

Project workshop: Scenarios and models for exploring future trends of biodiversity and ecosystem services changes

Brussels, 13 May 2009

Background and aims of the workshop

Recent studies such as The Cost of Policy Inaction on Biodiversity (COPI) and the wider review on The Economics of Ecosystems and Biodiversity (TEEB) have revealed that biodiversity loss has widespread and substantial economic costs and impacts on human wellbeing. Such studies have taken into account a number of recent global and regional assessments that project future changes in drivers of ecosystem change and biodiversity loss. In order to support the second phase of TEEB, the European Commission (DG Environment) has initiated a study to examine the use of scenarios, models, and other quantitative tools for exploring future trends in biodiversity and their impacts on ecosystem services.

The workshop aimed to discuss the interim results of Task 1 and Task 3 of the project report. While Task 1 focuses on identification and overview of available models of biodiversity and ecosystem services and key assumptions, the objective of Task 3 is to assess how changes in key assumptions affect the results of different models and how such models could be adapted to better assess policies.

In particular, the workshop participants were invited to discuss:

1. the modelling approaches currently available;
2. how these can be used to assess policies; and
3. how current models and scenarios could be further developed.

Proceedings

Opening and introduction: What this study aims to do?

Robin Miège (DG Environment) opened the workshop and welcomed the participants. He explained that the current project takes place in the context of the wider study on “The Economics of Ecosystems and Biodiversity” (TEEB) and that its purpose is to pick up the recommendations and suggestions from the TEEB expert workshop, which took place in March 2008 in Brussels. The central recommendations from that workshop were:

- to run scenarios on sustainable ecosystem use;
- to work more on the absence of feedback loops between loss of biodiversity / ecosystems and economic growth to enhance the credibility of results;
- to pay attention to quantifying the trade-offs between provisioning and regulating services in models;
- to produce an inventory of model runs for all major ecosystems and to illustrate the loss of ecosystem services expected under different scenarios; and
- to develop maps of best conservation opportunities available.

Robin Miège outlined that the **aim of this workshop** was to discuss the interim project report, which was produced by the project team, to review the assessed models, and to discuss a set of suitable models and scenarios for TEEB, but also to set the future research agenda. Eventually, the results shall feed into the TEEB phase II reports and facilitate the discussions on the post-2010 biodiversity target.

The role of the scenarios and models project in the TEEB context

Patrick ten Brink (IEEP) summarised the political background that led to the TEEB project and outlined how the current project will feed into TEEB. With regard to the timeframe, he mentioned **three important milestones** that should be taken into account in the discussion:

- September 2009, when the results from the projects “Further Developing Assumptions on Monetary Valuation of Biodiversity Cost Of Policy Inaction (COPI)” and “Scenarios and models for exploring future trends of biodiversity and ecosystem services changes” should feed into the TEEB report for policy-makers;
- October 2010, by which some further runs of models and scenarios should be completed and fed into a TEEB update to be presented at the CBD COP-10 in Nagoya; and
- 2015, which is the target date for achieving the Millennium Development Goals (MDG), and by when further modelling could be used to support discussions on future MDGs.

Patrick concluded his presentation by outlining the following main questions for consideration during the afternoon session

- What do you think can and should be done in terms of modelling and scenarios for TEEB?
- Which models would be useful to TEEB and what improvements could be made to existing models?
- What scenarios/sensitivities (covering what issues?)
- What biomes/ecosystems/geographic scales?
- What is feasible in the timescale?
- What costs/inputs would be required?
- Ideal vision vs. Pragmatic reality – what can be done for Nagoya and what to 2015 (MDGs) and what beyond?

Discussion

The subsequent discussion focussed on the questions which models will be used in the wider TEEB project to assess the loss of biodiversity, and whether these models will continue to be land-based. Patrick stated that in the COPI I project, the Image-GLOBIO model was used, as it produces the Mean Species Abundance (MSA) indicator. Limitations of the analysis were that the exercise did not take into account marine ecosystems and did not make use of a range of scenarios or sensitivities. He emphasised that, in the TEEB phase II, there is a need for a **more developed approach**, which also adequately includes marine ecosystems. Ideally, a range of scenarios shall be run to take into account various assumptions and predictions.

After the first introductory presentations, the following two sessions discussed the main results of **Task 1 (Review of available models and scenarios)** and **Task 3 (Assessment of key assumptions in the available quantitative tools)**.

Session 1: Review of available models and scenarios: “State of the Art”

Tom Kram (Netherlands Environmental Assessment Agency) presented the key findings from Task 1 of the project, which aims to provide an overview of existing models and scenarios that have been built and applied to model biodiversity and ecosystem services, often in the context of comprehensive assessment studies. He summarised that quite a lot of material is available that could be used for a qualitative assessment. While provisioning and regulating services were to a reasonable extent covered by the reviewed models, **regulating and cultural services were covered to a lesser extent**. It appeared that, in most models, **land use is the central link** between drivers of biodiversity loss and the decline in associated ecosystem services. As no model was identified which covers all aspects of biodiversity loss, Tom recommended **the use of a combination of models** for TEEB phase II.

Discussion

The subsequent discussion focussed on several issues regarding the capabilities of the models reviewed. It was remarked that **most existing models focus on provisioning ecosystem services**, whereas all other ecosystem services categories are barely covered (with the exception of carbon sequestration). The fact that the impact of **invasive alien species** on the provision of ecosystem services has so far not been taken into account was also raised. The participants agreed, however, that a global assessment of biodiversity loss will always be subject to compromise, as the whole range of available ecosystem services (especially at the local level) **cannot be covered by a single model**.

The issue of **how to avoid double counting** of ecosystem benefits from integrated assessment models was discussed and it was acknowledged that this is a complex and difficult task. An assessment of the problem cannot be made without detailed knowledge about the respective models. Within the scope of the TEEB project, such a task was regarded as not feasible. Instead, it was suggested that the **focus should be on assessing the most important ecosystem services**. It was also noted that integrated assessment models tend to incorporate uncertainties in their complex structure and multitude of variables, thus users should be aware of their possible limitations. One way of dealing with this could be to use minimally realistic models, and considering the purpose of the model. Another way could be the use of expert opinions on the impact on biomes under certain local conditions.

One alternative option would be to **identify different groups of models**, of which several could be used for the modelling exercise within TEEB phase II. In this way, the results of different modelling approaches could be compared to each other. An alternative option is to join together simpler and more specialised models in which the limitations and assumptions of each model are better known and there is greater scope to take account of local differences. This was largely discounted as an option in the short term, as coupling models of biodiversity is difficult given the different parameters, priorities, timescales and geographical scales used. However, this approach may be an option in the medium to long-term.

When reporting results, note should be taken of the **IPCC approach** of reflecting their uncertainty.

Part of the challenge for biodiversity models is that fewer data exist than, for example, on climate change, and thus the models are heavily reliant on assumptions. This makes it difficult to make reliable projections of biodiversity change in response to future scenarios, in particular if the diversity of impacts is taken into account. This requires combining the expertise of different research communities and working with often disparate bodies of knowledge. Another problem is that the relationships between biodiversity and the provision of various ecosystem services are often not well understood.

As a practical recommendation, it was suggested to first **establish an inventory of existing ecosystem services** and, in a following step, see which economic benefits these services provide and for which services economic assessments are available. Appearing gaps could be used to show policy-makers and researchers the needs for new primary research (to some extent, this work is available through the COPI I exercise). New primary research is also needed on the **relationships between biodiversity loss and ecosystem service provision**, as explored in the ‘Scoping the Science’ study conducted in parallel with COPI I during TEEB phase 1. Moreover, when **aggregating the values of different ecosystem services**, attention should be paid to the fact that some of them might originate from the same ecosystem function. In such cases, there is a clear **risk of double counting**, which needs to be avoided by careful, case-specific assessment.

In conclusion, it was agreed that the appropriate choice of models and scenarios depends on the **sort of policy questions** that are supposed to be answered by the exercise. In general, the setup of global assessments should focus on the target audience. Moreover, the assumptions made in terms of scenarios need to be clear. However, it was agreed that too explicit assumptions would, on a global level, confine the number of interested parties, which would weaken the messages from such a global assessment. As, within the scope of TEEB, not all dimensions can be covered, the aim should be to **identify what can be done with the help of existing models in the available time**.

Session 2: Assessment of key assumptions in the available quantitative tools

Leon Braat (Alterra) presented the key findings from Task 3 of the project, which aims to assess how changes in key assumptions affect the results of different models, to evaluate large-scale assessments of the impacts of the loss of biodiversity, and to assess how such models could be adapted to better assess policies. He found that a **limited number of models and scenarios** have so far been used for large-scale assessments and policy impact assessments; **no single model comprehensively assesses all aspects of biodiversity and ecosystem services and links to the economy**. Leon considered that, while modelling approaches are quite different in the terrestrial and marine domains, **no model was identified that could compete with GLOBIO on a global scale as far as terrestrial ecosystems are concerned**.

However, there are new promising models which could not be evaluated as they have not been subject to a peer review process nor been applied within large assessments.

It is **difficult to assess the reliability** of many of the various models, because **independent reviews** of them are **not generally available** and only a very limited number out of the 40 models in the survey is being used more frequently. Moreover, detailed examinations of the models are not possible within the scope of this current study. Similarly, it is not possible to assess the models’ sensitivity to changes in assumptions because these are not normally documented. An assessment of driver-assumption sensitivity could only be found for the IMAGE model. The sensitivity of other models to changes in assumptions can only be made by comparing outputs according to different scenarios, but it is difficult to draw conclusions from such comparisons, because many parameters vary among the scenarios.

Discussion

In the subsequent discussion, several modelling approaches were suggested to be considered in the evaluation. The **Atlantis model**, which deals with fisheries was mentioned to be

currently at the same state of development as MIMES, was regarded as a useful tool that **could potentially cover the marine dimension within TEEB**. (Unfortunately there is no documentation available in the web for the Atlantis model). It has been applied in two or three places so far and progress has been made to include the economic aspects of biodiversity loss. The **FAO review on marine models** was suggested as a reference. With regard to GUMBO, which is not spatially explicit, it was noted that this is a dynamic model with a long-time projection, while the **focus within TEEB should rather be on evolutionary models** with a timeframe of max. 20 years.

There was some detailed discussion of the **Mean Species Abundance (MSA)** metric and its use in the GLOBIO model as well on the use of indicators in general. It was recognised that the **MSA has some significant limitations** (being based on averaged species responses to a number of key drivers of biodiversity loss) and can be misunderstood and misapplied (partly due to its name and lack of easily accessible documentation). Although the MSA indicator has been verified in a study of biodiversity change in the Netherlands, it needs to be tested more widely. However, this is difficult, because the MSA cannot be directly measured in the field.

Overall, it was generally agreed that the best means of modelling global biodiversity impacts at the moment is probably through the GLOBIO model and MSA despite their limitations. Thus the **MSA indicator can be regarded as a potential metric for use in TEEB**, but not necessarily the only one to be used. Its use in the COPI I biodiversity study to refine per hectare values of ecosystem services is a critical issue and needs to be re-examined. The approach needs to be validated and if appropriate the MSA / ecosystem functional relationships adjusted accordingly. It was also pointed out that some ecosystem services may be better modelled in other ways, as they may not be strongly correlated with MSA or biodiversity more broadly.

It was suggested that consideration should be given to assessing biodiversity impacts according to the **Human Appropriation of Net Primary Production (HANPP) indicator**. HANPP measures to what extent land conversion and biomass harvest alter the availability of Net Primary Production (biomass) in ecosystems as compared to the potential natural vegetation as the baseline. This has been shown in some studies to closely reflect pressures on biodiversity, but generalisation would probably be premature. If linked to GLOBIO, it could be used to **compare results obtained from the MSA indicator**, although they are based on the same data inputs (e.g. FAO statistics).

It was acknowledged that there needs to be a **strong economic perspective connected to the modelling exercise**. Leon Braat explained that this is currently a huge gap in most of the models, which the COPI I exercise attempted to address. Some participants were in favour of **assessing economic implications which go beyond GDP**, for instance employment and tax revenues, in order to assess the full social impact of the global loss of biodiversity. This **multiplier effect** has partly been taken into account in studies on the impacts of agri-environmental schemes on the Dutch agricultural sector. **The Global Ocean Economics Project** takes value chains into account, while more limited work has also been done on trade impacts of biofuels. It was remarked that the idea of multipliers can be questioned in the context of global assessments, as there are still too many uncertainties which need to be overcome first.

Session 3: Policy recommendations: How to use the quantitative tools for policy development within TEEB

Rob Alkemade (Netherlands Environmental Protection Agency) acknowledged that the interim project report gives a good overview of the existing models. He pointed out that most of them are still missing the crucial point of **how the loss of biodiversity feeds back into the economy**. Although the MSA indicator seems to be the only available biodiversity indicator so far, he saw a need to **go beyond this indicator**, as it does not say anything about species functions, species richness, red-list species, or the community level – aspects which are of major relevance for the provision of ecosystem services. The same goes for biodiversity in aquatic environments. The aim should therefore be to **develop a set of new biodiversity indicators that link to ecosystem services**.

Rob preferred the **use of parallel model suits** in order to ensure that modelling results can be compared to each other. As a positive example the competitive use of different models within the IPCC has been mentioned. Furthermore, he stated that there is a need for the **formulation of scenarios that focus on biodiversity** (instead of climate change) in order to **derive a set of relevant policy options**. A problem with the scenarios that have been analysed in the project so far is that they differ little in their biodiversity outcomes.

It was noted in the discussion afterwards that, when coupling models together, it is important to include appropriate feedback between the models.

Heather Tallis (Stanford University) suggested that the project team should consider the **creation of new, more policy relevant scenarios**, which differ from the usually applied scenarios. Policy-makers often find it difficult to engage with complex scenarios that have little to do with the real world and are based on multiple assumptions (e.g. the impact of talking about TechnoGarden, one of the four scenarios in the Millennium Ecosystem Assessment, to most people is limited). She recommended **considering only a few types of policies** (e.g. payments for ecosystem services, mitigation and offsetting, subsidies, caps). For example, it is important to develop scenarios that are relevant to REDD now, so that the impacts of possible policy options can be examined. The results could have implications for a range of ecosystem services, beyond carbon storage, including biodiversity and water benefits. The use of models for such purposes would help politicians and other decision-makers understand their value. She also stressed the use of competing models similar to IPCC, considering rigour and political sensitivity.

Heather stressed that the **link between biodiversity loss and poverty** should be a central aspect of the assessment. In this context, she noted that the Millennium Development Goals (MDG) rely on ecosystem services. Ecosystem services are so far not covered in most models, because those can often not take informal markets into account. Rather than covering the whole range of ecosystem services, she suggested that it would be better to **focus on only a few important services** such as clean water and flood control. The latter one could probably be assessed more easily in the context of institutional settings. In addition, for ecosystem services models, it is important to not only consider the supply of a service (for example, water availability), but also the demand, as this will change significantly in the future with implications for the availability of the service.

Furthermore, she promoted the idea of using **simple models** such as InVEST. The exercise should be focussed on what is appropriate for different policy contexts, rather than being aligned with the models' requirements. It was noted in the discussion that InVEST would be useful to try out in the TEEB setting to test how well it performs.

Villy Christensen (University of British Columbia) acknowledged that the interim project report covers all of the important issues. He stressed that the relevance of the project results depends to a high degree on the **policy questions to be answered**. Such a set of policy questions should be developed within TEEB. Furthermore, a **common set of drivers and indicators** to be used in all assessments should be developed, as well as **guidelines for how to translate scenario policies into changes in model drivers or objectives**.

He stated that most models require a vast amount of data and that these data are often missing in the area of biodiversity. Therefore, modelling approaches should build upon available data. He stressed that **the informal sector and value chains should be taken into account** [producer-processor-distributor-seller-consumer] in the modelling exercise, as these aspects will make a huge difference with regard to the social dimension of biodiversity loss (as the work of Hernando de Soto could demonstrate). He mentioned the example of the **Global Ocean Economics Project**, which takes account of these issues. The underlying model will be finished in time to be of relevance for the TEEB project. The model showed the importance of taking the whole value chain into consideration, as this has changed the outcome of the model significantly. Only looking at the entire value chain could explain why current overfishing has its roots in economic pressures although revenues for the fishery sector are decreasing.

With regard to priority options to be incorporated into the models, Villy suggested to **couple reliable, specialised models** set-by-set to avoid one big model that could become unmanageable (the so called ‘Frankenstein’ model). This could facilitate the integration of terrestrial and marine domain models. However, in this context, scale issues and data-exchange formats are important factors to consider.

Villy noted that model calibration with existing data is important, however, this is limited by data availability. He therefore suggested that a **global database** is needed of data resources, their use and status. Consideration also needs to be given to data exchange formats so that database can feed models directly.

On the use of the project results for policy and decision-makers, he commented that one should think about tools such as decision-support systems, policy toolkits, and end-user interfaces. Policy-makers are usually less interested in the assumptions and specifications made in the assessment process, but demand **simple communication tools**. Villy demonstrated the output of the EcoOcean model linked to gaming software, which visually illustrated the impacts of specific policies on the marine environment, demonstrating a potentially powerful tool for communicating to policy-makers. Visual outputs had been used before, but not linked to gaming software, which enable dynamic visual feedback that reflects the impacts of chosen policies.

Henrique Pereira (University of Lisbon) stated that not all of the most important drivers of biodiversity change are being addressed in the scenarios. We lack models that project biodiversity changes from the expansion of natural vegetation in developed countries. He regards the **MSA indicator as an adequate tool** for modelling, but noted that the **GLOBIO methodology used to calculate it has not been validated**, which is a widespread problem with many scenarios and models but causes problem with the acceptance of MSA as an indicator. There are more models to project the impacts of climate change, since this is – in contrast to projecting changes in biodiversity from other drivers – a relatively easy exercise.

Henrique noted that particularly **invasive species and biotic exchange** are not covered by the majority of the models, although these are important drivers for the global loss of biodiversity (for instance on islands). In freshwater systems, dam construction is one of the biggest drivers of biodiversity loss, but no scenarios account for it. Moreover, issues such as **overexploitation of resources** (other than fisheries) and **pollution of ecosystems** are not yet in the focus of modellers. Neither are models able to deal with issues such as intensification and extensification of land-use management, or the recovery and expansion of natural vegetation (which are important issues in many regions, e.g. Europe).

Another limitation of current models is that they do not address **flows of ecosystem services** (where do people benefit from services produced elsewhere?) and the **scale of ecosystem service delivery**. Furthermore, we lack understanding of the direct links between ecosystem services and biodiversity.

Henrique suggested that it would be worth doing some ‘**reality checks**’ on important issues using simple robust models of the key ecosystem services. Moreover, one needs to be more open with regard to models, e.g. make them available as open source.

Regarding a possible communication strategy, Henrique Pereira proposed **the use of storylines** or even the use of ‘scary’ scenarios, since people tend to pay more attention to them than to the bare figures. The project team should also develop storylines that are based on partial, simpler models that accompany the big integrated approach. He also suggested the development of scenarios by cross-cutting experts to incorporate the threats that have not to date been considered.

Discussion

Graham Tucker pointed out that positive visioning stories often have a greater impact than negative scare stories (because many people chose not to believe them). Henrique Pereira agreed about the need to communicate positive scenarios side-by-side with negative ones and responded that in GBO-3, a number of experts will also be writing about the biodiversity restoration opportunities arising on apparently negative scenarios for biodiversity conservation.

There was also a discussion regarding the appropriate scale/spatial resolution and accuracy of the modelling exercises. It was mentioned that for many issues, like the assessment of impacts of agricultural practices on riparian vegetation local/smaller scale models/assessments are necessary as the global one lack in a scientific basis for this small scale interdependencies.

Joachim Spangenberg (Sustainable Europe Research Institute) stressed that, in order to be relevant to policy-makers, a model needs to be able to **show the impacts of certain policy decisions** as it has been attempted in the ALARM project. Scenarios are useful for pointing to the general direction, but cannot provide the detail of the implications of policy decisions. Policy-makers should focus biodiversity policies on the major pressures (such as land use patterns including transport, invasive alien species and climate change) and aim to minimise these pressures (for example through agricultural policy, EU TEN, or structural funds).

Within TEEB, it should be emphasised that if there is no apparent economic value for a certain ecosystem function, this does not mean that it is worthless. In this respect, it is important to emphasise that “**there is no useless biodiversity**” and **TEEB must clarify what can and what cannot be monetised**. Joachim pointed out that the models do not currently

take account of shocks, such as the recent economic crisis, or non-linear changes in biodiversity and ecosystem services. He suggested **priming models with shocks** to gauge how they respond. For example, the International Energy Agency predicts a recovery from the current crisis followed by another crash due to oil shortage. These shocks should be examined in future projections of models. He also noted a problem with IMAGE, namely that it does not allow for the feed back of economic parameters into the model.

Joachim concluded by emphasising that the figures produced within TEEB must not necessarily be precise, but that **they must be robust** enough to provide the basis for directionally secure policy decisions. The project team needs to consider what the requirements of decision-makers are and design tools to fit around them.

Finally, he strongly suggested **including recent FP6 projects** on biodiversity modelling in the evaluation.

Summary of the expert feedback

Alexandra Vakrou (DG Environment) and Patrick ten Brink summarised the session by stating that it was likely that the GLOBIO and EcoOcean models would be used between now and Nagoya, but that it should be supplemented with simpler models as a reality check. The overall move should be towards a more specialised suite of models in the medium term. GLOBIO could also be run with a different set of scenarios.

Ecosystem services values are currently not adequately addressed in models, making it an area for future development. There needs to be a greater focus on the local scale, which can be provided by the specialised models, which should accompany the bigger picture.

It was concluded that there is an urgent need to add fisheries and the marine environment to the used global models.

Alexandra Vakrou observed that issues surrounding joining models together, such as the differences in scales and units (data availability), will have to be addressed before it becomes a viable option, if at all.

Irrespective of which models are used in the future there is a need to address current knowledge gaps such as the influence of IAS or technical infrastructure on freshwater biodiversity and the relationship between biodiversity and ecosystem services . There is no perfect indicator available so far. Work on indicators has to be intensified and in respect to the MSA it is crucial that the MSA link to ecosystem services is tested.

From the policy maker side it would be beneficial to run scenarios that reflect “real” policy options. An interesting example would be the discussion on REED or biofuels. To increase the communicative power of global models they should be supported by local/small scale models and narrative stories e.g. on specific ecosystem functions or tipping points.

Finally it would be useful to have a set of competing models in the medium term as for example promoted by the IPCC.

Closing of the workshop

Alexandra Vakrou (DG Environment) thanked the participants for their fruitful contributions to the discussion and closed the workshop.