PBL Netherlands Environmental Assessment Agency

PBL Note

Review landscape appreciation model

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Summary

PBL needs reliable indicators, data and models to evaluate the perception, appreciation and recreational use of nature and landscape. However, the application of existing models has revealed some limitations. PBL Netherlands Environmental Assessment Agency requested the Department for Legal Research Tasks in the policy area Nature & Environment of the Wageningen University and Research Centre (WOT-WUR) to develop a landscape appreciation model that is based on revealed preferences in recreational use instead of on stated preferences as in the existing model. PBL organised an external review of the WOT-WUR proposal for this new model to assess whether it would meet the PBL Term of Reference.

The review focused on four issues:

1. Indicators that best suit PBL policy studies for the Dutch Government
2. Scale to be considered (e.g. the countryside or the Netherlands as a whole, including urban areas)
3. Type of data
4. Sufficient discrimination to assess the effects of policy measures set out in the Terms of Reference.

This note describes the review approach and the results, leading to the following conclusions:

- There is a need for a more profound evaluation of the four options for an indicator of landscape appreciation. This evaluation should take into account the future availability of primary data.
- There is an urgent need to redesign the data acquisition tool to optimise its use in calibration and validation of the prediction indicator. Other reasons to redesign this tool are technical developments and the high non-response level of inquiry panels. A promising approach to collecting more data with greater accuracy and improved data handling opportunities would be to convert the web-based survey tool to an app for mobile devices.
- PBL requested WUR-WOT to execute the proposed improvements in the predictive power of the model and to incorporate policy measures into the model as set out in the Terms of Reference.

Introduction

PBL Netherlands Environmental Assessment Agency in cooperation with the Department of Legal Research Tasks in the policy area Nature and Environment of the Wageningen University and Research Centre (WOT-WUR) and the University of Groningen (RUG) have developed a set of indicators, monitoring systems and models to evaluate landscape quality for use in strategic policy analysis and assessment. The indicator set elaborates the definition of spatial quality in national policy documents on spatial planning in the period from 1985 to 2010 (VINO, VINEX, VIJNO, Nota Ruimte), see Box 1. PBL is now reconsidering indicators for the evaluation of perception, appreciation and recreational use of nature and landscape because of the recent shift in policies to the environment, spatial planning and nature. The national government prefers to evaluate policies from a welfare and economics perspective, for instance, in cost-benefit analysis.

PBL landscape quality indicators

Biodiversity and landscape appreciation are the key indicators to estimate and evaluate the impacts of policy measures on nature and landscape. However, these two indicators do not cover all relevant impacts on the quality of nature and the landscape[1].

A more effective indicator is required for the impact on the cultural quality of nature and landscape, including landscape design. Landscapes are not static entities. Their qualities and how they are perceived by people change continuously, and can acquire new meanings as a result of landscape design.

A set of criteria is available to evaluate the cultural heritage (Witteveen+Bos, 2008; Commissie voor de milieueffectrapporatge, 2012) but an operational system hampered by a shortage of data. While development of such a system is not part of the PBL mission, the urgency of and requirements for such a system have been discussed with other institutes, such as Rijksdienst Cultureel Erfgoed (RCE). The design quality should been evaluated at project by expert teams.

PBL evaluates biodiversity and landscape appreciation of nature and landscape in a functional framework. We want to place our indicators in international and national functional frameworks, such as ecosystem services and cost-benefit analysis (CBA), which is a requirement to evaluate national government investment in the land system. In order to fit into these frameworks, PBL is re-designing an indicator to evaluate landscape appreciation to take into consideration the intensity of recreational use of nature and landscape.

[1] PBL distinguishes four aspects of landscape quality; landscape appreciation, biodiversity, cultural quality and suitability for use, which is based on the translation of Vitruvius criteria of good design (venustas, firmitas, comoditas) into four aspects of spatial quality in the policy document on spatial planning, 'Nota Ruimte'. De elaboration of the four aspects, is presented in Dossier Landschap of Compendium voor de Leefomgeving (http://www.compendiumvoordeleefomgeving.nl/onderwerpen/nl0012-Landschap.html?i=12)

Knowledge about perception and appreciation of nature and landscape is required for monitoring systems and models. Data on landscape preferences are collected by the Hotspotmonitor (HSM) (www.hotspotmonitor.eu; Sijtsma et al., 2013; De Vries et al., 2013). The models currently used are GLAM (GIS-based Landscape Appreciation Model; De Vries et al., 2007; Van der Wulp, 2008) and AVANAR to determine the balance between demand for and supply of recreational opportunities (De Vries et al., 2010). As these models have various limitations, PBL requested WOT-WUR to develop a landscape appreciation model 'GREAT' (GIS-based REcreational ATtractiveness), based on revealed preferences in recreational use.

In October 2012, PBL and WOT-WUR organised a review to determine how the GREAT model could be developed to meet PBL requirements as a basis for WOT-WUR proposals for a landscape appreciation model for the 2013-2015 period.

Approach review

Four experts were invited to review the model in April and May of 2013. Professor Mari Sundli Tveit (Universitetet for Miljø og Biovitenskap, Ås, Noorwegen) and Professor Agnes van den Berg (University of Groningen) accepted the invitation. Professor Dirk Sijmons, who is a member of the PBL Advisory Board, agreed to discuss the review results.

The review was carried out in three stages. In the first stage, the reviewers were presented with PBL requirements and the WOT-WUR project plan, set out in the following documents:

- PBL Terms of Reference (Attachment 1)
- Descriptions of PBL and WOT-WUR instruments to monitor and model landscape perception
- WOT-WUR project plan to develop the landscape appreciation model (GREAT) (Attachment 2).

The first stage concluded with a review meeting on 28 May 2013 with Wim Nieuwenhuizen and Sjerp de Vries, PhD, from WOT-WUR and Arjen van Hinsberg, PhD, and Hans Farjon, MSc, from PBL. Frans Sijtsma, PhD, of the University of Groningen was invited to present the HSM data acquisition tool.

In the second stage, the reviewers prepared the recommendations (17 June 2013; see Attachments 3 and 4), and the WOT-WUR research team was asked to comment (Attachment 5).

In the third and final stage, PBL summarised the results and prepared a research proposal for the period from 2013 to 2015 (this note). On 5 November 2013, this note was discussed with Professor Dirk Sijmons and Steffen Nijhuis, MSc, Landscape Architecture, Delft University of Technology (Attachment 6).

The results of the review are summarised in the following section and were based on:

1. the most suitable indicator for PBL policy studies for national government; the indicator most suitable for cost-benefit analysis in policy analysis; and the appropriate best aggregation level to address appreciation;
2. whether the indicator and the model should address only the countryside or include the whole of the Netherlands including urban areas;
3. the relationship between the proposed model and the Hotspotmonitor (HSM) data acquisition tool;
4. whether the proposed model has sufficient discriminating power to assess effects of policy measures described in the Terms of Reference, and which of those policy measures could be evaluated. Consideration was given to whether there are policy measures that cannot be evaluated by any model using state of the art knowledge.

A summary and conclusions are given for each of the four issues above, under the following headings:

- PBL Terms of Reference
- Proposal for the GREAT model by WOT-WUR
- Review
- Response by the WOT-WUR team
- PBL conclusions

Results - Indicator

PBL Terms of Reference

PBL requested WOT-WUR to develop an improved landscape appreciation model based on revealed preferences in recreational use. The indicator should fit with CBA in addressing the effects of policy measures on human welfare, and should be based on revealed preferences and the estimated size of the impact population. This indicator is defined as the value of potential recreational use by the Dutch population and is based on the physical characteristics of an area and the impact population.

Proposal for the GREAT model by WOT-WUR

WOT-WUR proposed stepwise development of the landscape appreciation model, starting from a visual attractiveness indicator, via an indicator of attractiveness for recreational use and an indicator of recreational use, to finally an indicator of the value of recreational use. Only the first two stages have been elaborated in the GREAT model proposal.

Review

The reviewers recommended considering another indicator with higher relevance for policymakers, such as the restorative power of nature or even the health effects of nature.

They support an attractiveness indicator that is broader than visual attractiveness. Rather than focusing on recreational use, the recommendation was to make a distinction between appreciation and recreational use. Doubts were expressed about whether the revealed preferences approach would be feasible.

Response by the WOT-WUR team

The team subscribed to the notion that an indicator of the health effects of nature would score higher than recreational value on the political agenda, but implementation would have far-reaching consequences. There is little evidence of health effects of nature and landscape other than in relation to proximity. These effects have only been reported on a local scale. More knowledge and data on quality of the urban environment would be required. The team was not convinced of the needs for a broad, non-specified attractiveness indicator, because a broad definition introduces uncertainties about the context of the stated preferences.

PBL conclusions

PBL choses to develop an indicator of nature and landscape appreciation based on preferences in recreational use. This choice is based on the fact that other aspects of appreciation of nature and landscape are covered by other indicators, such as those on the contribution of nature to the appreciation of the living environment, and on the value of biodiversity and cultural quality.

Many hedonic pricing studies have been carried out on the relationship between real estate value, an indicator for appreciation of the living environment, and nature and landscape characteristics. A meta-analysis of these studies in the United States was carried out by Brander and Koetse (2011). Dutch studies have been carried out on this theme by, for instance, Luttik (2000), Bervaes and Vreke (2004), Crommentuijn et al. (2007), Dekkers (2010) and Marlet et al. (2013). This knowledge has already been applied in cost-benefit analyses of government policies.

For the evaluation, expert judgement on the value of biodiversity, cultural history and design seems to be more appropriate than citizens’ stated preferences.

The reviewers recommended that PBL considers an indicator for the health benefits of nature and landscape. However, PBL did not adopt this recommendation because it considers nature ‘on people’s doorstep’ to be more important for health than nature in the distant countryside and in nature reserves. One of the reviewers is in agreement on this point.

The review also showed that there is not yet a clear operational definition for the landscape appreciation indicator based on revealed preferences in recreational use. Furthermore, the reviewers doubted whether preferences could be revealed from recreational behaviour. The recommendation was to select an integrated appreciation indicator. For more information on this issue, see Chapter 4..

Results - Spatial aspects

PBL Terms of Reference

The model should discriminate between effects at local, regional and national scale (as in the Hotspotmonitor).
The model should be sensitive to present effects on national, regional and ecosystem or landscape level.

Proposal for the GREAT model by WOT-WUR

The proposal addressed the regional scale; day trips. It was assumed that preferences are the same for both national and regional scale.

Review

The reviewers recommended that less emphasis be put on the national scale because national preferences are robust and stable. The local scale should be included because of its relevance in terms of impact on appreciation, proximity and frequency of contact.

Response by the WOT-WUR team

The team concluded that the reviewers favoured the local scale. However, the local scale has major consequences and will require more knowledge and data on urban quality. It is doubtful whether integrated modelling at local and regional scales would be feasible.

PBL conclusions

PBL concluded that the key variables to explain recreational use frequency are distance from and accessibility of nature and landscape. Thus, it would be preferable to include these variables in modelling landscape appreciation rather than to distinguish different levels in data collection and modelling. The implication is one model for the all of the Netherlands, and this has implications for the further development of the Hotspotmonitor and for the proposed GREAT model.

Results - Data acquisition

PBL Terms of Reference

Data source requirements were not included for the model, except for linking it with the data collection tool, Hotspotmonitor.

Proposal for the GREAT model by WOT-WUR

The proposal for the GREAT model includes data from the websites 'My place to be', Hotspotmonitor and WoON, used for calibrating and validating the indicator of recreational attractiveness and the underlying sub-indicators of scenic beauty. The proposal also makes it clear there is no on-going monitoring programme that generates reliable data on visits to specific location, which is needed to validate the indicator recreational use.

Review

The reviewers stressed the need for primary data acquisition on preferences and appreciation, and suggested using the potential of Hotspotmonitor in data acquisition, and recommended optimising the connection between Hotspotmonitor and the GREAT model.

Response by the WOT-WUR team

The HSM questionnaire should be adjusted to meet the requirements of the indicator and the model (the aggregation level of the indicator and the type of object evaluated).

PBL conclusions

PBL adopted the reviewers' recommendations to optimise the link between the model and the data acquisition tool, Hotspotmonitor. The need for primary data acquisition on preferences for nature and landscape and recreation is evident. The HSM questionnaire should be adjusted to fit better with the indicator and model. The primary data set should meet the needs of indicator calibration and validation in the model. The links between data acquisition, indicator definition and model design have to be elaborated further before the model can be built.

Results - Discriminating power to assess effects of policy measures

PBL Terms of Reference

In combination with other PBL models, the model should be able to estimate the effects of most of the following types of policy measures:

- Public investment on construction, restoration and improvement of nature reserves, parks, landscape elements and recreational facilities (e.g. paths);
- Public financial allocations for management of nature areas, parks, high-value agricultural land and natural and cultural landscape elements;
- Restrictions to or plans for building new elements that disturb the landscape such as wind parks, large sheds and new infrastructure.

Proposal for the GREAT model by WOT-WUR

The proposal aims to improve the discrimination and predictive power of modelling of scenic beauty by improving the sub-indicator naturalness in the GLAM model and adding a sub-indicator on variety in scenery, peace and quiet, and (non-natural) points of interests.

Review

The reviewers state that the predictive power of the GLAM model is high but not sufficient for all relevant policy measures, and could be improved by using more detailed data about naturalness (land-use classes and biodiversity data). Data on variety, complexity, landscape mystery or points of interest might improve the predictive power of the GLAM model. The stepwise approach to the GREAT model seems time consuming and full of risks, and thus it would be preferable to use the most aggregated indicator. In the GREAT model, this would be the value of recreational use.

Response by the WOT-WUR team

The team is working in the direction suggested by Agnes van den Berg, but it remains to be seen whether this will improve the predictive power for scenic beauty.

PBL conclusions

The reviewers indicated that the GLAM model has good explanatory and predictive power. Thus, it would be a good investment to improve this power by upgrading the naturalness indicator with new secondary data, such as land-use classes and biodiversity data sets. Variables for POIs, variety of scenery and peace and quiet might also improve the predictive power.

It is doubtful whether higher predictive power will improve evaluation of all policy measures included in the Terms of Reference. Incorporating policy measures in the model requires further elaboration in the GREAT model proposal.

Conclusions

The indicator definition requires further elaboration, especially on (1) how nature and landscape characteristics contribute to recreational behaviour, and (2) how citizen satisfaction can be derived from the data available. An in-depth evaluation of the options for a landscape appreciation indicator is required before starting modelling, because the reviewers expressed concerns about the political relevance of a recreational use indicator and the difficulties involved in revealing landscape preference from recreational data. These options are the contribution of the characteristics of nature and landscape to:

- the stated happiness of a person at a specific location;
- the stated appreciation of a specific location, not specified for aspects such as scenic beauty or recreational use;
- the stated appreciation of a specific location for specified recreational activities;
- the frequency of recreational use of a certain location or area.

The evaluation of these options should specifically take into account:

- the availability of primary data to calibrate and validate the predicted indicator;
- the options to start modelling the indicator without a stepwise approach as proposed in the GREAT model. Stepwise calibration of subsets of variables does not seem to offer advantages over a direct calibration with all variables.

There is an urgent need to redesign the Hotspotmonitor to optimise its use in calibration and validation of the predicted indicator. Other reasons for redesigning the Hotspotmonitor are technical developments and the high percentage of non-responses in inquiry panels. A promising approach to collecting more data with greater accuracy and improved data handling opportunities would be to convert the web-based survey tool to an app for mobile devices. Examples to consider are the MAPPINESS App of the London School of Economics (http://www.mappiness.org.uk/; MacKerron, 2012) and the Landscapiness project of Delft University of Technology.

PBL requested WOT-WUR to improve the predictive power of the sub-model for appreciation of scenic beauty described in the GREAT model proposal, because it was fully supported by the reviewers. This action was started in June 2013.

PBL requested WOT-WUR to incorporate policy measures as input variables, in the landscape appreciation model. The policy measures to be incorporated are summarised in the Terms of Reference.

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Attachment 1 Terms of Reference for modelling preferences for recreational use of nature and landscape

Hans Farjon and Arjen van Hinsberg, 13 May 2013

Introduction

Over the last 10 years, PBL Netherlands Environmental Assessment Agency, in cooperation with Wageningen UR (WUR) and University of Groningen (RUG), has developed knowledge on the appreciation for and recreational use of nature and the landscape. This knowledge has been implemented in monitoring systems and models used by PBL for strategic policy analysis and assessment. The Hotspotmonitor (HSM) is used to collect data on landscape preferences. The models currently used are the GIS-based Landscape Appreciation Model (GLAM) and AVANAR (a model to determine the balance between demand for and supply of recreational opportunities). However, the application of these models has revealed some limitations. Therefore, PBL has requested WOT-WUR to develop an improved landscape appreciation model based on revealed preferences in recreational use.

This note sets our PBL's requirements for this improved model, starting with its application in PBL research to support political discussions and government decision-making. Subsequently, the limitations of the current model (GLAM) are summarised, and the requirements for future model improvements are specified.

Field of application

PBL Netherlands Environmental Assessment Agency is the national institute for strategic policy analysis in the fields of the environment, nature and spatial planning. We contribute to improving the quality of political and administrative decision-making by conducting outlook studies, analyses and evaluations in which an integrated approach is considered paramount. Policy relevance is the prime concern in all our studies. We conduct solicited and unsolicited research that is always independent and scientifically sound.We conduct solicited and unsolicited research that is always independent and scientifically sound. Our core tasks are :

- to investigate and document current environmental, ecological and spatial quality;
- to explore future social trends that influence environmental, ecological and spatial quality, and evaluate policy options;
- to identify social issues of importance to environmental, ecological and spatial quality and raise them for discussion;
- to identify strategic options for achieving government objectives in environment, nature and spatial policy.

In our analysis on nature, we focus on the functions of nature with respect to biodiversity, utility and appreciation. We define nature broadly to include landscape as defined by the European Landscape Convention[1]. Our analytical toolbox includes a set of linked indicators, monitoring systems and models. The indicators are used to quantify functions in policy relevant terms. The monitoring systems use tools to describe and evaluate the current status of functions. Monitoring results are published and frequently updated on http://www.compendiumvoordeleefomgeving.nl/onderwerpen/#Natuur.

We use models to assess future trends and effects of policy options[2]. Our standard national models are Meta NatuurPlanner for biodiversity, GLAM for appreciation and AVANAR for aspects of the recreational utility function. PBL applies these models in outlook studies and ex-ante evaluations of government policies and plans. Recent outlook studies include the Nature Outlook 2010-2040 (http://themasites.pbl.nl/natureoutlook) and the scenario study Welfare, Prosperity and Quality of the Living Environment (http://www.welvaartenleefomgeving.nl/context_UK.html). Recent ex ante evaluations have been published on the National Policy Strategy for Infrastructure and Spatial Planning[3] and the 2012 National Election Manifestos[4] and cost-benefit analysis (CBA) of integrated spatial projects funded by the national government (see Sijtsma et al., 2013).

Limitations of current tools

Application of the GLAM and AVANAR models in PBL studies has revealed some serious limitations. Firstly, the current set of indicators for appreciation and recreational use does not fit the government requirements for integrated evaluation studies based on cost-benefit analysis (CBA). Secondly, the predictive and discriminating power of the GLAM model is a serious limitation in some applications.

Indicators do not fit in cost-benefit analysis

In the Netherlands, CBA has become an important method for the ex-ante evaluation of national investments, for example, in infrastructure, ecological restoration, housing programmes and integrated spatial projects. PBL undertakes these evaluations quite often in cooperation with Netherlands Bureau for Economic Policy Analysis (CPB). CBA determines the effects of public and private investments on society, providing insight into all effects on welfare. CBA monetises effects, and if possible on revealed preferences. However, effects on nature are often difficult to monetise and figure as PM items in these evaluations. This is a serious limitation in CBA.

There are three further reasons for the limited influence of our indicators of appreciation and recreational utility function of nature in decision-making.

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[1] 'An area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors.' (Council of Europe 2000)
[2] PBL uses models also to interpolate monitoring data
[3] http://www.pbl.nl/publicaties/2011/ex-ante-evaluatie-structuurvisie-infrastructuur-en-ruimte
[4] http://www.pbl.nl/publicaties/2012/keuzes-in-kaart-2013-2017-een-analyse-van-tien-verkiezingsprogrammas

Firstly, the current appreciation indicator is based on stated preferences and not on behaviour or revealed preferences. From this perspective, our indicators on appreciation should be based on the relationship between behaviour and physical characteristics of nature rather than on a relationship between stated preferences and these characteristics.

Secondly, the current indicator is too narrowly defined with regard to effects on welfare. The indicator calculated by the GLAM model is defined as the attractiveness of a landscape in terms of its scenic beauty. This limited definition does not take in consideration other types of value, such as the attractiveness of the landscape as the environment for living, working and recreation.

However, there is another methodological issue to be considered. It is unclear what aspects are included in the stated preference of respondents, and what they consider to be nature and landscape. Several studies[5] have clearly shown that people differ in perception and appreciation of nature and landscape. The respondent's socio-economic and cultural background influences their perception, just as their practical value of nature and landscape does. Thus, there is no shared perception or definition of nature and landscape. The problem of a lack of a shared definition will not tackled by applying a sharp definition in questionnaires.

A further weak point in the current model is the lack of information about the impact population. It is not clear how many people would benefit from a calculated increase in landscape attractiveness and whether it is the happy few in the direct neighbourhood or all inhabitants of the Netherlands. The GLAM model evaluates the landscape attractiveness for people living within a 20 km range, and does not include changes in attractiveness for tourists and travellers. This is a serious limitation in evaluating national investment in local projects.

The GLAM model's limited discriminating and predictive power

The discriminating and predictive power of the GLAM model is too limited, both qualitatively and spatially, for application in PBL evaluations and outlook studies. With regard to the first aspect, the model only discriminates changes between three broad land use classes, but not changes in the classes of natural, agricultural and urban land use. For example, a hectare of monoculture production forest has the same value as a

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[5] Berg, A.E. van den, 1999. Individual Differences in the Aesthetic Evaluation of Natural Landscapes. PhD Thesis, University of Groningen, the Netherlands.
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hectare of coastal dunes or heathland. Thus, the model has little use in evaluating measures in nature and spatial planning policies.

With regard to predictive power or the explained variation in its regression model, GLAM reviewers concluded in 2005 that they considered the model 'a useful and cheap instrument to get a rough estimate of the geographical variation of perceived landscape quality that can be used in combination with other much more expensive methods that provide more detailed data'. The reviewers advised investing in improving the predictive power of the GLAM model. However, various attempts to improve the predictive power using larger and geographically more distinct data on stated preferences have meet with little success. This experience was the main argument for developing another method to collect data with Hotspotmonitor.

Reference

To improve the quality of decision making on policies related to the quality of nature and landscape, PBL needs to develop a coherent set comprising an indicator, a monitoring system and a model for the appreciation of nature and landscape to assess effects of policy measures on nature in terms of welfare and prosperity of the society. In 2010, a new method was developed to survey nature and landscape preferences (Hotspotmonitor) and to calculate a new indicator (Hotspotindex). The first monitor results[6] seem useful for policy support and applicable in CBA. In 2013, consideration was given to improving the GLAM model to meet four requirements:

1. The model should assess a policy relevant indicator; the value of potential recreational use by the Dutch population based on the physical characteristics of an area and the size of the impact population.
2. The model should be useful in assessing effects of policy measures.
3. The model should enable comparison of the effectiveness of measures in different regions and thus be sensitive to spatial differences.
4. The model should fit in the PBL model framework.

Ad 1): Deliver a policy relevant indicator

- The output variable should reveal the potential value of areas for recreational use, based on revealed preferences for the physical characteristics of the area and its surroundings.
- The size of the impact population should be included in the calculation.
- The indicator should integrate aspects of appreciation and recreational utility value.

Ad 2) Sensitive to relevant policy measures

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[6] Sijtsma, F.J. et al. 2013. Evaluation of landscape impacts – enriching the economist's toolbox with the Hotspotindex In: C.M van der Heide and W.J.M. Heijman. The economic value of landscapes. Routledge studies in Ecological Economics 136-164.
De Vries, S et al. (submitted to Applied Geography) Measuring the attractiveness of Dutch landscapes: identifying national hotspots using Google Maps.

The model should estimate (in combination with other PBL models) the effects of most of the following types of policy measures:

- Public investment on construction, restoration and improvement of nature reserves, parks, landscape elements and recreational facilities (e.g. paths);
- Public financial allocation to management of nature areas, parks, high-value agricultural land and natural and cultural landscape elements;
- Restrictions to or plans for building new elements that disturb the landscape, such as wind parks, large sheds and new infrastructure.
- The typology of current input variables in the GLAM model (naturalness, urbanity, disturbing landscape elements) is not sufficiently discriminating to evaluate these policy measures.

Ad 3) Sensitive to relevant spatial differences

- The model should be sufficiently sensitive to estimate regional differences in effects of policy measures.
- The model should discriminate between effects on local, regional and national scale (as in Hotspotmonitor).
- The model should be sensitive to present effects on national, regional and ecosystem or landscape type.

Ad 4) Fit in the PBL model framework

- The model should fit in the PBL model framework used in outlook studies and ex ante policy evaluations, see Figure 1.
- The model should communicate with other relevant models, most of which work with a spatial resolution of 100*100 m grid.
- There should be adequate interface with Ruimtescanner, a model that simulates land use changes, and MetaNatuurplanner, a model that simulates changes in biodiversity and ecosystems.

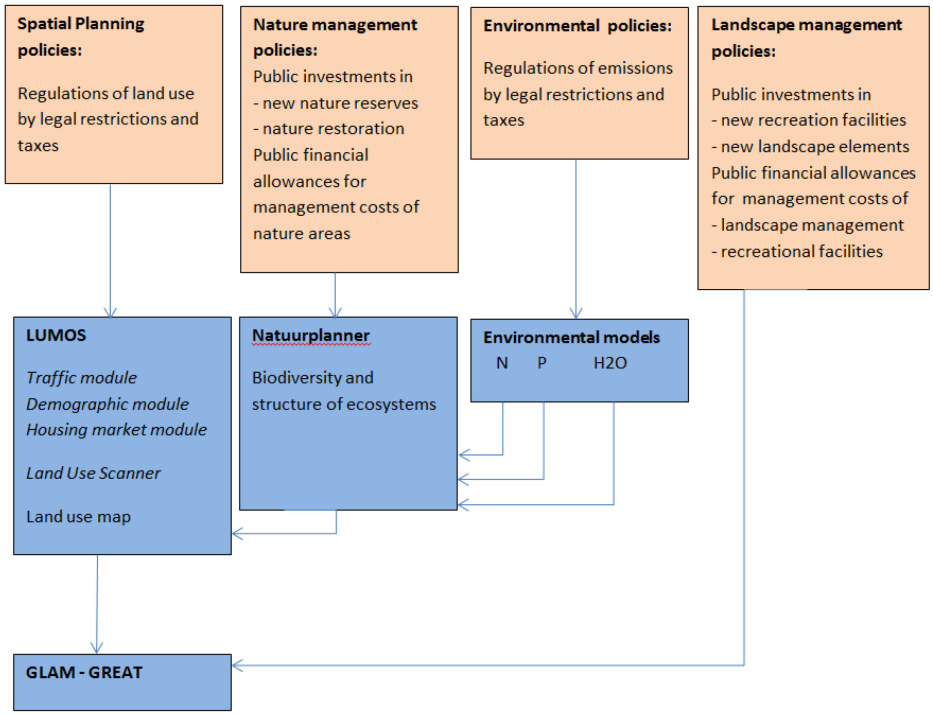

Figure 1: Input of the GREAT and GLAM models in terms of policies and output of other models in the PBL model framework.

Attachment 2: Towards a GIS-based REcreational ATtractiveness model; GREAT Project proposal

Sjerp de Vries and Wim Nieuwenhuizen, WOT-WUR Wageningen UR

1 Introduction

1.1 Background and goal

The Netherlands Environmental Assessment Agency (PBL) needs tools to conduct prospective (ex ante) evaluations of spatial developments, planned and unplanned. Such developments may take place in the city or in the countryside. As a national agency, PBL is mainly concerned with the countryside and assesses the consequences of developments in the countryside for a wide range of functions and values. One of these is the value an area has for the Dutch population, the citizens. This value may be based on many different functions of an area for different groups of people. PBL would prefer an integrated value assessment for citizens, and for the value assessment to be a suitable input for social cost-benefit analyses (SCBA) and environmental impact assessments (EIA).

By definition, ex ante evaluations deal with future situations. This means that revealed preference approaches are not feasible, unless combined with benefit transfer models. The first type of tool is information collection by which people are asked directly how much they value a specific area (directly stated preference). In the case of ex ante evaluations, this would be a hypothetical area, which has to be presented to the survey participants in a way so that they become familiar with it. Because of the many possible functions, which differ in relative importance for people, an adequate and unbiased presentation is not easy. Moreover, taking a presentation (becoming familiar with the new situation) is likely to be time-consuming for survey participants. It may lead to low response levels, leaving only highly motivated people in the final sample.

If the ex ante evaluation concerns a development plan for an area to be executed in the foreseeable future, the transition phase (from old to new situation) may influence value ratings (De Vries, 2007). While valuation of the transition phase is useful information, planned spatial developments are usually intended to create long-lasting (sustainable) new end states. In this respect, the impact of the transition phase on an intended valuation of the end state may easily be greater than considered desirable. In addition, the social and policy process surrounding the physical transition may influence value ratings strongly. Psychological resistance to change based on uncertainty about the form of the new situation and reaction to uncalled for change may be relatively short lived. These issues are important in their own right. For example, they may influence acceptance of the proposed development plan. However, in a long-term evaluation of the new end state, based mainly on its spatial and physical characteristics, the survey approach may not be the most suitable method.

For the above reasons, PBL requested WOT-WUR to assess the potential for developing a model to predict the value Dutch citizens assign to existing areas and to areas after proposed plans involving substantial changes have been implemented. Modelling should start with the spatial and physical characteristics of the area and focus on the countryside. Such an approach immediately raises an important issue. While people may be asked to assign an overall, integrated value to a certain area, for model development it is necessary to know the functions on which the assigned value is based. The desired function more or less defines the characteristics of the area that are likely to be of high importance for the value assigned, and thus guides model development. To model an integrated value rating, several sub-models may be needed, one for each function. Most Dutch people use the countryside mainly for recreation. Arguably, this makes recreation the most important function of the countryside (De Vries, 2009). Thus, it was decided to assess the potential for developing a spatially explicit model for the recreational value of the Dutch countryside. This is referred to as recreational attractiveness.

In addition to the theoretical framework for the new model, three factors are crucial in determining the effectiveness of knowledge systems in contributing to sustainable development ; salience, credibility and legitimacy of the model output (Cash et al, 2003). The legitimacy for the development is stated here as a reflection of PBL needs for modelling recreational attractiveness. For credibility, see section 4 on calibration and validation. To ensure the model is salient, chapter 5 presents how the new model is related to the products that PBL aims to produce.

Valuation of ecosystem services in general ; 'cascade' model (De Groot et al., 2010)
Opportunities for nature-based recreation may be considered an ecosystem or landscape service (Termorshuizen and Opdam, 2009). De Groot et al. (2010) developed a generic conceptual model for such services and goods. The ecosystem or landscape has a structure that is defined by spatially explicit landscape characteristics. Based on this structure, it fulfils certain functions. When a specific function is used and valued by humans, it becomes a service with benefits that can be valued, possibly in economic or monetary terms.[7] This model offers a framework in which to position the cultural ecosystem or landscape services of aesthetic appreciation and recreational use.

[7] People are not always aware of the use and/or value derived from this use. In our opinion, awareness is not necessary for a service. For instance, people at street level are not always aware of the positive effects of green roofs on air quality and ambient air temperature in cities. Another issue is whether non-use values, such as existence, option and bequest values, should be included.

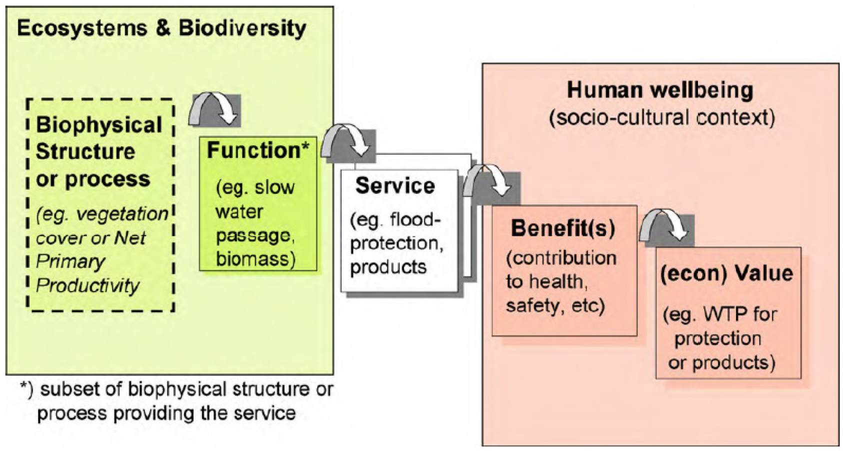

Figure 1: 'Cascade' model (De Groot et al., 2010)

The term 'value' is used here in an economic, utilitarian sense, as opposed to a moral sense (see also Figure 1). Different types of economic value may be distinguished. Here, the focus is on the value that individuals derive from their use of the resource. Use value is only generated when an individual actually uses the resource. This may be distinguished from the potential use value ; the value generated when the opportunity would be used, regardless of whether this use actually occurs (similar to the distinction between function and service made by De Groot et al., 2010). The end point of our modelling is the value that people derive from the recreational use of or visits to natural environments.

1.2 Contours of the new model

The GLAM model (Roos-Klein Lankhorst et al., 2011) focuses too exclusively on scenic beauty for the present purposes. Scenic beauty is assumed to be a key component of the recreational attractiveness of an area, but not the only one. On the other hand scenic beauty is also considered to be of importance outside a nature-based leisure or recreational context. For example, the landscape can be appreciated while going to work, school or home. Thus, it was decided to keep this model intact and even develop it further in its own right. The GLAM output will be used as input for the new model for recreational attractiveness to cover the scenic beauty component. The scenic beauty rating of an area is assumed not to differ according to recreational activity.[8] The perception quality component will be complemented by an utilisation quality component (see Goossen and Langers, 2000). The latter may be expected to differ according to activity. Thus, each activity requires its own sub-model. We propose to develop a model with a similar structure to the GLAM model. Since spatially explicit modelling is almost impossible without GIS data, the name chosen for the new model is 'GIS-based REcreational ATtractiveness' (GREAT).

[8] This rating may differ according to transport mode, for instance due to differences in velocity. A landscape considered boring as a setting for a recreational walk may be more attractive as a setting for a bicycle tour. This has to do mainly with the level of variation encountered 'along the way'.

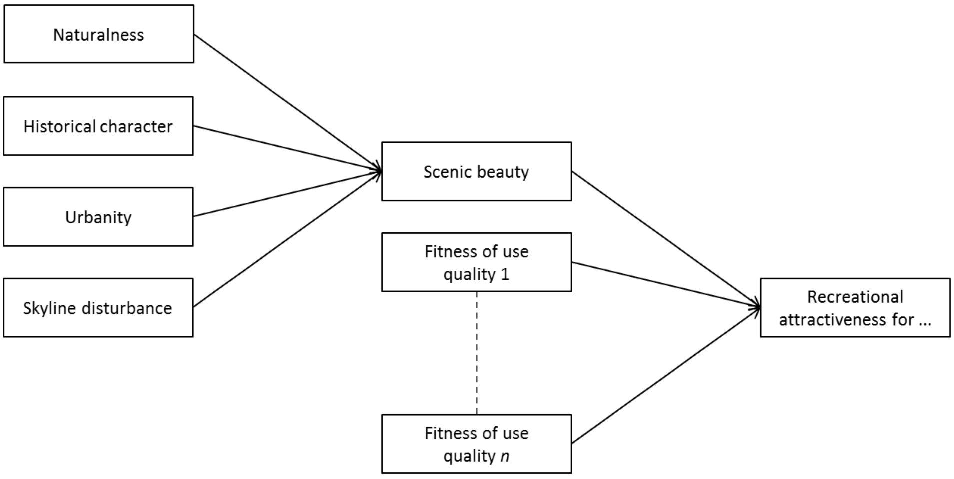

Figure 2: Conceptual scheme of the GREAT model for a destination area to be elaborated by activity.

The conceptual scheme for the GREAT model is presented in Figure 2. However, modelling recreational attractiveness is only the first step in modelling the use value generated by recreational visits to a natural environment or destination area. An intermediate step is the recreational use made of the area. In addition to the overall recreational attractiveness of the area, other factors include:

- accessibility of the area from a person's place of residence (permanent or temporary);
- attraction value of competing destination areas.

The annual number of recreational visits to a destination area may be considered a proxy for its recreational use value. But not all visits are of the same duration. The total amount of time spent in the area per year may be a better proxy. Based on these ideas, a simple conceptual scheme for the recreational use value is presented in Figure 3. However, the quality of the experience during recreational visits is also importance. High densities of visitors in the destination area may reduce the quality. At some point, more visits at one time may reduce the aggregated use value of all people simultaneously visiting the area. The step from visits or use to use value is not as straightforward as the scheme in Figure 3 suggests (see also, De Vries, 2009).

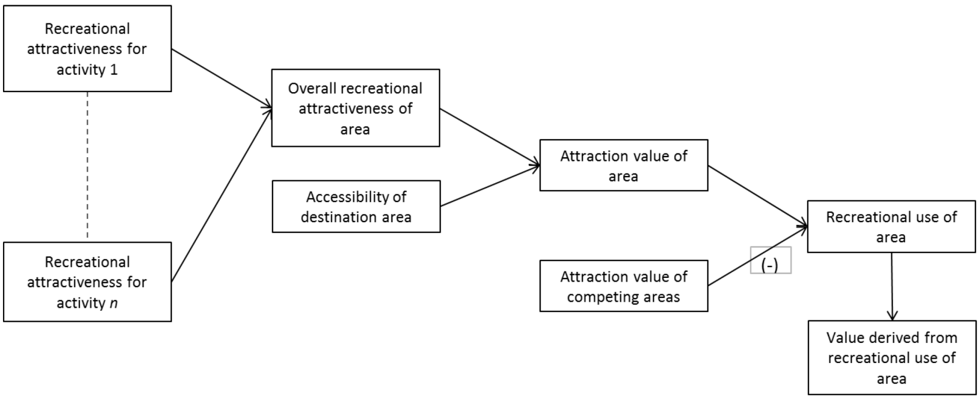

Figure 3: Scheme for extended model for the recreational use value of a destination area

The rest of this proposal focuses on a model for recreational attractiveness, but eventually a model for the recreational use value of natural environments as destination areas will be developed. Next steps could be to model the recreational use of an area and its recreational use value. Another approach would be to start with modelling recreational use value. Given the budget and time constraints, this approach would be at the expense of the level of detail in and thoroughness of modelling recreational attractiveness. However, later parts of the model may be refined.

Thus, there are two possible approaches:

- Start with a crude model for recreational use to be refined later;
- Stepwise approach, starting with recreational attractiveness and later including use and use value.

This proposal is for a roadmap for the second option and is presented below.

1.3 Scope of the model

The model will focus on the attractiveness of countryside areas for nature-based recreation. It will generate predictions for all of the Dutch countryside but not for urban areas and large water bodies. Furthermore, the model will be limited to nature-based recreation. Large-scale attraction and theme parks, zoos and events may generate many visits , but their visitors rarely visit the area surrounding the park or event site. These leisure destinations are not included. Historical sites embedded in the landscape and small facilities that are usually not the sole or even primary reason to visit an area are considered to be a part of the landscape.

The model focuses on the attractiveness of an area as a destination for nature-based daytrips. This is expected to differ from its attractiveness as a holiday destination. Opportunities for nature-based recreation are assumed to be a factor in the choice of a holiday destination, and concern opportunities in a wider region around the holiday accommodation. In addition to this difference in scale, other factors are expected to influence the choice of holiday destination, for example, the holiday accommodation (availability, type, facilities and amenities, quality, price) and supply of other types of leisure destinations (cultural, historical, amusement, shopping).[9] However, in terms of nature-based recreational activities, holiday-makers are expected to value the same qualities in an area as local and regional recreationists. Thus, the GREAT model may offer useful input for a model that predicts the attractiveness of larger areas as a holiday destination.[10]

The model will predict the potential value of an area when visited. It will not model the use value, which also depends on the number and duration of visits made and the value derived from these visits. However, the potential value is thought to be an important determinant of the probability that an individual will visit an area. Thus, the GREAT model may offer useful input for a model to predict numbers of visits to an area for nature-based recreation or for a model to predict the value people derive from such visits (De Vries, 2009).[11]

Initially, relatively little attention will be given to individual differences as to why an area is considered an attractive setting for a certain recreational activity (for market segmentation purposes). While there may be substantial individual differences, the objective is not to predict attractiveness for individuals, but for larger groups of people, mainly defined spatially. It is assumed that most individual differences will average out quickly, already at a detailed spatial scale.[12] There is empirical support for this assumption for the scenic beauty part of the model. For example, Van der Wulp (2008) showed that only average age had some added predictive value (see also, Ode and Miller, 2010). However, account will be taken of the fact that individuals in the Dutch population differ in their desire to participate in a certain recreational activity (size of demand).[13] This is important in aggregating attractiveness by recreational activity into an overall recreational attractiveness score.

1.4 Relationships with existing models and tools

The proposed model is related to models and tools developed by WOT-WUR and/or PBL, at least conceptually and some also functionally. In this section, these relationships are described to help position the new model.

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[9] This is about destinations that might be considered 'foot loose'. As mentioned,, in as far as things are deeply embedded, a part of the landscape so to speak, they will in principle be included.
[10] Note that the nature-based day trips people make when on holiday are also part of the recreational use (and sometimes may outweigh use by 'local' people). They can be included in a model for recreational use. However, how many (Dutch) people spend how many holiday nights where is an additional question. See also Henkens et al. (2005).
[11] By modeling potential use value separately, later on this may be compared with actual use. This comparison may help to identify areas whose potential is not yet utilized.
[12] A possible exception is the ethnic origin of people, because a. differences in desired qualities/facilities may be substantial, and b. the composition of local populations in these terms may differ considerably. See also Buijs et al, 2006).
[13] It has been established that there is a large difference in the yearly number of nature-based day trips per person between people living in the Randstad region and the people living outside this region (Agricola et al., 2011). However, it is unclear to what extent this difference is due to a smaller and less attractive supply of opportunities for such activities in the Randstad region, or to different preferences of the population of this region.

GIS-based Landscape Appreciation Model (GLAM)

The GIS-based Landscape Appreciation Model (GLAM; De Vries et al, 2005) predicts the scenic beauty of the landscape, also referred to as the visual attractiveness of an area. Predicted stated preferences refer to a function that does not necessarily become a service (see Figure 1). To experience scenic beauty, an area has to be visited. In this sense, potential for visual enjoyment is modelled.

Based on a literature study, landscape spatial and physical characteristics that are expected to affect visual landscape appreciation were identified. For each characteristic, an indicator was developed using data from national GIS databases. This enabled the construction of a spatial map of the present (predicted) landscape attractiveness for all the Dutch countryside.

Each indicator was validated separately and adjusted where necessary and feasible. The indicators were combined in a linear model. The weight of each indicator was determined empirically based on survey data and using linear regression (calibration phase). The model generates predicted values for 250 m cells (see Figure 4). However, the calibration was based on average predictions for areas with a 5-km radius. The present GLAM model (2.1) has four indicators:[14] Naturalness, Historical character, Urbanity, and Skyline disturbance.

The GLAM model was validated with data from other surveys, and the results varied considerably with the survey used. Explained variances ranged between 1% and 59%. This might be due largely to the formulation of the question in the surveys on which the validations were based. As the GLAM model focuses on scenic beauty, strong references to the visual aspect of the area may need to be included in the question to get a good correspondence. Therefore the optimal question is considered to be how attractive is the landscape in the specified area looked at? This is a more specific question than, for instance, how attractive do you find the specified area? If the above hypothesis is correct, this would reinforce the argument made earlier that clarity is essential about what the new model is intended to predict.

Recreational Quality Indicators

Based on a literature study, Goossen and Langers, (2000) identified factors for assessing the quality of a rural area for a specific recreational activity. These factors were divided into two groups. One group concerned the scenic beauty (perception quality) and the other group the fitness for use of the area for the activity (utilisation quality). The relative importance of these factors and their levels were determined for each activity, using a conjoint analysis design. Hypothetical areas were described in terms of their levels of the factors and rated by study participants (stated preference). Some factors and their levels were operationalised as quality indicators using GIS data

[14] Similar characteristics and accompanying indicators may also be found in studies on landscape character (see e.g. Tveit et al., 2006; Van Eetvelde & Antrop, 2009). However, the purpose here is somewhat different. The purpose is not to define a landscape typology, regardless of how the types are valued, but to predict scenic beauty ratings (see also, Ode et al., 2008; Uumeaa et al., 2009). These approaches may contribute to one another.

to produce in a national map of predicted stated preference. This last step in the model development was not calibrated and validated. The model deals with the attractiveness or suitability for the recreational function, and not use or the value derived from this use. At least conceptually, this model may be considered a predecessor for the new model. A distinction will be made between scenic beauty indicators and fitness for use indicators, with the latter being dependent on the recreational activity.

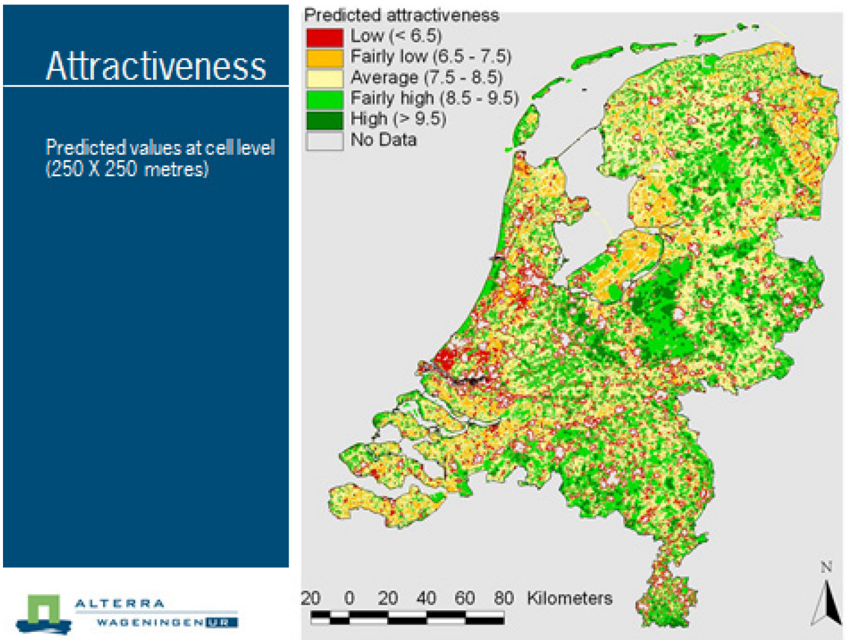

Figure 4 Output map of the GLAM model (version 2.1)

FORVISITS

In contrast to the two previous models, FORVISIT (De Vries et al., 2004; Henkens et al., 2005) predicts use, and more specifically the annual number of visits to individual forest and nature area in the countryside. The number of visits may be considered a first proxy for the recreational value a natural area has for an individual, and when aggregated, for society as a whole (see De Vries, 2009).

FORVISITS is a distribution model. The average number of visits is assumed to be independent of the local and regional supply of forest and nature areas. Moreover, even the distribution of transport by car and by bicycle (modal split) is assumed to be fixed. Each transport mode has its own sub-model.[15] On the supply side, the inputs are the size and recreational quality of nature and forest areas, with quality estimated by the model described above. On the demand side, inputs are the size and

[15] Other modes of transport have not bee included in applications However, in version 2.0 of FORVISITS, there is a sub-model for visits on foot (Henkens et al, 2005).

composition of neighbourhood populations. Another input is the distance between neighbourhood and destination area. For visits by car, distance to the parking area for the destination area is used. For visits by bicycle, beeline distances are used, with a higher 'resistance' of the distance through built-up areas. Distance and quality are used to calculate the relative attractiveness of each destination area within 25 km of the neighbourhood by car or by bicycle. Subsequently, the number of visits expected to be generated by a neighbourhood is distributed according to the relative attractiveness of the destinations within this choice set, by mode of transport. The number of visits originating from different neighbourhoods and modes of transport are aggregated to arrive at a predicted number of visits per destination area. Calibration and validation of the model proved to be difficult because of lack of reliable data on number of visits to forest and nature areas. The new model could offer an improved, and more empirically based recreational quality indicator as input for a model such as FORVISITS.

MyPlaceToBe

The Dutch version of MyPlaceToBe (Goossen et al., 2011a*)* is a website that enables custom-made maps of the Netherlands to be generated indicating the attractiveness of various parts of the Dutch countryside for recreation according to user's own preferences.[16] The first step is a presentation of the landscape surrounding the user's residential area in terms of land use. The user can change this composition to accommodate personal preferences. A constraint is that changes can only be made within the range of land use that occur in the Netherlands. In addition to land use, the website visitor can indicate preferred levels of aspects, such as traffic noise and skyline disturbance. The user can assign weights to different types of land use and other aspects. The percentage of each land use type and the level of each aspect are known for the whole of the Netherlands except for large water bodies. This makes it possible to generate custom-made maps. Before a map is created, the website visitor is asked questions, such as how attractive do they consider the landscape surrounding their place of residence.

The map gives an attractiveness value per 500 m cell, based on the area within a 5-km radius of the cell. Based on the composition of the landscape surrounding the place of residence and the score on additional aspects, a regression analysis was performed for the average attractiveness score per 4-digit postal code area. Only post code areas from which at least five visitors originated were included in this analysis (n = 1664). Eight land use types and four additional aspects were included in the final model that had considerable predictive value (52% explained variance).[17] However, the variables in the regression model are largely inter-correlated, making interpretation of regression weights difficult as the size of unique contributions (possible multicollinearity issues). Nevertheless, this model and the data behind it may offer useful insights for the new model. A positive feature is that a website visitor is confronted with the composition (in terms of land use) and aspect scores of the

[16] There is also a European/English version: www.myplacetobe.eu
[17] This percentage of explained variance concerns the fit of the model after calibration. It has not been validated used independent data, i.e. data that have not been used to develop or calibrate the model.

landscape surrounding his/her place of residence, as a reference point. Thinking about landscape preferences may help to anchor the subsequent preference rating of the individual's 'own' landscape.[18] The variable on which the regression model was calibrated (criterion variable) focused on the landscape attractiveness. The word 'landscape' is assumed to have a strong visual connotation. The website visitor is not asked for the desired infrastructure and facilities for recreational activities, for neither general nor specific activities. The focus is on perception qualities.

Hotspotmonitor
Hotspotmonitor (HSM; www.hotspotmonitor.eu) is a web-based tool for collecting information on which places people consider to be attractive or valuable.[19] It generates spatially explicit information. Respondents are asked firstly to indicate where they live, and subsequently to mark the place they consider most attractive, valuable or important. However, there are some constraints. A place may be in or outside a city or village, but it should be green, water or nature. It may be a place in a park, by a lake, at the sea, in the forest, near cows in the meadow, in a tulip field, a place to watch birds. These can be places the individual has never visited or places visited frequently (Sijtsma et al., in press). The choice set from which to select the place is limited. More specifically, participants were asked to place markers at three levels: local (<= 2 km from home), regional (<= 20 km from home) and national (all of the Netherlands). At the national level, two markers could be placed, the most preferred and second most preferred place.

The Hotspotmonitor identifies the most valuable places at different spatial levels, regardless of the reasons these places are highly valued. It is an integral, overall valuation of the place.[20] Moreover, the difference in spatial level is thought to be highly relevant when HSM data are to be used in SCBAs because both the size of the impact and size of the impact population are important. With regard to use in an SCBA for a proposed regional development plan, the valuation of the new situation should also be available. In addition to stated preference for the existing situation, the predicted stated preference for the new situation after the development is also required. Although the Hotspotmonitor is not a model, attempts have been made to develop a model based on the average density of markers an area of a certain type receives (Sijtsma et al., in press). When continued, this could be considered a related, or parallel model development to the proposed new model.

HSM data give information on the overall attractiveness of a place and not on its use value (see Figure 3). For development of the GREAT model, data at local and regional level may be more important than at national level. There are clear indications that many of the markers placed at the national level signify high attractiveness as a

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[18] Although the answering scale has predefined end points, this process may still make it somewhat of a self-anchoring scale (Cantril, 1965).
[19] Dutch version 1.2: http://www.wetenschapwerkt.nu/hotspot/5/survey/index.php?lang=nl
English (demo) version 1.0: http://www.wetenschapwerkt.nu/hotspot/4/en/survey/index.php
[20] In second instance, people are asked to indicate on which qualities they base the placing of their marker. They have to make a choice from a predefined list with 14 qualities or values, and may add a free-format description.

holiday destination (De Vries et al., submitted). As already argued, additional factors are likely to come into play for holiday destinations compared to day trips. HSM data seem especially useful in identifying fine discriminations people make at the high end of the attractiveness continuum.

2 GREAT conceptual model

2.1 Preface

Our initial ideas for the detailed development of the GREAT model are presented. Chapter 2 focuses on the conceptual model and operationalisation of the conceptual model is presented in Chapter 3. These two phases will not take place in a strict sequence in the development process. We will start with developing a conceptual model, followed by a first operationalisation of a proposed quality that we expect to be important as a GIS-based indicator. However, the plan is to validate this first operationalisation as well as possible (based on available data) and, if deemed desirable, to adjust the operationalisation (and maybe even the underlying conceptual quality). The next step is to try to validate this new version. After operationalising several fitness of use qualities (or additional perception qualities), we will calibrate the model thus far and look at its fit. We will also perform an error analysis and examine the spatial distribution of errors. This may lead to adjustment of indicators and conceptual qualities. Thus, the development process is iterative in nature. As stated above, each recreational activity requires a sub-model.

2.2 Improved and/or additional perception qualities

Scenic beauty is considered to be a perception quality and will be covered in the GREAT model by another model, GLAM 2.1. However, the GLAM model may be improved, and in addition to scenic beauty, there are other perception qualities to consider.

Naturalness

In the present version of the GLAM model, naturalness is one of the four indicators. Validation of the GIS-based indicator shows reasonable correlation with the average naturalness rating given by people familiar with an area (Van der Wulp, 2008: $r = 0,61$ for amount of nature and $r = 0.66$ for spontaneity of nature). The naturalness rating (amount of nature) is strongly related to the attractiveness rating. If the rating on the amount of nature is included in a regression analysis, as well as the four GLAM indicators, the explained variance in attractiveness almost doubles. So, improving the naturalness indicator, in the sense that it coincides more closely with perceptions of naturalness will improve prediction of the scenic beauty of an area considerably. At present, this indicator makes little distinction between different types of nature or ecosystems.

Variety in scenery

In the literature, variety (or complexity) is considered an important aspect (see e.g. Tveit et al., 2006). Usually, it is expected to contribute to scenic beauty, unless it makes the scenery chaotic or messy. Most studies deal with variety at the level of a single scene or view shed (see e.g. Ode et al., 2010). However, for daytrips, variety at a higher spatial level may also be relevant, such as variety in scenery encountered on the trip.[21] While variety at both levels may be expected to be related, especially in areas of low visual openness, low variety at the viewshed level does not have to imply low variety across scenes.

Peace and quiet

One of the frequently mentioned reasons for visiting the countryside is peace and quiet (Coeterier and De Boer, 2001). This is usually connected to low intensity of human activity, and to 'slow' activities. The absence of signs of highly dynamic activities contributes to this perception quality. Such signs may be visual or auditory. Industrial or traffic noise (silence or no non-natural sounds), and noise made by other people contribute negatively to this experience. Recreational use may also detract from this quality, when use is intensive (high density of visitors). See also, De Vries et al. (2010).[22]

Points of interest (non-natural)

Recreational trips may include short stops to visit a point of interest, which need not be nature-based, or about scenic beauty. Such points may be visited because they are considered interesting rather than of scenic beauty. They may also be beautiful without fitting into the surrounding landscape (e.g. some land marks). They can be historical and/or cultural in nature. This is a more cognitive dimension of attractiveness. In line with the focus on nature-based recreation, points of interest are limited to those that are not the main reason to visit to an area and are only a small part of the daytrip. Landscapes may be rated as highly attractive because they are considered interesting or intriguing rather than of scenic beauty. Rather than pleasing the senses, a landscape may tickle the mind.

2.3 Fitness for walking

As fitness for use qualities may differ per recreational activity, qualities are described partly by activity. The focus is on three of the most popular nature-based activities (Goossen et al., 2010, p. 19) ; walking, cycling, water-based recreation (including swimming).

Infrastructure for recreational walking

A key aspect of fitness for use for recreational walking is a network of paths and roads. People tend not to like walking up and down the same road, and like to have choice on where and how long to walk. Compared to other modes of transport, walking is done at low speeds, and thus a rather dense network is considered preferable. Path density (including suitable roads) might be considered a first indicator. However, this is only an approximation of network density. Nodes in the network are important because they determine how many routes and distances are possible in an area. Sometimes, a small stretch of path, or even crossing a previously

[21] For holiday destinations, variety at a higher spatial level is likely to be relevant, allowing for daytrips to different types of areas.

[22] An exception should be made for water-based recreation, especially when swimming is included. This activity usually takes place at high densities. If the sub-model can be calibrated by activity, this will not constitute a problem. See also, Goossen and Langers (2000).

impermeable barrier can open new possibilities without significantly changing the path density of the area (see also De Vries and De Boer, 2006).

The infrastructure does not need to consist entirely of footpaths, although they are likely to be preferred to infrastructure shared with other types of transport. Walking on multi-modal paths or roads requires attention to bicycles and/or cars and motors, which travel at higher speeds. Motorised transport is also accompanied by traffic noise. While dirt paths and roads may be preferred for the recreational experience, hardened surfaces may be preferred by people with walking difficulties, people pushing a buggy, pram or wheelchair, and on rainy days.

Supporting facilities

Not all recreational walks start from home, especially if more leisure time is available. Often, people use another mode of transport, usually a car, to reach an attractive walking destination in the countryside. For such car-based walks, parking facilities are an important quality. The distance from home to destination areas is also an important factor in determining attractiveness. However, this distance is not considered an inherent quality of a destination area, since it also depends on where the potential visitor lives.

In addition to the infrastructure and facilities for the dominant recreational activity, another type of facility may support a longer stay in the area. Examples are benches, picnic tables, fresh water fountains, toilets (and showers), visitors centre, and catering facilities. Because of the focus on daytrips, overnight accommodation, such as campgrounds and holiday resorts, are not included here.

Facilities for additional activities

As well as the points of interest already mentioned, there may also be small-scale facilities for other activities, such as a small playground, maize maze and midget golf. Such facilities can also help to make the area more attractive as a destination for a daytrip. Facilities for other activities that are usually more time-consuming and thus constitute the main activity of a trip are not to be included here.

2.4 Fitness for cycling

The same three categories may be distinguished for cycling as for walking ; infrastructure for the activity, supporting facilities, and facilities for additional activities. Cycling has different infrastructure requirements than does walking. Dirt paths are likely to be less valued, except for mountain biking. Because of the higher speed, the network density may be lower in terms of absolute distances. Destination areas are larger than for walking. Bike rentals may also be considered a part of the infrastructure.

2.5 Fitness for waterside recreation

In waterside recreation, there is a considerable difference whether swimming is involved. Where included, water should be suitable for swimming and the shore should enable easy access to the water. The amount of sediment is important for safety reasons (no sharp rocks or broken glass) and for more sensory reasons (not everyone appreciates the feeling of mud oozing between the toes).

Supporting facilities, toilets and showers are relatively important the longer one stays in one place (Goossen and Langers, 2000). The international Blue Flag quality system requires that beaches are clean and the provision of sufficient toilets and trashcans. Changing rooms may also be appreciated. Catering facilities are also likely to be appreciated by many. Parking space and nearness to the waterside are also relevant.

Facilities for additional activities, such as sunbathing (beach or mown lawn), are likely to contribute to the attractiveness of the site, as well as shade from the sun. Play areas may also be appreciated, for example, for volleyball.

The perceptual quality 'peace and quiet' may be less important for swimming. More so than for walking and cycling, the presence of relatively larger numbers of people may even be considered a positive feature.

3 GREAT operational model

3.1 Preliminary thoughts on operationalising qualities

To compute the current situation, input for the GREAT model will predominantly comprise different types of land use, in grid cells with a resolution of 25x25 m. Grids are used instead of polygons for two reasons. Firstly, combining polygon information from different sources causes sliver polygons, which cause difficulties in analysis. These difficulties are prevented by using grids. Secondly, models run faster using grids than when using polygons.

A small-size grid cell is chosen to keep the model sensitive to relatively small spatial changes but this does not necessarily mean that model output will be meaningful at the level of a single 25x25 meter cell. Even the level of a single view shed is expected to be difficult to model, because spatial configuration or composition of landscape elements is vital (design quality). Moreover, day trips are not based on a single view shed. Thus, the model will generate predictions for areas. Based on experience in validating the GLAM model, aggregated outcomes for areas of 4 km^2 are expected to be meaningful. Alternatively, for presentation of the results at national level, a neighbourhood operation may be performed, averaging predictions for an area with a radius of around 1.5 km.

The main input for computing the current situation will be digital 1:10 000 topographic maps of the Netherlands. These maps contains land use classes representing forests, residential areas, high-rise buildings, greenhouses, water bodies, point elements such as power pylons and wind turbines, and line elements such as trees and ditches. For modelling recreational attractiveness, more input than just land use is needed. Searching for available input data and metrics for modelling scenic beauty and 'fitness for use' by activity is part of the development of GREAT (see also Antrop and Van Eetvelde, 2000; Ode and Miller, 2010; Ode et al., 2010).

In addition to theoretical/conceptual issues, application-oriented considerations may arise in this phase of the model development. Distinctions important from a policy or planning perspective, for example because they can easily be influenced or are subject to debate, will be given extra attention. As indicated before, operationalisation of qualities will be an iterative process.

3.2 Preliminary thoughts on modelling software

Two relatively new programming options are being explored for modelling. Based on the outcome, a software environment will be chosen. An operational requirement is that the model application does not require a great deal of expertise to run. The software should be fairly user friendly.

4 Calibration and validation

4.1 Validation of indicators

Each operationalisation (GIS-based indicator) will be validated to determine whether it indicates what it is intended to indicate. For these indicator-wise validations, no new data will be collected. Thus, validation will be based on available data but not used for the development of the indicator, or based on expert judgement (e.g. by applying the Delphi method). A combination of both methods may be used. After validation based on secondary data analysis, the prediction errors can be mapped. Spatial clusters of errors may show up. Subsequently, field experts will be invited to discuss why certain types of errors occur predominantly in some areas, which may help to improve the indicator. This is a iterative process.[23]

4.2 Calibration of the model

After a number of qualities have been operationalised, a first version of the GREAT model may be calibrated based on available data. As mentioned before, we will start with a simple linear model with the weights assigned to the indicators based on a linear regression analysis. In addition to the weights, this analysis will also give the fit of the model so far. As with the validation of the individual indicators, prediction errors can be mapped, inspected and discussed with experts. This discussion may generate ideas about the type of information needed to improve the model and guide further development. We do not expect to be able to validate the model as a whole within the first year of development.

4.3 Relevant data sets for validation and calibration

For indicator validation, data sets are needed to evaluate landscapes and areas on aspects, or on an overall evaluation in terms of attractiveness. For model calibration, data sets are needed that contain at least an overall evaluation of an area or landscape in terms of attractiveness, preferably attractiveness for recreation.[24] If the available data sets contain landscape or area evaluations that are not precisely defined according to what the model aims to predict, this has to be taken into account.

Data sets considered are:

- HSM data ; spatially explicit locations with a high overall attractiveness (not otherwise specified), no aspect ratings but with predefined list of 14 value levels that could be used to indicate the qualities of the marked place.
- WoON data (2006/2009) ; some aspect ratings. WoON is a large-scale survey that was done in 2006 and in 2009, with a focus on the home and direct residential environment. In both editions, different questions were asked about the wider living environment (De Boer and De Groot, 2010).

[23] After a first validation, the next round may not strictly speaking qualify as a validation. By then, the data have been used to guide the refinement of the operationalisation.
[24] Attractiveness as a setting for a specific recreational activity, such as walking, would perhaps be better. However, it is unlikely that such data sets are available for a representative sample of the Dutch population.

- Website www.daarmoetikzijn.nl ; overall attractiveness rating of landscape on 10-point scale.

For recreational use, there is no on-going monitoring programme that generates reliable data on visits to specific places. One version of the Hotspotmonitor offers data on places visited for recreation in at least in one version/study (Goossen et al., 2011b). Some modifications could help to generate information that is especially useful for model development and calibration. For example, rather than asking for the place last visited, the tool could ask for the places visited most often. Participants could delineate the area they visited more precisely, rather than just place a marker. At present, participants are asked whether the marker stands for the exact spot or indicates a larger area, but this is only of limited use.

4.4 Impact population

The ultimate goal is to determine or predict the value people award to their recreational use of an area. This implies that only Dutch citizens who will visit the area are relevant, tourists as well as local inhabitants. This group is called the impact population. However, to be able to predict the impact population also the preferences of people that will not visit the area are relevant. Therefore, the total Dutch population is relevant.

This leads to the conclusion that preferably a representative sample of the Dutch population should be used to calibrate or validate the model for recreational attractiveness. An important question with regard to representativeness is whether preferences may be expected to differ spatially. If so, a sample representative at the national level need not be representative for a specific region. Spatial stratification of the sample may help to reduce this problem.

While people may respond to representations (e.g. photos) of landscapes whether or not they are familiar with the landscape, without such representations they can only judge or rate landscapes they are familiar with. In some studies used for calibration or validation, people were asked to rate the countryside near where they live. All ratings were given by local people. This raises the question whether the ratings are representative of the Dutch population. Would people living elsewhere have rated the landscape differently? It is likely that familiarity increases attractiveness. However, as long as the increase in attractiveness due to familiarity is the same everywhere, it will not affect relationships between physical landscape characteristics and attractiveness greatly, in the sense that differences in attractiveness will remain the same. A study by De Vries and Gerritsen (2003) suggests that the landscape in a person's region of origin does not have a strong effect on their landscape preferences. This notion is supported by a recent study by Goossen et al. (2011a). In this study, people living in densely forested areas indicated that their ideal landscape contains fewer forests, and the reverse was the case for people living in sparsely forested areas; preferences tended to converge.

5 GREAT model applications

5.1 Required applications by PBL

Netherlands Environmental Assessment Agency (PBL) needs tools for making policy evaluations on a national scale for the Netherlands. The need differs with the type of evaluation. The GREAT model should preferably be applicable for all types of evaluations and thus meet the requirements for the different types. Three types of evaluation were identified for which the GREAT model should to be applicable:

Type of application	**Associated PBL products**
Long-term scenario studies	Nature Outlook (every 4 years)
Impact evaluation of policy measures	Assessment of the Living Environment 2012 (every 2 years) Analyses of the election manifest for 'Charted Choices' in cooperation with the Netherlands Bureau for Economic Policy Analysis (CPB)
Societal cost–benefit analysis	For example, MKBA Schaalsprong, Almere

The applicability of the GREAT model for the different PBL products based on the above three types of analysis is discussed. Monitoring is not included as a possible application. Experience with GIS data for monitoring has shown that this is not a viable approach. Data collection is often not standardised to such an extent that it can safely be assumed that changes in the data between T1 and T2 are due to changes in the physical world. Often, changes are due to differences in the way data are collected and/or processed.

5.2 Long-term scenario studies

Every four years, PBL publishes a Nature Outlook. These outlook studies provide insight into trends in society and/or environment in relation to possible policy measures for nature and landscape. During the project, ex ante evaluations are made for different themes, one of which is attractiveness of the Dutch landscape.

The Nature Outlook usually works with different scenarios as a basis for the ex ante evaluation. To evaluate the effect on attractiveness of the scenarios, spatial explicit information is needed as input for the GREAT model.

For the Nature Outlook, the PBL uses the Land Use MOdeling System (LUMOS) model for forecasting land-use change as an effect of different driving forces. The aim is to develop the GREAT model to use the output of LUMOS. This requires that either the GREAT model is developed to directly use LUMOS output as input, or LUMOS output can be converted to GREAT input.

The LUMOS output consists of grids with a land use classification with a resolution of 100 x 100 m. The current land use classification in LUMOS comprises the following classes: housing, recreation, employment, nature, agriculture, livestock farming, greenhouse horticulture, intensive livestock farming and infrastructure (Figure 5).

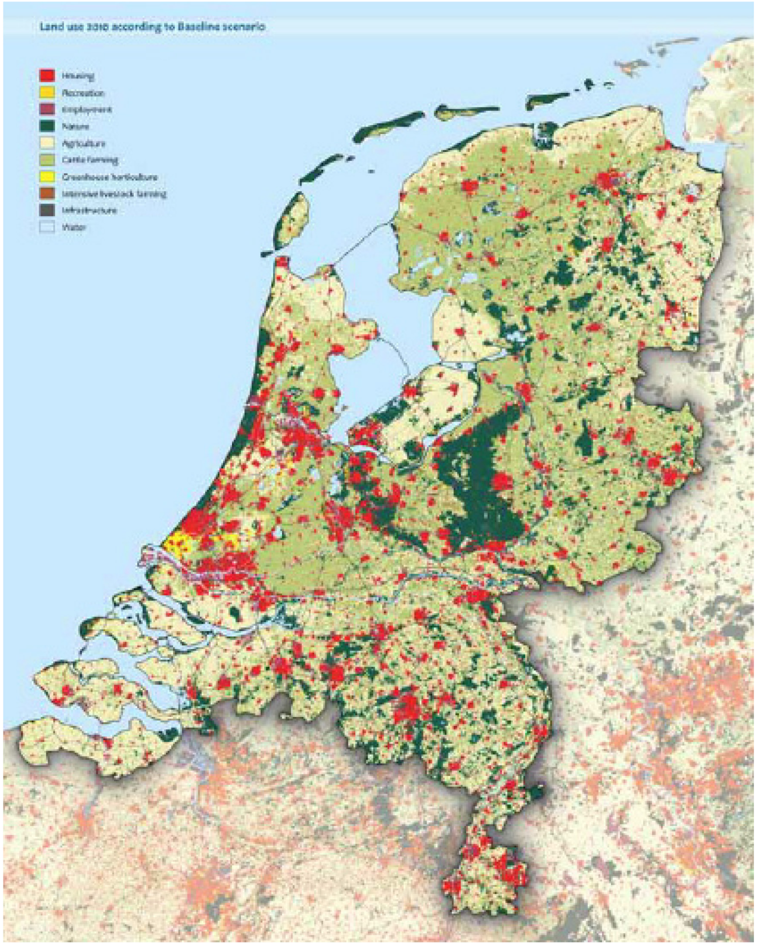

Figure 5: Example of a scenario output of LUMOS (MNP, 2010).

This land use classification is limited in terms of relevant information for estimating recreational attractiveness. Specific land cover types, such as linear green elements, are not part of the classification. Also, nature types and information on recreational infrastructure for walking and cycling are not differentiated in the LUMOS output. As a consequence, the GREAT model must be developed to deal with these limitations of the LUMOS scenario output. The grid size of 100x100 m of LUMOS output must also be taken into account because the GREAT model will use input of 25x25 m grid cells.

This problem may be partly solved by developing and implementing knowledge rules that translate the LUMOS output to more fine-grained GREAT input. For example, it may be assumed that if the land use in an area remains the same, other characteristics of this area (on which LUMOS does not offer information) will also remain the same. This type of approach to run the GLAM model has been used for previous Nature Outlook studies. However, such knowledge-rule based translations are only possible with fixed and clear relationships between LUMOS output categories and GREAT input categories (which may be conditional on other available information).

For more fine-grained information about nature types, the output of the 'Meta Natuurplanner' can be used.

An alternative approach is to take the LUMOS output and create widely differing versions of GREAT input in the range of possibilities that the LUMOS output allows. These different versions can subsequently be used to perform a sensitivity analysis. If they result in quite different GREAT outcomes, then it clearly depends on the specification of the LUMOS output used as an add-on to the original scenario that gave rise to the LUMOS output. If the different versions result in more or less the same GREAT outcomes, then further specification of the scenario is not necessary (and perhaps new or additional knowledge rules can be formulated).

5.3 Impact evaluation of policy measures

Another application of the GREAT model would be the ex ante evaluation of the effect of policy measures on recreational attractiveness. No land use maps are available for use as input in the GREAT model. Therefore, the GREAT model will be made suitable to deal with non-spatially explicit policy measures. This can be done by making 'knowledge matrices' in which expert knowledge is used to relate policy measures to an effect on physical landscape characteristics. For instance, an increase in budgets for landscape management will positively affect the amount and quality of landscape elements, resulting in an increase of naturalness and subsequently attractiveness. Thus, more quantitative assessment of policy measures of autonomous trends can be made without having detailed land use input from, for instance, LUMOS.

During national elections, political parties in the Netherlands have the opportunity to send proposed policy measures to the Netherlands Bureau for Economic Policy Analysis (CPB) and the Netherlands Environmental Assessment Agency (PBL) to calculate the effects. The results reflect the effects of the different choices political parties make. One indicator on which the effects must be evaluated is the attractiveness of the Dutch landscape.

In recent evaluations of proposed policy measures of political parties, it was not possible to perform a quantitative evaluation. Instead, expert knowledge was used to estimate the effect of policy measures without using a computer model. The disadvantage was that the evaluation was not spatially explicit and could not be repeated or adjusted easily. With the GREAT model, a more quantitative and more spatially explicit evaluation can be carried out. The problem of how to translate proposed policy plans and measures into input for the GREAT model needs to be solved in order to use the model, as discussed in Section 5.2.

Where policy plans and measures are formulated in well-known terms, there are knowledge-based rules. In other cases, new rules may be developed. Where there is too much uncertainty, the sensitivity analysis approach may be applied. This entails envisioning widely different but realistic implementation of the proposed policy measures, in terms of the input needed for the GREAT model, and running these different versions with this model.

Compared to the long-term scenario application with LUMOS output being available, the proposed policy measure may not only be 'crude' in content, but also in spatial explicitness. Thus, it is likely that different spatial implementations need to be developed, for instance, for assessing the effect of planning more green recreational areas around cities. The effect of the total size of these new areas in combination with the choice of locations of these new areas can be assessed more quantitatively than possible in the current situation of using expert knowledge without a model.

5.4 Social cost−benefit analysis

To evaluate large-scale regional projects, PBL uses social cost-benefit analysis (SCBA). To evaluate quality indicators, such as recreational attractiveness, the GREAT model could be a tool for this type of analysis.

When societal cost-benefit analysis is applied, detailed maps are made of the current situation and the situation after the project. This information can be transferred to grid input for the GREAT model and subsequently be used to compare the two situations. From that point, the application is comparable with that described in Section 5.2. One possible difference between the long-term scenarios set out in Section 5.2 and the social cost-benefit analysis is the need for more differentiated land use types. This is caused by the scale on which social cost-benefit analysis is done. In developing the GREAT model, an issue requiring special attention will be the adaptions needed to evaluate more detailed land use maps.

5.5 More general requirements

In the introduction, three requirements of an effective knowledge system for sustainable development were stated ; saliency, credibility and legitimacy. These requirements concern the influence of the information generated by the knowledge system on policy making and planning, passive acceptance and active use of the information presented. In this sense, they are additional requirements to the scientific requirements. Meeting the scientific requirements is likely to contribute to the credibility of the knowledge system. However, it may be argued that this is only one way for a knowledge system to obtain credibility and sometimes may not be sufficient.

Saliency concerns selecting the right indicators ('graadmeters'), the type of information and knowledge relevant for decision makers. This may be either information that decision makers are interested in or information that they cannot afford to ignore. Saliency does not only depend on the content of the information, but also when it becomes available and on the way it is presented. For some of the applications mentioned above, the information has to be available within a relatively short time period. For ecological information, this requirement has led to the development of simplified knowledge-rule based model because the original process models took too long to run.

The timing aspect does not seem to be a critical factor in models for scenic beauty, recreational attractiveness and/or recreational use. Once developed, they require a short time to run. There are no well-established process models available on which to base simpler knowledge-rule based models. In this domain, knowledge rules will have to be based on expert opinion, rather than on more sophisticated and empirically validated process models. Information that is salient may also change with time. Indicators may need to be adapted to changes in relevant policies. Currently, the GLAM map serves as an indicator for scenic beauty and is part of the Compendium voor de Leefomgeving (http://www.compendiumvoordeleefomgeving.nl), as one of the landscape indicators (indicator nl1023).

Legitimacy concerns whose values are taken into account. In addition to economic value, also moral and political values are relevant. Clarity about the model scope may help to prevent legitimacy discussions. For example, recreational use value is not the same as total economic value. Other types of economic value are not taken into account and different stakeholders may think differently about these other types of value, including non-use value, such as bequest value, existence value, and, arguably intrinsic value.

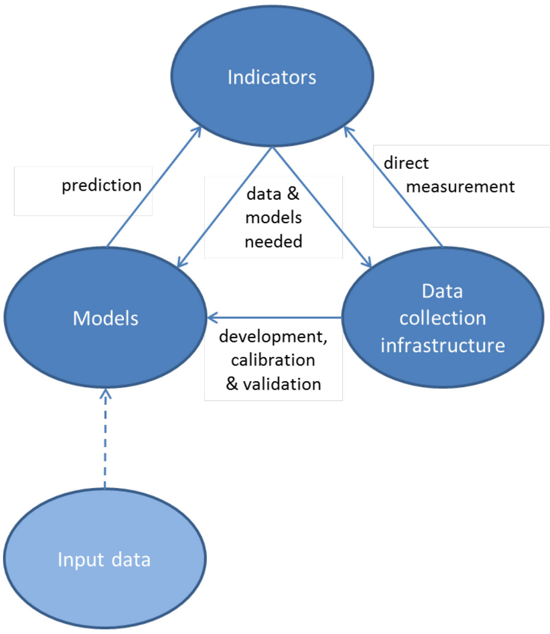

Figure 5 Triangle of indicators, data collection infrastructure and models plus input data for models

The desired endpoint goes beyond an operational set of models. Based on experience in other domains, especially biodiversity, PBL envisages a triangle of indicators ('graadmeters'), data collection infrastructure ('meetnetten') and models (see Figure 5). The indicators are at the top of the triangle and determine the data and models required. For the present situation, data collection may directly provide indicator values. In other situations, direct measurements of the indicator for the present situation may not be possible (or too expensive) and some modelling may be needed.

For hypothetical or future situations, direct measurements are usually not possible, and more extensive modelling is likely to be required. In these cases, direct measurements are replaced by predictions of the indicator values. The data collection infrastructure in Figure 5 refers to data collection with regard to direct measurements of the indicators (or at least close proxies). This type of data is also required to guide model development, and for calibration and validation. Such data may be distinguished from the data the models need as input, which do not have a direct relationship with the indicators.[25] Especially that part of the data collection infrastructure is relevant for which PBL is responsible, or at least involved in.

Coherence is not only required between indicator, data gathered and model, but also between the indicators. Indicators in the same domain, such as cultural ecosystem services, should form a coherent set. Indicators in the set may complement one another or may be linked hierarchically. Inconsistencies within the set should be avoided because this can lead to conflicting outcomes. A possible set would be:

- Scenic beauty of natural area
- Recreational quality of natural area (potential recreational use value)
- Local and regional use of natural area (day trips starting at permanent address)
- Tourist use of a natural area (day trips starting at holiday accommodation)
- Total recreational use of a natural area (local, regional and touristic combined)
- Recreational use value of a natural area
- Support for conservation of a natural area/resistance to changes in that area.

The data collection infrastructure should be as coherent as possible. However, not all of this infrastructure may be controlled by PBL. Efficiency considerations also contribute to the importance of a coherent data collection infrastructure. This may even hold across domains. Tensions may arise between efficient data collection and collecting the right data. Also the coherence of the different models used by PBL is important. For example, as already mentioned, one of the desired applications of GREAT requires good interface between LUMOS output and GREAT input .

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[25] If it is desired to keep the scheme confined to the triangle, the input data could be subsumed in the data collection infrastructure and an arrow from models to data collection infrastructure could be added, signifying that then the models also define which (input) data are needed.

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Gewijzigde veldcode

Attachment 3 Review 1

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Introduction

PBL Netherlands Environmental Assessment Agency is responsible for research and support for political discussion and government decision-making. To aid in this, PBL needs monitoring systems and models for strategic policy analysis and assessment. Current monitoring systems and models in use by PBL are the Hotspotmonitor (gathering data on landscape preferences), the GLAM model (modelling landscape appreciation), and the AVANAR model (recreational opportunities).

At present, PBL in cooperation with Wageningen UR (WUR) and University of Groningen (RUG) are developing an improved model for landscape appreciation. This is presented in the proposal for the GREAT model (GIS-based REcreational ATtractiveness).

PBL has provided detailed Terms of Reference for the project, framing the proposed project within the core tasks of PBL. A primary concern of PBL in landscape and nature assessment is the policy relevance, with which the toolbox including indicators, monitoring systems and models must comply.

PBL has identified some limitations of the currently used tools regarding landscape appreciation and recreation. The first concern is that these tools do not fit the cost-benefit analysis (CBA) practice. This is a government requirement enabling integrated evaluation, for example, in relation to different types of national investment and development projects.

PBL is also concerned about the preferences in the model being stated rather than revealed, and wants the improved model to link with behaviour. It is also stated that the current indicator is limited to scenic beauty, and although important, it should be expanded to encompass attractiveness, for example, for living, working or recreation. The current model does not provide information about impact on the population, the size of the population affected either positively or negatively by landscape change.

Another main concern with the current GLAM model is its limited predictive power, in both the qualitative and spatial sense. The model operates with three very broad land use classes (natural, agriculture and urban land), and can only discriminate changes between these three. This rather coarse approach limits usefulness in terms of evaluations of proposed developments, projects and policies. Thus, an improved model is needed to reach greater detail in terms of nature characteristics, and other land use classes that are most important for people’s appreciation linked to recreation.

As a consequence, PBL has set out the following requirements for future modelling of preferences with regard to recreational use of nature and landscape:

1. The model should assess a policy relevant indicator ; the value of potential recreational use by the Dutch population based on the physical characteristics of an area and the size of the impact population.
2. The model should be useful in assessing effects of relevant policy measures.
3. The model should enable comparison of the effectiveness of measures in different regions and thus be sensitive to relevant spatial differences.
4. The model should fit in the PBL model framework.

This review is aimed at improving the joint research programme on perception and recreational use of nature and landscape to provide a strong starting point for further development of the project, project plan and future model.

The reviewers have been asked to address five choices:

1. Which indicator is best suited to PBL policy studies for the national government, and in particular, which is the best aggregation level to indicator appreciation going from scenic beauty, recreational attractiveness, recreational use, to value derived from recreational use.
2. Scale levels. Should the model focus on all three scale levels (national, regional and local) as in the Hotspotmonitor or should it focus on the local or regional scale?
3. Should PBL focus on development of a model or data collection with the Hotspotmonitor? Maybe, investment in data collection is more profitable than investment in expanding 'a rather good' regression model of appreciation of scenic beauty.
4. Which policy measures (described in the Terms of Reference) can be evaluated by the model proposed in the GREAT model proposal and which not? Are there policy measures that cannot be evaluated by any model given the state of the art knowledge?
5. Which parts of the proposed GREAT model will be a profitable investment and which not at all?

Assessment of the GIS-based REcreational ATtractiveness model (GREAT)

The proposed model is a GIS-based model of recreational attractiveness. The model aims to predict the value that Dutch citizens assign to areas for recreational purposes. The scope is nature-based recreation in the Dutch countryside , focusing on day-trips. The proposal sets a scheme for the extended model starting with the different recreational activities and the recreational attractiveness for these activities. From this, the overall recreational attractiveness is achieved, which together with the accessibility of the destination area makes for the attraction value of the area. From this, and from the attraction value of competing areas, the recreational use of the area can be predicted. The final step is predicting the value derived from the recreational use.

The proposal suggests a stepwise approach, starting with recreational attractiveness, then including recreational use and finally modelling recreational use value. The first step, modelling the recreational attractiveness and value when visited, is the focus of the proposal. Given time and resource limitations, another possibility is to flip the process and go directly to modelling the recreational use value. However, according to the proposal, this would be at the expense of level of detail and thoroughness in modelling the recreational attractiveness.

The model integrates people's landscape appreciation and recreational value and will provide an integrated indicator of landscape attractiveness that is policy relevant and useful for several PBL purposes, although in its current state there are limitations for others. It is a cost efficient way of approaching overall recreational attractiveness on a national level, as well as regional and local levels. It will include the size of the impact population, which was a limitation of the previous model. It should communicate with other relevant models in the PBL framework.

One of the weaknesses with the proposed model, or identified areas for improvement for the development of the project comes from the GLAM model. A crucial point will be to achieve the level of detail needed in landscape characteristics for the model to be relevant with regard to what people perceive and appreciate as attractive for recreation. The original GLAM model only distinguishes three very coarse land use classes. It does not reflect that nature (or any of the other classes) as a category holds a vast variety of landscapes and landscape characteristics which are perceived and appreciated quite differently by people (e.g. Lamb and Purcell, 1990; Ode, Tveit, and Fry, 2008). This is a serious challenge to the predictive power of the model as well as its usefulness in reflecting and predicting what people perceive. Although the explained variance in earlier calibration is rather high considering the coarse land use classes and indicators, it is probably not at a sufficiently high level for PBL purposes.

The GLAM-2 model operates with four indicators; two positive: naturalness and historical character; and two negative: urbanisation and skyline pollution. In the proposal, there are several suggestions on how to include different landscape characteristics and to diversify the input to the model, which is of great concern, particularly with regard to naturalness and historical character. This will be a crucial point in terms of increasing the predictive power of the model. Balancing the need for detail, appreciating that people do not perceive the landscape from a bird's perspective, and finding the right and available input data and metrics for scenic beauty and fitness of use is a challenging task.

An important requirement in the Terms of Reference is that the model developed is sensitive to relevant policy measures:

- Public investment in construction, restoration and improvement of nature reserves, landscape elements and recreational facilities;
- Public financial allocations for management of nature areas, parks, high value agricultural land and natural and cultural landscape elements;
- Restrictions to or plans for building new elements that disturb the landscape, such as wind parks, large sheds and new infrastructure.

Assessment of the first and second points above is limited in the GLAM framework because of the coarse land use categories. Even in the GLAM-2 model, the categories in the naturalness class do not distinguish between different types of natural landscapes. For example, heath, dunes, swamps and forests are all counted equally when the percentage ‘nature’ is translated to 5 levels (0-4). Values of the different indicators are added to an integrated indicator value of predicted attractiveness.

Changing one nature type for another will thus not be detected within the model, as I understand it. This problem arises in the calculation of the naturalness indicator. In the integrated overall indicator, it is difficult or impossible to distinguish which change in which landscape quality changes the overall indicator. Differentiation in management regimes will be even more challenging. Thus, to meet the requirements in the first point above, substantial changes would need to be made to the GLAM-2 model, introducing more detail in the land use classes and landscape characteristics within the indicators, particularly the naturalness indicator. Whether this is feasible with currently available data sets is a concern.

With respect to the third bullet point, this is probably possible to do with the model as proposed, at least in terms of applying restrictions to and avoidance of plans for introduction of new elements that disturb the landscape in areas of very high recreational attractiveness and potential use value. This requires achieving the required predictive power of the model. In this setting, the information provided by the integrated indicator may be adequate for PBL purposes. Values assigned to areas using the model could be supplemented with information from the Hotspotmonitor.

Increasing the predictive power will be a prerequisite for making and improving a model rather than investing in data collection, for example, through an extended version of the Hotspotmonitor. Provided adequate predictive power of the regression model of appreciation of scenic beauty, the model should be useful for PBL purposes, such as outlook surveys and support in decision-making and prediction of short- and long-term effects of projects, interventions, and overarching policy and management measures (ref. Terms of Reference).

At a more detailed level, where the usefulness of an integrated indicator is more limited (for reasons mentioned above), additions to the Hotspotmonitor would be of great interest to collect valuable information about recreational landscape preferences in the Netherlands. If this approach is chosen, I would underline the need to retain the original elements of the model and any changes are additions not replacements of original features, to ensure continuity and comparability in collected data over time.

As to the different levels in the Hotspotmonitor, I suggest focusing more on the local and regional level. From a public health perspective, the local (everyday) scale and the regional scale are the most important for overall effect. The national level is probably more important from a holiday and tourism perspective. Differences in preferences in relation to distance from home were already detected in the data gathered with the Hotspotmonitor. As landscapes affect people’s health both directly and indirectly (Hansmann, Hug, and Seeland, 2007; Hartig, Evans, Jamner, Davis, and Gärling, 2003; Kaplan and Peterson, 1993; Ulrich, 1979), it is a raising concern to provide people with surroundings in their everyday lives that are aesthetically pleasing and that also promote health and well-being.

In this respect, a major concern is accessibility to recreational areas for close-to-home everyday recreation as well as for day-trips (e.g. Koppen, Accepted). The proposed model incorporates information about suitability for different recreational purposes, such as walking, bicycling and water-related activities. Recreational purpose is key to the perceived recreational attractiveness, and paths and trails as well as different types of leisure facilities have been found to be of importance for perceived accessibility and recreational attractiveness. These are included in the model. However, accessibility also has cultural, social and juridical dimensions not included in the model. The model does not aim to detect group differences, although such differences may be considerable in preferences for different landscape types.

Given the time and resource limitations, a crucial decision is whether to settle for developing the first step of the model and make a detailed approach to recreational attractiveness, or to flip the process and go directly to modelling recreational use value at the expense of level of detail.

The indicator that best suits PBL policy studies for the national government is a key question, and will affect many of the other considerations provided in this review. The model suggests several aggregation levels for recreational appreciation, going from scenic beauty, recreational attractiveness, recreational use to value derived from recreational use. Whether recreational value of an area from the PBL perspective should be seen as dependent on actual use and the value derived from that should be discussed thoroughly. This is an underlying assumption in the current proposal and Terms of Reference that could be questioned. In our discussions in Bilthoven related to this review, it was stated in relation to the Hotspotmonitor that an area could have strong value to a person even if the frequency of visits was very low, such as once a year or less frequently. This goes against changing the data collection to frequency or length of stay.

It is also uncertain whether opting for revealed preferences would strengthen the link to CBA. I believe that for the model, the proper aggregation level may well be the recreational attractiveness (potential for use). In this case, flipping the approach as discussed above is not appropriate. At this stage, I am uncertain whether taking all the steps to recreational use value, from stated to revealed preferences, is necessary for the model to be valuable to PBL, and whether these steps would substantially increase the value of the model.

Conclusions

- The proposed model is of value for several of PBL purposes, but needs further development (particularly naturalness indicator) to be useful for others, such as detecting changes in land use classes.
- The predictive power of the model needs to be increased.
- There may be reason to reconsider the assumption of linking recreational value to revealed preferences and subsequently including all the steps in the proposed model.
- The recreational attractiveness may be the adequate aggregation level for most PBL purposes.

- The Hotspotmonitor should be developed alongside the GREAT model, providing valuable information about people's recreational preferences. The focus should be on developing the monitor at local and regional level. The original setup should be kept intact during the development.

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Attachment 4 Review 2

Agnes van den Berg (University of Groningen)

Summary/background

The Netherlands Environmental Assessment Agency (PBL) needs tools to support the prospective evaluation of the impacts of spatial plans and developments on people's appreciation of nature and landscape. Currently, the main model used by PBL for this purpose is GLAM, a GIS-based Landscape Appreciation Model.

The GLAM model predicts the scenic beauty of nature and landscape outside the cities from nationally available data on four physical indicators: naturalness, historical character, urbanity and skyline disturbance. The GLAM model has been empirically validated in several studies that show that the model captures a substantial amount of the geographical variation in scenic beauty with only a few predictors. However, a key problem is that the model is insensitive to more fine-grained variations in different types of settings.

Findings from the national Hotspotmonitor, a web-based tool for collecting data on places people find attractive, suggest that setting type does matter to Dutch people. Some types of natural places, the 'Hotspots' are more frequently marked as attractive on the map of the Netherlands than other places. Thus, the GLAM model appears to fall short on predicting people's appreciation of different types of natural settings. Consequently, the model cannot be applied for cost-benefit analyses, which typically involve comparison of an existing situation and various plan alternatives at a very detailed scale level (for instance, should a new road go through the part of the forest with pine or deciduous trees).

A second limitation is that the GLAM model focuses on predicting scenic beauty, but the concept of nature valuation or public apprehension is much broader. People's appreciation of nature and landscape is not only a function of beauty, but also of the attractiveness and usefulness of an area for recreation and other activities, and the values derived from those activities. PBL is considering extending the model to other output variables to increase its policy relevance and to provide a more accurate estimate of the real value of nature and landscape for the Dutch public.

There are two key reasons why PBL wishes to improve their landscape appreciation model:

1. The current model is too coarse to capture subtle differences in appreciation between different types of natural settings at a detailed spatial scale.
2. The current model uses a narrow definition of appreciation in terms of scenic beauty that does not take into account the value of nature for the welfare of society.

Proposal for developing a new GREAT model

Research institute WOT-WUR has made a proposal for the further development of the GLAM model, so that it will meet PBL needs. The acronym of the new model is GREAT (GIS-based REcreational Attractiveness). The GREAT model is considered to be the first step towards developing a more encompassing recreational use value model. The GREAT model aims to predict the attractiveness of areas in the Dutch countryside for nature-based daytrips from the perceived beauty and fitness for use of the areas. To achieve this aim, the following activities are proposed:

a. improvement and/or extension of the naturalness indicator and other visual quality indicators of the perceived beauty component of the model;
b. development of fitness of use indicators for recreational activities, such as distance from home, car parks, cycling paths and other facilities.
c. validation and calibration of a first version of a model that predicts the attractiveness of an area for nature-based daytrips from the perceived beauty and fitness for use indicators.

For all three activities, the researchers plan to use secondary data from national surveys and other sources. The next step in the model development is to try to predict recreational use of areas from recreational attractiveness of the areas and competing attractiveness of other areas. For this activity, additional data will probably need to be collected, for example, by using an adapted version of the Hotspotmonitor.

General comments

The limitations of the current models are clearly and accurately identified and described by PBL in the Terms of Reference, which also clearly indicates why PBL needs to address these limitations. Thus, there seems to be a sound rationale for investing in the development of an improved landscape appreciation model. However, it is less clear whether the proposed investment will lead to the required outcome. My main concern with the proposal is that PBL and WOT-WUR seem to be committed to one specific model development scenario, while there are many alternative scenarios that should be considered before a final choice is made. Thus, I suggest that PBL and WOT-WUR reconsider the following basic issues/decisions.

Focus on recreational use

While recreational behaviour may seem a more tangible outcome than scenic beauty, it is also generally considered a luxury rather than a basic need. Thus, it seems doubtful whether a focus on recreational use or attractiveness for recreation will make the model more relevant to assessment of the importance of nature for the welfare of society than a focus on scenic beauty. Another argument against recreational use as a central concept for modelling the value of landscape to people is that it highlights easily measurable use characteristics and facilities, such as benches and parking lots, instead of the more difficult to measure 'experiential characteristics' that are more at the heart of people's landscape experience.

To increase the policy relevance of the GLAM model, the focus needs to be shifted from scenic beauty to health benefits and restorative potential. It could be quite strategic to replace 'scenic beauty' with 'restoration likelihood'. The importance of restoration (or relaxation, stress reduction) as a basic need and benefit for society is widely recognised. In my own research, I have found correlations of .90 and higher between scenic beauty and restoration likelihood (of photographs), and this strong correlation is confirmed by other studies. This suggests that moving from beauty to restoration likelihood would require little changes to the current GLAM model but would make a large difference in terms of societal impact.

In a next phase of model development, restoration likelihood could be linked to objectively measured health. However, I am not sure whether the added value of an extension to health is worth the effort. Empirical data suggest that objective health measures are not very sensitive to variations in physical characteristics of nature and landscape, except for naturalness. Thus, a model of the health benefits of nature is not likely to be more discriminatory with regard to physical characteristics than a model of scenic beauty.

More fundamentally, I think that scenic beauty and recreation are complementary indicators of cultural ecosystem services rather than hierarchically linked indicators, and thus should be represented by distinct models. It does not seem right to reduce scenic beauty to an indicator of recreational attractiveness, as proposed in the GREAT conceptual model. It could just as well be argued that recreational attractiveness is subordinate to scenic beauty. For example, it has been found that the presence of 'walkable' grounds and other 'affordences' are important predictors of scenic beauty.

Alternatively, scenic beauty and recreational use could be conceived of as indicators or predictors of the general attractiveness or perceived quality of an area. Thus, I would advise maintaining separate models for scenic beauty and recreational attractiveness and use. The two models will be overlapping, and output from one model may be used as input to the other model (e.g. data on recreational use could be used to calculate the number of people affected by changes in scenic beauty). However, the two models should be clearly separated in the PBL toolkit.

Focus on landscape/countryside

Similar to the current GLAM model, the proposed GREAT model focuses on the attractiveness of areas in the countryside, and urban areas are not included in the model. However, green space in the nearby living environment may be equally important to urban residents as nature further away, as is also indicated by the Hotspotmonitor. In the long term, the cumulative benefits of green space exposure in the living environment may be even stronger than the benefits of more accidental recreational visits to the countryside. Thus, restricting the model to landscape outside urban areas may greatly reduce its relevance to the welfare of society.

An important advantage of including urban areas in the model is that it opens up the possibility to build a more multifaceted model that focuses on people's general satisfaction with green space and nature in their living environment. This satisfaction is predicted from a broad spectrum of experiential, recreational and other functions and qualities of the areas. This may ultimately yield a more comprehensive estimate of the value of nature to people than a model based on the value that people derive from recreational use. By including urban areas, the model will also be more compatible with the Hotspotmonitor, facilitating data exchange between the two models.

Focus on secondary data

The availability of secondary data appears to be a guiding principle for the proposed research. However, it is clear that all the available data sets suffer from limitations that compel the researchers to adopt suboptimal solutions with respect to the theoretical and practical relevance of the model. Given these limitations, a more viable strategy would be to allocate more budget to the collection of primary data that fully match the researchers' needs.

In the Terms of Reference, PBL clearly indicates that data collected with the Hotspotmonitor (HSM) is very useful because the data capture differences in preferences for different types of settings not captured by the GLAM model. If HSM data could be linked to physical characteristics of the settings, it would be a very useful tool for cost-benefit analysis. However, at present the HSM database is not large enough and data are not sufficiently spread across regions to calculate reliable relationships at the national level. Strengthening the HSM database by conducting a nation-wide survey of a large geographically representative sample may provide the data needed to develop a powerful nature appreciation model with strong internal and external validity. This option deserves carefully considered as a possible alternative to the current research proposal.

Basic choices

In an email dated 5 June 2013, Hans Farjon of PBL formulated five basic choices or questions for the reviewers to provide feedback.

1. Which indicator best suits PBL policy studies for the national government? I am especially interested in the best aggregation level to indicator appreciation going from scenic beauty, recreational attractiveness, recreational use to value derived from recreational use.
2. Scale levels. Is it recommended to focus on all three scale levels as in the Hotspotmonitor or should we focus on the local or regional scale?
3. Should PBL focus on development of a model or data collection with the Hotspotmonitor? Maybe, investment in data collection is more profitable than investment in expanding 'a rather good' regression model of appreciation of scenic beauty.
4. Which policy measures (described in the Terms of Reference) can be evaluated by the model as proposed in the GREAT proposal and which not? Are there policy measures that cannot be evaluated by any model the state of the art knowledge?
5. Which parts of the proposed GREAT model will be a profitable investment and which not at all?

These questions are addressed below.

Ad 1.

It seems that a fundamental choice for PBL is whether landscape appreciation should be measured in terms of subjective indicators or 'stated preferences' (scenic beauty, recreational attractiveness), or whether moved towards more objective indicators or 'revealed preferences' (recreational use, economic value derived from recreational use). In general, both options have advantages and disadvantages. While objective indicators are more tangible and easier to monetise than subjective indicators, they are more difficult to interpret because they are influenced by many other variables apart from people's appreciation of the area. Thus, in choosing between objective and subjective indicators, there is a trade-off between relevance and reliability.

In general, there is no single answer to the question which indicator best fits the needs of PBL, because different questions and situations require different indicators may be most suitable. However, if a choice has to be made, priority should be given to developing a reliable and sensitive subjective indicator of landscape appreciation in terms of people's evaluations and judgments. To capture the multifaceted nature of people's nature appreciation, an indicator should measure the general attractiveness, perceived quality or residential satisfaction with nature and landscape rather than merely scenic beauty. When a broad subjective indicator is available, it can be used directly for monitoring and evaluation, or indirectly as a building block for more objective (use or value-related) appreciation indicators.

Ad 2.
At national level, relatively few highly appreciated areas and regions are well known (e.g. Wadden Sea, Veluwe, North Sea coast, South Limburg). People's appreciation of these 'national monuments' can be easily monitored by surveys (e.g. ask people to rank or grade a list of areas). There is not much added value in a model that predicts appreciation at national level from physical characteristics. More generally, there is no reason to assume that relationships between physical characteristics and appreciation at the local/regional model differ greatly from those at national level. Thus, a model based on regional/local appreciation should also be useful at national level.

Ad 3.
'A model is only as good as the data that feed it'. In view of the many limitations of the currently available (secondary) data on nature and landscape appreciation, I would strongly recommend allocating at least a part of the budget to data collection. For example, a relatively easy and perhaps not very expensive option could be to hire Intomart GfK or another agency to collect new data for the Hotspotmonitor from a large geographically relevant sample of the population. However, collecting new data is only useful if the type of data required is clearly defined. Thus, before starting to collect new data, consensus is required on the model and the type of questions that will provide the data that are needed.

Ad 4.
I think that all measures can be evaluated unless the measure is so large and invasive that the identity of an area changes and relationships calculated for old situations no longer apply to the new situation.

Ad 5.
Improvement and/or extension of the naturalness indicator will be a profitable investment that seems worthwhile pursuing regardless of any other decisions made. Research on people's landscape preferences has generally shown that visual preferences or beauty judgments differ greatly between scene types, so it should be possible to capture more variance in the data with a more fine-grained naturalness

indicator. There are several 'no regret' activities that could be done immediately to improve the naturalness indicator at low cost with secondary data. For example, the researchers could compare secondary data on perceived naturalness with model-predicted naturalness to identify which dimensions of naturalness are not well captured by the model. The researchers could also compare predictions by the GLAM model with HSM data to determine whether the GLAM model systematically overestimates or underestimates appreciation of specific types of settings, and use these comparisons to improve the naturalness indicator. It would also be interesting to check whether the inclusion of objective indicators of biodiversity or other readily available ecological measures would improve the predictive and discriminatory power of the GLAM model.

I am not convinced that developing detailed map-based indicators of fitness for use qualities of different types of recreational activities will be a profitable investment. Although some minimum amount of usability and accessibility is required to enable people to use and experience an area, the number and appearance of user characteristics, such as paths and benches and parking lots, seems less important.

User facilities and other man-made objects may detract from the naturalness and visual quality of a setting and thus have a net negative contribution to people's appreciation. Instead of focusing on fitness for use qualities for different activities, I would recommend investing in the development of improved and/or additional perceptual qualities in addition to naturalness (as indicated on p.14/15 of the GREAT project proposal). In particular, variety or complexity appears to be an important variable that plays a key role in people's landscape perception and appreciation. Another quality found to be a powerful predictor of people's landscape appreciation is mystery, as measured by winding paths and rivers, relief, and other elements that make people curious about what lies further ahead. Perhaps, this quality could be combined with 'points of interest' to create an indicator of the degree to which a landscape is intriguing or interesting.

As regards the other parts of the proposed GREAT model that go beyond the current GLAM model, I advise PBL and the researchers to thoughtfully reconsider the general direction of the model development and compare it with other alternatives, such as investing in an extended appreciation/restoration model or a residential satisfaction model.

Attachment 5 Response to reviews of the GREAT project proposal

Sjerp de Vries and Wim Nieuwenhuizen, 22 July 2013

PBL asked the two reviewers five questions:

1. Which indicator best suits the PBL policy studies for the national government In particular, what is the best aggregation (?) level to indicate appreciation going from scenic beauty, recreational attractiveness, recreational use to value derived from recreational use
2. Scale levels. Is it recommended to focus on all three scale levels as in the Hotspotmonitor, or should PBL focus on the local or regional scale?
3. Should PBL focus on development of a model or data collection with the HSM?
4. Which policy measures (described in the Terms of Reference) can be evaluated by the model as proposed by the GREAT model, and which not? Are there policy measures that cannot be evaluated by any model given the state of the art knowledge?
5. Which parts of the proposed GREAT model will be profitable investments and which not at all?

Our responses to these questions, and suggestions and recommendations are presented.

Ad 1.
One of the major issues is whether it is wise to develop a model that focuses on the recreational use of natural areas (and the benefits derived from this use). Van den Berg proposes a switch from recreational use to health benefits, with restorative potential being an important mediator of such benefits.

We consider this to be a strategic choice to be made by PBL. We agree that research on health benefits is likely to score higher on the political agenda than attractive opportunities for nature-based recreation. We wish to point out that a shift in focus has far-reaching consequences. At present, model development focuses on the countryside. A shift in focus from nature-based recreation to (mental) restoration and health and well-being would increase the importance of nearness to natural areas and elements. It is not only the greenery that is purposefully visited in leisure time that may generate health benefits, but also the greenery encountered in everyday life. Greenery close to home is likely to be of importance, ranging from the natural elements viewed from the living room and garden to greenery in the street. Thus, in connection with restoration and health benefits, the focus may have to be re-directed to the residential environment. Recreational visits to forests and nature areas outside the city may be of relatively less importance because most people do not have frequent contact with them.

A second issue is that at present there is very little empirical support for the idea that the type of nature has a substantial influence on the health benefits generated by contact with it (especially by way of restoration). Whereas for scenic beauty, there is (especially experimental) evidence indicating that all types of nature are not appreciated equally, there is no evidence base for restoration. While the type of nature is not an important factor in the GLAM model, it is likely this is a shortcoming in the model and that the model can be improved. For restoration, the importance of the type of nature is less clear. Finally, changing the focus from recreation to restoration implies the existing model cannot be built on and the model would have to be more or less built from scratch. For example, it cannot be assumed that in the green domain an area with a higher scenic beauty score has a higher restorative potential. The studies referred to by Van den Berg, to the best of our knowledge, compare environments that range from completely built-up ('grey') to completely natural ('green'). If so, they may say more about the amount of nature (green space, greenery) than about the type of nature.

Partly overlapping with the previous issue is that of not limiting the model to the countryside, but to include predictions for urban areas and/or focus on the local level. It is important to make a distinction between including only larger urban green areas and all areas, green as well as grey. The former may be relatively easy to do. To begin with, the focus could still be on the area as a destination for recreational activities, although perhaps of somewhat shorter duration than is common for trips outside city limits. Moreover, the focus would still be on natural areas, implying that the same or very similar factors and characteristics are important in determining its beauty and recreational attractiveness.

If the model has to make predictions for completely or predominantly grey areas, then new factors are likely to come into play. For example, the architectural quality of the buildings could be considered to be an important factor in scenic beauty. Many parts of cities are unlikely to be considered to be recreational destinations but they may be used for leisure the people living in that part of the city for short strolls and/or walking the dog. A more 'natural' question with regard to such areas might be their attractiveness as a residential location. However, residential satisfaction is an overall evaluation that is influenced by many factors other than the characteristics of the physical environment, and certainly more than the natural parts of that environment.

Van den Berg argues in favour of an indicator that measures general attractiveness rather than only scenic beauty. While we appreciate the need for some sort of overall valuation as input for CBAs, modelling an overall value rating is relatively difficult. It is not known why an individual finds a place highly attractive or valuable, which perhaps is something completely different. In our opinion, this is a similar problem to that mentioned by Van den Berg with regard to revealed preference methods. It is not clear which characteristics of the environment this is based on and their relative importance. We also consider the preference for general attractiveness somewhat at odds with Van den Berg preference for more attention to perceptual qualities (closely related to scenic beauty) than to 'fitness for use' qualities, mentioned later in her review.

We agree with both reviewers that both stated versus revealed preferences, have strengths and weaknesses.

Ad 2.

Both reviewers suggest dropping the national level and focusing on the regional and local level. We agree with dropping the national level, with results at lower levels also having some significance for the national level. As mentioned above, we think that including the local level has serious consequences for the model to be further developed. This does not mean we are against it or consider it not feasible, but more effort may be required to come up with a usable model. The proposal reviewed focuses on the regional level (day trips).

As for taking different levels into account (e.g. local and regional) we are interested in the reviewers' view on how best to achieve this. Are separate models for each spatial level considered the best approach to dealing with differences in the relevant physical characteristics of the environment at different levels. Or is one model that incorporates both levels from the start considered to be more appropriate. The Hotspotmonitor asks for attractive places at different spatial levels separately. We are inclined to think that predicting HSM outcomes at different spatial levels will require separate models for each level.

We are also interested in how the reviewers envisage integrating HSM outcomes at the different levels into one overall measure for a given place. For example, assuming adequate samples at all spatial levels involved, would adding the number of markers placed in an area, weighted by population size at the different levels, provide an overall measure of attractiveness or social value. This presumes that a marker is equally valuable, whether placed at local or national level. It implies that a marker has an absolute value, rather than only indicating the relative attractiveness of a place within a given (spatially confined) choice set. Furthermore, for recreational use, places marked at the local level may be visited more often than those marked at the national level. Thus, the outcome of a stated preference approach is likely to diverge from that of a revealed preference approach.

Ad 3.
Maybe, investment in data collection is more profitable than investment in expanding 'a rather good' regression model of appreciation of scenic beauty.

Both reviewers support investing part of the available budget in primary data collection. They also seem to be in agreement that model development should go hand in hand with data collection. However, they disagree somewhat about using the Hotspotmonitor in its present form. Tveit is more in favour of keeping the Hotspotmonitor intact and making only for additions. Van den Berg argues that the tool should be optimally shaped to generate the data required (as input for the desired model).

We strongly agree with Van den Berg on this point. While we understand the desire to keep Hotspotmonitor intact in its present form (also advocated by Sijtsma) in order to generate a large and consistent database, this may not coincide with collecting optimal data for model development.

There are several possible issues to be asked of respondents:

- unspecified attractiveness or perhaps for attractiveness as a destination for a nature-based day trip;
- most frequently or most recently visited destination, rather than a highly attractive place;
- to indicate more precisely the area they are referring to;
- limit the spatial scale or ask for the place considered most attractive for a given purpose, regardless of distance from home;
- include or exclude natural places within cities.
-

The answers to these questions depend on the model PBL decides to be the most desirable.

If eventually the Hotspotmonitor is considered to be suboptimal, we would like to propose the development a totally new data collection tool, rather than a minimally adjusted version of the Hotspotmonitor. In this respect, what would the reviewers consider to be the potential weaknesses or limitations of the Hotspotmonitor to be that possibly could be avoided in developing a new web-based tool.

Ad 4.
Tveit is somewhat concerned about feasibility, given currently available data sets. We are more optimistic in the sense that not all the available information on objective nature and landscape characteristics has been fully explored. This does not mean that making a more refined distinction between types of nature will have a highly predictive value for scenic beauty and/or recreational attractiveness. This remains to be seen (empirically tested). We have already taken some first steps in this direction, similar to those suggested by Van den Berg.

Ad. 5
Both reviewers support investing in an improved, more detailed way of taking naturalness into account. However, Tveit and Van den Berg disagree on the importance of taking the suitability of an area for specific recreational activities into account. Tveit argues that accessibility is highly relevant, while Van den Berg would rather place more effort on experiential or perceptual qualities (relevant for scenic beauty/refining the GLAM model), such as variety/complexity. We consider that if the model is to predict use and the benefits that result from this use, accessibility and suitability (fitness for use) are important and cannot be taken for granted.

Specific minor points, organised by reviewer:

Tveit

Tveit draws attention to cultural, social and juridical dimensions when modelling accessibility/ recreational use. We agree that these dimensions are important, but perhaps more so in the next step of modelling (from recreational attractiveness to use).

'Value assigned to areas using the model could be supplemented with information from the Hotspotmonitor.' We would like to know how this could take shape.

As for group differences, we would like to hear Tveit's opinion on the size of differences between groups relative to those between different types of natural environment. (We have the idea that the latter are larger than the former.)

Relationship between frequency and length of use, and the benefits resulting from that use. Tveit is not convinced that these are strongly (positively) related, and thus argues that skipping the step of modelling recreational attractiveness and going directly to use may be not appropriate. Rather, recreational attractiveness might be a suitable end point. We consider this to be somewhat at odds with the earlier suggestion of eliminating national level.

Van den Berg

We did not include distance from home as a fitness for use quality of an area, and it will not be incorporated in the GREAT model (recreational attractiveness), but in the next step, modelling recreational use.

Relationship between scenic beauty and recreational attractiveness ; we did not intend to 'reduce scenic beauty to merely an indicator of recreational attractiveness'. Rather, our argument is that scenic beauty is an important factor in recreational attractiveness. Furthermore, in our proposal we suggested keeping GLAM intact as a separate model, in addition to the GREAT model, which is in line with Van den Berg's suggestion.

Making the model more compatible with the Hotspotmonitor (not a model, but a data collecting tool) is desirable to the extent that the Hotspotmonitor measures exactly what PBL wants to measure. In our opinion, this has to be decided first. The same holds for strengthening the Hotspotmonitor database, although the issue of spatial representativeness would also hold for any database to be constructed.

Proposed actions

1. Continue to improve the role of naturalness in the GLAM model;
2. After the desired indicator and thus the desired model are decided use part of the budget to collect new primary data on this indicator on a large scale (this is not input, but data on which to calibrate and/or validate the model and that will guide model development);
3. Develop a new data collection tool.

An additional study to be carried out to aid model development with regard to preferences for different types of nature (e.g. large-scale web-based survey with people rating multiple photos of different types of nature, with the set of photos considered representative of types of nature distinguished in GIS databases).

Attachment 6: Reflection on review of PBL landscape appreciation model

Dirk Sijmons and Steffen Nijhuis (TU Delft, Landscape Architecture)

On 5 November 5 2013, Dirk and Steffen discussed the final draft of the PBL report 'Results and conclusions review landscape appreciation model' with Arjen van Hinsberg and Hans Farjon.

- Focus the research effort on collecting primary data on landscape appreciation and perception rather than on the construction of a model.
- Methodology focus shifts from a more psychological-descriptive (behavioural) to a phenomenological-normative (humanistic) approach. Although this may be positive for development of the model, it may lead to some inconsistencies in the systematic and scientific rigor. Thus, the theoretical background of the model needs to be detailed in order to pinpoint the strengths and weaknesses of both approaches, their relations and complementarities.
- Crowd sourcing is indicated as a powerful tool for development of the model, with the MAPPINESS project of the London School of Economics referred to as an example. Perhaps, the most surprising result of the data analysis is that people are happier outdoors than in buildings. It might be useful to contact this research group, which has experience in crowd sourcing by apps on mobile devices.
- To collect useful landscape appreciation data via crowd sourcing, effective indicators have to be developed. This is important to avoid bias in data acquisition caused by differences in interpretations by respondents to concepts, such as nature, landscape, green, attractiveness and visual beauty. Another advantage of a comprehensive set of indicators is that spatial dichotomies are avoided, such as town/country, and nature/culture.
- Happiness of a person in a certain place is an example of an overarching but still effective indicator. To elaborate this indicator, the focus will be on the analysis and explanation of differences in stated 'happiness' by physical landscape characteristics.
- To avoid general conclusions based on the model outcomes, it should also lead to location-specific strategies and interventions for landscape development. Thus, the operational value of the tool should be considered, with a shift from 'how things are' to 'how things ought to be', from matters-of-fact to matters of concern. For the latter, design thinking is crucial as underlined by complexity theories.
- Of the physical characteristics taken into consideration so far, 'attraction value' of locations has been given insufficient attention. Attraction value is a discriminating factor for stratification of theoretical highly appreciated areas, as indicated by extensive research in the (social) logic of space by UCL London and TU Delft.
- The application of results of model runs in PBL strategic policy analysis and assessment should always include a clear statement of model limitations and knowledge. Some proposed policy measures will have little impact with respect to the discriminating power of the model.

- TU Delft and PBL will explore opportunities for further collaboration based on the TU Delft and PBL working programmes 2014.