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Methods for quantifying the benefits of sustainable development policies and measures (SD-PAMs)

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How can the concept of sustainable development policies and measures (SD-PAMs) be operationalized in a multilateral climate regime? The strategic approach is to focus on policies and measures that are firmly within the national sustainable development priorities of developing countries but which, through the inclusion in an international climate framework, recognize, promote and support means of meeting these policy priorities on a lower-carbon trajectory. The concept of SD-PAMs is further elaborated in two ways: (1) possible methods for quantifying SD-PAMs and (2) policy design. An important step in operationalizing the concept of SD-PAMs is the examination of available methods to quantify their benefits. Four ways to quantify the effect of SD-PAMs on development and emissions are identified: (1) case studies, (2) national energy modelling, (3) analysis of sectoral data and (4) inclusion of policies in global emission allocation models. Each of the methodological approaches has its strengths and weaknesses, but these approaches are demonstrated as being capable of quantifying the effect of SD-PAMs on development and emissions. Formalizing the commitment of SD-PAMs could be aided by more fully elaborating these methodologies. Formal recognition could be given either by listing countries in an Annex to the Convention or by including the pledged policies in a dedicated register. Regular reporting on the sustainable development and climate benefits of SD-PAMs could take place through national communications or a separate reporting mechanism. Incentives for SD-PAMs could come from both climate and non-climate funding. Development funding through other agencies could also be mobilized. International finance will be critical, as will the mobilization of domestic investment.

Keywords: co-benefits of mitigation; developing countries; methodologies; policies and measures; post-2012 architecture; sustainable development

Comment le concept des politiques et mesures de développement durable (SD-PAMs) peut-il être opérationnalisé dans un régime climatique multilatéral? L'approche stratégique est de se concentrer sur les politiques et mesures étant fermement ancrées dans les priorités nationales de développement durable des pays en développement, mais surtout dans leur inclusion dans un cadre climatique international qui reconnait, encourage et soutient les efforts à dessein de satisfaire ces priorités politiques selon une trajectoire sobre en carbone. Le concept des SD-PAMs est davantage élaboré de deux manières: méthodes possible de quantification des SD-PAMs et forme des politiques. Une étape importante d'opérationnalisation du concept des SD-PAMs est l'examen des méthodes disponibles au calcul de leurs bénéfices. Quatre moyens ont été identifiés pour quantifier l'effet des SD-PAMs sur le développement et les émissions: études de cas, modélisation énergétique nationale, analyse de données sectorielles et inclusion des politiques dans les modèles d'allocation d'émissions à l'échelle mondiale. Bien que chacune des approches méthodologiques ait ses forces et faiblesses, la capacité de ces approches à quantifier l'effet des SD-PAMs sur le développement et les émissions est démontré. Une mise au point plus complète de ces méthodologies aiderait à formaliser l'engagement aux SD-PAMs. Une reconnaissance formelle pourrait être attribuée ou bien en inscrivant les pays dans une annexe à la Convention, ou bien en incluant les engagements aux politiques dans un registre dédié. Un rapport régulier des bénéfices des SD-PAMs pour le développement durable et le climat pourrait s'effectuer par le biais des communications nationales ou bien par un mécanisme de rapport séparé. L'appui aux SD-PAMs pourrait

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provenir de financement climatique ou autre. Un financement pour le développement provenant d'autres agences pourrait aussi être mobilisé. La finance internationale sera essentielle, comme le sera la mobilisation de l'investissement domestique.

Mots clés: architecture de l'Après 2012; co-bénéfices de l'atténuation; développement durable; méthodologies; pays en développement; politiques et mesures

1. Introduction

Negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol seek to build an effective and equitable multilateral response to climate change. Several elements will be essential to ensure a successful outcome (IISD, 2005a), critically balancing the need for climate protection and sustainable development.

To achieve the objective of the Convention, deeper emission reductions will be required in all developed countries, but the growth of emissions in developing countries also needs to slow rapidly. Meaningful participation by developing countries may take several forms. This article explores an approach for developing countries that starts from sustainable development – which is part of the UNFCCC objective – rather than climate targets.

Sustainable development policies and measures (SD-PAMs) are an approach to stimulating action on climate change mitigation in developing countries. Instead of starting from explicit climate targets, the approach deliberately sets out to start from development objectives. This strategic approach taps into the primary motivation for developing countries, namely development (Winkler et al., 2002b).

Previous work has focused on SD-PAMs as a strategic approach (Winkler et al., 2002b) and case studies to illustrate its viability (Bradley et al., 2005; Winkler et al., 2007). This article briefly revisits the concept of SD-PAMs, its basis in the Convention (Section 2), and analyses the type of commitment (Section 3). Section 4 outlines four methods that are available to specify the implications of SD-PAMs, ranging from bottom-up case studies, through national modelling, to international models. Broader questions of policy design are addressed in Section 5, which asks how SD-PAMs could be formalized within the UNFCCC system.

2. Starting from development: the basis of SD-PAMs

The challenge of integrating greenhouse gas (GHG) considerations into national development programmes is recognized in the very objective of the Convention, namely the:

> stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner (UNFCCC, 1992, Art. 2).

The oft-forgotten second sentence of this objective codifies the environmental, social and economic dimensions of sustainable development. Development is a key priority for decision makers in developing countries; climate policy tends to have lower priority. The contribution that alternative development paths can make to mitigation is increasingly recognized (Sathaye et al., 2007).

Sustainable development is critical in delivering improved basic services such as energy, housing, transport, health, food security, ecoservices and others. Socio-economic development and poverty eradication are the first and overriding priorities of developing country Parties. Making development more sustainable can significantly reduce greenhouse gas emissions, compared with what they would otherwise have been.

One of the underlying principles of the Convention is that Parties have a right to, and should, promote sustainable development (Art. 3.4). The Delhi Ministerial Declaration on Climate Change and Sustainable Development (Decision 1/CP.8) outlined the importance of linking climate change and sustainable development in both directions – contributing to mitigation through action in key development sectors such as energy, transport, industry, health, agriculture, biodiversity, forestry and waste management, but also taking climate change considerations into account in national sustainable development strategies.

Defining more sustainable pathways to meet given development objectives has significant climate co-benefits. These co-benefits have been widely reported in the literature (IPCC, 2001; Winkler et al., 2002a, 2006; Baumert and Winkler, 2005; Bradley et al., 2005; IISD, 2005b; Munasinghe and Swart, 2005; Szklo et al., 2005; Robinson et al., 2006; Sathaye et al., 2007); the question is how to capture these benefits in the multilateral climate regime. A new strategic approach for developing countries is needed, and SD-PAMs offer one possible approach.

The co-benefits of making development more sustainable are well-recognized in the IPCC's Fourth Assessment Report (Sathaye et al., 2007) and its Special Report on Emission Scenarios (SRES). Figure 1 shows four of the families of scenarios from the SRES. Each of the striped scenario families represents a different storyline of how global emissions might evolve in future. The SRES scenarios deliberately

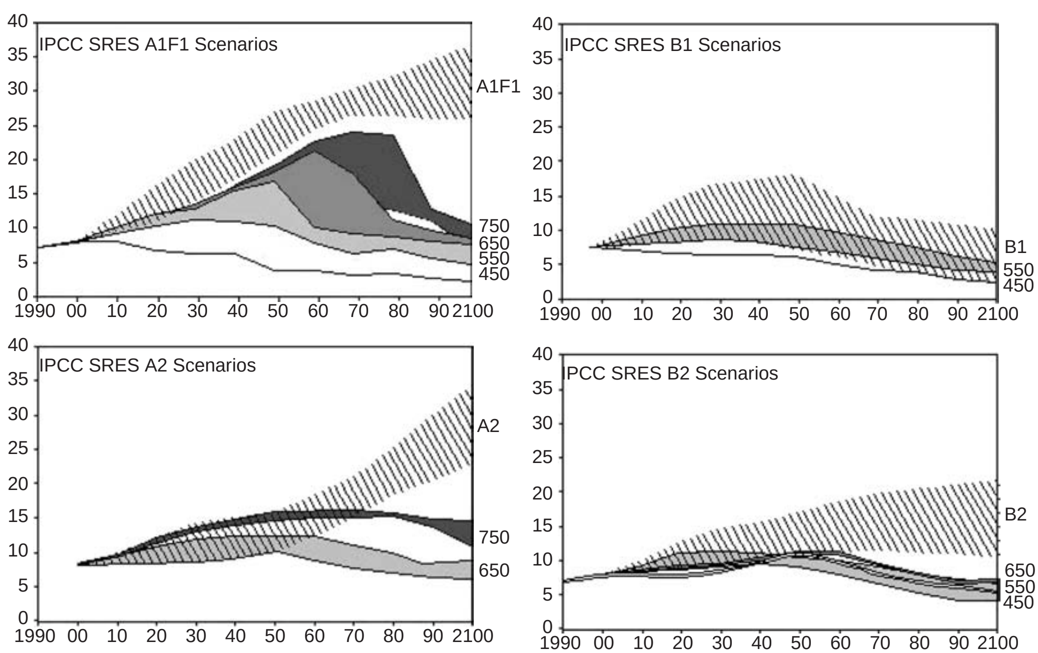

FIGURE 1 Comparison of SRES reference emissions scenarios (without climate policy) and 'post-SRES' climate change mitigation scenarios.

Source: Morita and Robinson (2001, p. 151, Fig. 2.14).

do not consider policies explicitly aimed at combating climate change. The striped reference scenarios shown in Figure 1 do not include climate policy and are shown together with mitigation scenarios resulting in stabilization of atmospheric concentrations of CO_2 ranging from 450 to 750 ppmv.

Choosing a sustainable development path means that the baseline – or reference – GHG emissions are lower than in other possible futures. Put differently, a more sustainable development path has lower emissions, *even without* any explicit climate policy. The IPCC's Third Assessment Report found this choice of future 'world' more important than the drivers determining GHG emissions (Morita and Robinson, 2001, p. 142). Future worlds are not chosen as a whole, but through multiple decisions affecting drivers such as GDP, population, technology, equity and others.

The corollary is also true – development objectives can be met in more or less emission-intensive ways. Beginning with one or more future development ambitions, it would be possible to describe paths towards those goals (Metz et al., 2002; Winkler et al., 2002a; Sathaye et al., 2007). The selected scenarios show clearly that to reach the same atmospheric concentrations, significantly less effort is required if reference emissions are low (in the B family) than if the future world had higher emissions (in the A scenarios). The difference in emissions between the reference case in A1FI and 550 ppmv is much larger than the corresponding difference between B1 reference emissions and a path stabilizing at the same level.

The use of USD-PAMs as an approach builds on existing commitments by developing countries. Under Article 4.1 of the Convention, all countries made the commitment to 'take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions' (Art. 4.1f). Developing countries' commitments under the Kyoto Protocol specify that mitigation programmes 'would, *inter alia*, concern the energy, transport and industry sectors as well as agriculture, forestry and waste management' (Art. 10b(i)).

Clearly, the co-benefits of pursuing sustainable development can make a meaningful contribution to mitigating climate change. The challenge considered in this article is to turn the conceptual link between sustainable development and climate change into a workable approach.

3. What are SD-PAMs?

The SD-PAMs commitment would be to *implement* sustainable development policies. The voluntary pledge would be to implement and accelerate national sustainable development plans.

The commitment is based on choosing a development path that results in lowered emissions, rather than an explicit climate target, i.e. targets to reduce or limit GHG emissions. The approach starts by considering a country's own long-term development objectives. Next, policies and measures are identified that would make the development path more sustainable. These SD-PAMs aim to encompass large-scale policies and measures – not only projects, as in the Clean Development Mechanism (CDM). Each country would define what it means by making development more sustainable, but when registering SD-PAMs the international community would have to accept that the policy constitutes sustainable development. The housing policy discussed below is an example of a large-scale policy, another would be cross-cutting measures such as air quality standards – both are not neatly packaged as projects in the current CDM architecture. Both climate and non-climate funding can be mobilized to implement SD-PAMs (see Section 5). Progress in achieving both the local sustainable development benefits and climate co-benefits is monitored through national institutions, but is also reviewed internationally. Acknowledgment for the contribution of SD-PAMs could be achieved by recording them in a registry maintained by the UNFCCC Secretariat. How the approach could be formalized is considered further in Section 5.

A wide variety of approaches to future climate action have been identified (see reviews in, e.g., Bodansky et al., 2004; den Elzen and Berk, 2004; Höhne and Lahme, 2005; Gupta et al., 2007).

Some approaches have a more bottom-up approach like SD-PAMs, for example sectoral CDM or Triptych approaches. Sectoral CDM proposes extending the mechanism beyond projects to sectors in various ways (Sterk and Wittneben, 2006), while the Triptych approach (Phylipsen et al., 1998) develops mitigation options focused on three broad sectors – the power, energy-intensive industry and domestic sectors. Like any other approach, using SD-PAMs has its strengths and weaknesses. The greatest strength of the approach is its alignment with the national priority of most developing countries, namely development. It makes the approach attractive to developing countries, and also gives greater certainty about the actions taken. This strength also leads to its main weakness, that the environmental effectiveness of the approach is not clear. The climate implications of SD-PAMs depend on the number and scale of policies actually implemented. Avoided emissions might be offset by other policies, not registered as SD-PAMs. Similarly, another strength is that the development-focused approach allows for non-climate, development-related funding sources. At the same time, this distances SD-PAMs from the efficiency of market-based instruments and the carbon markets, seen by many as key sources of future climate funding.

Some analyses on future climate action have suggested architectural elements or options for approaches to building on the Kyoto Protocol (Baumert et al., 2002, ch. 1; Bodansky et al., 2004; Höhne, 2005). Table 1 develops its own set of elements and summarizes the SD-PAMs approach to those elements.

TABLE 1 Summary of SD-PAMs approach to key architectural elements and options. Adapted from den Elzen and Berk (2004)

Element of climate architecture or option	SD-PAMs
Type of commitment	Commitment to implement sustainable development policies
Objectives and target-setting	Objectives framed in terms of development, rather than climate; targets set in SD units, GHG emission reductions reported as co-benefits
Legally binding nature of commitments	Voluntary agreement in multilateral regime
Top-down allocation or bottom-up pledge	Pledge-and-review
Accountability procedures	Reporting, monitoring and review, no compliance system
Environmental effectiveness	Depends on SD-PAMs pledged and implemented
Sensitivity to national circumstances	By design based on national policies and measures
Timing and triggers	Available to all developing countries without an entire new climate regime
Finance	Can mobilize climate and development funding; domestic and international
Market-based mechanisms	Not linked to carbon markets, avoiding issues of additionality and baselines
Technology commitments	Sustainable development requires technology innovation and diffusion
Forum	UNFCCC, but synergies with forums and agencies focused on sustainable development
Differentiation	Developing countries only
Complementarity with other approaches	Can be combined with other approaches in multi-stage schemes (and could become mandatory at agreed stages); important first step in creating a climate of trust

Table 1 provides a shorthand summary of the SD-PAMs approach. Critical to the definition of the approach, however, is the quantification of both sustainable development and climate benefits.

Hence, it will be important to establish methodologies to quantify the benefits of SD-PAMs, both for local sustainable development and climate co-benefits. The 'commitment' would be measured not only in GHG emissions units but primarily in sustainable development units ('SD units') – for instance, building 100,000 energy-efficient homes – rather than a specified reduction in tonnes of CO_2 emissions. Section 4 examines a range of different methodologies.

4. Methodologies for quantifying SD-PAMs

Methodologies are needed to quantify, firstly, the local sustainable development benefits and, secondly, the GHG co-benefits of SD-PAMs. Four methodologies are explored in this article:

1. Case studies of sustainable development policies
2. National energy modelling of policies and measures
3. Analysis by sectoral data
4. Global emission allocation models to investigate the implications of SD-PAMs within a multilateral agreement.

The first two of these methods focus on the national or subnational level in quantifying results. Case studies, by their nature, focus on a specific context, while energy modelling quantifies results (for energy and often also emissions) as a partial analysis of a national economy. Method 4 has a more global focus, being designed for the purpose of comparing international emission allocation schemes. Method 3 bridges the national/global divide by collecting fairly detailed data from countries (for selected sectors), but allowing international projections.

In the literature on SD-PAMs to date, the methodological approaches have tended to be bottom-up (Dubash and Bradley, 2005; Moreira et al., 2005; Szklo et al., 2005; Wei-Shiuen and Schipper, 2005; Winkler, 2006b). The approach itself starts from national development goals and, correspondingly, analysis has looked at detailed case studies and national energy models to illustrate the impacts of SD-PAMs.

Top-down methodologies could be explored, in particular, to answer questions about the environmental effectiveness – relating to climate change mitigation – of SD-PAMs. The quantification of GHG emissions avoided is not the primary driver of the strategic approach, but methodological tools to address this concern could include analysis of efficiency improvements and analysis of global emission allocation models.

A combination of bottom-up and top-down methods seems most likely to yield useful information for decision makers. Which method is most applicable would depend on the purpose or result that is of interest – to quantify specific policies with sensitivity to national circumstances or to compare implications in the multilateral context. Each of the four methods is illustrated in the following sections.

4.1. Method 1: Case studies

The first method – the use of case studies – has been reported the most extensively in the literature on SD-PAMs to date. Case studies can be used to quantify specific policies through a bottom-up approach. Case studies lend themselves to SD-PAMs, since the approach starts from specific national circumstances and can report on their own SD units. Some examples of existing case studies are summarized below.

Rural electrification in India seeks to empower the 56% of households that are still without an electricity supply. The development challenge is that 500–600 million people remain without access to electricity. Three paths were examined in one study (Dubash and Bradley, 2005):

1. A *grid first* approach, which has little chance of meeting electrification targets
2. A strategic approach of *diesel first*, which raises concerns about the cost of oil imports, security of supply and local air pollution
3. *Renewables first*, which provides benefits, contributing to rural electrification, but at significant incremental capital costs (Dubash and Bradley, 2005).

Given the concerns raised about the grid and diesel technologies, there are important reasons for India to prefer renewable energy on domestic policy grounds. Renewables already play an important role in rural electrification (measured in percentage of the population with access) and continue to contribute without adding to dependence on imports. The diesel scenario, by contrast, adds some $21 billion per year to India's import bill (as a share of total, this could be the SD units reported). Favouring renewable energy sources brings significant CO_2 emission savings: between 14 and 100 million tonnes of CO_2 compared with using the grid (Dubash and Bradley, 2005).

Other case studies include energy-efficient, low-cost housing in South Africa as one example of a SD-PAM, with the potential to remove the housing backlog while reducing emissions compared with a coal-fired grid (Winkler et al., 2002c; Spalding-Fecher et al., 2003). Avoided emissions come together with substantial local sustainable development benefits – household energy savings (Rand/household/month), reduced indoor air pollution (another SD unit), improved health, and increased levels of comfort. Experience at the project level has quantified some of these benefits – not only a level of thermal comfort at 21°C (as the SD unit was defined in this case), but less active space heating that reduces energy bills by some R625 (ca. $100) per household per year (SSN, 2004).

If implemented at larger scale – e.g. applied through policy to all housing, not just a single project – avoided emissions might range between 0.05 and 0.6 Mt CO_2-eq if implemented as policy (Winkler et al., 2005). The climate co-benefits are relatively small, since poor households use less energy than richer ones; the savings, at most, account for a reduction of 7% of residential CO_2 emissions or 0.2% of national emissions (Winkler et al., 2002b).

Case studies as a method illustrate both the local sustainable development benefits and the climate co-benefits of nationally specific actions. Further examples of the use of case studies in China's energy sector (Kejun et al., 2006), include China's efforts to reduce air pollution in the process of motorization (Wei-Shiuen and Schipper, 2005). In the case of Brazil (Moreira et al., 2005; La Rovere et al., 2006), the ethanol programme, which produces approximately one-third of Brazil's transport fuel, has saved $100 billion in foreign currency expenditure, has created over 1 million rural jobs, and has climate co-benefits estimated at 574 million tCO_2 over the lifetime of the programme. These measures suggest that these may be meaningful SD units in Brazil. Without the biofuels programme, Brazil's cumulative emissions of CO_2 from 1975 to the present would have been 10% higher (Moreira et al., 2005). A report combining case studies of India, China and Brazil found the potential for reductions below business-as-usual in 2020 totalling more than 625 Mt CO_2 per year – the equivalent of avoiding the construction of more than 150 coal-fired power plants (CCAP, 2006). Case studies on climate and development are not limited to large developing countries but have also considered electrification in rural Bangladesh (Rahman et al., 2006) and the impact of power sector reform in Senegal (Thiam, 2006).

Case studies, by their nature, are rooted in national circumstances. They can be used in any country. However, results from case studies are not always easily comparable, since the underlying assumptions and the results reported may not be consistent across studies. Guidelines might be needed for basic parameters that should be reported in SD-PAMs case studies.

4.2. Method 2: National energy modelling

The second methodology considered is to use national energy models to investigate the local sustainable development and climate implications of energy policies. In South Africa, emissions from energy supply and use account for almost 80% of total GHG emissions (van der Merwe and Scholes, 1998; RSA, 2004).

Studies on energy policies for sustainable development in South Africa have used this tool (Winkler, 2006a). The study considered a range of potential future energy policies, using the least-cost optimizing Markal energy modelling framework. On the demand side, the policy options modelled covered the industry, commerce, residential and transport sectors; on the supply side, they covered electricity and liquid fuels. The types of policy instruments investigated included both economic and regulatory instruments. Assessments against indicators of sustainable development were conducted to provide a sound means for policy makers to identify synergies and trade-offs between options, and to evaluate their economic, social and environmental dimensions.

In brief, the study showed that the combined effect of these energy policies could *reduce* total energy system costs over the period by about R16 billion (approx. US$2.3 billion) relative to base case. The cost savings are small in percentage terms (0.27%), since the costs on the whole system over the full 25-year period (2000–2025) are very large. The increased costs of a lower-carbon electricity supply were offset by the savings made through energy efficiency. At the same time, local air pollutants such as NMVOC (non-methane volatile organic compounds), NO_x, SO_2 and carbon monoxide were reduced. The climate co-benefits of the combined policies were avoided CO_2 emissions of 142 Mt CO_2 for 2025, or 24% lower than in the base case (Winkler, 2006a).

Over the 25-year study period, energy efficiency makes the greatest impact when seen against indicators of sustainable development. Industrial efficiency, in particular, shows significant savings in energy and costs, with reductions in air pollution. Energy efficiency in the commercial sector shows a similar pattern, although at a slightly smaller scale. Residential energy efficiency is particularly important for social sustainability. Even small energy savings can be important for poorer households. In the short term – the decade 2006–2015 – it was concluded that energy efficiency will be critical to making South Africa's energy development more sustainable (Winkler, 2006a).

In the longer term – the next several decades – transitions which include the supply side will become increasingly important. To achieve greater diversity, there will need to be a combination of policies, since single policies on their own will not change the share of coal in total primary energy supply (TPES) by very much. The various alternative electricity supply options show potential for significant emission reductions and improvements in local air quality. However, they will require a policy of careful trade-offs in relation to energy system costs, energy security and diversity of supply.

As a method, national energy modelling allows a range of policies and measures in the energy sector to be analysed together. With an appropriate model choice, the dynamics of the energy system are taken into account. For example, the reduced energy demand due to energy efficiency measures is passed through to electricity supply, so that emission reductions from lower-carbon power stations are not overestimated. National energy models are often used as a basis for energy planning as well, providing a means to mainstream climate mitigation into energy policy.

Höhne and Moltmann (2008) have compared the results of national energy modelling studies in several developing countries (Brazil, China, India, Mexico, South Africa and South Korea) and found, as a general result, that the policies considered in these analyses can reduce emissions 10–20% below reference emission in 2020 but, as such, would only slow the growth and not reverse the trend.

Clearly, the energy modelling method is appropriate only for the energy sector. It would be most useful in those developing countries whose GHG emissions derive mainly from the energy sector. A methodological approach for SD-PAMs in the LULUCF (land use, land-use change and forestry) sector would also be required for a more comprehensive approach. Methods for estimating emissions from LULUCF are complex, and the challenge of developing tools useful across countries is non-trivial.

4.3. Method 3: Analysis of sectoral data

The analysis of sectoral data can be used to compare GHG intensities. While the analysis in studies to date has focused on the energy sector, the approach differs from modelling in that the focus is on a comparison across countries. Höhne et al. (2006a) considered the electricity production, iron and steel, cement, pulp and paper, refineries, and transport sectors in this way.

With this method, the emission reduction potential of a country can be assessed on an aggregated scale in order to understand the order of magnitude of reductions that could be achieved with policies and measures, be they motivated by sustainable development or by climate change goals. Detailed data collected from the available literature includes activity data (in tonnes of product/output by economic sector), value added (in monetary terms), and energy use by fuel type. This data allows the calculation of both energy and GHG intensities. On the latter, the focus is mainly on CO_2 from the energy sector. It also allows a comparison of the GHG intensities between countries. Future scenarios can be generated, assuming production growth and improvements in efficiency.

The original purpose of this work was to analyse the implications of a possible sectoral approach as a post-2012 climate mitigation regime, but the insights can also be used to quantify the possible effect of SD-PAMs. The study found that large differences in energy efficiency and GHG indices can be observed between countries. There is also substantial variation in these indices between different sectors in the same country. By bringing together data in sectors that contribute to GHG emissions, the approach forms the basis for further analysis of particular policies that would make development more sustainable and would reduce emissions.

The effect of a set of policies was considered by Höhne et al. (2006a) in future scenarios, where the GHG indices of all countries converge to best-available-technology (BAT) by 2020 or 2030. The study found that large emission reduction potentials could be realized if countries were to use BAT. Together with ambitious Annex I reductions, global emissions could then stabilize by 2020 (Höhne et al., 2006a).

This is relevant in the context of SD-PAMs, as moving to the best-practice technology would be in the interest of developing countries improving their energy efficiency and reducing their dependency on fossil fuels.

Sectoral data analysis as a method has the advantage of comparability across countries, but compromises on country-specific details. Scenarios for the future can be developed although, by definition, for sectors rather than the whole economy.

4.4. Method 4: Global emission allocation models

The fourth method is analysis of SD-PAMs in global emission allocation models. Models such as the Framework to Assess International Regimes (FAIR) model (den Elzen and Lucas, 2005) and Evolution of Commitments (EVOC) model (Höhne et al., 2006b) are designed to allocate a given global greenhouse gas emissions budget across countries under different multilateral agreements. They could be used as a top-down approach to analysing the climate implications of SD-PAMs, even though the latter are, in principle, bottom-up approaches. The key motivation for doing so would be to illustrate the environmental effectiveness in terms of climate change mitigation of SD-PAMs. The method allows comparison of levels of efforts of countries through SD-PAMs.

These analyses place the SD-PAMs approach in the context of multi-stage approaches. Such approaches are based on participation and differentiation rules that come into play when a country moves from one stage to another (see, for example, Gupta, 1998; Berk and den Elzen, 2001; den Elzen, 2002; Criqui et al., 2003; Höhne et al., 2003; Ott et al., 2004). In Höhne et al. (2003), the progression is as follows. Stage 1 – no commitments: countries with a low level of development, i.e. the least developed countries, participate in this stage; Stage 2 – enhanced sustainable development: countries commit in a clear way to sustainable development by implementing SD-PAMs or no-lose targets; Stage 3 – emission limitation targets; and Stage 4 – absolute reduction targets. Annex I countries start at Stage 4. SD-PAMs are an option at Stage 2, which provides developing countries with incentives to start acting on mitigation. SD-PAMs might eventually become mandatory for countries at agreed stages.

Stage 2 is qualitatively described in terms of sustainable development requirements, e.g. improved energy efficiency and energy conservation, inefficient equipment being phased out, switching to low-carbon fuels. Studies have so far not quantified this explicitly, and have simply assumed that the emissions for the countries at Stage 2 are reduced by 10–15% below the reference emissions level (e.g. den Elzen et al., 2007) This value is consistent with the findings of Höhne and Moltmann (2008), as summarized in Table 15 of their study. This method, however, does not quantify sustainable development co-benefits.

A more sophisticated quantification of SD-PAMs depends on the detailed specification of a sufficient number of policies for several developing countries. A key constraint on this method is that data on policies and measures in key developing countries are not yet publicly available.

One approach would be to use results generated from national energy modelling (Method 2) to analyse the effect of detailed SD-PAMs. Results from these models could then be incorporated into models such as FAIR and EVOC. A more detailed quantification of the climate implications of sustainable development policies has been conducted by Höhne and Moltmann (2008). They illustrate the link between national climate and sustainable development policies for Brazil, China, India, South Africa, Indonesia, South Korea and Mexico and the international climate regime post-2012. Drawing on such a national analysis, an assessment could be conducted of SD-PAMs in the global context, and analysis of emissions avoided, compared against projections of both global and country emissions and other proposals or allocation approaches such as the Brazilian proposal (Brazil, 1997) or Multi-stage approaches.

In this context, Höhne and Moltmann (2008) consider what contributions developing countries could make to the global climate regime post-2012 that are in line with their national objectives and circumstances. Sustainable development objectives examined include energy security, sustainable economic development, technology innovation, job creation, local environmental protection, and enhancement of adaptive capacity to climate change impacts.

Their paper puts the impact of a set of SD-PAMs in the energy sectors of the seven developing countries (mentioned above) into a broader international context. The policies differ by country, from Annex-I-like commitments to moderate supported emission reductions (Table 1 in Höhne and Moltmann, 2008). Roughly speaking, the non-Annex I countries achieve around 10–20% reductions in CO_2 emissions, compared with the reference case, until 2020.

These policies are analysed with the following further assumptions:

1. *Reference scenario:* An assumed reference case of the IPCC's A1B scenario (IPCC, 2000) for all countries till 2020; CO_2 only.
2. *Annex I reduces:* Annex I emission reductions of 30% below the 1990 level by 2020, except for the USA, which returns to the 1990 level.

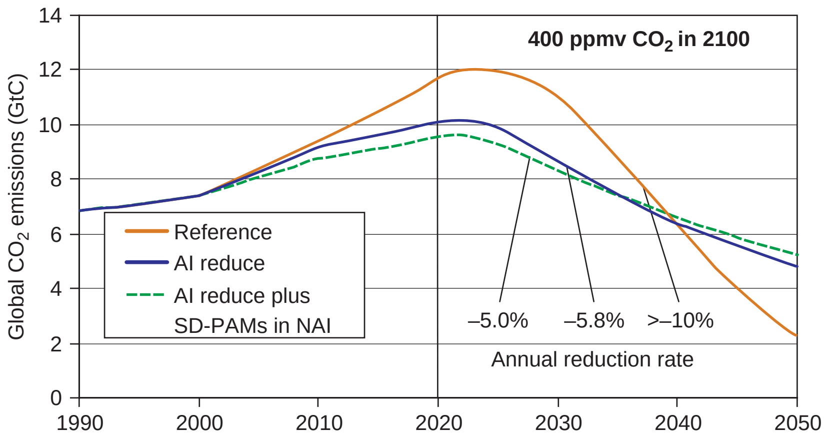

FIGURE 2 Alternative global CO_2 emission pathways leading to a CO_2 concentration of 400 ppmv in 2100 for a reference case, Annex I countries' reductions and additional non-Annex I countries' reductions.

Source: Höhne and Moltmann (2008).

3. *Annex I reduces plus SD-PAMs for non-Annex I:* In addition to the above reduction of Annex I countries, the non-Annex I countries achieve the 10–20% reductions in CO_2 emissions through SD-PAMs until 2020; constant LULUCF emissions at 1 GtC between 2000 and 2020; after 2020, for all three cases, global CO_2 emissions (all sources and countries together) decline so that CO_2 concentration in 2100 is below 400 ppmv (although the concentration first overshoots till 430–460 ppmv in around 2040). For details, see Höhne and Moltmann (2008).

The results in Figure 2 show that SD-PAMs in the energy sector from the seven countries reduce emissions to a lower level than Annex I reductions alone. To get from the A1B reference case in 2020 to the chosen stabilization level of 400 ppmv CO_2, emissions would have to decline by more than 10% per year after 2020. The assumed Annex I reductions reduce this to 5.8% per year; still a very demanding task. Adding sustainable development policies and measures in the energy sectors of seven larger developing countries reduces the required rate of reduction to 5% per year. Together with stringent reductions of Annex I countries, the combined package might be sufficient to keep global average temperature increase below 2°C, but only if followed by substantial global reductions of the order of 5–10% per year after 2020 (Höhne and Moltmann, 2008). In addition, meeting a 2°C target also depends critically on assumed contributions of other GHGs and the uncertainty range of the climate sensitivity.

For SD-PAMs to make a contribution to the overall effort, the approach would need to be formalized in the multilateral system. Ways would need to be found to give recognition to actions by developing countries through the Convention and its instruments.

5. How can SD-PAMs be formalized in the multilateral system?

Formalizing the pledged commitment could take two possible forms:

1. The initial register could simply be a list of countries that wish to record their existing contribution through sustainable development and pledge further implementation. This

could be recorded, for example, in a new Annex to the Convention. It has the advantage of simplicity and of giving recognition. By choosing to join Annex III, developing countries would no longer be defined by what they are not ('non-Annex I').
2. Another option would be a register of pledged policies and programmes. This approach has the advantage of specifying in more detail the actions to which countries are committing.

The two approaches are not mutually exclusive – there could be an initial list of countries, with a register of SD-PAMs maintained, for example, by the UNFCCC Secretariat.

A more detailed description of other aspects of formalizing SD-PAMs has been elaborated elsewhere (Winkler et al., 2007), but the issue of financing of SD-PAMs bears some restatement and elaboration.

To realize the potential of SD-PAMs, the appropriate incentives are needed. A major advantage of SD-PAMs is that they could access both climate and non-climate funding. Bradley and Pershing (2005) suggested that SD-PAMs can offer more *rigour* and *flexibility* than the present system: rigour by establishing quantifiable commitments towards which financial resources can meaningfully be directed, and flexibility by not separating climate funding from non-climate funding. Incentives for developing countries could include funding from development agencies, which have an interest in funding sustainable development, beyond climate change.

SD-PAM funding should be able to come from a wide range of sources: international financial institutions, bilateral aid agencies, the GEF, multilateral development banks, export credit agencies, the private sector, domestic sources, State and local communities, among others. Some funders – host governments, development banks and aid agencies – would be primarily concerned with alleviating poverty or otherwise boosting economic development. Since SD-PAMs implement national development objectives, significant amounts of domestic funding should be mobilized for the non-incremental costs. The real challenge is to instil carbon considerations into the broader set of international capital flows, only some of which are climate-specific.

Climate funding might instead be made available through expedited access to existing mechanisms, including the Global Environment Facility and climate investments by international financial institutions. Existing mechanisms include grants from the public sector, leveraging of investment by the private sector, as well as risk mitigation instruments. New mechanisms, such as a clean energy vehicle, might be particularly appropriate for SD-PAMs focused on energy development, while a clean energy support fund is more directly linked to emission reductions (World Bank and IMF, 2006).

A potentially large source of funding would be carbon markets, notably the CDM. Linking SD-PAMs to carbon markets initially would make it similar to CDM, accompanied by the complexities of additionality and project baselines.[1] To avoid these problems and to distinguish the approach (e.g. from programmatic or sectoral CDM), it is proposed not to link SD-PAMs to markets, at least initially.

Beyond the institutional arrangement proposed in previous work (Winkler et al., 2007), this article also suggests that the multilateral system could provide further support to SD-PAMs through elaborating and formalizing methodologies. The methodological approaches sketched in this article could be investigated and elaborated more fully, perhaps by the Consultative Group of Experts (CGE) or a sub-committee of the CGE. The Secretariat could be asked to prepare compilation and synthesis reports on the implementation of SD-PAMs.

6. Conclusions

SD-PAMs provide a strategic approach for capturing the climate co-benefits of developing countries' pursuit of sustainable development as one element of a future international climate regime. They offer the potential for a less confrontational approach between industrialized and developing countries, and a means to address developing-country emissions by promoting rather than threatening their development.

Sustainable development policies and measures are not a panacea. In particular they do not change the need for industrialized countries to lead with explicit action to mitigate their own GHG emissions. By itself, the approach may not guarantee a particular environmental outcome – although this would depend on the number and ambition level of the policies implemented. The approach, however, is aimed at mobilizing action, by turning climate change from a 'threat' to development into genuine opportunity to make development sustainable for developing countries. The approach does not require an entire new Protocol or mechanism, but 'only' a decision by the COP.

An important step in operationalizing the concept of SD-PAMs is to examine methods available to quantify the benefits of SD-PAMs. This article has identified four ways to quantify the effect of SD-PAMs on development and emissions.

The first method, case studies, has as its main aim to provide detailed examples of what SD-PAMs are and how they might work in a particular context. They are very specific to national circumstances. This strength also is a weakness of the method, in that results from different case studies might not be comparable, unless guidelines are developed for the parameters that need to be reported.

National energy modelling is the second method examined, a key strength of which is that it provides a link to energy policy and planning. While capable of providing an overview of emission from fuel combustion, no comparable method for LULUCF is available.

The third method draws on the analysis of sectoral data across countries. This allows comparative studies of energy and GHG intensity across countries, although setting up comparable indices limits the extent to which national circumstances can be taken into account. It combines detailed analysis at the national level for selected sectors with international projections.

Global emission allocation models potentially provide a comprehensive overview of the implications of SD-PAMs. Models such as FAIR and EVOC also allow comparison of the SD-PAMs approach with others. The key constraint is data availability to represent national policies and measures in sufficient detail. Combining this method with national energy modelling might provide both detail and comprehensive assessment.

The article suggests that formalizing the commitment of SD-PAMs could be aided by more fully elaborating the methodologies initially outlined here. Establishing the pledged commitment within the UNFCCC could take two possible forms – a new Annex to the Convention or a dedicated register of pledged policies. Confidence could be built through regular reporting of both the local sustainable development gains and the climate co-benefits of implementing SD-PAMs. Incentives for SD-PAMs could come from both climate and non-climate funding. Article 12.4 of the convention provides the means for countries to propose projects for climate financing (UNFCCC, 1992). Development funding through other agencies could also be mobilized.

SD-PAMs could be important as one approach among others to build trust between countries in enhancing the climate regime. This article has elaborated the concept and has begun to outline some methods for operationalizing SD-PAMs. Sustainable development policies and measures, implemented through technology, enabled by finance, in balance with adaptation, could be an important package of options to take us beyond 2012.

Note

1. For a detailed comparison of SD-PAMs with CDM and other approaches, see Baumert and Winkler (2005).

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