the delivery of different ecosystem services (Luck et al. 2009). In this context, species accounts, in combination with land and ecosystem accounts, can help evaluate different public and private land-use options by identifying the following:

- Species hotspots and, in particular, their location in relation to infrastructure, urban development, and important ecosystem services

- Where trends in species distribution and abundance infer a risk to current or future ecosystem service provision
- What regulations or investments are needed to maintain or increase biodiversity and species for natural solutions (for example, reduced pesticides)
- Where agricultural and other industry practices might have the greatest impact (and hence where the biggest gains for minimum cost could be achieved).

A key aspect of accounting is that it produces systematic data that can be used to implement the NBSAPs and refine the strategies and management actions. Accounts can also be used to show the importance of biodiversity to the economy and to highlight risks to the economy and human well-being more generally. Thus, accounts could form a central part of the machinery of government that would draw together the NBSAP and the national development plan, land-use plan, and economic growth plans. If this can be done, biodiversity will have truly entered the mainstream of government and corporate decision making.

24.6 | Acknowledgments

A large number of people have contributed to the development of the ideas and experiences presented in this paper. In particular we would like to acknowledge the work of Heather Keith, David Lindenmayer, Phil Gibbons, Mark Eigenraam, Tony Varcoe, and Rocky Harris.

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24.8 | Endnotes

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1 Many people have contributed to the development of the ideas and experiences presented in this paper. In particular, the authors would like to acknowledge the work of Heather Keith, David Lindenmayer, Phil Gibbons, Mark Eigenraam, Tony Varcoe, and Rocky Harris.
2 https://www.cbd.int/nbsap.
3 Harare Statement, 2015, Mainstreaming Biodiversity into Development Policy and Planning, http://pubs.iied.org/G04010/.
4 https://www.cbd.int/decisions/cop/?m=cop-13.
5 Personal observation of co-author Carlos Manuel Rodriguez.
6 See Aichi Biodiversity Targets http://www.cbd.int/sp/targets/.
7 See https://www.cbd.int/doc/decisions/cop-13/cop-13-dec-28-en.pdf.
8 IUCN protected-area categories, http://www.iucn.org/about/work/programmes/gpap_home/gpap_quality/gpap_pacategories/.
9 IUCN & UNEP-WCMC, www.protectedplanet.net.

25 | Applying Natural Capital Accounting to Water Policy

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Summary

This chapter provides an introduction to key water policy areas and the concepts of full cost recovery and integrated water resource management to which natural capital accounting (NCA) has or could contribute. The discussion uses examples from Australia, the Netherlands, and Wealth Accounting and the Valuation of Ecosystem Services (WAVES) countries to illustrate some key points, which are likely to be relevant beyond the countries examined.

It is important to understand, that the limited freshwater resources on the planet require management through water policies that regulate the supply as well as the demand of multiple users. Freshwater resources are unevenly distributed in time and space. Reservoirs are used to manage water over time, but options for increasing water supply in dry areas are limited. Because water is a bulky good, the demand in one region cannot simply be addressed by supply from another region.

Water policy targets are set at different levels: globally (for example, through the Sustainable Development Goals [SDGs]), regionally (for example, European Water Framework Directive), as well as through national strategies and legislation. Water accounting is a helpful tool to analyze current water uses and related environmental and financial implications. Accounting helps in demand forecasting to assess the impact on the economy of reduced water availability and determine cost-effective options for increasing supply or reducing demand. Furthermore, it is a useful tool to model the impact of regulative measures on water use patterns and the impact of changing the price of water on the economy.

25.1 | Introduction

Several countries have experience or are experimenting with NCA for their water resources. This chapter summarizes the main water policy areas and outlines some key concepts used in these policy areas that are particularly amenable to being informed by NCA. This assessment is based on a range of experiences in a number of countries, spanning every continent and a variety of social-economic-environmental settings, in particular Australia, the Netherlands, and the five WAVES countries (Botswana, Colombia, Costa Rica, Madagascar, and the Philippines). The main points in this chapter are broadly applicable and hence useful for other countries beginning water accounting.

25.2 | Objectives of water policy

The amount of freshwater on earth is limited, and the demand by a variety of users is continuously increasing due to the planet's growing population and economy. Freshwater resources are unevenly distributed across regions, and the amount available varies significantly over time. Droughts and floods are extreme situations, with huge possible impacts on human well-being, the economy, and the environment. The quality and quantity of the available water resources are under constant pressure due to human activities, including the degradation of water-related ecosystems and climate change.

The World Bank report *High and Dry: Climate Change, Water, and the Economy* (World Bank 2016) suggests that water scarcity, exacerbated by climate change, could cost some nations up to 6 percent of their gross domestic product (GDP), spur migration, and spark conflict. The combined effects of growing populations, rising incomes, and expanding cities will result in an exponential increased demand for water, while supply becomes more erratic and uncertain. The World Bank (2016) report stresses the need to increase water security for all, as it is considered to be among the top global risks to development.

Water policy targets are set at many levels: globally (for example, through the Sustainable Development Goals), regionally (for example, European Water Framework Directive, Zambezi Watercourse Commission), nationally, and subnationally (for example, by river basin) through legislation and planning. In general, water policies ensure water security by satisfying four major objectives (see figure 25.1 and UNSD and WWAP 2011):

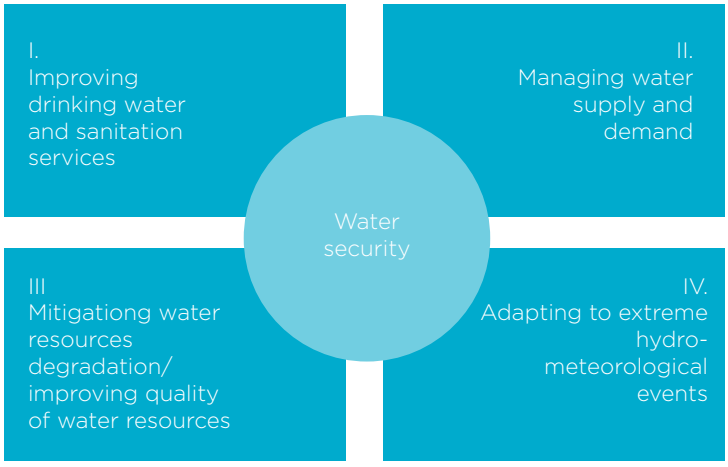
1. Improving and maintaining drinking water and sanitation services: This requires investments in infrastructure (water supply, sanitation facilities, and waste water collection, and treatment) and decisions on pricing of water services to ensure full cost recovery.

2. Managing water supply and demand: The policy options to manage supply and demand include regulations of water uses (for example, water permits, water use restrictions), education of consumers (awareness raising campaigns), increased water use efficiency and various technical measures to increase supply or reduce demand (building of dams, desalination plans, reducing leakages, and so forth), and financial incentives to save or reuse water.

3. Mitigating water resources degradation and improving water quality: The policy options include land protection (for example, for important aquifers of springs), regulation of the use of harmful substances (for example, nutrients and pesticides), and technical measures, such as reforestation.

4. Adapting to extreme hydro-meteorological events: Adapting to both extreme water scarcity and floods includes land management (for example, protecting or restoring natural flood prone areas), settlement planning, and different technical measures (transferring water from other areas, building wells, dams, and so forth).

Figure 25.1: Four major objectives of water policy



Source: UNSD and WWAP (2011).

These four objectives are also addressed by goal 6 of the SDGs (ensure availability and sustainable management of water and sanitation for all). It has the following targets:[1]

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all.

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women, girls, and those in vulnerable situations.

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

6.6 By 2020 protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies.

6.b Support and strengthen the participation of local communities in improving water and sanitation management.

25.3 | How can NCA support water policy?

25.3.1 | Water accounting

NCA helps to understand the complexity of water-related issues by integrating information from different sources into a suite of connected accounts, including the following:

- Water accounts (physical and monetary supply and use tables, value and condition of water supply, and wastewater collection infrastructure)
- National accounts, and in particular, the metrics for the water supply, agricultural, and energy industries
- Land cover and land use accounts
- Environment protection accounts
- Ecosystem accounts (water provisioning and water filtration services)
- Energy accounts (important when there is significant hydro-electric power generation)
- And other accounts, such as agriculture, forestry, and fishery accounts.

WAVES uses the System of Environmental-Economic Accounting (SEEA; UN et al. 2014) as the underlying framework for its NCA application, with data originating from different sources (for example, water supply companies, household surveys, industry surveys) that are integrated in a globally standardized way. It allows for comparable data across countries (for example, for benchmarking or regional assessments) and helps to identify important data gaps. NCA provides a useful tool for demand forecasting and the assessment of the impact of reduced water availability on the economy. It also helps to model the impact of price changes on the economy (for example, increase of water price) and the impact of regulative measures on water use patterns.

NCA has proved to be especially helpful for the objective of managing water supply and demand. Brief examples of this are provided in section 25.4, but it must be understood that supply in a certain region is ultimately limited and that demand cannot simply be met by supply from other regions. With the physical water accounts, it can be monitored how much water is stored in groundwater aquifers and natural or artificial lakes, and how much water is demanded in other sectors or flows toward other regions or countries. Water accounts are helpful for keeping track of transboundary water issues. One of the roots of regional conflicts is often the competition for limited water resources (for example, in the Middle East and North Africa, AbuZeid and Abdel-Meguid [2006]). Moreover, water accounts are useful to follow water uses and emissions to water sources from various economic sectors, such as agriculture and energy production. So, the water accounts are used to consider important cross-cutting issues in the water-food-energy nexus.

To a smaller extent, NCA also supports the achievement of the other three major objectives of water policy (improvement in drinking water and sanitation services, mitigation of water resources degradation, and adaption to extreme hydro-meteorological events). The limitations are due to lack of consideration of the social dimension (for example, human health), water quality, and temporal and spatial disaggregation of the information (that is, considering seasonal and subnational phenomena, such as local or short-term water scarcities). To some extent, these are addressed through the emerging ecosystem accounting which has, among other things, a spatial underpinning and recognizes a broader suite of benefits to people than recognized in the SEEA.

25.3.2 | Use of NCA for two key policy concepts

Water accounts in particular provide valuable information for two of the key concepts that are on the basis of many water policies and that contribute to all four objectives: full cost recovery and integrated water resources management (IWRM).

Full cost recovery includes incentive pricing and applying the polluter pays principle. In the European Union, full cost recovery is specified in Article 9 of the Water Framework Directive, and member states often face a key challenge in setting up a functional pricing system that satisfies this requirement to an adequate degree while keeping water services affordable (EEA 2013).

Applying full cost recovery means that those providing water services (water supply, wastewater collection) should charge those using these services to cover costs, including:

- Direct costs (all capital and running costs)
- Externalities or the costs of dealing with public health or environmental impacts of water use and the discharge of wastewater (the polluter pays principle)
- Opportunity costs (the value of future sacrifices implied by current use).

To assess cost recovery, the following information is needed, which is provided by the water accounts:

- Water supply assets (expected life, performance profile and value of the built and natural infrastructure)
- Operating costs
- Water users (how much they use, what they use it for, how much they pay)

The second key concept is integrated water resources management, which is defined by the Global Water Partnership (GWP) as "a process which promotes the coordinated development and management of water, land and related resources, to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems." Therefore, IWRM covers water for people, food, nature, and industry, and an enabling environment, with institutional roles and management instruments.

IWRM was recommended in the final statement of the ministers at the International Conference on Water and the Environment in 1992, and it has become a requirement to be globally implemented through SDG target 6.5.

For IRWM, the water accounts provide information about

- Water resources, users, and uses
- Water pricing, water supply assets, and operating costs
- Land, land use, and the environment
- Water quality and environment protection expenditure.

Table 25.1 shows the links between the four objectives and the corresponding natural capital accounts and key water policy concepts. The country examples mentioned in the table are discussed in more detail in section 25.4.

Table 25.1: Links between natural capital accounts and key water policy areas and concepts

Policy area	Key concept		Examples
	Full cost recovery	Integrated water resource management	
1. Improving drinking water and sanitation services	Physical and monetary water supply and use tables SNA accounts (with the emphasis of the water supply and sewerage industries) Environment protection expenditure accounts Water asset account	Physical and monetary water supply and use tables Land cover and land use accounts	Colombia, Costa Rica
2. Managing water supply and demand	Physical and monetary water supply and use tables Water asset account Land cover and land use accounts SNA accounts (with the emphasis of the water supply and sewerage industries)	Land cover and land use accounts Physical and monetary water supply and use tables Water asset account	Australia, Botswana, Colombia, Costa Rica, Madagascar, Netherlands, Philippines

Policy area	Key concept		Examples
Mitigating water resource degradation	Physical and monetary water supply and use tables (emphasis on return flows and operation on sewerage collection and treatment) Land cover and land use accounts Water quality accounts Environment protection expenditure accounts	Land cover and land use accounts Physical and monetary water supply and use tables Water asset account	Netherlands, Philippines
Adapting to extreme hydro-meteorological events	Land cover accounts Water asset accounts Environment protection expenditure accounts Ecosystem service accounts (for flood protection and regulation of water flows)	Land cover accounts Water asset accounts Environment protection expenditure accounts Ecosystem service accounts (for flood protection and regulation of water flows)	Philippines

Source: Developed by authors.

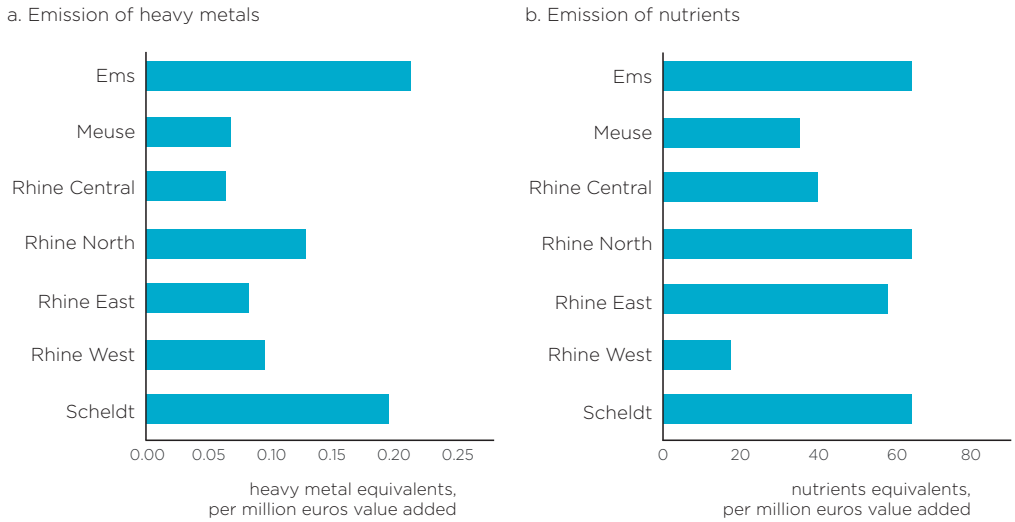
25.4 | Case studies

This section provides case studies from the Netherlands, Australia, and the five WAVES countries. These examples show how NCA is used for the key concepts IWRM and cost recovery (water pricing).

25.4.1 | The Netherlands

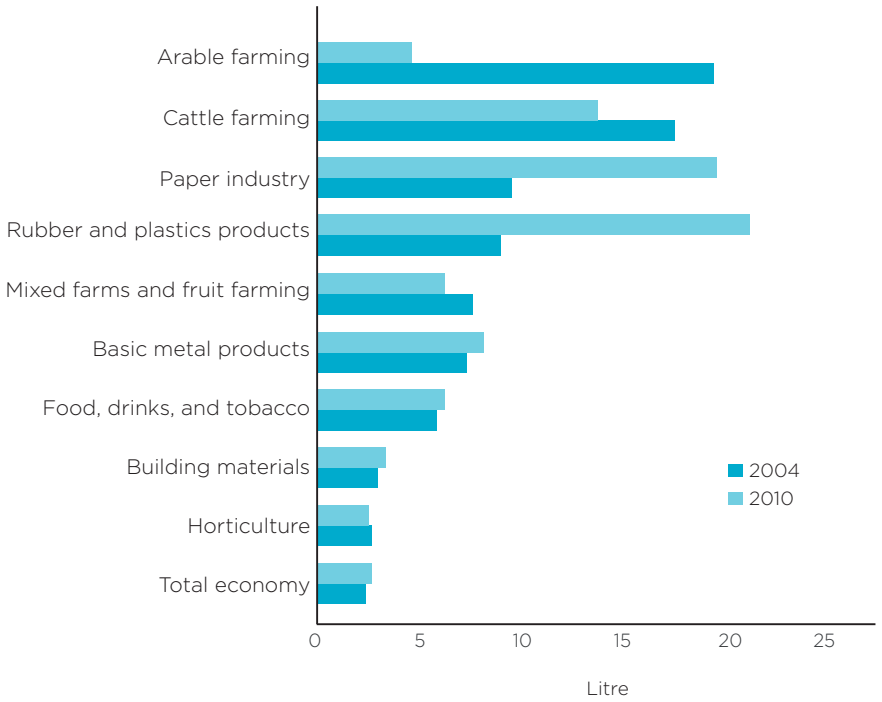
As a member state of the European Union, the Netherlands must achieve good status for all its surface water bodies according to the European Water Framework Directive (2000/60/EC), which is an example of a water policy to mitigate water resources degradation. Water accounts play an important role in the implementation of this directive. Examples for water accounts based information are the emission intensities for different river basins (figure 25.2) and the groundwater abstraction per-euro value added in different sectors (figure 25.3).

Figure 25.2: Emission intensity for different river basins for 2007, producers only



Source: Statistics Netherlands (2011).

Figure 25.3: Groundwater abstraction per Euro value added in different sectors



Source: Statistics Netherlands (2011).

The Netherlands uses the water accounts for the economic description of the river basins and the analysis of cost recovery. The use in selecting measures to achieve the objectives of the Water Framework Directive is limited due to scale and nature of these measures (see also chapter 16 of this document).

25.4.2 | Australia

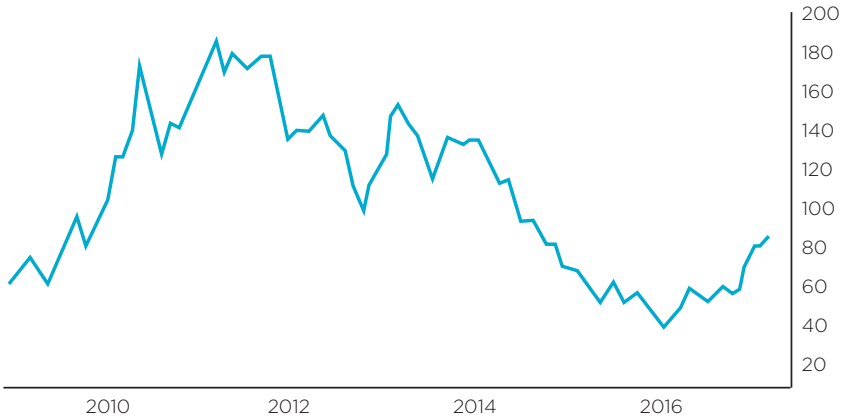
In South Australia, the Natural Resources Management (NRM) Act of 2004 is the primary legislation that regulates the use and management of natural resources. With respect to water resources, the NRM Act governs the development of Water Allocation Plans, which provide a formal water sharing arrangement for the natural water stocks, by allocating the right to access a share of the water resource on an ongoing basis. Water Allocation Plans are generally prepared in areas where water resources are scarce and are prepared by Natural Resource Management Boards (NRM Boards).

The NRM Act (section 76) dictates that Water Allocation Plans must set out principles used in the determination of water access entitlements (the formal rights to access the water resource) and for the taking and use of water so that there is an *equitable balance achieved between environmental, social, and economic needs for the water.*[2] In reality, balancing these often competing factors is far from easy. It requires an understanding of the value of water resources to the environment, society, and the economy, and also some understanding of the linkages between them. For example, consider two identical agricultural water users, each extracting the same quantity of water each year and generating the same economic output. One employs 15 people (Operator 1), the other (Operator 2) employs 5. From an economic efficiency perspective, as labor is an input cost, Operator 2 may be the more efficient operator. The economist may therefore prefer that water be allocated to Operator 2. However, there are strong social benefits to employment, and in this example, much of society may prefer Operator 1. While such trade-offs are difficult using environmental accounts alone, by adding in other social information, these decisions can be made much easier.

To inform their decision making, NRM Boards have engaged independent consultants to conduct analysis on the economic impacts of various water sharing scenarios. These scenarios include a range of volumes of water allocated to the water entitlement holders licensed in each region. The analysis used Australian Bureau of Statistics (ABS) data, including data from the water accounts (for example, ABS [2016]) on water use by industry type (including agricultural, commercial, domestic, and other industries). Other ABS economic data are used to highlight the economic value-added of the water used by industry type, as well as other ABS social data, such as employment by industry. Decisions can then be made, following a public consultation process, by the NRM Boards as to which scenario maximizes the benefits and are socially acceptable in the region at that time. The result is a water resource sharing regime that takes into account environmental, economic, and social objectives using evidence and a participatory decision-making process.

However, using water accounting information for this process has its limitations. For example, estimates of economic value derived from water use can fluctuate substantially for certain industries. In mining, for instance, commodity prices can fluctuate substantially from year to year (see figure 25.4). In agriculture, water used in irrigation can vary considerably from year to year, as in wet years, less irrigation water is needed. Such temporal changes in either the amount of water used by industry or the value of output of commodities produced need to be understood, hence single-point-in-time estimates from water accounts have limited usefulness. A time series of accounts can help show the long-term average of industry contributions and water uses and be used to understand particular times of stress or how demand might change with commodity prices.

Figure 25.4: Iron ore price, 2009–17 (US$ per ton)



Source: Trading Economics (2017).

The water accounts remain one of the best tools available in South Australia for allowing for such assessments as those required for the preparation of Water Allocation Plans, particularly through their linkages between environmental and economic information. Furthermore, market-based mechanisms such as water trading can provide effective tools to help correct for significant temporary adjustments to the value of water to an industry at a point in time. These tools can allow water entitlement holders to buy or sell their entitlements on either the permanent or temporary market in accordance with the value that they place on water.

25.4.3 | WAVES countries

All of the first five WAVES countries—Botswana, Colombia, Costa Rica, Madagascar, and The Philippines — developed either national or regional water accounts (Vardon et al. 2016). A range of policy applications of the water accounts to particular industries, regions, or issues were examined, and these are summarized in table 25.2.

Two of the examples, one for Botswana (Pule et al.) and one for Colombia (Romero et al.), are explored more fully in other chapters of this document (chapters 7 and 9, respectively).

Table 25.2: Summary of use or potential use of water accounts in WAVES countries

Country	Issue	Year	Reference
Botswana	Mining	2015	WAVES Policy Briefing, https://www.wavespartnership.org/en/knowledge-center/policy-briefing-water-resources-and-mining-botswana
	Water use efficiency Water allocation	2015	WAVES Policy Briefing, https://www.wavespartnership.org/en/knowledge-center/policy-briefing-sustainable-equitable-and-productive-use-water-through-water
	Wildlife water use	2017	Pule et al. (chapter 7, this publication)
	Water management	2017	Pule et al.(chapter 7, this publication)
Colombia	Regional water planning in Lake Tota and Chinchina		Vardon et al., https://www.wavespartnership.org/en/knowledge-center/achievements-and-lessons-waves-first-5-core-implementing-countries
	Water pricing	2017	Romero et al. (chapter 9, this publication)
Costa Rica	Water pricing Infrastructure investment	2015	WAVES Policy Briefing, https://www.wavespartnership.org/en/knowledge-center/policy-briefing-water-accounts-inform-policies
Madagascar	Access to water Water use efficiency	2016	Madagascar Comptes Eau, https://www.wavespartnership.org/en/knowledge-center/madagascar-comptes-eau
Philippines	Flood mitigation Water quality	2016	WAVES Policy Briefing, https://www.wavespartnership.org/en/knowledge-center/policy-briefing-ecosystem-accounts-inform-policies-better-resource-management

The WAVES countries applied accounting for water pricing or water management. In all cases, information was missing on the value of water supply and sanitation infrastructure, thus the determination of full cost recovery was hampered.

The use of water accounts for the management of industries or areas was clearly evident. These were areas of limited water availability and increasing demand (for example, for Lake Tota and Chinchina in Colombia) or areas with water quality concerns limiting supply (for example, in Laguna de Bay in the Philippines). The use of the accounts for understanding and managing the water demand of particular industries was evident in Botswana, Colombia, Costa Rica, and Madagascar. The focus was generally on agriculture, typically the largest consumer of water, but Botswana, which is a water-scarce country, also used water accounts to examine the dependence of the mining sector and wildlife tourism on water.

25.5 | Final remarks

Water accounting has been undertaken in range of countries around the world. This initial review has shown that accounts can inform a range of water policy issues, including the important notions of full cost recovery and IWRM related to managing water supply and demand. In most cases, accounts have lacked full information and, in particular, information on the economic aspects of the value of infrastructure and estimates of the damage

caused to the environment from pollution, thus limiting their ability to fully inform full cost recovery for mitigating water resource degradation.

The broad range of experience, spanning low- to high-income countries with high and low water availability (for example, Botswana to the Netherlands), demonstrates that accounts can be prepared and clearly indicate where they could be useful for decision makers. Explicit, direct use of accounts in decision making for water is still uncommon, but the signs are encouraging. There are examples from the Netherlands and Australia, two countries with long histories in the production of water accounts and their use in decision-making processes. There are likely to be others, particularly in Europe (for example, Sweden and the United Kingdom) but also in other places (for example, Mexico).

Uses of accounting for water policy and management are emerging from WAVES countries, and the water SDGs provide an excellent opportunity to demonstrate the potential of the accounts, not just for monitoring the SDGs but also for achieving the targets. Adding additional information on economic values and further analysis of data in the accounts (for example, scenario modeling) will increase the usefulness of the accounts and should lead to a broader use of NCA in water policy.

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25.7 | Endnotes

1 https://unstats.un.org/sdgs/indicators/Official%20Revised%20List%20of%20global%20SDG%20indicators.pdf.
2 https://www.legislation.sa.gov.au/LZ/C/A/NATURAL%20RESOURCES%20MANAGEMENT%20ACT%202004/CURRENT/2004.34.UN.PDF.

26 | Business and National Accounting for Natural Capital—Toward Improved Understanding and Alignment

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Summary

This chapter provides a brief introduction to the natural capital accounting (NCA) undertaken by governments and business with the aim of improving the understanding and alignment of these two distinct accounting communities. Both communities have long accounting traditions, which have evolved over the last few decades to include natural capital and the impacts of economic activity on the environment. While many of the concepts and formats used are similar, the scale, terminology, and purpose of the accounting undertaken are different. This chapter aims to improve the comparative understanding of government (or national) accounting and business accounting. It outlines some of the history and key features of each system, noting where they are similar and where they diverge, and the implications for aligning the accounting of natural capital. Both accounting types have begun by including individual natural resources in their accounting, for example water, energy, or timber use, as well as air and water pollution. In such areas, there has been considerable success. However, both accounting communities face challenges, for example, how to include ecosystems and biodiversity in their accounts, assign meaningful values to natural capital, and communicate complex information to a broad range of stakeholders. These achievements and challenges provide a good basis for shared learning in the development and application of NCA by both business and government.

26.1 | Introduction

NCA is a relatively new tool that can help to manage the impacts of business, governments, and people on nature and to ensure the benefits provided by nature are sustained. NCA is being increasingly promoted by businesses and governments around the world. While there is much commonality in the purpose and approach to accounting for natural capital in business and government, the two disciplines tend to be separate and each has its own purpose, traditions, and communities of practice. Moreover, it is not well understood how the two disciplines are similar and where they are different.

This chapter provides a brief introduction to both business accounting and government accounting and their relevance to NCA. The accounting undertaken by governments for the purpose of macroeconomic planning is known as national accounting, and this, among other things, produces the indicator gross domestic product (GDP). The accounting undertaken by business is to support management and build investor and consumer confidence, and it is often required for regulatory purposes. The aim of this chapter is to aid mutual understanding between the two disciplines of business and national accounting and to identify areas where each may benefit from the experience of the other in developing and applying approaches to account for natural capital.

26.2 | Purpose and history of business accounting

Standard business accounting represents a system for recording and organizing financial data so that it can be used for management. This system generates regular financial statements that can be used by business managers, debtors, creditors, investors, and regulatory authorities (for example, Birt et al. [2016]). Among other

things, business accounting can be used to manage cash flow and detect fraud, theft, and waste. The accounting is for a single business, which may be relatively simple in structure, for example, operating at one site and involved in only one type of business. Or it may be more complex, characterized by many segments, that is, operating over many sites and/or having a range of business activities.

The basics of business accounting were established by the merchants of Venice and first articulated by Luca Pacioli in 1494 in a broader textbook summarizing the mathematics of the day. Over time, the accounting concepts spread, being used by a wider range of people including monarchs as well as businesses (Gleeson-White 2012).

Business accounting has been standardized internationally through the International Financial Reporting Standards (IFRS).[2] Many countries, including all of those in the European Union, have adopted the IFRS as the national standard, while other countries have separate national standards, for example, the United States, China, and Japan. In some cases, national standards are based on IFRS, as in Australia through the Australian Accounting Standards Board.[3] IFRS are also supported by many international organizations, including the G20, World Bank, Basel Committee, and the International Monetary Fund (IMF).

In the past few decades, the scope of business accounting has expanded to include consideration of the environment in business reporting. The expansion was driven by the increasing recognition of the negative impacts that business could have on the environment, the dependence of many businesses on natural capital, investor and consumer pressure, and, in one case (South Africa), new regulatory requirements. A number of different initiatives have emerged internationally or at the country level. These include (in order of appearance):

- King Report on Corporate Governance (South Africa) established 1994, expanded to sustainability reporting in 2002 ("King II"), latest standards 2016 ("King IV")[4]
- Global Reporting Initiative, established in 1997, first guidelines in 1999 and latest standards 2016[5]
- CDP (formerly known as the Carbon Disclosure Project) established in 2002, provides guidance on how to report environmental data for companies, cities, states, and regions[6]
- Prince's Accounting for Sustainability Project (A4S), established in 2009, with a range of guidance is available[7]
- International Integrated Reporting Council, established in 2010 and reporting framework produced in 2013[8]
- Sustainability Accounting Standards Board (SASB), established in 2011, has developed sustainability[9] accounting standards for 79 industries in 11 sectors
- The Natural Capital Coalition produced the Natural Capital Protocol, 2016.[10]

These initiatives and others provide guidance to businesses that want or need to expand their reporting to account for the natural environment, including, for example, their use of their natural resources (for example, water, energy, timber) and their impact on the environment from CO_2 emissions, land clearing, and biodiversity loss. There are some similarities in the approaches, and there are connections between the organizations and individuals involved in these initiatives. For example, Professor Mervyn King, who led the work in South Africa (the King Reports), is the Deputy Chair of the International Integrated Reporting Committee. In addition to these initiatives, there is a growing body of academic literature covering the expansion of business accounting into environment and sustainability reporting (for example, Bebbington et al. [2014], Junior et al. [2014]). Topics include voluntary disclosures, ethical issues, and costing of externalities (Linnenluecke et al. 2015).

26.3 | Purpose and history of national accounting

National accounting began in the 1930s as result of, firstly, the Great Depression and then World War II. Keynes' (1936) macroeconomic theory was instrumental in the evolution of national accounting, identifying the need for a new economic understanding and the increased information requirements of government to target interventions in the economy in support of broader public interests. This ultimately led to the creation of the System of National Accounts (SNA), first released in 1953 and updated in 1968, 1993, and 2008 (United Nations et al. 2009). The SNA defines agreed and standardized concepts for presenting a series of accounts for macroeconomic management and from which economic aggregates, such as GDP, are derived. The SNA enables governments to better understand economic conditions, thus providing the basis for monetary and fiscal policy and supporting microeconomic reform programs. The SNA can also be used by the business community, for example, for benchmarking its own performance against national information and can be analyzed to identify business risks and opportunities.

26.4 | Integrating environmental issues

Academics, businesses, governments, and international agencies have long recognized that traditional national accounting poorly represents the environment. For example, the contribution of the environment to generating economic value, how the economic activity can deplete or degrade the environment, and the nonmarket benefits enjoyed by people, is weak (for example, Nordhaus and Tobin [1972], Peskin [1972], Repetto et al. [1989], Wackernagel et al. [1999]).

Following the challenge of sustainable development set by the UN Brundtland Commission in 1987 and action agreed by 100 Heads of State at the Rio Conference on Environment and Development in 1992, the international community began addressing the shortcomings of the SNA by developing guidelines for environmental accounting. These were first published in 1993 and updated in 2003 (Smith 2007). They evolved into the System of Environmental-Economic Accounting (SEEA) Central Framework, which was adopted as an international statistical standard in 2012 (UN et al. 2014a).

Overlapping with the work on the SEEA Central Framework (SEEA-CF) were efforts to consolidate the material on accounting for ecosystems (for example, Barbier [2007], Boyd and Bazhaf [2007], Costanza et al. [1997], Daily [1997], EEA [2007], Pearce [1993], and TEEB [2010]), which culminated in the SEEA Experimental Ecosystem Accounting (SEEA-EEA; UN et al. 2014b). This provided a framework for testing the integration of ecosystem services and ecosystem condition into the broader national accounting frameworks of the SNA and the SEEA-CF.

26.5 | Comparison of business and national accounting

Table 26.1 presents a side-by-side comparison of business and national accounting. Important similarities are seen in the key concepts and starting points for the accounts. Both are also used for management and planning, although there are differences, especially in terms of scale of application. There are also differences in the scope of the accounts, the size and pathways of the professions, the presentation of accounting information, and the nature of the users.

Table 26.1: Comparison of accounting by business and government and implications for NCA in each sector

Aspect for comparison	Business accounting	National accounting
History	In practice for centuries, since the Pacioli treatise of 1494	Evolved from business accounting and macroeconomic theory beginning in 1930s with Keynes
Scope	A single economic entity, for example, a particular business (company)	Entire economy—all business, government, nongovernmental organizations, and households
Key concept and approach to accounting for the environment	Records the transactions of a particular economic entity; records mostly flows of natural resources and pollution; can be a physical or monetary system (or both); a double entry system.	Same as for business accounting, but records the entries by both parties to transactions, hence quadruple entry; both economic agents involved as well as the environment and an entity
Size of profession	Huge number of professionals around the world	Small number of professionals, nearly all in government
Path to profession	Clearly defined higher education path and certification; taught at some schools and most universities	With the exception of ANU, not taught at universities; path to profession through specialist areas of national statistical agencies or central banks
International standards for NCA	Still emerging; Many countries are undertaking projects to develop national standards for NCA or sustainability reporting; early adopters include South Africa, the Netherlands, France, and the Philippines.	Defined by SEEA; started in 1993 and completed in 2012; ecosystem accounting standards being developed
The starting point for NCA	Inputs include water, energy, timber, fish, and land; pollution generation (for example, CO_2, emissions, wastewater); environmental protection and management expenditure	Inputs include water, energy, timber, fish, and land; pollution generation (for example, CO_2, emissions, wastewater); environmental protection and management expenditure
Purpose of accounting for natural capital	Understanding supply chain dependencies; risk management; market advantage for (1) sales and (2) current or future investors	Complement to traditional economic measures, for example, GDP; development planning; modeling (for example, input-output analysis and forecasting)
Presentation of traditional financial and national accounts	Usually as financial statements as an annex to annual reports or similar documents; reflect on the year and chart a path for the future; supported by detailed notes	As a set of accounts with limited reflection and interpretation; no future pathways explored (left to other parts of government)
Presentation of NCA	Can accompany annual reports and the traditional accounts, but often in separate reports (for example, sustainability reporting); increased use of internet-based sustainability reporting	Natural resources are shown in national balance sheets of a few countries; most countries include them in a set of environmental-economic accounts

26.6 | Achievements and challenges

26.6.1 | Achievements

Perhaps the greatest achievements of both business and national accounting communities are the creation of frameworks for recording exchanges between the environment and economy. Such frameworks require immense effort to (1) consolidate the new concept of natural capital into a consistent set of definitions and reporting formats that link to the existing standards, (2) ensure government or internal business acceptance of the frameworks and standards, and (3) demonstrate that the frameworks and standards can be implemented and useful. The degree of effort needed to achieve international standardization is evident in the 20 years it took between the call for national environmental accounting at Rio in 1992 and the adoption of the SEEA-CF as an international statistical standard in 2012. Two drafts were produced, in 1993 and 2003, on the way to the adoption of this standardization. While the standards are still new and aspects of the theory and practice are still being developed, both accounting communities should feel encouraged by the integration of natural capital into accounting systems used by both businesses and governments.

26.6.2 | Challenges: Valuation, biodiversity, and communication

To continue to improve NCA, a range of challenges need to be addressed. Key among them are the issues of valuation, biodiversity, and communication.

Valuation is high on the SEEA research agenda (UN et al. 2014a). It is evident that there are differences between the approaches of accountants and economists (Obst et al. 2013). In particular, the notions of exchange value used by both business and national accountants and welfare values used by environmental and ecological economists are not comparable. In general, economists' welfare values include consumer or producer surplus, that is, the additional amount consumers would have paid if they had to and the decreased amount producers would have taken if they had to. In contrast, the exchange values used by accountants are based on transaction prices or the concept of fair market value, that is, based on a range of market information, the amount the particular good, service, or asset could have sold for in a market. To further complicate the concept of fair market value, most assets are also subject to impairment testing. Understanding the difference between exchange and welfare is progressing, and it is important that both national and business accounts agree on the approach to be used in their respective accounting frameworks. If one adopts a different approach from the other, then the results will not be comparable.

How to account for biodiversity is an area of active research for both business and national accountants. For national accountants, UNEP-WCMC (2016) summarized the issues and proposed ways to develop species accounts as well as recognizing the need for biodiversity measures to be included in ecosystem condition accounts. (How to apply these accounts to the Aichi Targets[11] is covered in chapter 24 of this document). Approaches to measuring, valuing, and recording biodiversity in accounts by business in a range of countries are summarized by Jones (2014). For both business and national accounting, the impacts of economic activity on biodiversity and the contribution of biodiversity to production are both areas of interest.

A recurring challenge for all types of accounting is how to communicate complex sets of information in a manner that can be relatively easily understood. The financial accounts of business are usually included in company annual reports as an annex. The numbers follow a narrative that include both the reasons for past performance and what future performance might be. The numbers are also supported by detailed explanatory notes. The approach of national accountants is different: accounts are usually presented in tables, sometimes with graphic summaries and key figures highlighted, but seldom with detailed commentary. This reflects the general splitting in roles between the producers of government information, including the national accounts, and the analysis, policy developers, and users of this information in government.

26.7 | Parting remarks

While business and national accounting systems have differences in terminology, structure, and applications, inevitably they rely on similar data and the same main concepts: stocks, flows, and valuation of natural capital. In addition, in many cases, both governments and business depend upon or have impact on shared natural resources. As such, identifying and understanding the differences, as well as leveraging the synergies in business and national systems that account for natural capital, are important for supporting coherent private and public decisions related to its sustainable management.

26.8 | Acknowledgments

This paper has grown out of a short briefing note provided to the "Forum of Natural Capital Accounting for Better Decision Making," held in The Hague, The Netherlands, November 22–23, 2016. This Forum was followed immediately by another conference, "Natural Capital—Let's Talk Business." We are grateful to the organizers of both events and particularly to Omer Van Renterghem of the Dutch Ministry of Foreign Affairs for facilitating the dialogue between business and national accounts. Valuable comments were received from Steve Bass on earlier versions of this manuscript.

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26.10 | Endnotes

1 This paper does not necessarily reflect the policies or practices of Ernst and Young or other organizations.
2 http://www.ifrs.org.
3 http://www.aasb.gov.au/.
4 http://c.ymcdn.com/sites/www.iodsa.co.za/resource/collection/684B68A7-B768-465C-8214-E3A007F15A5A/IoDSA_King_IV_Report_-_WebVersion.pdf.
5 https://www.globalreporting.org/Pages/default.aspx
6 https://www.cdp.net/.
7 https://www.accountingforsustainability.org/en/index.html.
8 http://integratedreporting.org/.
9 https://www.sasb.org/.
10 http://naturalcapitalcoalition.org/protocol/.
11 https://www.cbd.int/sp/targets/.

Annex 1. Summary of Country Questionnaires for the Forum on Natural Capital Accounting for Better Policy Decisions

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Introduction

As part of the planning for the Forum, countries were asked to complete a questionnaire to begin sharing, exploring, and synthesizing the experiences in producing and using natural capital accounting (NCA). The questionnaire was completed by participants from 10 countries: Australia, Botswana, Colombia, Costa Rica, Guatemala, Indonesia, the Netherlands, the Philippines, Rwanda, and Sweden. The completed questionnaires were used to plan the Forum agenda as well as guide the World Bank's work in support of the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) countries that wish to apply NCA in decision making. Below is a summary of the responses.

Summary of responses

Context

- There are important differences among the institutes that develop NCA. In some countries, the statistical agencies are responsible. In other countries, the ministries of planning, environment, natural resources, or finance are responsible. To what extent do these differences affect independence of the NCA building process? Some questions are whether there is political interference in NCA setup, the data are trustworthy, there is an ability to share data among ministries and institutes, and independency of institutes using the data for policy analysis.

- In most countries, the accounts produced were chosen on the basis of consultation with several ministries—sometimes at a high ministerial level, sometimes at a lower technical working group level.

- In some countries, NCA efforts started out of academic interest, and they were later adopted by the ministries. For setting up the accounts, most countries organized stakeholder meetings with data providers.

Factors driving account production

- For most countries, the main driver is growing international attention for sustainable development or green growth. This pursuit dates back to the 1992 Rio Declaration, and today it is embodied in the Sustainable Development Goals (SDGs) and the increasing attention for green growth as a means to ensure that natural and human capital are integrated in economic decision making.

- NCA gives the countries a way to understand the importance of their natural resources and inputs for improving their management. The drivers for account production have not changed greatly for most countries, except that some countries are now more convinced of the importance of accounts.

Findings from accounts and their use

- NCA provides information about the importance of the natural capital to the national economies, trends, and drivers of change to countries. Some countries acknowledge that NCA provides them essential information to understand the natural and economic system and also about the trade-offs they make development decisions. NCA informs governments aware of the need to take action and give them directions for policy change.

- Although the productions of accounts in most of the countries participating in the Forum is still recent, the accounts have already played a role in several policy documents, development plans, and policy briefs. They are used especially for awareness raising and descriptions of the relationship between natural resources and the economy to prepare policy makers and the general public for future policies. In some countries it has been reported that NCA is going to play a role in preparing and monitoring policies. Other countries report that the accounts have already played a role in new water laws, mining and forestry regulations, and action plans on climate change. Others report that the accounts will be used for risk analysis, land use policies, water fees, and conservation and mineral policies.

- All countries see sufficient potential in continuing to compile natural capital accounts as they move toward green growth, climate change, and SDGs.

- The use of the accounts in analysis, models, and indicators is country dependent. Some countries are currently experimenting with new indicators to present or monitor changes in natural capital. In addition, some countries have built input-output or computable general equilibrium (CGE) models (sometimes jointly with other institutes) using the NCA as data inputs and the modeling for scenario analyses of different policy proposals.

Process to engage potential users

- Most countries have organized meetings, training workshops, and forums with ministries, as well as related institutes and experts. Moreover, several reports and policy briefs have been published to show the potentials of the accounts and be transparent about how the accounts have been set up.

- All countries stressed the importance of developing clear communications strategies at the beginning of the process to ensure buy-in from accounts users and policy makers.

Challenges to broader use of accounts

- While there have been successes in WAVES and other countries with the production and use of accounts, most countries face a number of serious challenges. Awareness of the existence or potential of NCA is often low in ministries, and many accounts are often seen as complex and hard to understand.

- Communication between compilers and users of NCA is a point of concern, especially to assure that budgets will be made available to continue to compile the accounts and that data sharing among institutes is well arranged. Several countries report that the capacity to analyze or interpret the data is limited and that data validation is not always well arranged.

The way forward

- Countries would like more ideas and evidence to show how accounts can be analyzed and used in decision making by the government.
- Most countries would like specific guidance on how to use NCA for the SDGs and green growth.
- Many countries would like sector-specific guidance (for example, on water, minerals, energy, and biodiversity conservation).
- Most countries are looking for ways to better engage the policy and analytical communities.

Annex 2 | 2016 Forum on Natural Capital Accounting for Better Policy Decisions, Participant List

Name	Institution	Designation
	Donors	
Eckhard, Franciska	German Federal Ministry for Economic Cooperation and Development	Desk Officer
Hijkoop, Jan	Netherlands Ministry of Foreign Affairs	Senior Policy Officer, for Land, Water, and Ecosystems
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Grigg, Annelisa	United Nations Environment Programme	
Jansen, Ruud	Gaborone Declaration for Sustainability in Africa	Executive Secretary
Maddox, Thomas	Fauna and Flora International	Senior Technical Adviser
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Coronado, Fernando	Ministry of Environment and Natural Resources	Vice-Minister
Vargas, Ismael Matías	Central Bank of Guatemala	Director
Colombia		
Alterio, Henry	World Bank	WAVES National Coordinator
Otalo, German Romero	National Planning Department	Coordinator, Economic Impacts of Climate Change
Bostwana		
Pule, Ogopotse Batlokwa	Ministry of Minerals, Energy, and Water Resources	Senior Water Resources Engineer
Rwanda		
Uwera, Claudine	World Bank	WAVES National Coordinator
Philippines		
Gervacio, Bresilda	Department of Environment and Natural Resources	Director
Indonesia		
Airlangga, Buyung	Indonesian Statistical Office	Director, Account Production
Medrilzam Medrilzam	Ministry of National Development Planning	Director, Forest Economy and Management
World Bank		
Ahlroth, Sofia	WAVES Secretariat	Senior Environmental Economist
Jain, Sonu	WAVES Secretariat	Communications Officer
Johansson, Stig	WAVES Secretariat	Program Manager, WAVES Program
Vardon, Michael	WAVES Secretariat	Senior Consultant

Annex 3. Short Biographies of Authors

Nissa Cita Adinia Nissa Cita Adinia has been with the World Bank's Wealth Accounting and Valuation of Ecosystem Services (WAVES) for Indonesia as communication specialist since 2015. Her experience is in communication for development, which covers topics such as water, sanitation, climate change, women, and environment. Ms. Adinia earned her master's degree in communication and social change from the University of Queensland, she is now also a researcher and lecturer at Universitas Indonesia.

Sofia Ahlroth Sofia Ahlroth is a senior environmental economist at the World Bank, focusing on natural resource accounting and valuation. She is part of the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) secretariat and focal point for WAVES in Africa. Ms. Ahlroth has extensive experience in natural capital accounting and environmental economics, and has a PhD in natural resource economics and environmental strategy analysis from the Royal Institute of Technology, Sweden.

Henry Alterio Henry Alterio is an economist with more than 15 years of professional experience. He is a specialist in environmental economics and policy designing, in particular, the design of conservation instruments and incentives to improve environmental performance. He is currently the country coordinator for the World Bank Wealth Accounting and Valuation of Ecosystem Services (WAVES) initiative.

Irene Alvarado-Quesada Irene Alvarado-Quesada is an economist and the head of the Environmental Statistics Area of the Central Bank of Costa Rica. Her specialization areas are game theory, environmental statistics, and conservation. Ms. Alvarado-Quesada has conducted research on market-based mechanisms for biodiversity conservation, international environmental agreements, and spatial economic analysis

Andrés Álvarez Andrés Camilo Álvarez is an economist from the National University of Colombia and holds a master's degree in economics from Andes University. He works at the Colombian Department of National Planning in the Sustainable Development office. His particular areas of interest are economic modeling, energy economics, and mitigation and adaptation issues of climate change. He also has experience as a consultant for the private sector in the economic evaluation of environmental impact at CIINAS. Previously, Mr. Alvarez worked at National Health Institute for Colombia and other think tanks.

Kate Auty Kate Auty is the Commissioner for Sustainability and the Environment in the Australian Capital Territory. She was recently a Vice Chancellor's Fellow at the University of Melbourne, formerly the Commissioner for Environmental Sustainability in Victoria, and a magistrate and mining warden in two Australian subnational jurisdictions. Dr. Auty has chaired advisory boards for the University of Melbourne Sustainable Society Institute and the NCRIS National Electronic Collaboration Tools and Research Network. She is a member of other boards, including the NCRIS Australian Urban Research Infrastructure Network and the Murray Darling Basin Authority Social, Economic, and Environmental Committee. Dr. Auty has reported widely on environmental matters and published on Indigenous justice issues. Dr. Auty's academic qualifications include BA (with honors)/LL.B, MEnvSc, and PhD.

Onil Banerjee Onil Banerjee is a natural resource economist at the Inter-American Development Bank (IDB) in Washington, DC. Mr. Banerjee works across economic sectors in the design and implementation of ex ante and ex post economic impact evaluations of international development policies. He leads the development of the natural capital-based policy and decision-making framework known as IEEM, the Integrated Economic-Environmental Modeling platform. Prior to joining the IDB, Mr. Onil worked with Australia's national science agency, the Commonwealth Scientific and Industrial Research Organization, where he engaged in projects related to ecosystem service assessments, climate change, and water and food security in Australia and South Asia.

Nick Barter Nick Barter is responsible for developing England's main environmental policy, the government's commitment to improve the environment within a generation through a 25-year plan for the environment. He also manages the secretariat to the independent committee that advises the UK government on natural capital, the Natural Capital Committee. Prior to joining the UK's environment and agriculture department (Defra) in 2012, Mr. Barter worked for 15 years in the UK Department for Transport and in the UK Treasury on a variety of economist and policy roles, mainly in the area of environmental modeling and European financial legislation.

Steve Bass Steve Bass is a senior associate at International Institute for Environment and Development (IIED). His work explores inclusive green economy progress and prospects in developing countries; he cofounded the Green Economy Coalition in 2009. His 35 years of experience are principally in international policy processes for sustainable development, with much in-country work in Southern Africa and Southern Asia. Until recently, he was responsible for IIED's work in economics, business, and market governance mechanisms. Mr. Bass chairs the UK Government's eight-year research program, Ecosystem Services for Poverty Alleviation (ESPA); is a fellow of the World Wildlife Fund-UK; and serves on several advisory boards, including boards for the Fundação Amazonas Sustentável, the Caribbean Natural Resources Institute, and Cancer Research UK. He has published several books and over 120 papers on sustainable development and forest management. He was awarded the 2001 Queen's Award for Forestry.

Jacqueline Birt Jacqueline Birt is an associate professor in accounting at the University of Queensland. Her research areas are international accounting, sustainability accounting, and accounting education. She is currently an editor at the Accounting & Finance Journal and associate editor at the Accounting Research Journal. She is a board member of the International Accounting Education Standards Board and the Accounting and Finance Association of Australia and New Zealand.

Peter Burnett Peter Burnett spent many years in government in Australia, much of that time as a regulator or policy adviser in environment agencies. He is now researching policy on sustainable development at the Australian National University. Mr. Burnett's paper in this volume offers a personal perspective that seeks to blend the practical experience of a former official with the insights of a researcher into environmental information.

Silvia Calderon Silvia Calderon Diaz holds a bachelor's degree in economics from McGill University and a master of public administration from Columbia University in New York. Prior to joining Colombian Department of National Planning, Ms. Calderon was the manager for Sustainability and Climate Change at KPMG Colombia. Ms. Calderon has broad experience studying and analyzing the macroeconomic impacts of climate change, the impacts of natural disasters on poverty, and the implications of the Paris Agreement for the Colombian economy. At the DNP and the Ministry of Environment, she has led the establishment of the National Climate Change System and the Climate Finance Committee, among others. Ms. Calderon was also a consultant for the World Bank and senior associate to the Inter-American Development Bank on issues related climate change adaptation and sustainable development.

Juan-Pablo Castañeda Juan-Pablo Castañeda works in the Environment and Natural Resources Global Practice (ENR GP), and is part of the Wealth Accounting and Valuation of Ecosystem Services team at the World Bank in Washington, DC. He works on aspects related to the economics of the environment, with a special focus on implementing and promoting the use of Natural Capital Accounting (NCA). He leads NCA work related to forest, land, and ecosystem accounting, and developing capacity-building programs and methodologies linked to the System of Environmental-Economic Accounting (SEEA). He is an NCA practitioner. He coordinated the National Green Accounting initiative in Guatemala for almost eight years and advised environmental accounting programs in Africa and Latin America. Prior to his involvement with the World Bank, Mr. Castañeda worked as a senior consultant in different Latin American countries, working and collaborating with public institutions, international organizations, research institutions, and nongovernmental organizations. His related academic background is in ecological economics from the University of Edinburgh in the United Kingdom and in economics from Tilburg University in the Netherlands.

Martin Cicowiez Martin Cicowiez is deputy director at the Center for Distributive, Labor and Social Studies, based at the Universidad Nacional de La Plata (UNLP) in Argentina, and professor of international economics and computational economics at UNLP. Dr. Cicowiez also teaches courses on the use of computational methods to assess public policy options in various countries. He has worked as a consultant for international organizations such as the World Bank, the Inter-American Development Bank, and the United Nations. Dr. Cicowiez earned his PhD in economics from the Universidad Nacional de La Plata.

Dimpho Galegane Dimpho Galegane works for the Department of Water Affairs as a water resource engineer and is currently part of the Water Accounting team. He has a bachelor of science in soil and water conservation engineering and a higher diploma in agricultural engineering from Botswana University of Agriculture and Natural Resources.

Bresilda Gervacio Bresilda M. Gervacio is the director of the Knowledge and Information Systems Service of the Philippine Department of Environment and Natural Resources (DENR). She supervises the development and implementation of information systems and necessary network infrastructure to promote efficient and effective delivery of services by DENR offices; and she supervises data management, including the compilation of environment and natural resources statistics, production of knowledge products to support evidence-based decision making, and tracking the progress of the sustainable development goals.

Edgar Gutierrez-Espeleta Edgar Gutierrez-Espeleta is the Minister of Environment and Energy of Costa Rica. He is a professor at the University of Costa Rica, where he was the founder of the Observatory for Development. He was a cofounder of the project State of the Nation of the National Rectors Council of Costa Rica. Previous positions include director of the School of Statistics of the University of Costa Rica and director of the Graduate Program in Statistics. He was the coordinator of the project Atlas de Desarrollo Humano Cantonal, a joint initiative with the United Nations Development Programme. He led the United Nations Environmental Programme reports on the status of the environment in Latin America and the Caribbean and Central America. He also directed the National Environmental Strategy of Costa Rica in 2005. He has published more than 30 articles in national and international journals and one book about statistical methods.

Mark Horridge For the last 30 years, Professor Mark Horridge has worked with the Centre of Policy Studies, now based at Victoria University, Melbourne. He specializes in computable general equilibrium (CGE) modeling (particularly multiregional and environmental CGE models) and in creating CGE-related software. He holds degrees from the Australian National University, Cambridge (UK), and the University of Melbourne.

Jane Carter Ingram Jane Carter Ingram is a senior manager in Climate Change and Sustainability Services at EY US where she supports public and private sector clients in integrating natural capital values into business decisions. Ms. Carter has worked closely with governments, multilateral institutions, nongovernmental organizations, and companies in conducting natural capital assessments and developing strategies for aligning conservation and sustainable economic development in Africa, Europe, Latin America, Asia, and the United States. She has a bachelor of science in Biology from the University of North Carolina– Chapel Hill and a master of science and PhD in environmental change and management from the University of Oxford, and she completed a postdoctoral fellowship at Columbia University's Earth Institute.

Stig Johansson Stig Johansson is the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) program manager. He is a native of Finland and joined the World Bank in 2012. His specialties include global environmental services, forestry, biodiversity, and protected areas. Previously, he was the regional director for National Parks at Natural Heritage Services in Finland and served as the vice-chair for the International Union for Conservation of Nature World Commission for Protected Areas, representing Pan-Europe. Mr. Johansson represented Finland for over 10 years in the permanent working group for Terrestrial Ecosystems at the Nordic Council of Ministers and was the chairman of the Finnish Society for Nature and Environment from 2011. He has worked extensively with sustainable forest management, conservation, and natural resources management and research in developing countries, primarily in eastern and southern Africa, with more than 10 years of field experience in Kenya, Tanzania, and Namibia. He holds a doctorate of science in agriculture and forestry from the University of Helsinki.

Daniel Juhn Daniel Juhn is a geographer and senior director leading the Integrated Assessment and Planning Group at the Moore Center for Science Division of Conservation International (CI). He is also the principal investigator and coleader of the of the Ecosystem Values and Accounting Program (EVA), which is the natural capital accounting initiative at CI. Mr. Juhn earned a masters in environment and development from Clark University. His work at CI includes mapping, monitoring, and modeling landscape change; aerial survey systems design; and early warning systems. In the past five years, his research interests have focused on ecosystem services assessment and modeling, landscape planning, and ecosystem accounting, and applying the accounting results to decisions and policy. He has previously worked with Doctors Without Borders, the United Nations, and the International Organization for Migration, managing development and emergency projects ranging from public health, refugee assistance, food security analysis, aquaculture and agriculture development, to community-based malaria interventions for indigenous groups in the Amazon.

Peter Katanisa Peter Katanisa is the advisor to the Minister of Natural Resources of Rwanda. For the past four years, he has been advising regarding all the initiatives in Rwanda's Environment and Natural Resources Sector to ensure the smooth implementation of the Rwanda Environment and Natural Resources Policy, Strategies and Programmes. Mr. Katanisa has served in different leadership roles and on many government program committees related to the environment and natural resource management in Rwanda. Currently he is the national government focal point person for the World Bank Wealth Accounting and Valuation of Ecosystem Services and natural capital accounting program. Mr. Katanisa holds a postgraduate degree in project management and a bachelor's degree in economics sciences. He is currently pursuing a master of science in economics science.

Steve King Steven King is an environmental economist at the United Nations Environmental Programme-World Conservation Monitoring Centre (UNEP-WCMC). Dr. King's PhD focused on the design and nonmarket valuation of river habitat restoration. Since joining UNEP-WCMC in 2014, Dr. King has coordinated work on approaches to biodiversity accounting and is currently working on the development of species and ecosystem extent accounts with Uganda, using the System of Environmental-Economic Accounting framework. Dr. King has also supported UNEP-WCMC projects on the Natural Capital Assessment for Green Economy transition, the benefits analysis of REDD+, and forest ecosystem service valuation, and he has contributed to case studies for the Arctic TEEB scoping study.

Laure Ledoux Laure Ledoux joined the European Commission in 2005 after a 10-year research career in the United Kingdom. She is currently deputy head of the Biodiversity Unit in the Directorate General for Environment, having also previously worked in Eurostat and the Directorate General for Climate Action. Ms. Ledoux has been involved in the development of EU biodiversity policy since 2010, from the adoption of the European Union's "biodiversity strategy to 2020" in 2011, to the midterm review in October 2015 and its follow-up, and in this context, she has been driving the Directorate General for Environment's work on ecosystem accounting.

Dr Medrilzam Dr. Medrilzam has worked for the Indonesia Ministry for National Development Planning (BAPPENAS) for 24 years, currently serving as the director for Environment Affairs. He completed his PhD in environmental management at the University of Queensland, Australia in 2013, and his particular interests are mostly related to the environment and climate change, and forestry and land-use management, including conservation and peatland management. At the moment, Dr. Medrilzam is preparing the Strategic Environmental Management (SEA) for the next Indonesia National Mid-Term Development Plan 2020–2024. This will be the first-ever SEA applied to the National Development Plan in Indonesia.

Collins Mwai Collins Mwai is a communications consultant and an experienced journalist covering multiple aspects of Africa's social economic affairs. He has worked in multiple countries across Africa as a journalist, researcher, and communications expert, from which he has gained insights on multiple aspects of the continent's socioeconomic aspects and issues. Mr. Mwai is also an analyst on various development issues across the East African region. In 2015, Mr. Mwai joined the Rwanda Natural Capital Accounting Team as a communications expert to collect information and disseminate findings from of the World Bank–funded program.

Michael Nagy Michael Nagy is an environment statistics and environmental-economic accounting expert at the Statistical Division of the United Nations Economic Commission for Europe (UNECE). He has more than 16 years of experience in environment statistics with a focus on water statistics and environmental-economic accounting. Before joining UNECE in October 2014, Mr. Nagy was the head of the Section for Environment Statistics and Sustainable Development of the Qatar Statistics Authority (QSA). Prior to working at QSA, he was the head of the Department for Data Management and Reporting of the Environment Agency Austria where he worked for more than 12 years. He provided his expertise to several countries of Eastern Europe and the Middle East in the implementation of water statistics and water accounts. Mr. Nagy is a member of various international expert groups and has been playing a central role in the development of international statistical standards and guidelines, such as the International Recommendations for Water Statistics and the United Nations Framework for the Development of Environment Statistics.

Frans Oosterhuis Frans Oosterhuis is a senior researcher at the Institute for Environmental Studies (IVM), Vrije Universiteit, Amsterdam. He has a background in environmental economics and experience in a wide variety of multidisciplinary, policy-oriented research projects. Recent areas of expertise include the analysis of economic instruments and environmentally harmful subsidies, the role of cost assessments in decision making on the control of harmful substances, and the use of environmental statistics and natural capital accounting in environmental policies.

Stuart Peevor Stuart Peevor has over 16 years of experience in water and environment-related roles in both the public and private sector. He has undertaken water statistics and accounting projects for the Australian Bureau of Statistics and the World Bank, and he has been central to drought response policy reform in South Australia. Mr. Peevor was integral in establishing the South Australian water industry regulatory framework, through his role in establishing independent economic regulation in the sector and in developing the pricing frameworks to apply to the water industry.

Ogopotse Pule Ogopotse Batlokwa Pule is the principal water resources engineer at the Department of Water Affairs. Current duties include heading the water accounting unit, catchment management and water balance studies, and assessment of the use of remote sensing and GIS to supplement scarce water resources monitoring data and national water master plan review. Mr. Pule previously was a research engineer for the consulting firm Stephenson and Associates. He earned his master's degree in water resources and environmental management from Leibniz Universität Hannover, Hannover (Germany), and his bachelor of science in civil engineering from North Carolina A&T State University, Greensboro (NC, USA).

Luis Rivera Luis Rivera is a Costa Rican economist with 20 years of work experience in Costa Rica, Nicaragua, Honduras, El Salvador, Belize, Peru, Mexico, Chile, Ecuador, The Netherlands, and Panama. He has collaborated with national and international organizations like Universidad de Costa Rica, INCAE Business School, the World Bank, and the Inter-American Development Bank. Has worked on topics related to trade policy, productive development, tourism, agricultural markets, renewable energy, emission mitigation strategies and investments, and environmental accounts compilation. Mr. Rivera has a bachelor's degree in economics from the Universidad de Costa Rica and Institute of Social Studies and master's in engineering in manufacturing systems from the Instituto Tecnológico de Costa Rica.

Leidy Riveros Leidy Riveros works at Colombian Department of National Planning in the Sustainable Development office. She holds a bachelor's degree in economics, a bachelor's in business administration, and a master of science in economics from Andes University. Ms.Riveros currently works at the Study on Economics Impacts of Climate Change, a research agenda on climate change in Colombia. Previously, she has worked as a research assistant in topics of public policy, institutional design, and marketing research in private sector.

German Romero German Romero is currently the coordinator of the Environmental Economics Research Agenda at Department of National Planning. This agenda includes topics such as climate change, economic impacts, environmental dividends of peace, green taxes, risk associated to natural disasters, and others. He is an economist at the University of the Andes. Mr. Romero holds a master of science degree and was lecturer in the same university. Mr. Romero also has professional experience in impact evaluation, climate change, industrial organization, and social topics. He has also worked in academia, think tanks, and the Colombian government.

Carlos Manuel Rodriguez Carlos Manuel Rodriguez is vice president for conservation policy at Conservation International (CI). Before joining CI, Mr. Rodriquez was the Minister of Environment and Energy for the Republic of Costa Rica, where he was a pioneer in the development of payment for ecosystem services. A lawyer, politician, and, above all, a conservationist, Mr. Rodriguez held various political posts in Costa Rica, including director of the National Parks Service. He is also a founder and board member of many environmental nongovernmental organizations in Costa Rica, in addition to several tropical research institutes.

Arjan Ruijs Arjan Ruijs is a senior policy researcher at PBL Netherlands Environmental Assessment Agency. He has a background in environmental economics. Before joining PBL, he worked at Wageningen University and as a consultant on water economics. He has experience in a wide variety of environmental economic topics, ranging from climate change, water economics, and energy economics, to the evaluation of environmental policy instruments. Currently, he works on natural capital–related work, dealing, for example, with the questions of how to better include natural capital in decision-making processes and how to improve the inclusion of nature in the Dutch cost-benefit analysis guidelines.

Sjoerd Schenau Sjoerd Schenau senior researcher, is a geochemist with a MSc. specialization in marine geochemistry. He earned his PhD at Utrecht University. In 2001, Dr. Schenau joined Statistics Netherlands, and since 2002, he has specialized in environmental accounting. Since 2005, he has been the project manager of the further development of the Dutch environmental accounts. He has worked on several Eurostat grant projects in the area of environmental monetary activity and physical accounts. He is a member of the London Group on Environmental Accounting and currently chairs the United Nations technical committee for the SEEA-CF.

Becky Smith Becky Smith managed and coauthored the 2015 State of the Environment report for the Australian Capital Territory. She is working with the Australian National University, the Australian Bureau of Statistics (ABS), and other institutions to develop a complete set of (SEEA based) environmental-economic accounts for the 2019 ACT State of the Environment report. Prior to this, Ms. Smith worked for the Planning Authority, negotiating and developing the ACT's first strategic assessment under the Commonwealth's Environment Protection and Biodiversity Conservation Act. Ms. Smith has a bachelor's degree in agricultural science and an honours degree in law (her thesis was on law, policy, and soil degradation). She has worked in government, the community, and private sectors, alternating between social justice (including overseas aid and Indigenous community legal work) and environmental/rural science and practice (including Landcare coordination and commercial apiculture). Ms. Smith sees the potential and possibilities the SEEA accounts provide in reconciling these often disparate disciplines.

Nancy Steinbach Nancy Steinbach is a statistician who has been working with environmental economic accounts for the past 16 years at Statistics Sweden, Eurostat, and the Australian Bureau of Statistics. At Statistics Sweden, Ms. Steinbach is the leader of a team of eight people who produce statistics on physical flows and environmental economic instruments. The team also works on experimental statistics, notably on consumption-based environmental pressure and ecosystem accounting. Ms. Steinbach is also the current chair of the United Nations London Group on environmental accounts.

Claudine Uwera Claudine Uwera is an environmental economist and a senior lecturer of economics at the University of Rwanda. She completed her PhD studies in Sweden where she gained a significant experience by working closely with the environmental economists' team of the University of Gothenburg from 2008 to 2013. Dr. Uwera has substantial experience working on natural resource and environmental economics issues in Africa, especially in Rwanda. Most importantly, Dr. Uwera has been selected as the national environmental expert to work on the ongoing Rwanda Natural Capital Accounting program, funded by the World Bank.

Stefan van der Esch Stefan van der Esch is a senior policy researcher at PBL Netherlands Environmental Assessment Agency. His background is in economics, with an emphasis on international trade, and he quickly gravitated to environmental policy, policy evaluation, and global assessments of environmental change. He has experience with environmental policy development, as well as with the evaluation of environmental policies, and coordinates PBL's cooperation with the United Nations Convention to Combat Desertification's to develop scenario analysis for the Global Land Outlook.

Michael Vardon Michael Vardon researches and teaches environmental accounting at the Australian National University. His PhD and initial career focused on animal population dynamics. In 2000, his focus shifted to environmental information, when he began work at the Australian Bureau of Statistics, ultimately becoming the director of the Centre of Environmental Statistics in 2005. He left this position in 2014 after secondments to the United Nations (2007 to 2009) and the Bureau of Meteorology (2013), where he was an adviser on environmental accounting. Dr. Vardon was a member of the Editorial Board of the System of Environmental-Economic Accounting (SEEA) and has been an adviser to the Wealth Accounting and Valuation of Ecosystem Services (WAVES) since its inception.

Renato Vargas Renato Vargas studied economics at the University of Groningen in the Netherlands. He has a decade's experience in the implementation of the System of Environmental-Economic Accounts and its analysis for policy in Guatemala. He consults on environmental economic topics with the World Bank's Wealth Accounting and Valuation of Ecosystem Services program and other partner initiatives in Latin America. He is an associate researcher at the Institute of Agriculture, Natural Resources, and Environment of Rafael Landivar University of Guatemala.

Henry Vargas-Campos Henry Vargas-Campos is an economist and the director of the Department of Macroeconomic Statistics of the Central Bank of Costa Rica. His specialization areas are the national accounts, the balance of payments, and monetary statistics. Mr. Vargas has conducted research on topics related with economic growth, foreign trade, and tax incidence on income distribution.

Jakob Weichert Jakub Wejchert works in the Biodiversity Unit, Directorate General (DG) for Environment at the European Commission. He has worked for the DG for a number of years, including on eco-innovation, sustainable consumption, and production policy, as well as negotiation on the Sustainable Development Goals. His current responsibilities include contributing to the development of natural capital accounting at European Union and international levels and developing policy on ecosystem condition, services, and valuation. He also coordinates marine activities in the unit, with an emphasis on marine and coastal ecosystem restoration and conservation. Mr. Weichert holds a PhD and a bachelor's degree (Mod) in natural sciences from Trinity College Dublin.

Wealth Accounting and the Valuation of Ecosystem Services

Wealth Accounting and the Valuation of Ecosystem Services (WAVES) is a global partnership led by the World Bank that aims to promote sustainable development by ensuring that natural resources are mainstreamed in development planning and national economic accounts.

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