Scoping study on modelling of EU environment policy

Final report
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Abstract

This study provides an overview of modelling activities in the context of EU environment policy and identifies opportunities for improved modelling of environmental policies. Modelling can be structured around the three thematic priorities of the 7th EAP (natural capital; resource efficient, low carbon economy; and human health and wellbeing) along with the horizontal priority objectives (sustainable urban planning and design; and global challenges). Modelling can provide input for all the EU’s evaluation criteria: effectiveness, efficiency, relevance, coherence and EU value added.

A clear policy need will be for integrated economic, social and environmental analysis. There are modelling gaps in: sustainable production and consumption, material flows and resource efficiency, urban environmental policy modelling, resilience and adaptation. Linked to this, there are general challenges in terms of data and models often focus on the present ecosystem and socio-economic system rather than behavioural change. Agent based modelling can address behavioural change and show the issues with risks.

A two year modelling assessment could have as a priority the combined assessment of environmental policy, its social implications and its contribution to the Juncker priority on jobs, growth and investment though eco-innovation.
Executive Summary

This study provides an overview of modelling activities in the context of EU environment policy and identifies opportunities for improved modelling of environmental policies. The study finds that there is clearly potential for co-ordinated modelling that supports the evaluation of the 7th EU Environment Action Plan (EAP).

Modelling can be structured around the three thematic priorities of the 7th EAP (natural capital; resource efficient, low carbon economy; and human health and wellbeing) along with the horizontal priority objectives (sustainable urban planning and design; and global challenges). The enabling framework of the 7th EAP is harder to model, because it addresses institutional issues of policy enactment.

Modelling needs to be embedded within the wider evaluation work and address the following policy assessment criteria:

- Effectiveness
- Efficiency
- Relevance
- Coherence
- EU added value.

Conclusions on a possible way ahead

A clear policy need will be for integrated economic, social and environmental analysis. There are modelling gaps in: sustainable production and consumption, material flows and resource efficiency, urban environmental policy modelling, resilience and adaptation. Linked to this, there are general challenges in terms of data and models often focus on the present ecosystem and socio-economic system rather than behavioural change. Agent based modelling can address behavioural change and show the issues with risks.

A two year modelling assessment could have as a priority the combined assessment of environmental policy, its social implications and its contribution to the Juncker priority on jobs, growth and investment though eco-innovation.
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1 Introduction

1.1 Objectives of the study

This study provides an overview of modelling activities in the context of EU environment policy and identifies opportunities for improved modelling of environmental policies. More specifically, the objectives of the study are:

1. to provide an overview of models addressing the analysis of environmental policy that are currently available to the EU;
2. to identify any areas where there are gaps and therefore a potential need for additional modelling initiatives that could improve the development of EU environmental policies.

In particular, the study looks at the potential of the models to support the evaluation of the 7th EU Environment Action Plan (EAP). Whilst such an evaluation would focus on ex-post assessment, the study also touches on more forward looking questions about how issues will develop after the lifetime of the 7th EAP, which covers the period up to 2020 but also gives a more long-term direction by setting out a vision beyond that, of where it wants the Union to be by 2050. This issue also links to the ‘costs of non-Europe’, which are questions about what problems remain and is action at the EU level the most efficient level.

This study is a scoping study and is therefore not a comprehensive and detailed review of all the capabilities of environmental policy relevant modelling activities undertaken in or for DG Environment. Rather, it provides an overview of modelling capabilities, identifies limitations in the current portfolio of models and outlines proposals for model development to address limitations that are identified. A further general point is that there are some policy questions which cannot be answered using the techniques of computer simulation. In particular, a model cannot be used to determine the priorities of society and their reflection in policy directions. This applies especially to the questions of policy relevance. Modelling can help to assess whether environmental policies have made a difference, but this is only relevant in relation to the overall policy goals set by the policymakers in response to political processes.

1.2 Study approach

The study adopts a structure for the themes and problems of environmental policy in the EU and then uses this to classify relevant models and their capabilities. Given that Environment Action Programmes set the policy direction for EU environmental policy, and since the study is scoping elements of the upcoming evaluation of the 7th EAP, the project uses the 7th EAP as the basis for structuring the study (EC, 2014). The themes and priorities of the 7th EAP are shown in Figure 1.
The analysis is structured around:

- The three thematic priorities (1-3). The term green growth encompasses the policy priority of moving towards a more resource efficient and low carbon Europe; and
- the two horizontal priorities (8 and 9), which are considered to be overarching challenges that include most of the focus issues identified for priority objectives 1 to 3, but at different geographical scales.

The enabling framework (priorities 4-7) is looked at indirectly, through those thematic and horizontal priorities (see Section 1.3 below).

Although the study uses the 7th EAP to structure the analysis, EU environmental policy is also relevant to other strategic exercises. In particular, modelling can help linking EU environmental policy with the implementation of the Juncker Agenda for Jobs, Growth, Fairness and Democratic Change¹ and the UN Sustainable Development Goals² (SDGs). The analysis therefore also considers these two policy frameworks. It should also be

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noted that the policy agenda of the European Commission has moved towards Green Growth as an overarching policy concept and that a consideration of Sustainable Production and Consumption\(^3\) is high on the policy agenda.

The study then proceeds as indicated in **Figure 2**. Policy questions for which DG Environment requires model analysis are identified. Models currently used by DG Environment are then identified. The models were then be mapped against the policy questions and the extent to which the questions are not answered or only partially answered by current models will be assessed. From this gap analysis, recommendations for model development activity to improve modelling support for policy assessment in DG Environment were developed.

![Figure 2 Project work flow](image)

The policy questions, gap analysis and recommendations were discussed with both modelling experts and European Commission officials in the workshop. The discussions led to a better understanding of what an overarching modelling study could look like, how it could support the 7th EAP evaluation, and some of the practical issues involved in organising it.

\(^3\) As defined by the Oslo Symposium in 1994, sustainable consumption and production (SCP) is about "the use of services and related products, which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of further generations"
1.3 Addressing the Sustainable Development Goals and the ten priorities of the Juncker Commission

The UN's 2030 Agenda includes 17 Sustainable Development Goals (SDGs). The SDGs have a strong overlap with the 7th EAP, as both have sustainability as their goal. Many of the agenda’s goals and targets are therefore closely linked to EU environmental policies. In particular, several SDGs have a mainly environmental focus:

- Goal 6. Ensure availability and sustainable management of water and sanitation for all
- Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable
- Goal 12. Ensure sustainable consumption and production patterns
- Goal 13. Take urgent action to combat climate change and its impacts
- Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goals 6, 14 and 15 are directly addressed by the policy questions in the area of natural capital, with models of fresh water systems, oceans and coasts and ecosystems included in the review. Goal 11 is addressed by the 7th EAP horizontal priority on sustainable urban planning and design and is therefore a category of question and model in the analysis. Goal 14 is addressed by the 7th EAP thematic priority to move towards a more resource efficient and low carbon economy, as well as by the horizontal priority to address global challenges, where there are a series of global integrated assessment models (IAMs) specifically for climate policy analysis. Thus the models reviewed in this study are useful for directly addressing the progress being made towards the achievement of these SDGs. The question is whether they completely cover the Goals, and whether there are gaps e.g. in saying what we may achieve by 2030 with current policies.

The Juncker Commission’s priorities include:

- A new boost for jobs, growth and investment
- A resilient Energy Union with a forward-looking climate change policy

Whilst the links to climate change are direct, environmental policy also has the potential to contribute to the generation of new jobs and investment. Environmental technologies have become an important part of the EU economy. Their annual EUR 320 billion turnover has grown 8% per year since 2004. The EU has one third of the world market, which could double to EUR 2200 billion by 2020 (EC, 2016). There are also many new and expanding...
markets in environmental services. These markets have been created by environmental policy, both in the EU and internationally. They include technologies for end-of-pipe emissions abatement and new low emissions technologies. They also include new environmental monitoring and management services. There is also large potential in the area of natural capital and ecosystems. Products and services for agriculture and land use monitoring or management are developed to support the achievement of the goals set out by environmental policy. Markets for services in monitoring and management plans for ecosystems, river basins, coasts and oceans as well as products with reduced environmental impacts are also created by environmental policy. This wide range of new economic activity in environmental goods and services is implemented through investment and research, development and employment activities. These strengthen the competitiveness of European industry, enabling European industry to develop markets both in the EU and globally. Models for ecosystem management and for surveys of ecosystem and resources status could be used to show the market potential from these environmental policy initiatives.

At the same time, there are negative perceptions that environmental policy is a barrier to growth, placing a burden on business that dampens economic growth. A modelling exercise could reconcile these positive and negative narratives, identify how environmental policy can best contribute and identify the associated investment needs.

While climate change is directly addressed by the 7th EAP, there are connections with the Juncker priorities on a digital single market and migration. The digital single market can be an enabler of sustainability in many fields of environmental policy. There are many areas of environmental systems e.g. point source emissions monitoring and reporting, systems emissions monitoring and control environmental monitoring and services along value chains which become feasible through distributed software and the ‘internet of things’. This requires enabling regulation and standards as well as digital security in environmental management systems. These areas of products and services have the potential to generate new environment-related markets. Such new products and services are not considered by current models of environmental markets. There is particular potential in intermodal transport, emissions monitoring of transport systems, autonomous or decentralised energy systems, ecosystems monitoring and management. However, this digital agenda aspect of environmental policy (and the enabling framework) is a challenge to model – perhaps the best approach is not to try to do so systematically, but instead to look at how this affects assumptions e.g. on unit costs over time.

The other Juncker Commission priorities on Economic and Monetary Union, a Free Trade agreement with the United States, justice and fundamental rights, a stronger global actor and democratic change have only indirect links to environmental policy, at least in terms of modelling.
1.4 Enabling framework

The 7th EAP refers to a set of ‘enabling factors’ for environmental policy (see Figure 1). Although these factors are not used in the structuring of the analysis directly, they have been covered. These factors do not address specific policy areas. Instead, they are relevant in principle to all policy processes. Some of these factors are general issues for all models. If a policy model is available for a thematic area the factor can at least in principle be addressed. Others are considered explicitly in the analysis.

For example, the ‘implementation of existing legislation’ refers to political and organisational processes that are often not covered explicitly by thematic environmental policy models. They are usually addressed in exogenous assumptions – that is, they are dealt with outside the models and changes in implementation rates are not modelled directly. All modelling exercises contribute to the knowledge base, while modelling activities can lead to improved data collection and use. Investments/innovation and the accounting of impacts are directly addressed by the modelling questions developed for this analysis, as described below. The question of integration of environmental concerns into other policy areas is also included in the analysis.

2 Policy Questions that models should answer

EU environmental policy analysis is undertaken in the context of the policy intervention logic set out in the better regulation guidelines. The structure of this approach is summarised in figure 3. This policy logic was used to structure the policy questions that were considered for the analysis. This structure incorporates the following policy assessment criteria:

- Effectiveness
- Efficiency
- Relevance
- Coherence
- EU added value.
Figure 3  Simplified intervention logic and the five key evaluation criteria, EC (2015) p.271

These criteria are elaborated in Table 1.

Table 1  Evaluation criteria for the formulation of general policy questions

<table>
<thead>
<tr>
<th>Effectiveness:</th>
<th>Efficiency:</th>
<th>Relevance:</th>
<th>Coherence:</th>
<th>EU-added value:</th>
</tr>
</thead>
<tbody>
<tr>
<td>To what extent did the intervention cause the observed changes/effects? To what extent can these changes/effects be credited to the intervention? To what extent do the observed effects correspond to the objectives?</td>
<td>Were the costs involved justified, given the changes/effects which have been achieved? What factors influenced the achievements observed?</td>
<td>To what extent do the (original) objectives (still) correspond to the needs within the EU?</td>
<td>To what extent is this intervention coherent with other interventions which have similar objectives? To what extent is the intervention coherent internally?</td>
<td>What is the additional value resulting from the EU intervention(s), compared to what could be achieved by Member States at national and/or regional levels?</td>
</tr>
</tbody>
</table>

These criteria have been interpreted as overarching strategic questions to be answered in environmental policy modelling. From these strategic questions, a set of more specific questions which models might address has been developed. It was found that many of these specific questions can be applied to models in all the priority objective areas, while there are other specific questions that are only useful to ask for a single priority objective area. Table 2 shows the strategic questions and the general questions for all areas, and table 3 shows the questions for specific areas.
<table>
<thead>
<tr>
<th>Strategic questions</th>
<th>General modelling questions applicable to all models</th>
<th>Short form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness:</td>
<td>Does the model show historical trends?</td>
<td>historical trends?</td>
</tr>
<tr>
<td>What progress have different actors (the EU, the Member States, cities etc.) made over time towards achieving the objectives set out in the 7th EAP?</td>
<td>Does the model show future trends?</td>
<td>future trends?</td>
</tr>
<tr>
<td></td>
<td>Does the model identify actors who have made improvements and their behavioural drivers/incentives?</td>
<td>actors and drivers?</td>
</tr>
<tr>
<td></td>
<td>Does the model identify emissions by sector?</td>
<td>emissions by sector?</td>
</tr>
<tr>
<td>What have been the (intended and unintended) effects of the 7th EAP?</td>
<td>Does the model measure environmental footprints / contain LCI-data for SPC-assessment?</td>
<td>LCI data?</td>
</tr>
<tr>
<td>To what extent has the 7th EAP as a strategy contributed to the implementation of the Juncker priorities and the Europe 2020 Strategy?</td>
<td>Does the model account for social aspects of Sustainable Production and Consumption, such as CSR?</td>
<td>social aspects?</td>
</tr>
<tr>
<td></td>
<td>What are the impacts on growth and jobs?</td>
<td>growth and jobs?</td>
</tr>
<tr>
<td></td>
<td>What are the implications for investment?</td>
<td>investment?</td>
</tr>
<tr>
<td>Efficiency:</td>
<td>Does the model identify the direct and indirect economic costs of the policy?</td>
<td>economic costs?</td>
</tr>
<tr>
<td>What have been the costs and benefits involved with implementing the 7th EAP priorities?</td>
<td>Does the model identify emissions by economic sector?</td>
<td>emissions by sector?</td>
</tr>
<tr>
<td></td>
<td>Are these costs compared to the improved environmental performance?</td>
<td>cost vs. improvements?</td>
</tr>
<tr>
<td></td>
<td>Does the model identify the economic benefit of the environmental policy?</td>
<td>economic benefits?</td>
</tr>
<tr>
<td>To what extent has the enabling framework contributed towards achieving the three thematic objectives of the 7th EAP?</td>
<td>Does the model explicitly cover investment (in new products and services that have a lower environmental impact)?</td>
<td>eco-investments?</td>
</tr>
<tr>
<td></td>
<td>Does the model explicitly cover innovation (new products and services that have a lower environmental impact)?</td>
<td>eco-innovation?</td>
</tr>
<tr>
<td></td>
<td>Does the model explicitly consider implementation issues and rates?</td>
<td>implementation?</td>
</tr>
<tr>
<td>Relevance:</td>
<td>Does the model output refer to at least one of the objectives of the EU Environment Action Programme?</td>
<td>reference to 7th EAP?</td>
</tr>
<tr>
<td>Is it relevant to still have an EU Environment Action Programme?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are the 7th EAP objectives and structure still relevant?</td>
<td>Will the priority areas still be problematic in the future?</td>
<td>priorities still in the future?</td>
</tr>
<tr>
<td></td>
<td>Does modelling tell us there are problems that the 7EAP should have focused on?</td>
<td>problems missed?</td>
</tr>
<tr>
<td>Coherence:</td>
<td>Answered for specific policy areas under specific questions (see table 3 below)</td>
<td></td>
</tr>
<tr>
<td>To what extent is the Action Programme satisfactorily integrated and coherent with other parts of EU policies and strategies?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To what extent is the 7th EAP coherent internally in terms of its objectives and their delivery?</td>
<td>Answered for specific policy areas under specific questions (see table 3 below)</td>
<td></td>
</tr>
<tr>
<td>To what extent is the 7th EAP coherent with international obligations including the SDGs?</td>
<td>Answered for specific policy areas under specific questions (see table 3 below)</td>
<td></td>
</tr>
<tr>
<td>EU-added value:</td>
<td>Can policies be compared against no-policy by the models?</td>
<td>comparison policy no policy?</td>
</tr>
<tr>
<td>What would be the most likely consequences of abandoning the 7th EAP initiative?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To what extent do the issues addressed by the 7th EAP continue to require action at EU level?</td>
<td>Does the model demonstrate a continuing link across MSs?</td>
<td>link across EU MSs?</td>
</tr>
</tbody>
</table>

Table 2 General modelling questions applied to all five EAP priority objectives
<table>
<thead>
<tr>
<th>Strategic questions</th>
<th>Modelling questions applicable to all models</th>
<th>Priority area</th>
<th>Short form</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effectiveness:</strong></td>
<td>Can the model portray trends in the natural capital of interest?</td>
<td>Natural Capital</td>
<td>trends in natural capital?</td>
</tr>
<tr>
<td>What progress have different actors (the EU, the Member States, cities etc.) made over time towards achieving the objectives set out in the 7th EAP?</td>
<td>Can the model portray trends in recycling, material flows and waste?</td>
<td>Green growth</td>
<td>trends in material flows?</td>
</tr>
<tr>
<td></td>
<td>Can the model portray trends in resource efficiency?</td>
<td>Green growth</td>
<td>trends in efficiency?</td>
</tr>
<tr>
<td></td>
<td>Can the model portray trends in energy consumption, GHG emissions?</td>
<td>Green growth</td>
<td>trends in consumption?</td>
</tr>
<tr>
<td></td>
<td>Can the model portray human health impacts of air and water pollution, noise, toxic chemicals pollutants in food or consumer products?</td>
<td>Health impacts</td>
<td>impacts human health?</td>
</tr>
<tr>
<td></td>
<td>Does the model cover combined economic (growth), social (jobs) and environmental effects of policies for the preservation of natural capital?</td>
<td>Natural Capital</td>
<td>combined policy effects?</td>
</tr>
<tr>
<td>What have been the (intended and unintended) effects of the 7th EAP?</td>
<td>Does the model identify critical resource and energy constraints in the future?</td>
<td>Green growth</td>
<td>critical resources in future?</td>
</tr>
<tr>
<td></td>
<td>Does the model cover combined economic (growth), social (jobs) and environmental effects of policies for resource efficiency and eco-innovation?</td>
<td>Green growth</td>
<td>combined policy effects?</td>
</tr>
<tr>
<td></td>
<td>Does the model include changes in consumption and trade?</td>
<td>Green growth</td>
<td>changes in consumption and trade?</td>
</tr>
<tr>
<td></td>
<td>Does the model cover combined economic (growth), social (jobs) and environmental effects of policies for the reduction of pollution impacts on human health and well-being?</td>
<td>Health impacts</td>
<td>combined policy effects?</td>
</tr>
<tr>
<td></td>
<td>Does the model identify policy and policymaking processes at the international/global level?</td>
<td>Global</td>
<td>combined policy effects?</td>
</tr>
<tr>
<td><strong>Efficiency:</strong></td>
<td>Does the model cover indirect sectoral effects?</td>
<td>Green growth</td>
<td>indirect sectoral effects?</td>
</tr>
<tr>
<td>What have been the costs and benefits involved with implementing the 7th EAP priorities?</td>
<td>Does the model cover new industries, including services?</td>
<td>Green growth</td>
<td>sectoral change?</td>
</tr>
<tr>
<td></td>
<td>Does the model include the economic valuation of health benefits and the value of human life?</td>
<td>Health impacts</td>
<td>economic valuation of health?</td>
</tr>
<tr>
<td></td>
<td>Are the global external benefits of environmental action included?</td>
<td>Global</td>
<td>global benefits?</td>
</tr>
<tr>
<td></td>
<td>Are the marginal abatement costs compared across countries?</td>
<td>Global</td>
<td>abatement costs across countries?</td>
</tr>
<tr>
<td>To what extent has the enabling framework contributed towards achieving the three thematic objectives of the 7th EAP?</td>
<td>Does the model portray eco-innovation, competitiveness (costs of sustainable production, market shares in sustainable products)?</td>
<td>Green growth</td>
<td>competitiveness, eco-innovation?</td>
</tr>
<tr>
<td></td>
<td>Does the model include policies for eco-innovation, lead markets and learning effects?</td>
<td>Green growth</td>
<td>policies for lead markets, learning effects?</td>
</tr>
<tr>
<td><strong>Relevance:</strong></td>
<td>Addressed under general questions: see table 2 above</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3 continued

<table>
<thead>
<tr>
<th>Coherence:</th>
<th>Does the model portray the connections between env policy, policies for EU-MS and regional growth, energy, transport, other policy areas?</th>
<th>Green growth connections in policies?</th>
<th>Health impacts spatial distribution of pollution?</th>
</tr>
</thead>
<tbody>
<tr>
<td>To what extent is the Action Programme satisfactorily integrated and coherent with other parts of EU policies and strategies?</td>
<td>Does the model include the spatial distribution of population and the resultant distribution of exposure?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To what extent is the 7th EAP coherent with international obligations including the SDGs?</td>
<td>Can the models portray different types of natural capital (e.g. land use and biodiversity)?</td>
<td>Natural Capital types of natural capital?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EU-added value:</th>
<th>Can the models address fresh water and clean air across MS boundaries?</th>
<th>Natural Capital water and air across MSs?</th>
<th>Health impacts availability of resources across MSs?</th>
</tr>
</thead>
<tbody>
<tr>
<td>What has been the EU added value of the 7th EAP compared to what Member States could do alone?</td>
<td>Can the models address seas and ocean environments across MS boundaries?</td>
<td>Natural Capital oceans across MSs?</td>
<td>EU-wide markets?</td>
</tr>
<tr>
<td>To what extent does the model cover the availability of resources across the EU?</td>
<td>Does the model cover the development of EU-wide markets for eco-innovations?</td>
<td>Green growth EU-wide markets?</td>
<td></td>
</tr>
<tr>
<td>Does the model cover the EU-wide structure of production?</td>
<td>Does the model cover the EU-wide structure of production?</td>
<td>Green growth EU-wide production?</td>
<td></td>
</tr>
<tr>
<td>Can the model address air and water pollution across MS boundaries?</td>
<td>Can the model address air and water pollution across MS boundaries?</td>
<td>Health impacts pollution across MSs?</td>
<td></td>
</tr>
</tbody>
</table>

| What would be the most likely consequences of abandoning the 7th EAP initiative? | Can the model address pollutants along value chains for food and consumer goods across MS's? | Health impacts pollutants along value chains? |                                                   |

<table>
<thead>
<tr>
<th>To what extent do the issues addressed by the 7th EAP continue to require action at EU level?</th>
<th>Can the models address international trade in waste?</th>
<th>Health impacts trade in waste?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Can the models cover Life Cycle Assessment of products over a global life cycle?</td>
<td>Can the models cover Life Cycle Assessment of products over a global life cycle?</td>
<td>Health impacts LCA of products?</td>
<td></td>
</tr>
</tbody>
</table>
3 Models assessed

The models currently available to the EU were identified from several different sources. The most important source is the MIDAS database of European Commission models run by the Joint Research Centre (Hardy et al., 2016), which lists 200 models. These were reviewed to identify models relevant to environmental policy analysis. The LIAISE database, developed by the LIAISE FP7 network of excellence on impact assessment (LIAISE KIT, 2016), was also used. These sources were complemented by a literature search, including models for environmental assessment at the urban level.

The models were categorised into the five priority objectives and sub-categories have been defined to facilitate the mapping. The models are listed by the five priority objectives and the sub-categories in the appendix. A database of models grouped by EAP priority objectives and sub-categories is provided as a separate file. The histogram in Figure 4 shows the number of models reviewed by priority objective and the sub-categories.

![Histogram showing numbers of models reviewed by priority objective and sub-categories.](image)

**Figure 4** Numbers of models reviewed, models may be in more than one category

The majority of models address topics in the priority objective areas of natural capital and green growth. The MIDAS and LIAISE databases had only a few transport models that consider the urban scale. Therefore, a few urban models found through the COST action on urban integrated assessment were assessed. The number of natural capital models is dominated by agriculture and land use modelling.

The human health and impacts theme has mostly air pollution models, with only a few models on chemicals and noise impacts modelling. Global models are mostly integrated assessment models for climate change policy analysis.
Integration of analysis within thematic priorities is included through the sub-category of ‘multiple’ for natural capital, green growth and global models. The human health models were all single category models while the four urban models are all multiple category i.e. integrated assessment models. This does not consider integration between thematic priorities. The urban and global models mostly address multiple thematic priorities, while other models within the natural capital and green growth priorities are assessed for their treatment of multiple priorities in the following analysis.
4 Mapping models to questions

This section summarises the capabilities of models for the different priority areas. Each model was allocated to one of the priority objectives and assigned to a sub category, apart from the city level models. Each model was then reviewed against the general modeling questions and the specific questions for the assigned priority objective. To enable an overall assessment to be developed, the models were assessed for each question as one of: 'yes', 'partially yes', 'no' or 'not applicable'. Figures 5-9 summarise the results for the models in the five priority areas. The histograms show the numbers of 'yes', 'no' and 'not applicable' answers for the questions shown in tables 2 and 3.

4.1 Natural Capital

Biodiversity/habitats

These cover habitat assessment DOPA, PESTNAB (for pesticides impacts), PREDICTS, eHABITAT. The mussel fisheries model and FishHab consider marine environments.

Agriculture

This area covers a wide range of topics in environmental science. The models reviewed are mostly single area models. However, the CAPRI family of models, based around an economy/agriculture core, addresses a combination of agricultural practices, land economy and related agro-economy sectors, a biophysical model DND and the LUISA integrated assessment land use model. A considerable number of models (23) in this area are designed to answer questions of economics of agriculture-environmental policy. Models including AGLINK-COSIMO, CAPRI, FDF, IMAGE, SEAMCAP, SOSTARE, and TECHNOGIN address indirect economic effects to a partial extent. Only the SOSTARE model compares costs to benefits of policies in a comprehensive way. There is almost no coverage of innovation and investment in new technologies or practices; the only model assessed as having some coverage is EUFASOM. Almost all models can be used for a comparative exercise of policy assessment in their areas. This is the advantage of their largely numerical modelling approaches - that it is relatively easy to change input parameters to consider 'what-if' questions. A large number (16) of models address links across member states. There are no models that assess relationships between agricultural economics and biodiversity/ecosystems.

Air

Air models consider both the composition of air chemistry and physics and their attribution to sources. The CAM, ENSEMBLE, MAGCICC and TM5 models are physics or chemistry
models of the atmosphere. Sources models are CMB and TM5-FASST. APIS assesses biodiversity impacts. GAINS, RIAT+ enable emissions reduction policies to be assessed.

**Fresh Water**

There are a number of flood warning models such as EFAS, Flood Ranger, and LISFLOOD. LISQUAL and the REBECCA toolbox address continental scale water quality. River basin models are MODSIM-DSS, SWAT, WEAP, WATERSKETCH, and WATERWARE. MAPPE predicts soil chemical concentrations and run-off loads. None of the models in this category address social or economic/innovation questions. Some models do address management practices and can therefore be applied to innovation to a partial extent.

**Oceans and fisheries**

Ocean physics and chemistry models are COHERENS, EUTRISK (eutrophication), FAMOUS, FEMRAD-OC, and GOTM NAUSICAA. FAMOUS is also connected to global atmosphere models. Biogeochemistry models are: Flexsem, FABM, MedERGOM, MEDEM, and NEST. Fisheries including fisheries economics are COBECOS and PORPOISE.

**Summary**

The European Commission has access to many dynamic models capable of showing historical and potential future trends in many aspects of natural capital. In most areas of natural capital, these are natural science models, which do not have a representation of economic factors or social aspects. Most of the models fall into one of two groups. There is detailed natural science or technology models, which apply the state of the art to make the best possible assessment, or aggregated models trying to connect EU or global environmental issues and policy.

In the area of natural capital, there is a need for integrated models being capable to simultaneously address several different issues such as the SDGs which are usually not all captured by one single model.

There are a large number of models of agricultural production-consumption and emissions, which do also include trade and therefore competitiveness in the short run. These do not however address innovation. The GAINS and RIAT+ atmosphere models do include the costs of emissions reduction options and also emissions by source. There are no models for actors and their drivers. Social aspects and jobs are largely not addressed by these models. However, it should be noted that jobs are sometimes addressed by multi-sectoral economic models, which use data on activity for all the sectors to represent the whole economy. These models usually include employment in order to project the ability of industry to meet demand. Impacts are considered separately under health and impacts models. The focus on natural science models of complex ecosystems means that
there are relatively few models for combinations of policies across areas. Combined models usually combine a natural capital with economic analysis, which does enable the critical assessment criteria of efficiency (i.e. cost-effectiveness) to be addressed.

Institutional aspects are missing in most models: not only the overall economic performance needs to be addressed but also the question of how goods from different sectors (agriculture, industries etc.) are produced.

Figure 5 summarises the results of the question analysis for all models from the field of “Natural Capital”.

Overall, figure 5 indicates that the models assessed do cover the trends in the environmental indicators of concern and in principle at least, can assess the impact of EU policy on these indicators. However, there is little coverage of decisions or social aspects of sustainability. Costs and cost effectiveness of policies are also not well covered.
4.2 Green Growth

This covers a wide range of areas: Economy, energy, industry, transport and resources/waste as well as multiple category models.

Economy and multiple categories

This includes multi-sectoral macroeconomic general equilibrium (CGE) and Input-Output models. However, many multiple category models including E3ME, GEM-E3, PACE, ASTRA and others have a macroeconomic multi-sectoral core, which is then connected to detailed models of sectors and emissions. Many of these models include emissions improvements and the resulting reduction in GHG emissions. There is also an extensive literature on energy innovation and investment, including models such as POWERACE for energy supply, network infrastructure models such as EU-RTSGRID, and energy demand models. An important limitation of these models is that while they often consider jobs and competitiveness, other social aspects are not included. There are also no models that consider the processes of actors’ decision making, other than the parameterisation of a conventional preference function in the microeconomic sense for the economic optimisation models such as the CGEs. Most of the models in the global priority also cover the economy-energy-emissions system.

Energy

This area is extensively covered by modelling activities. There are both technical models of energy technologies and their emissions performance and technical-economic models of the energy system, such as POLES, TIMES-MARKAL, and JRC ETM. There are also many models available from independent institutes and universities. Again, social aspects and decision making are rarely considered in detail.

Industry

There are some models of specific industries with energy demand and emissions characteristics. While non-energy and transport industries do not have such extensive literatures, there are models of economic activity, emissions and energy/emissions efficiency for many specific branches available, including steel, aluminium, and cement. The emissions sources models in the natural capital air sub-category consider emissions from industrial sources.

Transport

This is also an area where there is very extensive modelling literature. The EU expends considerable resources on transport demand, network and technology modelling, including combined economic-transport activity-emissions and technology models such as ASTRA and TREMOVE. The EU does not regularly use the many urban transport network and emissions models, but such models are readily available. This is also considered in
the urban category. Transport is the one area where actor decision models have been developed to determine patterns of (travel) demand in detail, although these are not often used in policy assessment.

**Resources/Waste**

While there are numerous material flow models from the field of “industrial ecology” simulating the spatial distribution and life cycles of specific substances and raw materials (cf. Chen and Graedel 2012 or Müller et al. 2014), in this scoping study we have focused our research on economy-wide models for the EU covering general material use patterns at a macro level. Until now, four models have been reviewed in this sub-category: “E3ME-Materials” models material consumption at an EU member state level taking into account food flows, animal feed, wood, construction minerals and industrial minerals, ferrous ores and non-ferrous ores. The METRO model is a partial equilibrium model of metals markets and the mining sector which has been validated on the example of the rare earth market and which may be calibrated to many more industrial metals markets. The GaBi model is one of the best known models for Life Cycle Assessment. This model (and database) enables the detailed analysis of material consumption and environmental impact assessment for specific products or processes. The ETC/WMF waste and material flows model is an indicator framework evaluating the performance of waste management and recycling efficiency in different waste categories at a European level. The European Reference Model on Municipal Waste is maintained by the EEA for the Commission to support the assessment of progress towards the EU waste targets on municipal and packaging waste, and is a detailed bottom-up model of these issues.

**Summary**

This area is also very broad, including extensive modelling in economics, energy and transport. A number of single sector market models are also available. Many of these models address the dynamics of markets and there are also many explicit models of technological change, especially in energy and transport, but also in industrial energy demand. Models of system change and the dynamics of technological change are not so well represented. However, there are a number of models in the innovation literature, many of which have been used in European research projects that do address innovation and lead markets. The competitiveness and benefits in jobs and growth for European industry are addressed both through innovation studies and trade modelling. Trade is included in all economic models with an international (between EU member states or globally) dimension.

An important point is that there are relatively few models for actors and their drivers. The economic models either use aggregated analysis of data by sector or an aggregate preference function in the computable general (economic) equilibrium framework. This does not represent the dynamics of the adoption of new technologies by consumers, which is a critical element of technological change. A further aspect that is largely missing is an inte-
grated approach to sustainable production and consumption. This requires environmental assessment along a complete value chain. The only current modelling methodology for this is life cycle assessment, for which the GaBi model is used. GaBi, however, as an LCA does not include economic variables and therefore does not consider market impacts or social aspects of sustainable production and consumption.

Figure 6 summarizes the results of the question analysis for all models assigned to the priority area “Green Growth”. The models studied do address most of the questions considered in the analysis. There is much more coverage of economic questions than with the natural capital models – partly because the green growth category includes the economic aspects of sustainability. Two limitations do however stand out. Firstly, there is, as with the natural capital models, almost no consideration of social aspects of sustainability in the models. Also, there is very little life cycle assessment, which is required to assess policies for sustainable consumption and production.

Figure 6 Analysis: Green Growth

4.3 Health and Impacts

This category assesses human health and wellbeing, as well as the assessment of pollution impacts on ecosystems. Models cover the impact of air quality including chemical dispersion and absorption of pollutants into the body. Further models assess radiological impacts. Ecosystems models including pesticides have been assessed under the natural capital models. Noise impacts are not included in the models assessed, as this is a very localised phenomenon and is covered in national legislation.
Air quality

There are a range of models covering air composition and impacts. Of these, the GAINS model includes the economics of pollution abatement, while the ECOSENSE model estimates impact costs and enables a cost-benefit analysis. The other models of atmospheric composition identify emissions sources and the health implications of air-borne chemicals and gases.

Water quality

There are a range of models that consider different aspects of water quality. These include the FABM model system for water ecosystems, INITIATOR2 and REBECCA (model system) address regional pollutant flows into soils and surface waters, LISQUAL for water availability and quality at the EU scale, MAPPE for soil and surface waters, NEST for water quality in the Baltic region, RIVER BASIN MANAGER’S TOOLBOX and the SWAT model.

Chemicals and Radiological impacts

Another series of models assess impacts of chemicals on the human body and on animals. The ERICA model assesses the impact of radiological emissions on biota. None of these include economic assessments.

Summary

Some of the natural capital models, including most of the biodiversity models but also the river basin management tools, the ocean models and the BioMA biomass model all model impacts on the ecosystems that they study. The natural capital flood prediction and warning models also predict impacts of floods to some extent. The urban and global integrated assessment models also assess impacts of climate change through floods, temperature change on agriculture and heat waves and on the spread of disease.

Figure 7 summarizes the results of the question analysis for all models from the field of “Health and Impacts”. There are some models of absorption of pollutants into the human body. There is however almost no capability for epidemiological modelling, which is a reflection of the lack of such modelling in the scientific literature. A category of modelling that is also not well represented in the literature is resilience and adaptation i.e. the assessment of societies to limit the impacts of environmental damage and to change their structure or behaviour to minimise negative impacts of environmental or climate change. There is very little coverage of social aspects of sustainability and almost no capability for assessing cost effectiveness of policies. As was emphasised in the workshop, there are no models that cover the whole chain of pollution/emissions into ecosystems through the transport of pollutants through soils, air and water to absorption by ecosystems or people and the resulting health impacts.
It should also be noted that the number of models considered is small compared to natural capital or green growth, although many of the water and air quality models allocated to the natural capital section can also be considered as addressing impacts of pollution in at least a partial sense.

Figure 7 Analysis: Health and Impacts

4.4 Global challenges

The models assigned to this category are those with an explicitly global focus. There are a range of models in other categories that are also implemented at the global level, including climate (MAGICC), Economy-energy-emissions (E3ME), agriculture (CAPRI) and global climate-ocean (FAMOUS). GENIE and TM5-4DVAR are global climate models. The global multiple category models are mostly the climate change integrated assessment models (IAMs) such as IMAGE or PAGE. These all include economics, energy and GHG emissions coupled to a simple climate representation. They address emissions technologies from energy and transport and also land use. The technology and sectoral modules in these IAMs allow for technological progress, but the aggregated nature of these models makes the representation of heterogeneity among agents and choice behaviours and innovation processes difficult. Some models do include increasing returns in technological development through knowledge capital and spillovers, but this is only applied at a macroeconomic level. This means that the IAMs are not well suited to assessing competitiveness though eco-innovation or lead market effects in environmental technologies.

The Water-GAP model assesses global fresh water consumption and economics while GFTM and WATSIM are models of global agricultural trade. The GLOBIO model assesses global biodiversity and GLOFAS is a global flood awareness model.
The results of the question analysis for models from the category of “global challenges” are displayed in Figure 8. The global models are mostly intended to be integrated assessment models and therefore have a broader coverage of the policy questions than models in the other categories. They do still miss the social aspects of sustainability and the assessment of actors and decision making. Because they are intended to have a broad coverage, their ability to address implementation issues is limited. Their economic coverage is also limited, especially in respect to eco-innovation.

![Figure 8 Analysis: Global Challenges](image)

### 4.5 Sustainable Urban Planning and Design

Although the EU does not have urban environment models in the databases, there are a few environmental assessment models specifically addressing the urban level. The small number of models is surprising, given the identification of cities as a main priority objective in the 7th EAP and the very active city networks for sustainability (CIVITAS, POLIS, and EUROCITIES).

In order to provide some assessment of urban sustainability modelling, models reviewed in a COST action on Urban Integrated Assessment were assessed. These include the UIAF for London, NEDUM, SUSMETRO and YKR models. The UIAF combines I-O macro-econometric modelling with transport activity and also flood probability assessments for the Thames basin. The NEDUM model assesses housing, transport and temperature change impacts. SUSMETRO looks at sustainable land use and YKR is a special structure planning tool.
These urban models are mainly designed to undertake impact assessment and spatial planning. They can therefore consider social impacts in terms of the spatial distribution of jobs, employment, exposure to environmental pollution and climate impacts. They do not consider urban aspects of innovation such as innovation clusters or competitiveness effects. This is however an important argument for regional development of infrastructure and specialisation in ‘high-tech’ industries, which include eco-innovation.

There are also models of natural capital and ecosystems for the urban level and a large number of models on urban transportation and urban spatial structure. There are also some models of urban material, energy and waste flows.

To summarise, while the EU does not have its own models, there are urban sustainability assessment models available, especially in the areas of land use planning and transport. There are also localised atmospheric pollution models and ecosystem/natural capital models that can be applied to urban ecosystems, rivers and lakes and land management.

The results of the question analysis for models from the category of “sustainable urban planning and design” are displayed in 9. The capabilities of the models reflect in a similar way to the global models the implications of using integrated assessment models. While they cover many different aspects including cost effectiveness assessments, they do not explicitly consider a distribution of behaviours or the social aspects of sustainability. Also, their representation of eco-innovation is very limited.

**Figure 9** Analysis: Urban
5 Insights from the stakeholder workshop

The stakeholder workshop held in May 2016 brought out a series of points that are important to consider when modelling environmental policy, but are more about the structure and methodology of modelling than the policy questions analysed in the section above. These ideas are relevant for the further development of modelling activities for environmental policy analysis.

5.1 Issues of scale of modelling

While there are models at all scales in the EU portfolio, several critical points were brought out in the context of the discussion of health and impacts. Impacts of air quality are extremely localised or spatially differentiated. Air quality in a street with road traffic varies considerably from the road kerbside to the buildings, often over a distance of only 2-3 metres. This means that highly spatially detailed data and analysis is required to identify hot spots; many aggregated indicators do not apply at local/urban level. There is then a question of whether results from a hot spot analysis can be generalised between cities, but given that the vehicle technologies and infrastructure are the same or very similar, it was considered that measures could be identified that would be applicable to many cities in Europe.

Also, local authorities can only influence emissions locally, while air quality e.g. pm$_{2.5}$ and climate changes are mainly determined by emissions outside their area of responsibility.

Member state implementation of environmental policies will often be at the urban level. This means that different governance traditions and structures, both in local policymaking and in the relationships between policymaking at the member state level and the local level will have an impact on the feasibility and implementation of environmental measures.

5.2 General considerations

Fundamentally, there is the question of which models are suitable for use for EU environmental policy analysis. The first question is one of scientific quality. The usual criterion here is that a model should have been published in the peer reviewed scientific literature. In practice, there are some models that have a long track record of being used, which are in some priority themes only a small proportion of those that have been published. This has the advantage that the models and their behaviour are well known and results are therefore easier for the policymaking communities to understand and interpret. The possible disadvantage is that there is then 'lock-in' to a subset of models because of the previous time and financial investment, which may not fully reflect the state of the art in policy

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modelling. Comparisons between different models where there are alternative types of models in the scientific literature are important here.

The capability of models to deliver useful policy insights is also dependent on the context for the model development. Empirical data is necessary for model calibration and ex-post assessment. In some areas, especially health and impacts and also at the urban level, there are still major deficiencies in data collection. This is discussed further below.

Models are part of a process of policy development. There are connections to qualitative methods and models which can address the limitations of quantitative modelling. An area of particular importance here is Foresight, where the long term and speculative nature of Foresight activities require structured analysis, for which empirical data is only available to a very limited extent. Policy modelling can however play an important role (Köhler et al., 2015).

A particular problem was identified in modelling at the urban level. City authorities are usually the main deliverers of environmental policy, but they often have very limited resources for engagement with modelling activities. It was suggested that DG Environment could sponsor or provide models or modelling software for cities to use, such that they could undertake environmental policy analysis which would not be otherwise possible. For example, DG Environment could provide open source models and support for the ability to run them.

### 5.3 Model methodology

**Transparency**

A general problem with modelling for policy advice is that there is sometimes a lack of transparency of models even regarding historical input data; the model effectively becomes a “black box”. When assessing a need for policy modelling, it is necessary to start with a policy question and then identify a suitable model theory and structure. This can often be identified from current knowledge, but the need to combine areas of analysis means that developments in one area (e.g. economics) will sometimes spread into other areas (e.g. environment). The green growth agenda is an important example where this is necessary in current environmental policymaking. Clarity on important modelling assumptions is necessary for the results to be interpreted appropriately. In the scientific literature, some fields always make the source code available. This is not useful for policymakers, but it might be possible to make the funding of model development dependent on transparency regarding methodology, assumptions and data.

Uncertainty and sensitivity issues are often not sufficiently addressed when examining results from quantitative models. The “robustness” of conclusions drawn from modeling exercises is also an important aspect of model transparency. This can be addressed by sensitivity analyses and by exploring other modeling approaches.
Linking models

Environmental policy analysis is a field where there are many different interconnected aspects. This leads to the need for integrated/interdisciplinary modelling that connects the different fields e.g. emissions and economics. The trade-offs between level of detail and simplicity (transparency) are particularly difficult and sometimes fine scale models are simply not suitable. Integration cannot only be reduced to linking different models; it includes integration between data/ecosystem services/ spatial detail, temporal scale, general level of disaggregation (for example regarding economic sectors)/models. A major challenge will be to find a good balance between the modification/linking/coupling of existing models and the development of new integrated models. This is case specific. A judgement about the level of integration and detail of modelling requires a wide expertise in different modelling approaches.

The most ‘integrated’ models currently in general use in terms of overall coverage are the global integrated assessment models of climate change. However, in order to cover economic, emissions and climate variables for the whole globe for the relevant time span of 100 years for climate policy, they are of necessity much simpler in each of these areas than e.g. the specific natural capital, partial economic or sectoral technology models that are also reviewed here. The question for policy assessment is then, which assessment questions are critical and can these be covered to a reasonable approximation by a single model or would a model assessment require consideration of results from a range of models or the development of links between models either through manual data exchange or through coupling software, which is usually much more resource intensive.

A common proposal is to link a combination of existing models that cover the different areas. However, it is not clear that there is a real success story in linking different models for the development of highly integrated model systems. Even hard linked models do not always interrelate properly (e.g. feedback effects, trade-offs between resources and natural capital).

A useful alternative is to invest in models with higher integration explicitly developed for policy making in cooperation with decision makers. A possible process would be:

1. simple models / diagnostic models could be developed in cooperation with decision makers in a first step;
2. specification of the models in a second step;
3. linking model results with expert judgment through Bayesian Networks which might be a way to avoid inefficient hard links and data problems with soft coupling of different models. This might also enable the comparison of results from different models.
5.4 Thematic issues

Two themes of general relevance have been identified: the definition of ‘Green Growth’ and migration as a factor in environmental policy.

Green Growth

Green Growth as a policy concept is new and very general. The consequence of this is that the definition of what Green Growth is has to be clarified before deciding which models can address it. Progress has been made in green growth metrics (a current discussion can be found at Green Growth, 2016), but there is still a lack of integration in models.

Migration

Migration also has potentially a significant environmental component. In particular, it is argued (e.g. IPCC 5th Assessment) that increasing global temperatures will have negative impacts on sub-Saharan and north Africa and the Middle East (new World Bank report), as well as on north Asia. These regions already contain politically unstable areas which are the origins of the current migration wave. While IAMs such as IMAGE have been used to consider the environmental implications of climate change on land productivity in these regions, such assessments have not been connected to assessments of the consequent potential population movements. This may also become an issue in the European Mediterranean countries, which are already semi-arid and face water supply shortages.

It is important to note the different impacts of migration in the short- vs. in the long-term. In the short term, the current migration flows raise a series of political and environmental issues. In the long term, migration flows contribute to population growth and change the distribution of social factors such as age distribution.
6 Gap analysis

6.1 Structure of the analysis

The gap analysis used the results of the assessment of policy questions described in chapter 4 above and also considered the themes and general issues raised in the stakeholder workshop. A description of the structure of environmental policy modelling was proposed at the workshop and is shown in figure 10. The environmental policy assessment is influenced by a series of exogenous ‘macro’ factors such as economic activity trends, demographics and behaviour of people as users or decision makers. However, the Juncker priorities have placed a new significance on socio-economic implications of environmental policy, also reflected in the broader concerns addressed by the SDGs. The analysis in chapter 4 has addressed the positioning of current models in this assessment structure.

Figure 10 Structure of environmental policy modelling

This chapter summarises the limitations in modelling capabilities with regards to this structure. The links from environmental modelling to green growth and the Juncker priority on growth, jobs and investment are considered, followed by the more general sustainability themes of the SDGs. Then, specific topics of environmental policy modelling are discussed. Issues of modelling methods are also considered.

Integration across thematic priority objectives

In several themes, there is a limited capability for modelling links between natural capital and socio-economic systems. The links between the models considered under health and impacts with the green growth agenda have been found to be limited (but health impacts
do have a political value in their own right). Indicators for connections between health and impacts and other areas require further investigation.

In order to fully reflect the state of scientific understanding in such areas, models which are designed with integration in mind from the start are required. The IAMs address such issues, but mostly at a highly aggregated level.

It is emphasised that this exercise covers all the DG Environment environmental policy areas as well as related areas of environmental policy. With this wide scope, it does not cover all the detailed capabilities of all the models and the constant need and push for improvement that is happening in all areas (including the most mature modelling suites). Rather, the objective is to identify thematic areas where modelling activities are most limited or cannot answer the questions asked by environmental policy makers. Nevertheless, there is scope for advances in modelling of all policy fields including nature, water and land issues, even if not singled out below.

6.2 Green growth and the Juncker priority on jobs, growth and investment

In both natural capital models and health and impacts models there is limited capability for addressing these jobs, growth and investment issues. In these thematic priorities, models do not consider eco-innovation in technological innovation or in practices in e.g. management of land and water resources for agriculture, fisheries and eco-system services. Although management practices are assessed, there is little attempt to model possible pathways of change towards sustainability. This is partly due to the lack of models of decision making by agents for eco-innovation in environmental management or eco-innovation.

There is also limited modelling across all priority areas of the positive economic impacts of environmental policy on economic growth and employment. Although there are multi-sectoral macroeconomic models included in the review, which do assess the growth and employment impacts of investment, including in energy, transport and the other manufacturing and service sectors, there is little attempt to model the growth in manufacturing based on eco-innovation and still less the growth in services for environmental management. Hence ways to improve the competitiveness of European industry through eco-innovation or the potential to develop lead markets in environmental products and services are not addressed by the market models available.

This arguably induces a negative bias in the economic evaluation of environmental policy, which is seen as improving the environment, but at an increased economic cost, implicitly or explicitly in the case of Computable General Equilibrium economic models with reduced economic growth and less employment from environmental policies which are assumed just to give rise to abatement costs.
Perhaps the overall question is whether environmental policy changes the size of the economy or simply its structure and, secondly, whether even if the economy stays the same size whether there is a negative or positive impact on consumption. Certainly, a politically relevant question is what is the overall impact on jobs, and how can we make it as positive as possible?

6.3 Social aspects of sustainability and the SDGs

In all priority areas, there is very little modelling of the social aspects of sustainability. Modelling of distributional impacts of policies is lacking, except for country and sector comparisons. The social distribution (social groups/geographical areas) of the impacts of environmental policies are only considered in a very few models, usually across defined income distributions. The connections between health and impacts of the environment and policy to social/demographic distributions and poverty are not addressed.

In terms of the SGDs, what are missing in these models in general are assessments of social sustainability that are not directly connected to environmental issues. Nutrition, healthy lives, water supply and energy provision outside the EU, together with economic development and innovation as development goals are only addressed by the global Integrated Assessment Models of climate change mitigation at an aggregated level. Poverty, education, gender issues, social inequality, peaceful and just societies are not addressed by the models reviewed. However, these issues are considered in development policy. What is missing is a systematic attempt to consider the connections between these more social SDG goals and environmental policy, in particular the possibly positive impacts of environmental policies on poverty, health and social inequality.

6.4 Specific topics for environmental policy modelling

Sustainable consumption and production

There is a significant gap in the assessment of sustainable consumption and production. The assessment of SCP requires the tracing back of consumption decisions through the production chain and product life cycles. The question here is how to assess sustainability of both the production of goods and services along a complete value chain from raw materials through purchase and then use and through to the end-of-life waste or recovery. Also, how can management practices for improved sustainability in production and the use of goods and services be assessed? This can be regarded as an extension of Life Cycle Analysis to include market and social assessments. There is relatively little modelling of SCP, to our knowledge, but there is a significant theoretical and practical literature which could form the basis for model development.
Material flows and resources use

There are also very few models forecasting the use of raw materials and commodities. While there are disaggregated models for materials use and recycling available and national level material flows accounting models, there have been very few models that link such flows to economic activity or eco-innovation.

Environmental benefits/outcomes

There is limited capability for modelling the co-benefits of environmental policies for ecosystem services and aspects of health and impacts, indirect as well as direct. The workshop discussion came to the conclusion that there are no models that cover the whole chain of pollution/emissions into ecosystems through the transport of pollutants through soils, air and water to absorption by ecosystems or people and the resulting health impacts.

Urban environmental policy modelling

The EU does not have its own capability for urban environmental policy modelling. This is not necessarily a problem, because it is local rather than EU wide by nature. However, given that sustainable urban planning and design is one of the five main priorities of the 7th EAP, it would be useful to consider whether such a capability needs to be developed. An important first point is that there is a lack of data for urban environmental policy modelling. Also, there may be role for the EU so support local administrations in having access to modelling capability, as cities may have relatively limited resources to run models or specify model activities.

Also, similarly to the global integrated assessment models, there is no modelling at the urban level of eco-innovation as the source of green growth. The few urban models reviewed do not consider urban aspects of innovation such as innovation clusters or competitiveness/lead market effects. This is however an important argument for regional development of infrastructure and specialisation in ‘high-tech’ industries, which include eco-innovation.

Resilience and adaptation

A category of modelling that is still not well represented in the general environmental literature is resilience and adaptation i.e. the assessment of the ability of societies to limit the impacts of environmental damage and to change their structure or behaviour to minimise negative impacts of environmental or climate change. This is also lacking in EU environmental policy analysis.

6.5 Methodological limitations of current models

Behavioural change/Agent based modelling
Current models of environmental policy incorporate a wide range of behaviours, but decision making is almost exclusively represented as utility/welfare maximisation in the conventional economic sense. Behavioural change takes place in response to relative price changes. This has a major limitation for environmental policy analysis. Changes in the priorities of people and organisations to placing a higher priority on the environment or a lower priority on 'conventional' consumption e.g. owning one's own car and other changes to decision rules cannot be modelled. This does not reflect the state of the art in modelling methods. The application of Agent Based Models to environmental decisions and management allows for a range of actors to take a range of decisions based on varying decision rules. Such models can generate significantly different results to models assuming a single 'average' or 'representative' agent and can also match very well decentralised decisions such as farm management schemes or energy efficiency measures in households or buildings.

**Structural change in social-environmental-economic systems**

A question that was raised in the workshop was whether models are relevant in a significantly changed context. The answer is usually no, especially if the model outcomes are mostly determined by calibration to historical data. For physical or chemical processes which are understood, this is not a problem. However, for ecosystems and social and economic system structures this is often a major limitation. These are complex systems and can therefore exhibit highly non-linear behaviour when subject to large scale changes in their environment. This is important for example in the current policy emphasis on transformation/transition to sustainability including a low carbon society to address climate change, where a large scale transformation in society will be required. This requires economic and techno-economic assessment beyond marginal economic optimising methods. A further area requiring non-linear analysis is addressing non-linear changes in ecosystems – ‘tipping points’ where positive feedbacks dominate. Such effects as the turning off of the North Atlantic current or the failure of the Asian monsoons require models that are capable of reflecting the complex systems nature of these problems. Methods from complexity science can be applied here.

**Exposure chains in health and impacts models**

Models in this theme mostly address the response to a given exposure. There is a lack of modelling of the whole policy chain shown in the central chain in figure 10: feedback from a measure back to reduced dose to reduced response i.e. what is the health impact benefit of a measure?

For a wide range of pollutants, models are lacking that assess how many people are exposed to a particular pollutant/toxin/pesticide. Some examples are: there is no assessment of pesticide exposure from the pollutant/toxin/pesticides in e.g. water or in indoor exposure – e.g. endocrine disruptors – through consumption. While models exist of the stressors (such as pesticide run-off into rivers), data and models of the distribution of pes-
Ticide application and the subsequent path of pollutants through water systems to e.g. water consumed by people in different cities do not exist.

One important aspect of this is that models do not account for multiple exposures and their combined effects. The scientific understanding of multiple exposures — how to attribute impacts from multiple exposures to chemicals — also seems to be limited.
7 Areas for development for policy modelling

While the primary objective of this analysis is to identify possibilities for new models, other related opportunities have also been identified for data collection and urban environmental policy analysis.

7.1 New model development

Linking management of natural capital to social impacts and eco-innovation

New models can be developed for many aspects of natural capital which link ecosystem services and their management practices to the social and economic implications of policies and eco-innovation in technologies and services. This includes modelling of lead markets and strengthened competitiveness in environmental products and services, especially in new areas of natural capital and environmental management for green growth.

Models for behavioural and system change

The analysis of environmental policies requires a much more comprehensive assessment of the possibilities for changing consumption structures and for changing systems for natural capital use and environmental management. This requires model structures which incorporate a range of decision makers who take a number of possibly differing decisions i.e. agent based models. Such models should also enable the assessment of lead markets and strengthened competitiveness for green growth.

Social aspects of sustainability

Models should be developed that assess the impacts of environmental pollution and policy on health and well-being across social/demographic distributions, including explicit consideration of people in poverty.

Sustainable Consumption and Production

Modelling of sustainable production and consumption: sustainability of both the production of goods and services along a complete value chain from raw materials through purchase and then use and through to the end-of-life waste or recovery. How can management practices for improved sustainability in production and the use of goods and services be assessed?

Whole system assessment of exposure to pollution and impacts

System models are required that address the distribution of stressor sources and the industrial/management practices that give rise to these distributions, the chain of transport through the air, water and products to the distribution of exposures to multiple stressors
and the impacts on people and eco-system services. This should include scenario modelling for areas of potential big risk e.g. nanomaterials, new chemicals, which could make a major contribution to Foresight activities in the European Commission.

7.2 Data

Although there is now a large body of environmental research and modelling, empirical data is still limited in the following areas:

Health and impacts
- where people are in ‘real time’ as opposed to where they live, to enable realistic assessments of exposure;
- spatial distribution of emissions sources and sinks, including industrial chemicals;
- data on what actual environmental management practices are e.g. pesticide application rates;
- data on multiple/combined exposures and their combined impact on health;
- definitions and data for indicators of well being, beyond indicators of health.

Materials/resources
- Material flow indicators/accounts have not been developed in many areas.
- Lack of footprint-type indicators of materials and resources use.

Therefore, projects should be supported which collect or generate data in these areas.

7.3 Urban analysis

There are limited resources for measurement and modelling in smaller cities, which results in limited data and modelling at the urban level for environmental policy analysis. City authorities are usually the main deliverers of environmental policy, but they often have very limited resources for engagement with modelling activities. DG Environment could sponsor or provide models or modelling software for cities to use, such that they could undertake environmental policy analysis which would not be otherwise possible. For example, DG Environment could provide open source models and support for the ability to run them.
8 Conclusions on a possible way ahead

8.1 The contribution of modelling to the evaluation of the 7th Environment Action Plan

There is clearly potential for co-ordinated modelling that supports the evaluation of the 7th EU Environment Action Plan (EAP). Whilst the specifications of any such exercise need to be looked at more closely, this scoping study identifies potential and some ways forward. Some of the broad conclusions are that:

- **Modelling can be structured around the three thematic priorities** of the 7th EAP set out in Figure 1 (natural capital; resource efficient, low carbon economy; and human health and wellbeing) **along with the horizontal priority objectives** (sustainable urban planning and design; and global challenges). In all of these areas, modelling can contribute to the assessment of environmental policy, within the framework for environmental policy modelling illustrated in figure 10.

- The **enabling framework** of the 7th EAP is harder to model, because it addresses institutional issues of policy enactment, although data issues have been addressed in this report and are of direct relevance to modelling for policy assessment.
  - Implementation of existing legislation and an accessible knowledge base are rarely modelled explicitly, but their implicit consideration through the underlying assumptions needs to be identified and explored;
  - investments and innovation are central to the economic assessment of environmental policy and are included in models of eco-innovation, however, the processes of investment decisions including how environmental concerns are taken into account are difficult to model;
  - integration of environmental concerns into other policy areas is possible on a case to case basis such as the links between agriculture and natural capital or air pollution.

- **Modelling also needs to be embedded within the wider evaluation work.** Figure 3 shows the standard intervention logic of EU policy-making in line with the new better regulation rules, and clearly for some aspects indicators will provide useful information, whilst for other modelling is more necessary. Going beyond this, other issues are hard to address through modelling alone but could be addressed through foresight activities or one off case studies and ad-hoc analysis.
- The European Commission has an established structure for its ex-post evaluations, with all evaluations assessing effectiveness, efficiency, relevance, coherence and EU value-added. Modelling can provide input for all of these evaluation criteria, if the questions to be answered are identified early on – a first attempt in Table 2 and 3 shows some of the strategic questions that need to be answered and the modelling questions that can link in to these.

- Models use is not limited to the backwards looking questions that dominate an evaluation. There could be significant benefit from having a combined approach that involves both looking back, assessing the state of play and looks forward (in Commission jargon, combining the evaluation and subsequent Impact Assessment).

- Such a modelling exercise would need to start well in advance of any delivery date if it was to be properly delivered. Chapters 3 and 4 show a mixed picture. There is a wealth of models, with more than 200 potentially relevant and available. At the same time, models are not always tailored to the needs of the European Commission, and care needs to be given to the gaps and limitations identified in this report, including:
  - issues of scaling between the local to regional to national to EU level, and the need for models to tell consistent stories, whether from a single integrated model or combinations of models;
  - scientific quality needs to be demonstrated;
  - the models need to be transparent, and avoid black box analysis that excludes stakeholders. This presents a major difficulty, as most models are complex and require a considerable time investment to be fully understood;
  - linking models will be a key issue not least to show the need for integrated solutions and co-benefits;
  - in terms of thematic issues, the links to the green growth policy agenda and migration as factors in environmental policy need to be clarified.

8.2 Opportunities for improving environmental policy assessment modelling

- A clear policy need will be for more integrated analysis, stepping away from purely environmental modelling to look at integrated economic, social and environmental analysis. This is often a gap in the models, which will need to be addressed when looking at:
  - integration across thematic priority objectives;
o the links to the Junker priority on jobs, growth and investment (is environmental policy a net creator of jobs, what are the issues with managing the transition etc);
  o the link to the Sustainable Development Goals and in particular their social aspects;
- There are modelling **gaps in terms of substance coverage**: sustainable production and consumption, material flows and resource efficiency, urban environmental policy modelling, resilience and adaptation. Linked to this, there are general challenges in terms of data and models often focus on the present ecosystem and socio-economic system rather than behavioural change. Agent based modelling can address behavioural change and show the issues with risks.

- More generally, models tend to be better for modelling incremental change than for **modelling structural change**. This requires the modelling of systems and whole processes.

Whilst bearing in mind the different limitations, there is scope for a co-ordinated modelling exercise to provide an overview of many key issues related to environmental policy and the EU Environment Action Plans. Such an approach will need to bring together all of the stakeholders involved in modelling. If the 7th EAP evaluation is to be finalised in early 2019, a two year modelling assessment would be feasible if started by the end of 2016. Such an exercise could have as a priority the combined assessment of environmental policy, its social implications and its contribution to the Juncker priority on jobs, growth and investment though eco-innovation.
9 References


Hardy, Matthew; Ostlaender, Nicole; Smits, Paul (2016): Modelling Inventory and Database Access Services (MIDAS). Overview of models. Edited by JRC. European Commission.


## Annexes

### Annex 1. List of models by thematic and horizontal priority

See separate excel data file for model descriptions

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<th>Biodiversity / habitats</th>
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<th>Fresh water</th>
<th>Land use/Agriculture</th>
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Annex 2 Sustainable Development Goals

Goal 1: End poverty in all its forms everywhere

Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture

Goal 3: Ensure healthy lives and promote well-being for all at all ages

Goal 4: Ensure inclusive and equitable quality education and promote life-long learning opportunities for all

Goal 5: Achieve gender equality and empower all women and girls

Goal 6: Ensure availability and sustainable management of water and sanitation for all

Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all

Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10: Reduce inequality within and among countries

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12: Ensure sustainable consumption and production patterns

Goal 13: Take urgent action to combat climate change and its impacts

Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development
**SDGs and targets with mainly environment focus: SDG 6, 11, 12, 13, 14, 15**

**Goal 6. Ensure availability and sustainable management of water and sanitation for all**

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.b Support and strengthen the participation of local communities in improving water and sanitation management

**Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable**

11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums

11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries

11.4 Strengthen efforts to protect and safeguard the world’s cultural and natural heritage

11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management

11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning

11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels

11.c Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials

Goal 12. Ensure sustainable consumption and production patterns

12.1 Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries

12.2 By 2030, achieve the sustainable management and efficient use of natural resources

12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses

12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle

12.7 Promote public procurement practices that are sustainable, in accordance with national policies and priorities

12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

12.a Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production

12.b Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products

12.c Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities
Goal 13. Take urgent action to combat climate change and its impacts*

13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

13.2 Integrate climate change measures into national policies, strategies and planning

13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

13.a Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible

13.b Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities

* Acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution

14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans

14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels

14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics

14.5 By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information

14.6 By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation

14.7 By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism
14.a Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries.

14.b Provide access for small-scale artisanal fishers to marine resources and markets.

14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of The Future We Want.

**Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.**

15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.

15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.

15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.

15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.

15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.

15.6 Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed.

15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products.

15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species.

15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.

15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems.
15.b Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation.

15.c Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities.

Annex 3. Juncker Commission priorities

1. A new boost for jobs, growth and investment
2. A Connected digital single market
3. A resilient Energy Union with a forward-looking climate change policy
4. A deeper and fairer internal market with a strengthened industrial base
5. A deeper and fairer Economic and Monetary Union
6. A reasonable and balanced Free Trade agreement with the United States
7. An area of justice and fundamental rights based on mutual trust
8. Towards a new policy on migration
9. A stronger global actor
10. A Union of democratic change
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