ISSN 2467-4273

ISSN 2467-4273

Eionet report | No 1/2017

Mapping Europe's environmental future: understanding the impacts of global megatrends at the national level

Method tool kit

European Environment Agency

Eionet — European Environment Information and Observation Network

Cover design: EEA
Cover photo: © George Digalakis, My City /EEA
Layout: Rosendahls/EEA

Luxembourg: Publications Office of the European Union, 2017

ISBN 978-92-9213-843-1
ISSN 2467-4273
doi:10.2800/06901

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark

Tel.: +45 33 36 71 00
Web: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

Contents

Acknowledgements

The European Environment Information and Observation Network (Eionet) Improvement and Innovation Initiative (E3I) aims to explore how Eionet can contribute to meeting knowledge needs for future environmental policy, initially focusing on global megatrends and sustainability transitions. In this context, this report has been prepared through a process of co-creation and participation. The process has involved the support of numerous actors within Eionet, including National Reference Centres on Forward-looking Information and Services (NRCs FLIS), through participation in methodology development and testing workshops and discussions; National Focal Points (NFPs), which have supported the process and provided comments and guidance; pilot countries, which have tested the draft method in their own national studies and provided feedback and insight, including from the national experts that have participated in these studies; and experts at the European Environment Agency (EEA), who have provided support, technical input and feedback.

This report was made possible by the financial and practical support of the Swiss Federal Office for the Environment (FOEN) as part of the joint FOEN–EEA project 'Mapping Europe's future — understanding the impacts of global megatrends at the national and European level'. The main authors of this report were Karin Fink and Klaus Kammer (both FOEN), Anita Pirc-Velkavrh (EEA) and Owen White (Collingwood Environmental Planning (CEP), UK). Guidance, support and review were provided by Jock Martin (EEA), Nicolas Perritaz (NFP, Switzerland) and Sofia Rodrigues (NFP, Portugal). Further assistance and feedback were given by other EEA staff, namely Teresa Ribeiro, Milan Chrenko and Lorenzo Benini. The authors would like to express their gratitude for the key input and technical advice concerning causal loop diagrams and systems dynamic modelling provided by Ulli Lorenz (NRC FLIS, Germany) and Hördur Haraldsson (NRC FLIS, Sweden).

Hördur Haraldsson is also the author of *Introduction to Systems Thinking and Causal Loop Diagrams: Reports in Ecology and Environmental Engineering*, sections of which are reproduced in Annex 12 of this handbook, with the permission of the Department of Chemical Engineering Lund (2004).

The insights and value provided by the NRC FLIS pilot case studies is also recognised. The countries that commenced pilot studies, and through these provided input to the method development, were Belgium (Flanders), Germany, Hungary, Slovakia, Spain and Switzerland. The EEA and FOEN wish to thank all participants of the workshops, held in Bern and Copenhagen in 2015 and 2016, for their helpful advice and comments on earlier drafts of the method toolkit, in particular (in addition to the people already mentioned above) Gilbert Ahamer (Austria); Konrad Bishop (UK); Ed Dammers (Netherlands); Richard Filcack (Slovakia); Miguel Guerra (Portugal); Miroslav Havranek (Czech Republic); Miklós Marton (Hungary); Radoslav Považan (Slovakia); Alex Storch (Austria); and Marleen Van Steertegem (Belgium).

Introduction

Environmental challenges of unprecedented scale and complexity

In the 40 years since the emergence of European Union (EU) environmental policies in the 1970s, Europe has achieved major improvements in environmental quality, with associated benefits for economic development and human well-being. Despite these advances, Europe will face a variety of persistent and emerging systemic environmental challenges over the coming decades, linked to the adoption of unsustainable patterns of production and consumption (EEA, 2015a).

As noted in the European Environment Agency's (EEA's) five-yearly flagship report, The European environment — state and outlook 2015 (SOER 2015) (EEA, 2015a), Europe's progress towards decoupling environmental pressures from economic growth in recent years has been incremental, rather than comprehensive, and the gains achieved have only partially translated into improved ecosystem resilience and human health. In a rapidly changing global context, Europe needs to accelerate progress towards decoupling significantly (EEA, 2015b).

Against this backdrop, the EEA argued, in SOER 2015 (EEA, 2015a), that if Europe is to achieve its 2050 vision of 'living well within environmental limits' (EU, 2013), it must fundamentally transform its core societal systems, particularly those related to food, energy, mobility and the built environment. Achieving such changes will require 'profound changes in dominant practices, policies and thinking' (EEA, 2015a).

Thus, there is a need for new knowledge. During recent decades, Europe has developed an unparalleled international system of data collection and analysis to support the design and implementation of environmental policy. However, as understanding of the complexity and scale of Europe's environmental challenges has grown, so has recognition of the shortcomings of existing knowledge. SOER 2015 states that 'there is a gap between established monitoring, data and indicators and the knowledge required to support transitions'.

For a more complete understanding, it is important to acknowledge that global environmental change will be significantly affected in coming decades by a variety of global megatrends — large-scale, high-impact and often interdependent social, economic, political, environmental or technological changes. To design effective ways to manage the environmental changes ahead, societies and governments need to understand these global drivers and their potential implications (EEA, 2015a).

> Europe is bound to the rest of the world through multiple systems, enabling two-way flows of materials, financial resources, innovations and ideas. As a result, Europe's ecological and societal resilience is significantly affected by a variety of global megatrends — large-scale and high-impact social, economic, political, environmental or technological long-term change processes with decisive and critical implications. As the boundaries between developments in Europe and other parts of the world grow more blurred, Europeans are increasingly likely to be affected by developments in distant regions — some very sudden, others unfolding over decades (EEA, 2015c).

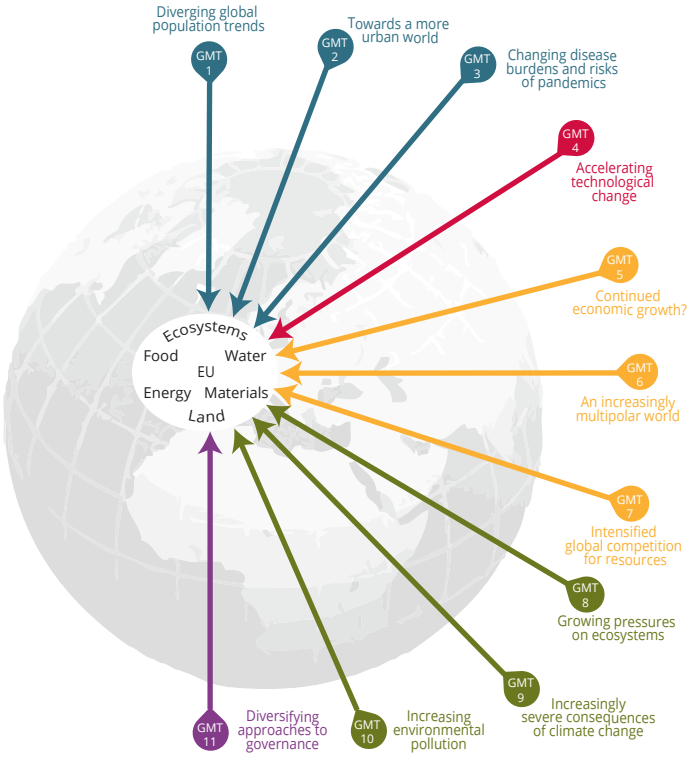
Why are global megatrends important for Europe and European countries?

Europe and European countries are increasingly connected to each other and the rest of the world. Changing global economic and population dynamics, the emergence of new technologies and wide-scale environmental changes can all influence Europe's environment, society and economies. At the same time, Europe contributes to environmental pressures in other parts of the world. Greenhouse gas emissions in Europe contribute to climate change impacts elsewhere, and globalised supply chains mean that European consumption contributes to pressures on ecosystems and communities in other areas of the globe.

In SOER 2015, the EEA analyses 11 global megatrends (GMTs) of relevance to Europe's environment (EEA, 2015c and 2015d and the figure below):

1. Diverging global population trends
2. Living in an urban world
3. Changing disease burden and risks of pandemics
4. Accelerating technological change;
5. Continued economic growth?
6. An increasingly multipolar world
7. Intensified global competition for resources
8. Growing pressures on ecosystems
9. Increasingly severe consequences of climate change
10. Increasing environmental pollution load
11. Diversifying approaches to governance.

EEA's Global Megatrends



Source: EEA, 2015a.

Although global trends are normally beyond the ability of any one nation to influence directly, they nonetheless represent very real challenges and opportunities for European countries. Some of their implications can present as pressures on the European environment, economy or society, while other implications may offer opportunities to move towards a more sustainable Europe. Their impacts also diverge in time and at different spatial scales. Developing an improved understanding of these implications, in a transparent and systematic manner, can help environmental policymakers and decision-makers to:

- respond to uncertainty and the complexity of systemic challenges by understanding and being prepared for emerging risks and opportunities;
- develop better (environmental) policy and strategy that are prepared for the future opportunities and risks emerging from GMTs;
- communicate with people outside the environment field by demonstrating the importance of environmental policy and the need for joined-up thinking;
- better understand the links between national, European and global trends.

The EEA SOER 2015 GMT report identifies two approaches to addressing GMTs for Europe (see the table page 8).

The European Environment Agency, Eionet and the Eionet Improvement and Innovation Initiative

The EEA asserts that addressing the gaps in existing knowledge will require a shift, namely the focus on understanding environmental problems should be extended to include a more comprehensive analysis of their possible solutions.

Barriers exist to the creation and use of such knowledge, such as academic barriers to transdisciplinary research or a lack of necessary skills and resources. However, the EEA and the European Environment Information and Observation Network (Eionet) are, with their science–policy interface, an established institution and network, and are very well positioned to bring together evidence and develop systemic co-created knowledge in order to support policymaking and decision-making at the European level. Striving to understand how the 11 GMTs analysed by the EEA will impact on the environment in

European and national approaches to addressing GMTs

Adapt and respond by being prepared	Shape and mitigate by working with others
'...find ways to adapt to global trends. This could take the form of seeking to anticipate and avoid harm by increasing the resilience of social, environmental and economic systems. It could involve restoring damaged ecosystems or correcting social impacts that have already occurred. Or it could involve exploiting opportunities that arise as a result of the changes, such as the commercial opportunities associated with innovation, expanding global markets and prosperity.'	'...seek to shape global change in ways that mitigate and manage risks, and create opportunities. This could be achieved, for example, through unilateral and multilateral efforts to mitigate environmental pressures or facilitate trade, or through using foreign aid mechanisms to invest in education and poverty alleviation.'

each European country and Europe as a region seems a good way to begin this journey in the search for the systemic knowledge required.

After the publication of SOER 2015 (EEA, 2015a), the EEA and Eionet are now looking ahead to structuring SOER 2020. With this in mind, the Eionet Improvement and Innovation Initiative (E3I) was established to explore how the network can contribute to meeting knowledge needs for future environmental policy, initially focusing on GMTs and sustainability transitions. Its objective is to bring a strategic approach to discussions about the improvement of interactions and engagement with Eionet, through the use of innovative ideas and approaches to knowledge developments. E3I consists of two activities, as outlined below.

Activity 1: Exploration of the implications of global megatrends on the environment and environmental policies at the national level ('E3I GMT')

The main objective of this activity is to support the understanding of the GMTs and facilitate/encourage the development of knowledge on their possible implications for the environment and environmental policies at the national level in Eionet countries. The activity is led by the EEA and the National Reference Centre (NRC) on Forward-looking Information and Services (FLIS) Switzerland, and supported by NRC FLIS experts.

Currently, the activity consists of three interlinked components:

- the development of a methodological approach/guidance towards the assessment of GMT implications at the national level (2015–early 2016);
- a series of discussions about the GMTs and testing of the methodological approaches/guidance towards the assessment of GMT implications with interested Eionet countries (2016);
- the analysis of GMT implications for the environment and environmental policies at the national level in Eionet countries (2017).

Activity 2: Assessment of sustainability transitions and niche innovations in Eionet countries ('E3I Transitions')

This activity aims to facilitate the discussions on the possible role of Eionet in knowledge contributions in support of the transition discourse in coming years. It is coordinated by an E3I working group (consisting of National Focal Points (NFPs), from Germany, the Netherlands, Finland, Portugal, Slovenia, Sweden, Switzerland and the UK, and the EEA). The E3I group has prepared a working paper 'Sustainability transitions: now for the long term' and launched an NFP/Eionet questionnaire exploring knowledge on sustainability transitions and niche innovations across the Eionet countries.

The E3I Transitions activity combines two major functions: (1) a process of shared learning among EEA and Eionet partners about sustainability transitions and related knowledge needs; and (2) the development of empirical evidence about transitions activities across Europe.

The work began in the summer of 2015 with the preparation of the working paper on transitions concepts and a questionnaire seeking information about niche innovations and emerging transitions. The questionnaire was distributed to all of the EEA's NFPs and European Topic Centres (ETCs). It resulted in 75 responses, which were analysed by the E3I transitions working group at three workshops organised by the EEA and the German Environment Agency (Umweltbundesamt (UBA)). The E3I Transitions report (EEA and Eionet, 2016) demonstrates the value of the case studies collected with regard to explaining the abstract and complicated transitions theory in a way that is easy to grasp, and with regard to illustrating how societies across Europe are promoting innovation and systemic change.

Context and background

Since its establishment in 2009, the proven added value and effectiveness of NRCs FLIS have been through their networking, community of practice and capacity-building qualities in the area of forward-looking assessments (Tuinstra and van 't Klooster, 2015).

The attention of NRCs FLIS in their first years was primarily focused towards strengthening their internal effectiveness, as well as towards direct or indirect contributions to external users, by working more at the interface between science and policy. Developing common FLIS projects is seen as an opportunity for external relevance and outreach. Such projects give the network common identity and goals, and provide a platform for knowledge and experience sharing. They also provide a shared stock of information for use with different target audiences, e.g. an overview of variations among countries and at different geographical scales (from the national to the European to global scale).

This report *Mapping Europe's environmental future: understanding the impacts of global megatrends at the national level — Method tool kit* demonstrates the practical applications of such a common approach.

What is included in this report?

This report sets out the logic for identifying the implications of GMTs at the national (see box on p. 11), regional or European level, and aims to provide inspiration to EEA member and cooperating countries to undertake their own national studies. In doing so, it describes the context and the reasons why understanding global trends is important, and sets out a suggested methodology for doing so.

The suggested method described in this toolkit has been developed under the project 'Mapping Europe's Future: understanding the impacts of global megatrends at the national level', which had two objectives:

1. to develop a method (described in a handbook) that enables countries to reflect on impacts of the EEA GMTs and their meaning at a national level (see the note below);

2. to develop a Europe-wide overview of risks and opportunities now and in the future.

This report and the toolkit it contains meets the first of these objectives by:

- seeking to inspire countries to consider the implications of GMTs by encouraging studies that are focused on topics of interest and in line with their levels of expertise and capacity;

- setting out a methodological toolkit that describes a suggested approach and provides guidance, templates and additional materials that can be used or adapted to help conduct national studies (see box below).

The second objective will be met through the combined outcomes of the individual European countries that are applying the method. It is hoped that this cross-country synthesis will be developed in the context of the next EEA SOER which is to be published in 2020.

Note: All tables/templates presented in the annexes of this report are intended as a guide on how the information may be recorded in each step. When applying the method, it may be useful to adapt these tables to the needs of a specific case or to modify their presentation/format. For example, if using a template in a workshop, it may be useful to prepare large (A2 or A1) simplified flip-chart versions of a template.

How has this report and the toolkit been developed?

This report and methodological toolkit was developed by Collingwood Environmental Planning ([1]) (CEP) and the Swiss Federal Office for the Environment (FOEN), with significant input and advice from members of the Eionet NRC FLIS ([2]). The EEA also participated in and provided financial support for the Eionet NRC FLIS expert workshops that tested and refined the method.

A draft toolkit was completed in March 2016. During 2016, the toolkit was discussed at Eionet NRC FLIS workshops and it is being trialled through a small number of national pilot case studies, including by Belgium (Flanders), Germany, Hungary, Slovakia, Spain and Switzerland. Although these national pilot studies are ongoing (as of October 2016), they have already provided valuable insights into the practical implementation of the suggested method, which has been reflected in this report and the toolkit. In addition, interest has been expressed for a regional study to be conducted in the Western Balkans. The EEA and European Commission (Directorate General for Neighbourhood and Enlargement Negotiations) are in the process of funding this regional study, which is expected to be completed in late 2016/early 2017.

Who is the toolkit intended for?

The toolkit presented in this report is intended primarily for experts within the Eionet NRC FLIS: it has been developed for use by experts in national environmental agencies, government departments and ministries with responsibility for environmental assessment, state of the environment (SOE) reporting, horizon scanning/foresight and (environmental) policy development.

However, it may also be of interest to other experts, such as consultants, researchers and academics that support environmental decision-making at the national scale, and could be applied by anyone with an interest in understanding the relationship between global changes and national, regional or European environmental issues and policy.

Who is the target audience for national GMT implication studies?

Studies completed using the method are intended to develop an improved, transparent and systematic understanding of the ways in which current and emerging global trends may be important at the national or regional level and for Europe. The target audience of these outcomes will depend on the needs and preferences of each case; however, it is suggested that the results can help to provide a valuable input to national SOE reporting and outlooks; communicate with senior governmental policymakers and decision-makers about how the environment is affected by global trends; contribute to reporting to parliament or other government bodies; and provide input to internal and external communication and reporting on emerging policy needs and priorities.

At the European level, the outcomes of individual and collective national and regional studies will be of interest to the EEA management board, and may provide future value and input to EEA reporting, e.g. for the SOER update in 2020.

([1]) http://www.cep.co.uk.

([2]) The NRCs FLIS have supported the development of this method through numerous email and telephone discussions; written feedback and comments: two webinars (April and July 2015), organised under the project to discuss early method proposals; a workshop (September 2015), to trial and feedback on the emerging method; and an NRC FLIS expert meeting on 21–22 March 2016 in Copenhagen, at which, the final handbook was presented and interested countries indicated their plans and presented their work on the case studies.

What is a global megatrend (GMT)?

One definition of a GMT is that they are 'large, social, economic, political, environmental or technological changes that are slow to form. Once in place, megatrends influence a wide range of activities, processes and perceptions, both in government and in society, possibly for decades' (CSG, undated). The EEA SOER 2015 defines GMTs as 'large-scale, high impact and often interdependent social, economic, political, environmental or technological changes' that can have decisive and critical implications (EEA, 2015d).

The megatrends analysed in the EEA SOER 2015 provide a research- and expert-judgement-based perspective on how interrelated and connected global drivers and trends are likely to evolve over time. The EEA SOER 2015 assessment of GMTs analyses 11 megatrends that are considered to be of key importance to Europe's long-term environmental outlook.

Which megatrends should studies using this method focus on?

It is proposed that studies using this toolkit should focus on the implications of the GMTs analysed by EEA as part of the SOER 2015. Other megatrend studies exist (EEA, 2015e) ([3]), but in this report we propose the use of the 11 GMTs selected and analysed by the EEA as a basis for considering the implications for European (countries and regions) environments and environmental policy related to global changes. The rationale for this advice is as follows: ([3]) the EEA GMTs were selected and analysed with an explicit European environment and environmental policy focus, as opposed to other studies that have been developed from different sectoral and spatial perspectives; and (2) the toolkit has been developed under the aegis of the EEA Eionet FLIS, and as such members of this group are familiar with the EEA SOER reports and GMTs.

([3]) For some examples, see EEA, 2015a.

Logic and philosophy of the suggested method

Balancing scientific rigour with utility

The suggested method and toolkit presented below was developed after a process of discussion and contribution from numerous experts within Eionet and, in particular, NRCs FLIS, and reflects the emerging lessons from the pilot country case studies. At the outset, the intention was to develop a specific methodology that could be applied in a scientific manner; for example, by adjusting national inputs to a detailed methodology, a country would arrive at logical conclusions regarding the implications of GMTs for their environment and environmental policy. Such a methodology would enable the production of transparent and reproducible results, and support direct comparison across countries.

Although an academic or scientifically rigorous procedure could, in principle, be developed to build an in-depth understanding of the systemic connections between GMTs and national trends (e.g. existing climate models focusing on single regions), this would be technically very complex to design and implement for all GMTs and, even if in-depth scientific analyses were possible, it would not necessarily help to understand and indicate priorities for a particular country or region. Additionally such an approach is very labour intensive and can only be done if data are available what in many cases may not be feasible.

The suggested approach in this report represents a moderated process, which encourages the participation of a group of experts. The exchange of perspectives and sectoral knowledge this approach facilitates can lead to a transparent and rigorous study that also allows trade-offs and prioritisation to be discussed, negotiated and, if possible, agreed. In cases in which agreement cannot be arrived at, the participatory approach and narrative reporting can facilitate the presentation of uncertainties and different perspectives. The suggested method supports the use of specific tools and methodologies, such as systems dynamic modelling or causal loop diagrams (CLDs), which can be particularly useful if developed through group discussion and participation. In addition, if discussion leads to agreement on priorities for a particular country or region, these priorities could then be subject to further research and study through specific foresight methods and/or modelling.

Note: The overarching philosophy of this toolkit is that **the process** of understanding implications of GMTs **is as important as the outcome**.

A suggested method to provide inspiration

The suggested method described in this report could be used as a roadmap to complete a national or regional study. However, the progress so far in the pilot country case studies has demonstrated that, in practice, national institutional capacity, context and priorities have an important influence on which approach is possible and appropriate. The key message from the pilot country case studies is that the most important thing is to 'start the conversation' with colleagues and experts, that is, to use the study as a means to get people interested and to bring different expert and policy perspectives together in order to allow the consideration of long-term trends and what they might mean for the environment and environmental policy.

The overarching philosophy of this toolkit is that the process of understanding implications of GMTs is as important as the outcome. Developing detailed analysis and assessment may be appropriate, if resources and expertise allow, but this is not required for a valuable outcome. Raising awareness of long-term global trends and what these may mean for a country or region, and encouraging discussions among experts and policymakers with different perspectives or areas of expertise, can be an important first step and a valuable outcome in itself.

Those using this toolkit to develop their own studies on the implications of GMTs are encouraged to consider what is appropriate and realistic in the context of their institutional capacities and priorities. The method is intended to be flexible and provides a suggested process rather than a prescriptive one.

Responding to varying needs, expertise and resources

The suggested method presented in this part is intended to be modular, but sequential: it is not necessary to complete all steps, but they should be completed in the correct order, i.e. it is necessary to complete Step 1 (project preparation and objectives) and Step 2 (scoping) before Step 3 (identifying evidence), and Step 3 should be completed before implementing Step 4 (identifying opportunities and risks). Thus, completing only Step 1 and Step 2 will result in valuable insights and a basis for discussion. If a more in-depth understanding is desired, then Step 3 can be completed. Finally, if a systematic assessment of potential risks, opportunities, and policy gaps and needs is required, then Step 4 can also be applied.

The suggested method is also intended to provide a framework and descriptions to guide the user through a suggested process. However, because the levels of expertise and resources will differ among studies, the method has been designed to allow flexibility within each step.

At the outset (see Step 1), the expert or team leading a study should discuss and decide on the objectives, focus and level of detail they wish to achieve. Depending on the level of interest, available resources and expertise, each country can choose to adapt specific steps (e.g. workshop sessions) to meet their needs.

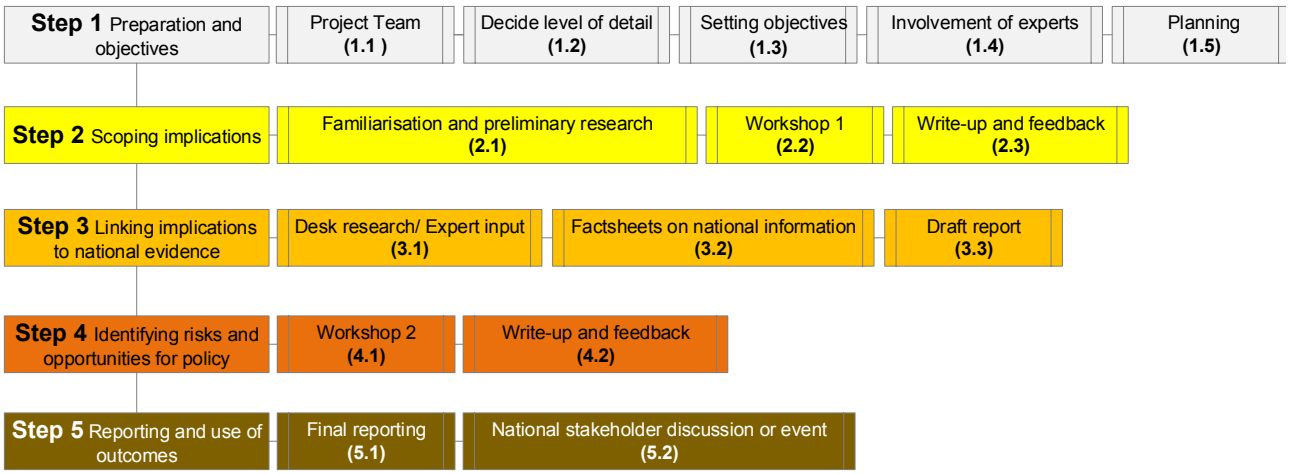
Suggested method and step-by-step guidance

On the following pages, the suggested method is described step-by-step. The figure below presents an overview of the suggested method and the steps proposed. The method presented is not intended to be prescriptive and, in each case, it will be important to decide which approach is possible and appropriate.

Annex 1 sets out an indicative estimate of the amount of expert time that may be required to complete each step of the method; however, the actual input time required will depend on the type of approach and the level of detail required.

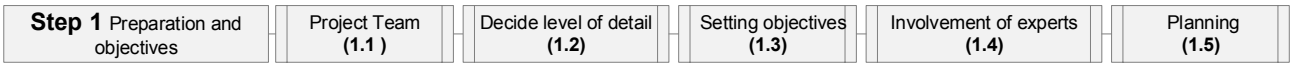
Note: Throughout, the suggested method description, reference is made to 'national-' and 'country-' level studies, as this was the original scale of use foreseen. However, the method could equally be applied to the regional or European level.

Mapping Europe's environmental future — process flow chart ([4])



([4]) All of the figures reported in the process flow chart for the 'Method guidance' are original and specifically developed for this report by the authors

Step 1 Preparation and objectives



Before starting, it is recommended that some initial planning and preparation is completed (see chart on Step 1 above). This will help to set the practical foundations for the project, agree on the scope and focus preferred, and ensure that sufficient time and expertise is planned from the outset.

Step 1.1 Establishing the project team

Initially, it should be decided who the 'owner' of the study is, i.e. who has overall responsibility for managing and implementing the process. The method has been designed with the assumption that one person could manage the process, but it is suggested that establishing a small team of experts (e.g. two–four people) will help to ensure that the process is not too much of a burden for one person, and will also make organising and running parts of the process (e.g. workshops) more efficient. This small 'core project team' could be made up of experts from the same department or agency, but could also include representatives from different agencies if cross-organisational working and exchange is desired.

Once the **core project team** has been established, it is recommended that a project inception meeting is held to discuss and agree on:

- what level of detail and type of study is possible and appropriate (see Step 1.2);
- the project objectives and focus (see Step 1.3);
- which experts, organisations and agencies to involve (see Step 1.4);
- other project management and planning issues, such as the timetable of work, responsibilities, etc. (see Step 1.5).

Step 1.2 Decide on the level of detail and type of approach required

The suggested method described in this toolkit can be used as a roadmap and followed in full. However, in reality, each case study will be unique, both in terms of the institutional context in which it is developed and the level of capacity and expertise available.

> **Note:** The pilot country case studies have demonstrated that 'one size does **not** fit all', and each has followed quite a different path in the early stages of completing a national study. However, in all cases, the basic steps have been successfully applied, with adaptations to suit the context of each study, for example: one pilot engaged directly with experts before the scoping workshop (Step 2.2) and invited them to pre-prepare their own thinking on GMT implications related to specific areas of knowledge.

Therefore, before beginning the study, the **core project team** should discuss and agree on the level of detail and type of approach that are appropriate for their case. For example:

- A **light touch approach** could be appropriate if resources are limited and it is known that experts will not have much time to contribute. In this case, a country study could commence with some initial desk-based research and identification of the potential implications by the core project team, followed by just one short workshop to discuss these, and a final report to communicate the findings and present the evidence available, such as indicators, to support them. Such an approach would follow elements of Step 2 and Step 3 of the method, but not in full, and would also not seek any formal assessment of risks and opportunities (Step 4).
- An **in-depth approach** could be followed if there is already a high level of interest, and if both resources and expert time are available. In this case, a country study could include much more detail, engage with experts multiple times throughout the process, and include in-depth desk-based research of evidence and existing policy together with the assessment of implications. Such an approach could follow all steps in the suggested method, adapting them as required to meet the national study's context.

Step 1.3 Decide on the project objectives and focus

As a second key aspect of setting the scope of the project, it is up to the **core project team** to decide on the objectives and focus of their study. The objectives and focus of the study will influence the approach taken. At the first project meeting, the **core project team** should discuss and consider if there is a specific objective for the study or if the goal is to gain a broader understanding of the possible implications of GMTs, raise awareness and provide a basis for deciding on priorities for future research. For example, the specific goals or focus of a national study could be to provide input to a national SOE report or to understand the implications of the GMTs for the achievement of specific policy outcomes (e.g. one or more environmental targets or sustainable development goals), as well as to support policy design and development.

Depending on the objectives, the project could focus on either an exploratory or policy-focused approach to discussing and identifying implications of the GMTs:

- **Exploratory** — what impacts might occur
  - Description: an open review of the GMTs and discussion of their possible implications for a country. This would identify a range of implications that are relevant for a country across environmental policy topics and, if desired, other policy domains (e.g. economic, social).
- **Policy/target focused** — what might be the impact on specific environmental policy priorities or goals
  - Description: a focused review of the GMTs that seeks to identify how they may impact upon one or more specific environmental policy goals (e.g. water quality and availability). This would identify the extent to which the GMTs may have implications for a country's ability to meet selected national or international policy agreements or goals.

The approach presented in this suggested method is primarily exploratory. However, if desired, each of the activities in Steps 2 to 4 could be framed around specific policy goals, i.e. rather than looking at the GMTs and considering, in an open way, what implications may be seen, the approach would be to select key environmental policy goals (set at the national, European or global level) and consider the ways in which the GMTs may influence the achievement of these specific goals.

Step 1.4 Who to involve

Once the level of detail, type of approach, project objectives and focus have been decided, the next step is to consider which experts should be involved in addition to the **core project team**, e.g. through the workshops foreseen in Steps 2 and 4.

It is up to each country to decide how many and how diverse a group of experts to involve through the workshops and/or to ask about project progress and outcomes. However, given the nature of the GMTs, which cover a very wide range of topics, it is suggested that a group is chosen with a broad range of areas of expertise, such as economic development and policy, land use and spatial planning, transport, etc. Knowledge of foresight and forward-looking assessments would also be valuable. Involving the national Eionet group may be a useful starting point, as Eionet experts will be familiar with the EEA and the relevant information and data management processes.

However, it is also recognised that it will not always be easy to engage with experts. One potential way of encouraging engagement could be to focus the study on an area of particular national interest (e.g. climate change or resource scarcity), or to link the study to an existing process or project (e.g. the development of a national SOER).

The number of experts to involve is not fixed, although the workshops proposed in Steps 2 and 4 assume that between 5 and 15 experts will be involved, but a wider group of experts may also be interested in such a study. More information on the roles of experts in the process is included in each of the method Steps 2–5.

Once it has been decided who should be involved and in what ways, it may be valuable to make initial contact with these experts, e.g. to make them aware of the study, invite them to participate and describe the role and level of commitment expected.

Note: The transparency and accountability of information developed through this process can be enhanced: by the direct involvement of experts in an iterative process; by undertaking background research between the workshops; and through consultation on the final draft report and, if possible, through a final event or conference.

Step 1.5 Project planning

At the outset of the process, it is also recommended that a project plan is developed and agreed. This plan does not need to be very detailed, but it should define the timing of key project milestones and outputs, in order to enable the management of project resources (especially experts' time) and ensure that workshops and other consultations are planned sufficiently in advance to maximise participation and input. The key output of project planning should be a project timeline or Gantt-chart showing the timing of meetings, workshops, outcomes, consultation periods, etc.

Some factors to consider with regard to developing an effective project plan include:

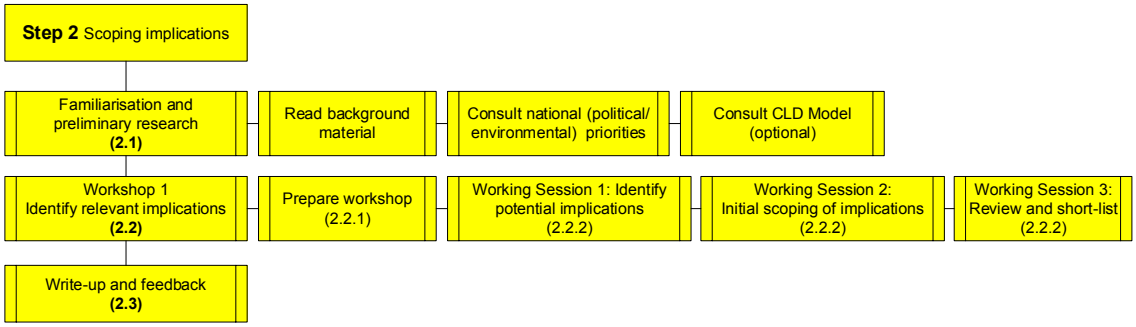
- the timing (dates) of existing processes and meetings/workshops, particularly if the GMT implications project is to be delivered alongside or as an input to an existing process;
- who needs to be involved and when, so that experts can be informed as early as possible of their involvement; more information on the roles of experts in the process is included in each of method Steps 2–5;
- that enough time is included in the programme to allow for the arrangement, organisation and consideration of the outcomes of project workshops and meetings;
- that enough time is included in the programme for consultation with experts (e.g. on draft reports or other outcomes), especially if input/opinion is being sought from experts outside the **core project team**;
- the timing and scale of other commitments, e.g. in relation to other projects or reporting requirements, of the **core project team** and other experts, so that GMT implication meetings or workshops can be arranged at times that do not conflict with other important activities;
- the timing of holidays/vacation periods, e.g. the summer months of July and August may not be the ideal time to seek consultation input from experts, or such consultation periods may need to be longer during these times.

Note: Templates for recording the process and reporting outcomes

It is vital that a record is kept of the outcomes of each step in the method, and the logic and assumptions behind these outcomes, so that the results can be presented clearly and transparently. **To help ensure that a record is kept, at various points in the method, reference is made to templates in the annexes of this document.** These annexes (e.g. tables and report content outlines) are intended to guide the user through the recording of discussions and outcomes in each methodological step.

The templates can be used as they are, or can be adapted to the needs of the specific case by modifying their presentation or format. For example, if using a template in a workshop it may be useful to prepare large (A2 or A1 size) flip-chart style simplified versions of a template so that experts can add notes during the working sessions. 'Tidy' versions can then be created, by the **core project team**, in Word or Excel as part of the record-drafting process after each workshop.

Step 2 Scoping implications



Step 2.1 Familiarisation and preliminary research

To effectively implement the method and guide discussions with colleagues and experts, it will be important to have a broad understanding of the megatrends (see chart on Step 2 above and box on p. 19). It is not necessary to develop a deep knowledge of the underlying drivers and trends, as the method assumes that the EEA SOER 2015 megatrend reports (EEA, 2015c and 2015d) and other existing information can be used as required.

It is suggested that the **core project team** should be familiar with:

- the EEA SOER 2015 GMT assessment report (EEA, 2015c) and the extended background analysis report (EEA, 2015d), if possible;
- the GMT summary sheets included in Annex 2, which incorporate the GMT summary text (extracted from GMT extended background analysis report) and GMT pathways;
- national (environmental and/or political) priorities and vulnerabilities, in order to help frame impact discussions, as, for example, set out in a national SOE report or sustainable development strategy, or by using existing national and European studies, such as EEA SOER country briefings (EEA, 2015a).

Step 2.2 Workshop 1: Identifying relevant implications and initial scoping

The **core project team** should organise a small workshop that includes experts from the group discussed and agreed in Step 1. As noted in Step 1, the exact size of the group depends on the individual project, but it is suggested that an initial group should have between 5 and 15 experts. The experts invited to the workshop should have a range of expertise that covers the objectives and focus of the study. It is also useful if the experts are from different types of organisation, such as environmental agencies, government environment departments/ministries or national experts working in academic fields related to the environment and environmental policy. If wider stakeholder participation is desired, civil society organisations, business organisations and non-governmental organisations (NGOs) could also be invited.

Ideally, experts with at least some degree of background diversity should be identified and engaged, as there is a risk that if all participating experts are from the same department or agency, certain perspectives may become dominant, which in turn may reduce the acceptability and credibility of the results for a wider policy audience. It is also important, that participants think beyond the short term interest of their organisations or sector.

The key added value of involving experts from different fields and institutions is that each will bring their own perspective and priorities in relation to the megatrends, and this may influence individual proposals for the relative relevance and importance of implications. This aspect of a participatory approach should not be considered a barrier to the acceptability of the outcomes, and, indeed, diverse views can be important in ensuring the broad acceptance of outcomes, as long as, at each step, the justification and logic behind the decisions made are recorded.

Step 2.2.1 Before the workshop

Approximately two weeks in advance of the workshop, the national lead should:

- send invited experts a short note including a project introduction describing the objectives of the project and workshop, and the role of experts (i.e. that they are asked to provide their own view rather than an institutional perspective);
- send invited experts the GMT summary sheets/' pathways' (see Annex 2) and recommend that they also look at the SOER 2015 GMT report (EEA, 2015c).
- send invited experts the template on scoping the implications in Annex 3, and invite them to consider, in advance, how they perceive the GMTs to be influencing their country and in what ways.

It may be appropriate to ask experts to focus on particular topics of expertise or interest (e.g. a climate change expert may be most interested in the GMTs that relate to climate change, and may wish to focus their thinking on climate adaptation or mitigation-related implications).

Invited experts should be briefed that the workshop represents an initial scoping discussion, and will (if it is decided to complete Steps 3 and 4) be followed up with more in-depth research (Step 3) and a second workshop (Step 4), which may explore short-listed implications in more detail. Ideally, the same experts would participate in both workshops.

What do we mean by an 'implication'?

An 'implication' is generally defined as being 'a possible future effect or result' ([5]). In the method, we refer to identifying implications of the GMTs. Over short time horizons, and in situations in which systems are well understood and data are readily available, specific 'impacts' can be predicted (e.g. the direct and measurable effects on local water quality of an increase in the use of fertilisers in agriculture in a defined catchment). However, in the context of GMTs, geographical and timescales are not clearly defined, and evidence, such as outlook indicators and scenarios, is often uncertain, or information is only partially available, meaning that there are knowledge gaps, especially in the long term. Under these circumstances, it is more appropriate to consider broader implications.

In the context of the method described here, we consider implications to be plausible outcomes (i.e. supported by clear reasoning and based on available evidence) or ongoing changes at the national or sub-national scale, resulting from the trends and drivers described in one or more GMTs.

How might we think about the implications of GMTs?

In the context of GMT implications, a megatrend can be considered:

- a complex system that manifests as a combined 'entity' that exerts a force (e.g. a weather system) that any one country cannot control, but will be affected by;
- a collection of individual drivers and sub-trends, each of which has its own importance and influence (such as the development of specific new technologies).

The method does not restrict the way in which the user may wish to interpret a megatrend, but it is suggested that, initially (e.g. as a starting point for the scoping discussion in Step 2), it may be helpful to think about GMTs as a whole: seek to understand how each, **as an entity**, may force change or require a response at the national level, and also how **combinations of GMTs** might interact with each other and, importantly, with a country's priorities and vulnerabilities.

This will require exploratory discussion and judgement on the part of experts: there is no defined or exhaustive 'list' of implications, and the method presented here assumes that national implications are a result of the interaction of megatrends with the characteristics and priorities of each country (e.g. physical, environmental, social, economic, political).

As discussions and consideration deepen (in the latter stages of Step 2 and in Step 3), it may be valuable to consider the evolution and implications of specific trends and drivers, within individual megatrends, that appear to exert a particular influence or correspond with national priorities, with the aim of developing appropriate policy responses.

([5]) See, for example, the definition provided by Merriam-Webster (http://www.merriam-webster.com/dictionary/implication).

Note: The pilot country case studies have shown that, although experts may have limited time to contribute before the workshop, it is valuable to engage directly with individual experts through, for example, face-to-face meetings and discussions. A further successful approach used in the pilots has been to invite experts to develop their own thinking before the workshop using simple visualisations of how GMT drivers and trends (as included in the GMT summary sheets in Annex 2) may be linked causally to implications.

In one pilot study, experts were invited to develop simple, linear 'mind-maps' (diagrams showing how factors are connected) using pen and paper before the workshop based on their own knowledge of their area of expertise, and this was felt to greatly enhance the workshop discussions.

Step 2.2.2 During the workshop

It is suggested that the workshop should be a one-day meeting. It is up to the **core project team** to set their own agenda, but an outline of the suggested sessions, as set out in this section, is as follows: introduction and scene-setting; three working sessions; and closing discussions and reflections. The proposed details for each working session are set out below.

Workshop 1 has the following objectives (these can be adapted to national needs):

- to discuss in an open manner how the megatrends, as described by the EEA, might impact on your country;
- to provide the opportunity for experts to share their knowledge and expertise;
- to compile a long list of potential impacts that are felt to be relevant (see box below on relevance) to your country, based on expert knowledge and judgement;
- to complete an initial scoping of this long list of implications.

The workshop can be structured around three working sessions, preceded by an introductory presentation and followed by a group plenary discussion.

Introduction

Short presentation by the **core project team:**

- welcome and introductions, especially if experts are not familiar with each other;
- proposed project and workshop objectives;
- overview of the project plan/timeline;
- key outcomes expected and relationship with other processes/reporting;
- principles for the workshop (see box);
- questions/clarifications.

Working session 1: Identifying potential implications

Note: Implications may be positive (i.e. leading to opportunities) or negative (i.e. causing risks).

Group discussions should be based around the following key questions:

- Looking at the GMT summary sheets, which of the GMTs respectively the factors that form them appear most likely to have implications for your country?
- As many drivers and trends appear in multiple GMTs, are there key interactions/interrelations between GMTs that are considered important? Does more than one GMT act together to have implications?
- Are other factors (i.e. the drivers and trends described in the summary sheets in Annex 3) also important?
- Which of the implications described in the summary sheets are relevant for your country? (See the section on 'How to think about "relevance" for your country' in the box p. 22). It should be noted that the implications included in the GMT summary sheets are those identified in the SOER 2015 GMT report (EEA, 2015c) and are not considered a complete list of possible implications.
- Are there other implications, not described in the GMT summary sheets, that you think might result from the GMTs?
- Why are the implications identified considered important?

Note: Suggested workshop principles

An effective workshop is one in which participants feel comfortable and able to contribute freely in an atmosphere of trust and creativity. Such an atmosphere can be created by:

- setting clear workshop objectives, so that everyone knows what they are contributing to and why, as well as what the expected outcome is;
- ensuring that everyone has the opportunity to contribute, and that all contributions are considered to be as valid as any other; this may be particularly important if experts are from different organisations or areas of expertise;
- encouraging open and free discussion, providing time in the agenda for people to reflect and discuss;
- ensuring people feel comfortable expressing themselves; it is suggested that confidentiality of views should be offered, so that the workshop outcomes are reported, but the contributions of specific individuals are not attributed, e.g. following the Chatham House Rule (Chatham House, 2016);
- ensuring participants have the opportunity to review and comment on the workshop outcomes (and that this is made clear during the workshop).

Depending on the size of the workshop, different approaches may be appropriate to facilitate the discussions:

- If the group is small (up to six people) it may be easiest for the whole group to discuss the GMTs and implications and for one person (the national project lead is suggested) to note down the identified implications and other reflections on-screen (using the template in Annex 3 and a laptop/projector) or on flip charts.
- If the group is larger (more than six people) it may be better for the group to break up into two or more smaller groups of three to five people, and for each group to discuss and note down the implications using either a printout of the template in Annex 3 or a flip chart. It will then be necessary for these smaller groups to report back and for a combined list of implications to be recorded. If different small groups have identified the same implication(s), these need be recorded only once.

There is not a specific number of implications that should be identified as relevant, but it is suggested that between 5 and 15 potential implications is appropriate.

Session 1 will result in a list of the potential implications considered relevant. These should include a narrative (written) record of the reasons why each implication is relevant and notes on any specific issues, disagreements or uncertainties (which can be explored in Step 3).

If used, the description of the implications can also be supported by the CLD model(s) or mind-maps developed during the working session.

Working session 2: Initial scoping of implications

In session 2, each potential implication identified in session 1 should be discussed in turn. If the workshop is small, then this can be done in a plenary discussion, or in two or more smaller groups if needed (as in session 1). If the workshop is to be divided into smaller groups, these groups can either discuss all of the implications and then compare the scope of the implications in a full plenary discussion before combining; or the list of implications can be divided so each group discusses only some implications, and then they can be combined on the basis of a full plenary discussion.

If CLD models or mind-maps have been developed during working session 1, these can provide a valuable input to the scoping discussions in session 2 (see box on p. 22).

The discussion in session 2 aims to draw on the combined knowledge of the experts present to discuss and consider:

1. the likelihood that the implication(s) judged as relevant will be experienced ('High' or 'Low');
2. the relative magnitude of effects for the country of the implication/s should they occur ('High' or 'Low');

Tools that can help structure thinking about GMTs and their implications

Mind-mapping or causal chains

An approach used successfully in the pilot country case studies is the use of 'mind-maps' or causal chain diagrams, e.g. using just pen and paper to illustrate how the drivers and trends described in the GMTs are connected to implications at the national level. These can be quite simple; for example, at its simplest, a causal chain is a series of linear connections. Mind-maps or casual chains provide a visual explanation of how an expert sees an implication occurring. Mind-maps can also be created during the workshop by, for example, small groups of experts working together to draw mind-maps using flip-chart paper and pens.

Causal loop diagram modelling

If desired, and if expertise/software is available, it may be useful to develop simple qualitative CLD/dynamic CLD models during working session 1 to help 'brainstorm', visualise and describe, in a transparent and systematic way, how GMTs might have an impact at the national scale.

It may be useful for the **core project team** to develop initial models prior to the workshop, and for additions/amendments to these models to be made during the workshop through joint working and discussion. An alternative, perhaps preferable, approach would be to ask participants, before the workshop, to consider and prepare some indications of the most important variables and relationships from their perspective and in their judgement, and to present these at the workshop. This has the advantage that it allows individual experts to elaborate their own results.

Annex 12 provides more information on the optional use of CLDs as a method of understanding the implications of GMTs. Annex 13 illustrates the use of pre-defined CLD models for a pilot exercise linking global trends with local impact categories.

For examples of how CLD modelling has been used to help understand the implications of GMTs, please see:

- *Impact assessment of global megatrends: Two case studies connecting global megatrends to regional topics*, a report developed by Ullrich Lorenz and Hördur Haraldsson, 2014 (see http://www.naturvardsverket.se/978-91-620-6602-4);
- previous work completed by the NRC FLIS under the EEA Article 5 project (see http://forum.eionet.europa.eu/nrc-flis/library/project/article-5-eea-regulation-2012/deliverables/final-report-1).
- examples and guidance related to the iModeler tool (see https://www.know-why.net).

How to think about 'relevance' for your country

In this method, 'relevance' is intended to be considered in an inductive, qualitative manner based on expert judgement. Relevance in this context is understood to relate to:

- a **judgement that the megatrend implication may have an influence on the environment** or the environment-related policy/goals in a country;
- a country's **vulnerabilities to external pressures** (e.g. to transboundary water or air pollution, or reliance on particular imports or exports);
- **what is considered important** for a country, which will entail a judgement of value that reflects factors such as **political priorities** (e.g. environmental policy goals, national objectives such as becoming self-reliant in terms of a particular resource) **and environmental priorities or needs based on a scientific understanding** (e.g. water security, fragility of certain ecosystems); the views of civil society and citizens can also be relevant for considering what is important for a country;
- **the potential timescales of implications**, e.g. if an implication will potentially affect the current generation in the short term (up to 2020) and medium term (2020–2050), or if the implication may have longer term effects (2050–2100).

3. the expected timescale of the implication(s): short term (up to 2020), medium term (2020–2050) or long-term (2050–2100).

Note: Implications may be positive (i.e. opportunities) as well as negative (i.e. risks).

While thinking about the relative effects of an implication, it may help to consider spatial scales, for example whether the implication affects the whole country or a specific geographical region (e.g. mountains, coast, urban areas), and if there are particular groups of people or sectors that may be affected more than others (e.g. industries reliant on scarce resources) (see box below).

As the evidence available at this stage does not support detailed assessments of impacts, this scoping assessment is intended as a **judgement** of the relative importance of each impact. Thus, no formal scale to measure the likelihood or impact strength has been developed, and the following approach is proposed: through the expert discussions, an exploratory and inductive approach can be applied to consider which impacts may be most likely to occur and which may have the greatest effects. This is considered appropriate given the nature of the evidence being used. At this initial stage of the process, the gathering of high-level expert views represents a valuable 'starting point' and forms the basis for looking at specific impacts in more detail (in Step 3).

A three-level ranking is proposed so that each implication is marked by each participant as being:

Rank 1: Important ([6]) to consider further
(high likelihood/high effects).
- Implications in this category should be taken forward to Steps 3 and 4.

Rank 2: Potentially important to consider further
(high likelihood/low effects **or** low likelihood/high effects) — implications with a low likelihood but high effects can be considered as potential 'wild cards'.
- Implications in this category should be discussed, and taken forward to Step 3, if the experts feel that either the level of potential effects or the certainty of effects requires further exploration. Wild cards may be of particular interest because of their high degree of uncertainty, but their potential for effects of a high magnitude.

Rank 3: Low importance for further consideration
(low likelihood/low effects).
- Implications in this category probably do not need to be taken forward to Step 3, but should still be recorded and included in reporting.

The 'importance' referred to in the ranking above will relate to the objectives and scope of each individual study, as decided in Step 1. For example, if the study has a specific focus on the implications of GMTs for the achievement of certain environmental policy targets, then it is in this context that importance should be considered.

Note: Timeframes and geographical scale considerations

The EEA GMTs analyse forward-looking information over various timescales, but focus on developments over the 2030–2050 period with some outlooks (e.g. population, climate change scenarios) considered for up to 2100 (EEA, 2015c). In this Step 2 scoping stage, discussions should consider the timeframe appropriate to the implication in question. If it is felt there are significant temporal differences in potential implications (e.g. limited implications up to 2030 but then much greater implications from 2030 onwards, as may be the case with certain climate change scenarios), then these can be noted for further research in Step 3. Note that **uncertainty** is also greater with longer term outlooks, and this may need to be considered in the workshop discussions.

The EEA GMTs (EEA, 2015c) present evidence on drivers and trends in an aggregated way using data generally at the global or global-region scale. However, thinking about the geographical scale of an implication may be useful when considering its likely effects and importance. For example, an implication may be particularly relevant for specific geographical areas, such as mountains or coasts, or for types of habitat or land use (e.g. forests or urban areas). In the discussions in Step 2, a national implication may be considered 'important' even if it is expected to affect only a relatively small geographical area/environmental receptor, if this is considered, by the experts involved, to be significant in the context of the country. If this is the case, it should be noted in the implication table.

([6]) 'Importance' in this context refers simply to the outcomes of the process based on the views and judgement of those people involved in the workshop. It is recognised that different groups (e.g. civil society) may have different perspectives on what is 'important'. Within each study, the diversity of stakeholders involved is at the discretion of the core project team.

During plenary discussions, the template in Annex 3 should be used to mark the agreed likelihood and effect estimates against each implication recorded in session 1. The reasons for arriving at particular assessments should also be noted, to ensure that the process is transparent. It is suggested that this session could be run as a plenary or group discussion during which participants are given sticky coloured dots (or different coloured marker pens) to rank the implications.

As a range of expert views are being sought, a consensus may not always be possible on which impacts are most likely or their effects. If there are differences of opinion with regard to the likelihood or effect of an implication, this can either be discussed, to see if agreement can be achieved, or these differences can be noted in the template (see Annex 3). It is suggested that if any one expert considers a particular implication important (based on the ranking above), then this implication should be noted as 'important' and considered further in Steps 3 and 4.

Note: This is intended as a relatively quick, qualitative and expert judgement-/discussion-based assessment and scoping of potential implications. The list generated will not be exhaustive and does not need to be considered 'final'. In Step 3, background research and further expert discussion can lead to modifications of any aspect of Step 2 outcomes (e.g. you may wish to select additional potential implications, and revise the outcomes of the scoping).

Working session 3: Review implications and select a short-list (if necessary)

For Step 3, it is recommended that between 5 and 10 potential implications are considered for more detailed exploration, although there is no formal limit on the number that may be taken forward. If the list of implications identified in session 1 is greater than 10, the scoping results can be used to discuss and group or select a short-list of implications to be explored in Step 4.

In a plenary discussion, the full list of implications and their scoping outcomes should be reviewed in order to check that there is agreement on the scores given. It is suggested that those implications considered 'important' (Rank 1) should be selected in the first instance. If only a small number are considered 'important', then those assessed as 'potentially important' (Rank 2) should be discussed and participants should seek to reach agreement on which are most relevant and most likely to have effects, and which are most likely to have the largest relative effects. It is suggested that any potential wild cards identified should be considered further in Step 3.

If there are differences of opinion on the scoping scores, the discussion should seek to reach consensus, but if this is not possible then a record should be kept of any uncertainties or differences of opinion, and these can be explored in more detail in Step 3 if needed.

Step 2.3 Write-up and feedback

The **core project team** should review and write up the workshop outcomes and complete a 'tidy' version of the table of scoped implications, together with recommendations for the implications selected for consideration in Step 3 and notes on issues raised at the workshop, such as differences of opinion and uncertainties (together with CLD models and illustrative mind-maps if developed).

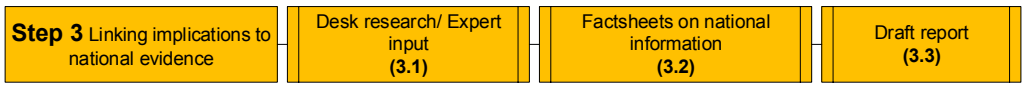
A draft workshop record should be shared with participants for comment and to help ensure that the record of workshop outcomes is accurate. Once any comments are received from participants, the workshop record can be finalised as the starting point for Step 3.

Option: After the workshop, outcomes can be shared with a wider group of experts to enable feedback and different perspectives. It would be valuable to include stakeholders from civil society organisations in this wider group of experts.

Outcomes: A 'long-list' of implications considered relevant for the country, and an initial scoping of their potential importance, using the template available in Annex 4, should be produced. There should also be a record of any key discussion points, differences of opinion and uncertainties that emerged during the workshop. These may be important issues to consider further in Steps 3 and 4. A proposed short-list of implications to be considered in more detail in Step 3 should also be produced.

If developed, illustrative mind-maps showing the rationale for the implications identified and qualitative CLD model(s) can be included in the write-up.

Step 3 Linking implications to national evidence



The aim of Step 3 is to pool combined (national) knowledge about the implications identified as important in Step 2 (see chart above).

Step 3.1 Desk-based research and gathering information from experts

For the short-list of implications identified (and if appropriate selected) in Step 2, the **core project team** should undertake desk-based research into existing national information that relates to each implication (see box p. 26). As noted, the national project lead should decide how many implications to consider, but it is suggested that between 5 and 10 may be appropriate.

The research in Step 3 should seek to identify information that provides:

- evidence of the implications manifested in historical and current national (trend) data or study outcomes;
- indicators that would be suitable for monitoring future change at the national level driven by or resulting from the implications;
- evidence of the possible future developments related to the implications and their likelihood (e.g. projections, scenarios, horizon scanning, and qualitative and quantitative outlooks, including indicators);
- research studies or reports related to the issues (e.g. NGO or academic papers and articles, media or other reports);
- existing national policies and plans that are related to the implications.

Experts are likely to be a key source of knowledge on existing national information (reports, research studies, etc.), and the **core project team** should request (e.g. via email/telephone) suggestions for relevant documents, data or indicators.

A suggested approach would be for the national project lead to compile a draft table (see suggested template in Annex 4) that sets out the existing information relevant to each implication and categorised as required (e.g. data sets and indicators, research reports, outlooks/scenarios, policy and strategic plans), and then to circulate this initial list to relevant experts for comment and to obtain proposals of additional sources of information.

As a minimum, the experts that attended the workshop in Step 2 should be contacted, but there may be value in consulting a wider group of experts, including colleagues in other government departments and agencies (e.g. in policy areas related to the environment, such as transport, but also other areas, such as education, economic development), representatives from NGOs and academic/research organisations, and relevant private sector organisations or associations (e.g. insurance industry, foresight consultants).

Note: When using reports from NGOs or business organisations, it is recommended that, if possible, a diversity of sources is used. This can help to minimise the risk of any perceived bias due to the objectives or sector of the source organisation. In any case, all sources of information should be referenced clearly to ensure transparency.

Note: An issue to consider is that some experts outside of government departments and agencies may not be willing to give their time for free. It may be useful as an incentive to mention that all experts who contribute information will be recognised in the reporting acknowledgements (unless they prefer not to be). If this is being offered, a list of experts who have provided input should be maintained so that this can be included in the Step 3 report and final project report (Step 5).

Where to look for relevant information

It is assumed that experts within the **core project team** will already have good knowledge of existing environmental and related reports, indicators and recent or ongoing research and studies. However, some suggested sources of relevant information include:

- national SOE reports;
- human development reports;
- national statistical agencies/offices;
- the policy pages of national government departments or ministries;
- references included in the EEA SOER 2015 country overviews (see http://www.eea.europa.eu/soer-2015/countries);
- EEA indicators (see http://www.eea.europa.eu/data-and-maps/indicators/), which can be searched and filtered by environmental topics/themes;
- EEA data and maps (see http://www.eea.europa.eu/data-and-maps), which can be searched and sorted by environmental topics/themes;
- EEA reports (see http://www.eea.europa.eu/publications), which can be searched and sorted by environmental topics/themes;
- EEA and European Commission information portals, such as the Biodiversity Information System for Europe (BISE; see http://biodiversity.europa.eu/), the Water Information System for Europe (WISE; see http://water.europa.eu/) and the European Climate Adaptation Platform (Climate-ADAPT; see http://climate-adapt.eea.europa.eu/countries);
- Eurostat (see http://ec.europa.eu/eurostat/en/data/database).

Short telephone or face-to-face interviews with experts outside the group that was directly involved in the workshop in Step 2 may also provide useful additional information, especially if a wider range of expert knowledge is desired, and may allow the involvement of experts who may be too busy to actively participate in the process.

Experts can be given a specified period to respond to the information request (1 month is the suggested maximum time limit, with a reminder sent approximately 10 days before the deadline), and then the results can be compiled by the national project lead to produce a complete table of references and information sources for each implication.

The documents, reports and indicators identified can also be collated (e.g. into folders structured by implication or GMT) to form the beginning of a digital 'library' of relevant information and a source of reference material for other projects.

Step 3.2 Summary factsheets on national information related to GMT implications

The **core project team** should use the information collected to draft 'factsheets' on each of the potential national implications of the GMTs, illustrated with indicators and other evidence, and including initial reflections on the current state and future vulnerability, preparedness for risks and/or ability to maximise opportunities.

A GMT implication factsheet template is included in Annex 5. A factsheet should be completed for each identified implication and should include:

- a description of the implication, including which GMT(s) it relates to and the outcome of the Step 2 scoping exercise; if an implication relates to more than one GMT, this should also be noted, and any reflections on this interaction or connection between GMTs discussed;

Note: Refining the CLD model(s) developed in Step 2

If CLD models have been developed in Step 2, the outcomes of the Step 3 research can be used to add to or refine them. This may take the form of revisiting the assumptions behind the causal connections in the model, and adding some quantitative information if desired or if appropriate to do so.

It may be appropriate to do such modelling work as part of a group discussion, e.g. by holding a working session with the **core project team** and any interested experts that had participated in the Step 2 workshop.

- a summary of what information is available at the national level;
- a narrative description of what the available information indicates about the implication for the country, namely the current situation (short term) (up to 2020), medium term (2020–2050) and long term (2050–2100);
- a description of key gaps and known shortcomings in the data/evidence;
- an overview of existing national policies and strategies that are relevant to the implication;
- some reflections on:
  - national vulnerabilities (to the implication);
  - any known level of preparedness.

Option: Updated Step 2 mind-maps to illustrate and understand how implications effect national issues/ priorities can be generated, along with updated Step 2 CLD model(s).

Step 3.3 Draft report, feedback and final Step 3 report

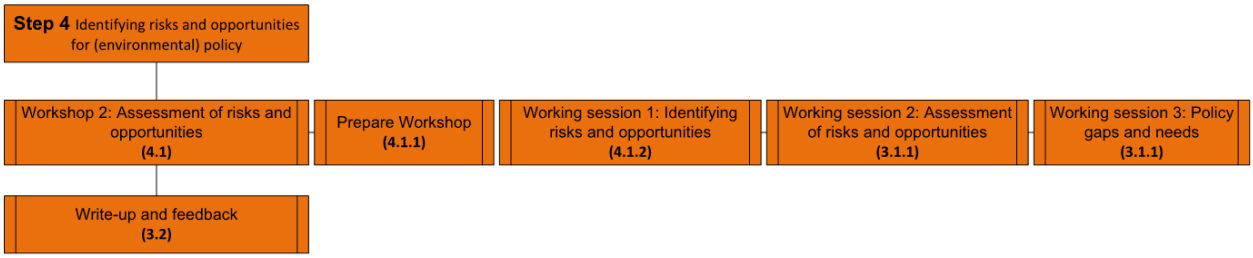
To provide input to Step 4, an overview report should be prepared. This should bring together each of the implication templates, and discuss the information availability, what the available information indicates about the implications' key gaps and information needs, and reflections on policy (existing and needed). A suggested Step 3 report structure is included in Annex 6, although this can be adapted to meet individual project preferences.

A draft version of the report should be circulated to all interested experts (it is recommended that this should include all those who contributed) to provide an opportunity for feedback and comments. Comments should be taken on board as appropriate and the Step 3 report finalised.

Option: It is not vital to develop a report at this stage, as the implication factsheets will, in themselves, provide a valuable source of information for consideration in Step 4.

Outcome: There should be a compilation of information and evidence sources, and factsheets for each implication. A narrative report describing selected implications and summarising the 'story' suggested by the available evidence should also be produced.

Step 4 Identifying risks and opportunities for (environmental) policy



In Step 4, the scoping results from Step 2 and the information collated during Step 3 are used to complete an assessment of the risks and opportunities that may arise from the implications identified and selected (see chart above on Step 4).

In this step, the outcomes of Step 2 and the evidence collected in Step 3 are used to consider the likelihood and magnitude of change in the short term (up to 2020), medium term (2020–2050) and long term (2050–2100). This assessment is then compared with existing policy and planning/strategy to identify policy gaps and needs. If evidence is not available to assess the implications selected in Step 2 and explored in Step 3, then this can be identified as a research need.

Step 4.1 Workshop 2: Assessment of risks and opportunities, and policy links and gaps

Step 4.1.1 Before the workshop

The **core project team** should organise a workshop to include the experts that participated in workshop 1 (Step 2), and additional experts or decision-makers if these have been identified during Step 3. The workshop size is at the discretion of the **core project team**, but it is suggested to invite a group of approximately 15 people.

Approximately 2 weeks before the workshop, invited participants should be sent the scoping outcomes from Step 2 and the GMT implications research report developed in Step 3, together with links to the SOER GMT report (EEA, 2015c) for contextual reading. Experts should be invited to consider in advance how the identified implications might be assessed in terms of emerging or future opportunities and risks, as well as the extent to which current national policy and strategic planning is appropriate for these long-term risks and opportunities.

Step 4.1.2 During the workshop

It is expected that up to 1 day will be needed for this workshop, and the following timetable is suggested: 1 hour for introduction and scene setting, 1.5–2 hours each for working sessions 1–3, and up to 1 hour for closing discussions and reflections.

Workshop 2 has the following objectives (these can be adapted to meet national needs):

- to provide an opportunity to reflect on the evidence on whether or not GMTs will have implications at the national level, and when these implications may occur;
- to assess the likelihood and magnitude of these implications in the short, medium and long terms; this will build on the initial scoping assessment completed in Step 2 using the evidence collected in Step 3;
- to identify the risks and opportunities posed by the GMTs at the national level in the short, medium and long terms;
- to consider the extent to which current national policy and strategic planning is 'fit for the long-term', and what gaps there may be with regard to managing risks and maximising opportunities.

It is recommended that the workshop is structured around three working sessions, preceded by an introductory presentation and followed by a group plenary discussion.

Working session 1: what national risks and opportunities arise from the implications?

Small groups (of up to five people) are asked to use the outcomes of Step 2 and the evidence from Step 3 to discuss what the key risks and opportunities of each GMT implication might be for their countries, and to consider the three timescales. After discussion, the groups should note down these risks and opportunities on the worksheets provided (see Annex 7 for a suggested template).

This session can be run as a structured brainstorming session. It should begin by discussing the ways in which the implication might have effects in the country, and questions such as the following should be considered:

- What factors (environmental receptors, ecosystems, resource types, etc.) might be most affected, in what ways and when?
- Who (which groups in society, types of business, etc.) might be most affected?
- In what ways will these effects be seen at different spatial scales (regional, local, etc.)?

If developed in Step 2 and 3, CLD models and mind-maps can provide a valuable tool for exploring how GMT implications relate to national risks and opportunities (see note below).

Examples of risks might include the following:

- There may be an implication for a key natural resource (one that provides social, economic or other value to the country) to potentially become degraded/damaged to the point at which it is no longer viable.
- There may be an increase in demand for domestic agricultural production (because of an increase in the cost of imports as a result of rising global demand and shifts in economic power), leading to the loss of natural habitat, through land use changes, and increased environmental pollution, through increased run-off and use of pesticides. This combination of factors would threaten the status of water bodies and increase water scarcity.

Note: The discussion of the implications is expected to identify that each implication will have a mixture of opportunities and risks, and that one implication will have more than one risk and/or opportunity.

Examples of opportunities might include the following:

- New technologies may enable existing polluting, resource-/energy-intensive industrial practices or social activities to become more efficient or to be replaced altogether. Such technologies lead to lower carbon emissions, reduced pollution (e.g. air, water) and reduced costs.
- There may be opportunities to expand domestic environmental industries because of an increase in the demand in developing economies. This will have economy-of-scale benefits for the national green economy.

Working session 2: assessment of risks and opportunities

In small groups (of up to five people), workshop participants should carry out an assessment of each risk and opportunity identified during working session 1. While completing the assessments, experts can consider the evidence available (the scoping assessments from Step 2 and the completed implication templates developed in Step 3), as well as use their own knowledge and judgement. The assessment should use the criteria presented below for magnitude and likelihood, considering three timescales: short term (now until 2020); medium term (2020–2050); and long term (2050–2100).

Exact criteria to assess magnitude and likelihood will depend on the type of risk and opportunity being considered, and it is not possible to provide specific criteria in this method. The guidance below provides an outline of the type of signifiers that should be considered. As part of the completion of this assessment of magnitude and likelihood for each risk and opportunity, the reasons for arriving at a particular magnitude and likelihood weighting should be recorded in order to support/explain the scores and to ensure that the decisions made are transparent and can be communicated to people not involved in the assessment itself.

Using the template in Annex 7, groups should discuss and agree on the following for each risk/opportunity and timescale:

- Magnitude of risk/opportunity (positive opportunity (+) or negative risk (–)):

  High (+++ or –––): the opportunity/risk is expected to lead to direct and lasting effects on nationally important environmental assets (such as ecosystems or natural resources), and these effects may be irreversible and/or have ongoing or increasing

impact over time. A high magnitude may result from opportunities/risks that effect different environmental receptors/assets across the entire country, or have large and irreversible effects on one or more smaller areas deemed of national significance (e.g. a national park or area with valued natural resources). A high magnitude is also likely to be associated with opportunities/risks that influence different domains, e.g. environmental risks that compromise (or support in the case of opportunities) economic or social well-being and may undermine (or enhance) existing economic and social systems. A risk of high magnitude may also compromise the ability of the country to meet national environmental priorities (such as resource-efficiency or pollution-reduction targets), perhaps with implications for meeting international environmental commitments.

Medium (++ or ––): the opportunity/risk is expected to have indirect or direct effects on the environment or the ability of the country to meet environmental policy goals and targets. Such effects may require mitigation action, and if not managed or minimised, could have significant implications for environmental, economic and social systems. Although significant effects are possible, these may affect only specific environmental receptors/issues, and perhaps only specific geographical areas or types of ecosystems.

Low (+ or –): the opportunity/risk may have some effects at the national level, but these are considered to be within existing levels of acceptable/expected change. A low magnitude may also be associated with opportunities or risks which, although expected to have effects, are already well understood and managed/mitigated/enhanced and therefore not expected to disrupt national environmental receptors/issues.

- Level of likelihood that the opportunity/risk will occur:

High (●●●): based on the available evidence, it is considered that there is a high likelihood that the opportunity/risk will occur and will have effects for the country. The likelihood of the opportunity/risk is judged to be 60 % or higher.

Moderate (●●): based on the available evidence, it is considered that there is a moderate likelihood that the opportunity/risk will occur. The likelihood of the opportunity/risk is judged to be between 20 % and 60 %.

Low (●): based on the available evidence, it is considered that there is a low likelihood that the opportunity/risk will occur. The likelihood of the opportunity/risk is considered to be less than 20 %.

If necessary, an 'unknown' score can be used (indicated by a '**?**') if a group does not feel that it is possible to estimate the magnitude or likelihood of an opportunity or risk.

These assessments can be noted down by each group in a blank template (see Annex 8).

It is proposed that a 3 × 3 matrix, as commonly used in risk assessment, is used to score the overall assessment. Once the magnitude and likelihood scores have been entered into the template for each time period (Annex 8), the assessment result can then also be entered following the scoring shown in the assessment matrices in the two tables below.

The evidence to support this assessment should be derived from the research completed in Step 3, and the completed Step 3 template for each implication should provide sufficient information to discuss and then decide on appropriate assessment scores. Given the nature of what is being assessed, some level of uncertainty is expected in this assessment; any doubts or disagreements about scores should be noted.

To complete the assessment, each group of experts should discuss the risks and opportunities identified in working session 1 for each implication in turn. It may be appropriate to divide the implications to be reviewed among the groups, so that, for example, each small working group considers the risks and opportunities associated with two to four implications.

Assessment of risks

Magnitude of risk	Likelihood: High	Likelihood: Medium	Likelihood: Low
High	–––/●●●	–––/●●	–––/●
Medium	––/●●●	––/●●	––/●
Low	–/●●●	–/●●	–/●

Assessment of opportunities

Magnitude of opportunity	Likelihood: High	Likelihood: Medium	Likelihood: Low
High	+++/●●●	+++/●●	+++/●
Medium	++/●●●	++/●●	++/●
Low	+/●●●	+/●●	+/●

A suggested approach would be for this exercise to be a mini-Delphi ([7]) survey, so that within each group:

- each expert works individually at first to assess the risks and opportunities;
- the group moderator/facilitator then collects the individual assessments;
- a moderated discussion is then held to discuss the assessments and agreements are sought; if there are specific concerns, these can be discussed and, if possible, agreements can be reached and the score(s) adapted as appropriate;
- if agreement is not possible on any one assessment score, this can be noted as an uncertain score and the key discussion points recorded.

Another option would be to conduct this as a 'carousel' exercise in which the risks and opportunities are divided among small groups at separate tables. Each of the groups would then start with one sub-set of risks and opportunities, and then, once each group had completed their assessment of one sub-set, each group would then consider another sub-set. This would be repeated until all the groups had seen and had the opportunity to comment on or amend the assessments made. The benefit of this is that everyone has the opportunity to consider at least some of the risks and opportunities in detail, while also having the opportunity to comment on all the others, in a fixed timescale.

Whichever approach is used, the discussion should begin with a review of the available evidence (it is suggested that each group should have a facilitator and that he or she could present a brief summary of the evidence based on the Step 3 template). Experts should then consider the evidence, and, using their judgement and own knowledge, discuss and agree on the most appropriate scores for the magnitude and likelihood of the risks and opportunities. Any differences of opinion on the appropriate score should also be noted.

For some risks or opportunities, there may be quite strong evidence (e.g. existing indicators with recent data, reports and studies into the nature of an issue at the national level, or recent outlook or scenario studies) and in these cases it may be relatively straightforward to agree on assessment scores. For other risks or opportunities, it is likely that there will be very little evidence available. In these cases, expert judgement will be needed, and, if this is the case, it should be noted. As noted previously, if the group feels that it is not possible to assess the magnitude or likelihood of a risk or opportunity, then an uncertain ('?') score can be assigned.

In all cases, a record should be kept of assumptions made and any uncertainties regarding the decision should be included in reporting.

After the group work is complete, a full plenary discussion should be carried out to review the assessments for each risk and opportunity and to ensure agreement, as well as to provide time to discuss different views and uncertainties. If there are different interpretations of the evidence and diverging assessments, this should be noted and recorded for reporting purposes.

Outcome: The outcome of this working session is a list of risks and opportunities related to each implication (some may have only one or a small number, others may have many), with a short explanatory text setting out the logic/reason behind the identification of these risks and opportunities.

Working session 3: policy gaps and needs

In working session 3, the intention is to review the policy and strategic plans identified in Step 3 as being relevant to each implication and compare these with the identified risks and opportunities identified in working session 1 and assessed in working session 2, focusing, in particular, on those risks and opportunities deemed to be of the highest magnitude and likelihood. It is suggested that participants should be provided with a hand-out that lists the policies and other strategic plans, etc., relevant to each GMT implication, as identified in the Step 3 report.

Small groups can then discuss the following questions:

- Do policies or strategies exist that relate to the risks or opportunities?
- If they do exist, to what extent do these policies or strategies address the identified risks and opportunities?
  - What opportunities may be missed given current policy?

([7]) For an explanation, see http://forum.eionet.europa.eu/nrc-flis/portal_glossary/glossary/delphi?lang=en.

  - Which emerging and future risks do not appear to be considered by current policy?

- What new policy or changes to existing policy or planning might be needed to prepare for identified risks, and cope with them should they occur (recognising that not all risk can be prevented)?

- What new policy or changes to existing policy or planning might be needed to maximise opportunities?

These discussions should consider all three timescales, as although some risks/opportunities may require short-term responses, other risks, such as climate change, can only be managed effectively if both short- and medium-term measures, with long-term perspectives, are considered. Discussion outcomes should be noted using the template provided in Annex 9, and each group should report their findings in full in the plenary discussion. It may also be useful to record specific topics, risks or opportunities for which additional future research or evidence would be valuable.

Step 4.2 Write-up and feedback

The **core project team** should gather the outcomes of each working session (completed templates, flip charts if used, and other notes taken during the working sessions and plenary discussions) and write-up the workshop outcomes in a short report. This should include 'tidy' versions of the completed templates (i.e. those in Annexes 7, 8 and 9) with the following information: the lists of risks and opportunities identified for each GMT implication, the assessment of each risk and opportunity, as well as overviews of how current policies address the identified risks and opportunities and the discussion of key policy gaps and needs. Any specific research needs identified can also be reported.

It is important that any key discussion points are also recorded, as it is likely that there will be different perspectives and points of view; if this is the case, this will also be a valid and important outcome to report.

This reporting should be shared, as a workshop record or report, with the participants to ensure agreement and that the conclusions represent an accurate record of the workshop outcomes.

Outcome: A short narrative workshop report should be produced containing an overview of the key risks and opportunities identified for each GMT implication, and an overview of the assessment of these risks and opportunities and the apparent policy gaps and needs.

The report should also include notes on key discussion points, differences of perspective or points of view, and any specific research needs or areas for further work.

Step 5 Reporting and use of outcomes

Step 5.1 Final reporting

Once the workshop report has been agreed, the **core project team** should develop a final project report (a suggestion of the content outline is included in Annex 10; see also chart above on Step 5).

This final report will include the following: an overview ('diary') of the process and discussions; a short summary of the results of the scoping (Step 2), presented in an accessible manner; a summary of the national information and policy/strategy related to the implications (Step 3, with the detailed implication factsheets in an annex); details of the assessment of the risks and opportunities; and information on the policy gaps and needs identified (Step 4). The final report should highlight key areas of uncertainty and gaps in existing research or knowledge. In relation to each step, the report should also include an overview of areas for which there was a divergence in the views or opinions of participating experts, such as on the nature or importance of specific implications or the assessment of risks and opportunities.

It is up to the **core project team** to choose the languages they would prefer to use for reporting. If preferred, the report can first be prepared in the official language(s) of the country, although an English-language version should also be completed.

As a matter of good practice, the final report should be prepared in draft and then circulated to interested experts, in order to provide an opportunity for review and comment before being finalised. It may be effective to initially complete an 'internal' draft and circulate it among a small core group of experts, before producing a final draft that can be circulated more widely for feedback. It is suggested that the experts who participated in the Step 2 and Step 4 workshops and any additional experts who contributed to Step 3 should be given the opportunity to comment.

Once completed, the final project report and any other project outputs (e.g. workshop records, templates) can be circulated nationally using whatever mechanism is considered most effective. The project outputs should be uploaded to the EEA FLIS platform (http://forum.eionet.europa.eu/nrc-flis/flip).

Step 5.2 National stakeholder discussion or event

To coincide with the publication of the final report, the national project lead may wish to set up a short (0.5 days at most suggested) event (or events) to publicise the outcomes of the project and present the results to a wider audience, including senior policy experts, politicians and senior civil servants, as well as those outside official administrations if desired (e.g. civil society/NGOs, academics, media representatives).

Even if an event is not held, the report can be circulated to a wider audience, particularly senior decision-makers, heads of department, parliamentarians, ministers, etc.

Step 5.3 Other use of outcomes

A key outcome of the project is the process itself: raising awareness and getting people involved in embedding long-term future thinking into policymaking. For example, the discussions in Step 2 will already engage a number of people across different fields in thinking about long-term trends and changes, and the indicators and evidence collated in Step 3 can provide a valuable basis for monitoring changes related to the identified GMT implications or establishing priority areas for future research.

It is hoped that the national project lead and colleagues/experts involved in the process will use the outcomes in their day-to-day work, to inform discussions with senior colleagues, and as an evidence base in other reporting (e.g. SOE reports).

Conclusions

Reflections on the development of the methodology and report

The introduction to this report reflects on the need for a better understanding of the implications of GMTs, which are complex and uncertain but have potentially large and far-reaching effects. GMTs may offer opportunities and play an enabling role for the future sustainable development of Europe or, alternatively, pose risks to our environment, economy and society.

Responding to this need, the NRCs FLIS have come together to cooperatively design a method to contribute to the development of improved and new knowledge to support policymaking. The proposed approach can be used across countries and can be adapted to national circumstances, needs and resources.

As noted in the acknowledgements and introduction, this report and the methodological toolkit it contains, have been developed through the participation and contributions of many Eionet partners, including NRCs FLIS, NFPs and the EEA. The expectation is that the success of this process can become a model for future content generation for the EEA, Eionet and EEA member and cooperating countries, especially in relatively new or emerging areas of knowledge development. Some reflections on the process involved in developing this report and method are included below.

Reflections on the methodology

Developing and implementing a methodology and toolkit to guide discussion, identification and assessment of the potential implications of GMTs at a European, regional or national scale was a challenging and ambitious goal. Methodological challenges were related to the following questions:

- What methods are appropriate for managing the complexity and uncertainty inherent in long-term trends?
- How can global trends be identified and 'linked' with trends or changes at a European or smaller scale?
- How should drivers and trends that are by their nature outside or intersecting traditional policy topics be presented and discussed?
- How should the potential implications of global trends be prioritised, and how should we think about policy responses?

In reality, there are several responses or solutions to such challenges. At the outset, the hope was to create a single coherent methodology that could be applied in a scientific manner; however, through discussions with Eionet NRC FLIS, and the emerging results of testing in the pilot countries, it became apparent that no one approach or methodology would be appropriate. Although a scientifically rigorous procedure could, in principle, be developed, this would be technically complex to design and implement and, even if in-depth scientific analysis was possible, it would not necessarily help us to understand and indicate the priorities for a particular country or region.

As a result, and benefitting from the diversity of knowledge and expertise within Eionet NRC FLIS, collective agreement on a methodological approach was arrived at. The final methodological toolkit is considered a work in progress, but, at the same time, it is a complete and usable method including a description of how to apply it. It is based on the central coordination of a process of desk-based research and expert discussion.

The method is flexible with regard to its implementation. For example, it can be implemented with great added value using only a few selected steps. It can be applied either mostly as a desk-based study or through using a broad range of participative techniques (workshops, interviews, questionnaires). This flexibility allows users to apply it even if time and resources are limited.

Similarly, many key steps in the method rely upon expert judgement and draw on views from a range of fields of expertise. There is a clear procedure and templates to record the process and enable the presentation of uncertainties and different perspectives. If resources are plentiful, complex and quantitative approaches can be applied as demonstrated in the examples in Annexes 12 and 13.

Benefits of a process of co-creation and participative working

Benefits for Eionet and individual members (National Focal Points and National Reference Centres)

The process of developing and agreeing on the methodology presented in this report was one of **'learning-by-doing'**: initial proposals were discussed bilaterally and through webinars; emerging method ideas were brainstormed and tested through a series of NRC FLIS expert workshops; and the draft of the complete method was or is about to be piloted by volunteer NRCs FLIS in the context of the ongoing national pilot studies in Belgium (Flanders), Germany, Hungary, Slovakia, Spain and Switzerland.

At each stage of the process (e.g. workshops, webinars), members of Eionet NRC FLIS shared knowledge, experiences and views in a participative manner, and as such the development of the methodology has supported **knowledge exchange and capacity building** within Eionet.

In addition, this cooperation and joint working, for example when sub-groups of NRCs collaborated to provide input on a particular topic (e.g. CLD modelling) or working sessions in workshops required focused discussion and consensus building, the process of developing the method and this Eionet report have **strengthened the network and created a strong sense of identity and common purpose**.

Benefits for the European Environment Agency

Although the process of developing this Eionet report has depended upon the support of and coordination by FOEN, and the external consultancy contract they funded, the network and collaboration benefits have nonetheless resulted in an outcome that is considered far beyond what would be possible with a 'traditional' project or if FOEN had decided to develop such a method for personal use only. The result is a **very efficient use of resources and a model for the future mobilisation of Eionet.**

The pilot country case studies have already commenced as part of the method development process, and are **expected to continue and develop national conclusions and reporting in the 2017–2018 period**. Together with other expressions of interest within Eionet NRC FLIS, and the proposed regional study for the Western Balkans to be led by the ETC on Inland Coastal and Marine Waters (ICM), this report and the methodology toolkit provide **a framework for looking at existing evidence in a new way in order to create a knowledge base** and improve the understanding of how global trends influence and will influence Europe's environment and environmental policy.

The process and expected outcome, although initially to identify the positive and negative implications (opportunities and risks) for Europe of GMTs, also have a key focus on **identifying solutions rather than problems, by incorporating the views of experts from across 'traditional policy silos' and by identifying long-term policy gaps and needs**.

Initial reflections from the use of the methodology toolkit

The methodology toolkit has been and is being tested in the six volunteer pilot countries. However, in all cases, these pilots are at an early stage: work has commenced on only the early stages of the proposed method (e.g. Steps 1, 2 and 3, which are related, to setting the objectives, scoping the issues and reviewing available evidence, respectively). Nonetheless, some initial reflections on the use of the method are possible. Notably, the use of the method has **provided opportunities to:**

- bring experts, scientific knowledge, data and policy spheres closer together;
- look at the data and other evidence that already exists, but from different points of view;
- facilitate knowledge transfer and exchange, which will potentially feed innovative thinking and new ideas for policy;
- encourage exploratory working and trigger discussions, thus bringing people out of their traditional policy or sectoral 'silos'; this enables the consideration of new pathways and opportunities rather than focusing on defining limits and problems;
- explore complex systems and uncertainty, by bringing together different thematic cultures and ways of working, recognising that there are no 'right' answers and that outcomes are expected to be exploratory.

Based on the initial experiences of the pilot country cases, The table on page 36 provides some reflections on potential 'success criteria' to be kept in mind while carrying out a study by applying the methodology described in this report.

Potential success criteria to bear in mind when carrying out a study

Step and task	Potential success criteria
Step 1: Preparation and objectives	**Clear initiation and goal/objectives**
1.1 Establishing project team	Participation, **capacity**
1.2 Project objectives and focus	**Dealing with uncertainty**
1.3 Identifying who to involve	Participation
1.4 Project planning	Capacity, process ownership
Step 2: Scoping implications	
2.1 Familiarisation	
2.2 Workshop 1	**Participation,** dealing with uncertainty, transparency: dealing with different views and conflicting information
2.3 Workshop record/feedback	Quality control and transparency
Step 3: National information	
3.1 Desk-based research and correspondence with experts	Participation
3.2 Summary factsheets	**Quality control and transparency**
3.3 Reporting on Step 3	
Step 4: Risks and opportunities	
4.1 Workshop 2	**Participation,** dealing with uncertainty, transparency: dealing with different views and conflicting information
4.2 Workshop record/feedback	
Step 5: Reporting	
5.1 Project final report	**Participation,** dealing with uncertainty, transparency: dealing with different views and conflicting information
5.2 National stakeholder discussion/event	**Participation**
5.3 Ongoing use of results	**Participation, capacity**

Conclusions and next steps

National case studies and regional study of the Western Balkans

The future of the methodology and toolkit presented in this report depends on its use by NRCs FLIS and others for studies on the implications of megatrends. As noted, there are six countries currently undertaking or developing national studies based on the methodology (Belgium (Flanders), Germany, Hungary, Slovakia, Sweden and Switzerland). Some outputs have already been seen in some countries and these case studies are expected to report in 2017 or 2018. The hope is that other NRCs FLIS will also commence national studies in 2016/2017.

In addition, the EEA and the European Commission have provided support for a regional study to be undertaken in the Western Balkans. This study will be coordinated by the EEA and the ETC ICM. It will seek to apply the methodology at the Western Balkans regional level, while highlighting national insights if possible. The Western Balkans study report is expected to be available in autumn 2017.

Building towards SOER 2020

In 2020, the EEA will publish its next European environment state and outlook report (SOER 2020). The roadmap to SOER 2020 is still being developed, but it is expected that there will be a **greater focus on identifying and understanding the socio-technical systems that underpin the relationship between human activities and the achievement of environmental goals and objectives**. Realising this aim will require new forms of knowledge and evidence, and one part of this could be an improved understanding of how Europe is effected by, and contributes to, GMTs.

In this context, the further application and use of this methodology and toolkit within Eionet and by NRCs FLIS will help to generate this knowledge base, and provide a valuable input to the SOER 2020, both in terms of national insights, and lessons from national and regional studies in Europe.

References

Chatham House, 2016, 'Chatham House Rule', Chatham House — the Royal Institute of International Affairs (https://www.chathamhouse.org/about/chatham-house-rule) last accessed 19 December 2016.

CSG, undated, Megatrends Definitions and Categories, Council of State Governments (http://ssl.csg.org/Trends/Megatrends%20Definitions%20and%20Categories.pdf) last accessed 12 December 2016.

EEA, 2015a, *The European environment — state and outlook 2015: Synthesis report,* European Environment Agency.

EEA, 2015b, *Assessment of global megatrends — an update,* European Environment Agency (http://www.eea.europa.eu/themes/scenarios/global-megatends) last accessed 12 December 2016.

EEA, 2015c, *The European environment — state and outlook 2015: Assessment of global megatrends,* European Environment Agency (http://www.eea.europa.eu/soer-2015/global/action-download-pdf) last accessed 12 December 2016.

EEA, 2015d, *Global megatrends assessment — Extended background analysis complementing the SOER 2015 'Assessment of global megatrends',* EEA Technical Report No 11/2015, European Environment Agency (http://www.eea.europa.eu/publications/global-megatrends-assessment-extended-background-analysis) last accessed 12 December 2016.

EEA, 2015e, *Global megatrends — Annex 1,* European Environment Agency (http://www.eea.europa.eu/publications/global-megatrends-assessment-extended-background-analysis/global-megatrends-assessment-annex-1) last accessed 12 December 2016.

EEA and Eionet, 2016, Sustainability transitions: Now for the long term, Eionet report No 1/2016, European Environment Agency (http://www.eea.europa.eu/highlights/innovations-across-europe-lead-way) last accessed 19 December 2016.

EU, 2013, Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet' (OJ L 354, 20.12.2013, pp. 171–200).

Tuinstra, W. and van 't Klooster, S., 2015, *Understanding the added value of the NRC FLIS Eionet network: 'What assets contribute to salience, credibility and legitimacy and what are promising ways forward to strengthen the added value of NRC FLIS?',* European Environment Agency and Forward-Looking Information and Services http://pfli.eionet.europa.eu/about/what-we-do/added-value/nrc-flis-a-network-that-works.pdf/download/en/1/NRC-FLIS-a-network-that-works.pdf?action=view) last accessed 19 December 2016.

Annex 1 Indicative resources for applying the suggested method

Although the project can be managed by one person, it is recommended that it is implemented by a small team of experts (e.g. two to four people), as this will allow the effort required for the organisation and completion of research, workshops, consultation and reporting to be shared. At various stages in the process, additional support may also be necessary for, for example, facilitating meetings and assisting with desk-based research. The method also assumes the involvement of a range of experts, in order to draw upon diverse knowledge and perspectives. More information on who to involve in a national study is provided in Step 1.4 above. Discussion with colleagues and experts in other policy areas or departments could help to enrich the study findings and will be a valuable outcome in itself. Further information on the number and range of experts to consider involving is included in the detailed descriptions of Steps 2 and 3.

Table A1.1 presents a summary of the estimated resources needed to implement the method. Please note that these resource estimates are indicative only, and that the actual time and resources required will depend on the individual case.

Table A1.1 Overview of estimated resources required

Step and task	Approximate time required across core team	Approximate time required for each expert ([a]) involved	Other potential costs to consider
Step 1: Preparation and objectives			
1.1 Establishing project team	1–3 days	–	–
1.2 and 1.3 Level of detail and Project objectives and focus	2–5 days	–	–
1.4 Identifying who to involve	2–5 days	0.5 days	–
1.5 Project planning	2–5 days	–	–
Total time for Step 1	**7–18 days**	**0.5 days**	
Step 2: Scoping implications			
2.1 Familiarisation	6–10 days	1–3 days	
2.2 Workshop 1	8–10 days	1.5–3 days	Venue hire, catering costs, printing materials, expert travel, CLD modelling (license costs, time)
2.3 Workshop record/feedback	4–6 days	0.5 days	
Total time for Step 2	**18–26 days**	**3–6.5 days**	
Step 3: National information			
3.1 Desk based research and correspondence with experts	10–15 days	1–2 days	Interviews, travel to face-to-face meetings
3.2 Summary factsheets	8–15 days	–	
3.3 Reporting on Step 2	6–10 days	1 day	
Total time for Step 3	**24–40 days**	**2–3 days**	
Step 4: Risks and opportunities			
4.1 Workshop 2	10–12 days	2–3 days	Venue hire, catering costs, printing materials, expert travel
4.2 Workshop record/feedback	4–6 days	0.5 days	
Total time for Step 4	**14–18 days**	**2.5–3.5 days**	
Step 5: Reporting			
5.1 Project final report	8–10 days	0.5 days	Printing, proofreading
5.2 National event (optional)	4–6 days	0.5–1 days	Venue hire, catering costs, printing materials, expert travel
5.3 Ongoing use of results	–	–	
Total time for Step 5	**12 –16 days**	**1–1.5 days**	
Approximate total resource requirement	**75–118 days**	**9–14 days**	**As above**

Note: These are broad and indicative estimates of total resource (time) across the **core project team** (i.e. this time can be shared across a small team of experts) and for each contributing expert. The actual resources required will depend on the specific case, focus of study/ level of detail desired and approach adopted.

([a]) More information on who to involve in the study is provided in Step 1.4 under Step 1.

Annex 2 GMT summary sheets

The original PowerPoint versions of the GMT pathways described below are available from the Platform for forward looking information (available from 2017 at the EEA web site).

How to interpret these pathways:

- The 'pathways' provide a visual overview of the GMTs described in the EEA SOER 2015 GMT extended background analysis EEA, 2015e (EEA, 2015d).
- The pathways are not meant to be an accurate representation of the real world, but an illustration of the megatrends, as described in the SOER 2015. (EEA, 2015c).
- They create a structured picture of the key drivers, trends and potential implications referred to in the SOER 2015 narrative (EEA, 2015c).
- However, they do not include all the detail in the narrative to enable a reader to see the key things more easily and quickly understand the 'story'.
- The pathways are intended as 'storylines' and do not attempt to illustrate direct, causal linkages between factors.
- The aim is to make the megatrends accessible and provide a basis for discussion of possible national-scale implications and priorities.
- The 'potential implications' included in the pathways are those referred to in the SOER 2015 narrative, but **these are not an exhaustive/definitive list:** other implications will exist depending on a country's characteristics and priorities.

Presented here are pathways for each of the 11 EEA SOER 2015 GMTs (EEA, 2015c):

1. Diverging global population trends
2. Living in an urban world
3. Changing disease burden and risks of pandemics
4. Accelerating technological change
5. Continued economic growth?
6. An increasingly multipolar world
7. Intensified global competition for resources
8. Growing pressures on ecosystems
9. Increasingly severe consequences of climate change
10. Increasing environmental pollution load
11. Diversifying approaches to governance.

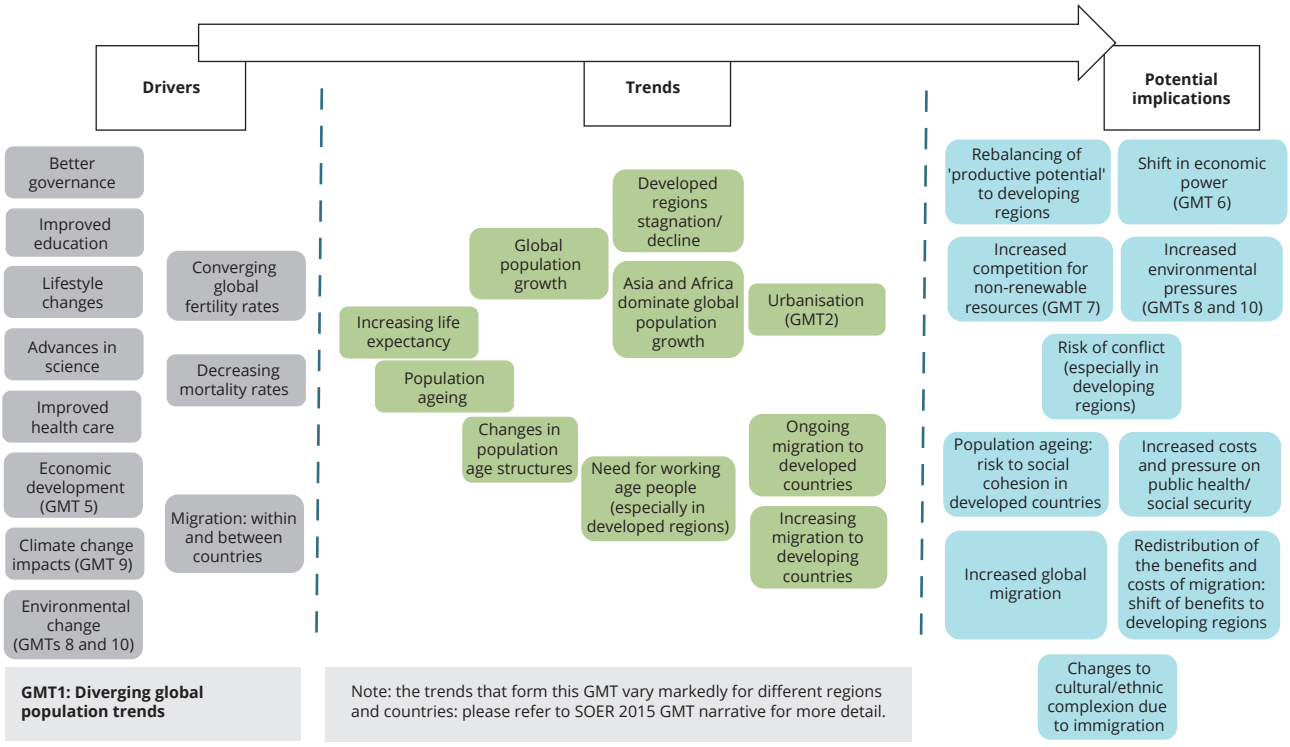
The summary text for each GMT is taken from SOER 2015 report (EEA, 2015c).

GMT 1: Diverging global population trends

Across the world, the basic determinants of population size and structure — fertility, mortality and migration — have been fundamentally altered by the processes of social and economic development. As a result, the global population doubled to 7 billion in the last half century and will continue to grow rapidly in coming decades, although regional trends differ markedly. In advanced economies, populations are ageing and, in some cases, reducing in size. At the other extreme, populations in the least developed countries ([8]) are expanding rapidly. Migration is also affecting the distribution and structure of populations, as people move in search of higher earnings or to escape conflict or environmental degradation.

An expanding workforce can create a 'demographic dividend' of greatly increased economic output. But it can also create the risk of social unrest if there are insufficient employment opportunities. Furthermore, some of the returns from the demographic dividend must be invested in areas such as health and education, and in savings for retirement, if living standards are to be sustained as the population ages.

If the world remains on its current development path, population growth and investments in human capital will continue to provide a boost to global economic output, potentially increasing the burdens on natural capital stocks. But the challenges facing regions will vary. Developing countries will need to identify ways to exploit the opportunities presented by a large economically active population with few dependents. Advanced economies will need to maintain living standards as the elderly population expands and the workforce contracts.



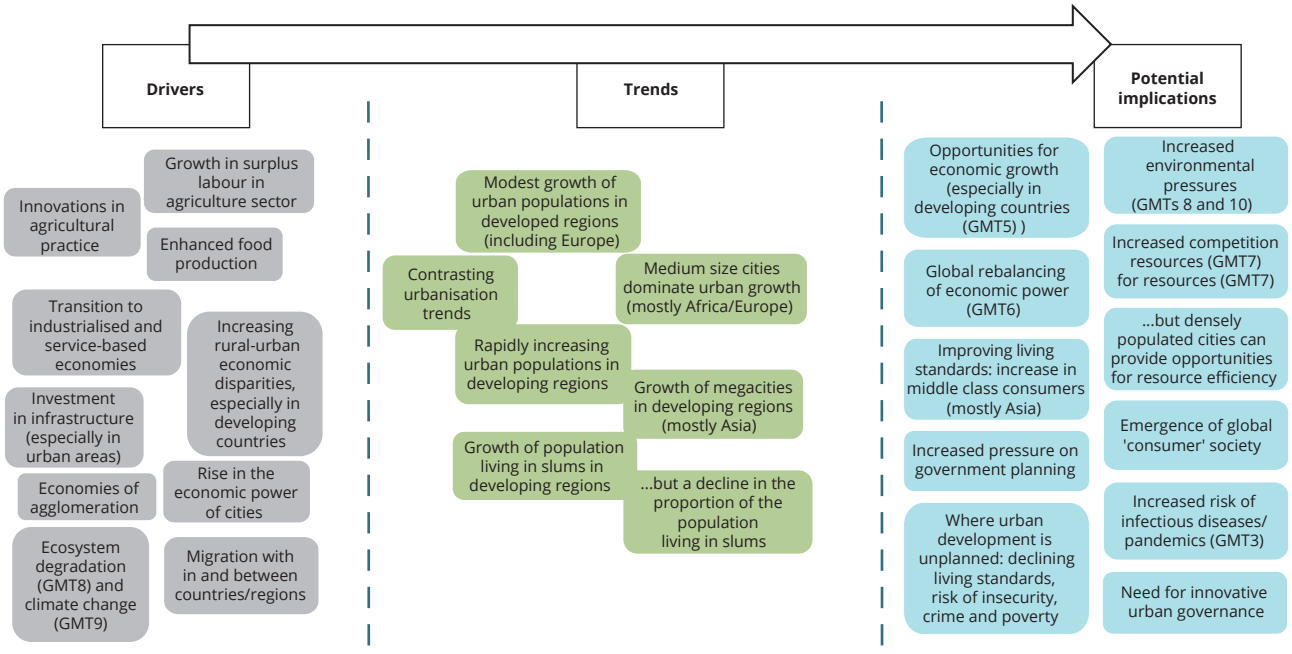
([8]) The GMT report employs the United Nations categorisation of countries and regions according to their level of economic development (see http://unstats.un.org/unsd/methods/m49/m49regin.htm). As of 2013, the UN defines 49 countries as 'least developed countries', and identifies seven 'developing regions' and four 'developed regions'. As such, references in this annex to 'developing countries' and 'developed countries' thus relate to countries in those regions. 'Developed countries' are also referred to as 'advanced economies'.

GMT 2: Living in an urban world

Urbanisation is an integral aspect of development. As countries transition from primarily agricultural economies, the shift to cities offers substantial productivity gains. Jobs and earnings in urban settings create strong incentives for internal migration, often reinforced by government policies and environmental degradation. Only later in economic development do urban-rural disparities begin to dissipate, easing the pressure for further urbanisation.

Together, these drivers have brought extraordinary changes to the geographical distribution of humanity during the last century. Whereas just 10–15 % of the global population lived in urban areas in the early 20th century, that figure had risen to 50 % by 2010 and is projected to reach 67 % by 2050 (UN, 2012). Almost all of that growth is expected to occur in today's developing regions, with urban populations in these regions expected to increase from 2.6 billion in 2010 to 5.1 billion in 2050.

At the individual level, urbanisation can boost opportunities and living standards. At the macroeconomic level, cities drive innovation and productivity. But although the associated growth of the middle class is welcome, it also carries risks in terms of a rapidly growing burden of resource use and pollution. Dense urban settlements can provide for comparatively resource-efficient ways of living, but exploiting this potential and creating a healthy, secure living environment requires effective urban planning. Indeed, the consequences of ill-managed urbanisation are apparent in the vast slums that today accommodate a quarter of the world's urban inhabitants — more than 850 million people.



GMT2: Living in an urban world

Key uncertainties in drivers of urbanisation include: demand for cash crops that may increase the value of agricultural land, technological leapfrogging and the development of decentralised energy production that may increase rural economic opportunities

GMT 3: Changing disease burden and risks of pandemics

The world is currently experiencing a major shift in health problems related to economic development and changing lifestyles. Since 2000, the global burden of disease from communicable diseases (such as human immunodeficiency virus (HIV), tuberculosis, and measles) has been outweighed by non-communicable diseases (such as cardiovascular diseases, cancers, chronic respiratory diseases and diabetes). Non-communicable diseases are also the most important cause of death in the world and are typically associated with developed-world lifestyles. But although communicable diseases are in decline globally, they still pose a significant health burden, especially in the developing world. A third factor in changing health conditions is the persistent threat of pandemics.

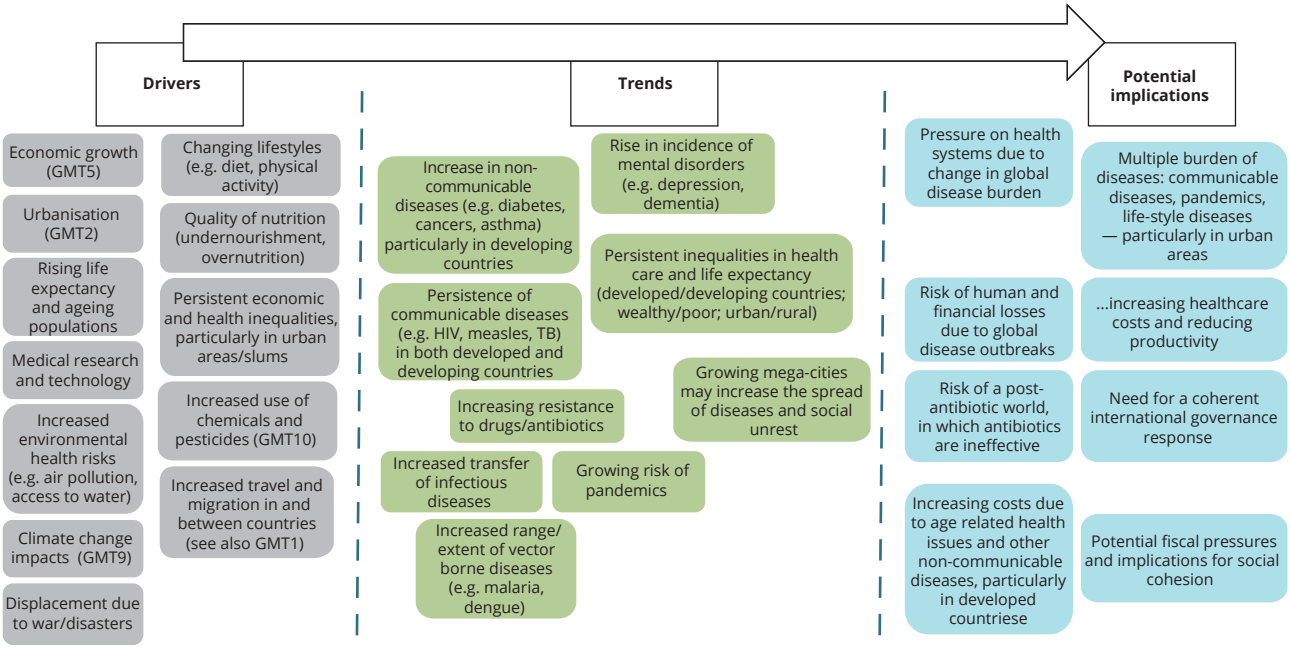
Many developing countries will find this shift challenging, as they will have to deal with the multiple burdens of persistent communicable diseases and the risk of pandemics, combined with the increasing burden of non-communicable diseases.

In addition, significant health disparities still exist between and within countries, particularly between urban and rural areas. Consequently, some vulnerable population groups (e.g. children and people living in poverty) are still at greater risk of poor health, although life expectancy and general health have been continually improving around the world.

A broad range of economic and social trends will influence the future of global public health. Although some global environment-related drivers (e.g. access to drinking water) are improving, others — such as urban air pollution and lack of access to basic sanitation — continue to pose a serious risk to human health. In addition, the incremental effects of climate change are contributing to the global burden of disease (by, for example, increasing the risk of spreading vector-borne diseases). Another driver is related to accelerating technological innovations, which are bringing many health benefits but also unknown health risks. Additionally, the pharmaceutical industry is slowing down its development of new drugs for the treatment of 'non-profitable' diseases (mostly communicable diseases in developing countries) and diseases resistant to traditional antibiotics.

Action at the global and national levels is needed to greatly reduce the risks posed by these trends. Increased investment in health and infrastructure, improved education and better governance are key factors in realising sustained improvements in human health.

The Millennium Ecosystem Assessment underlined that human health depends on healthy ecosystems, and so there are synergies between efforts to address health issues and those to protect the environment, both in Europe and worldwide.



GMT3: Changing disease burdens and risks of pandemics

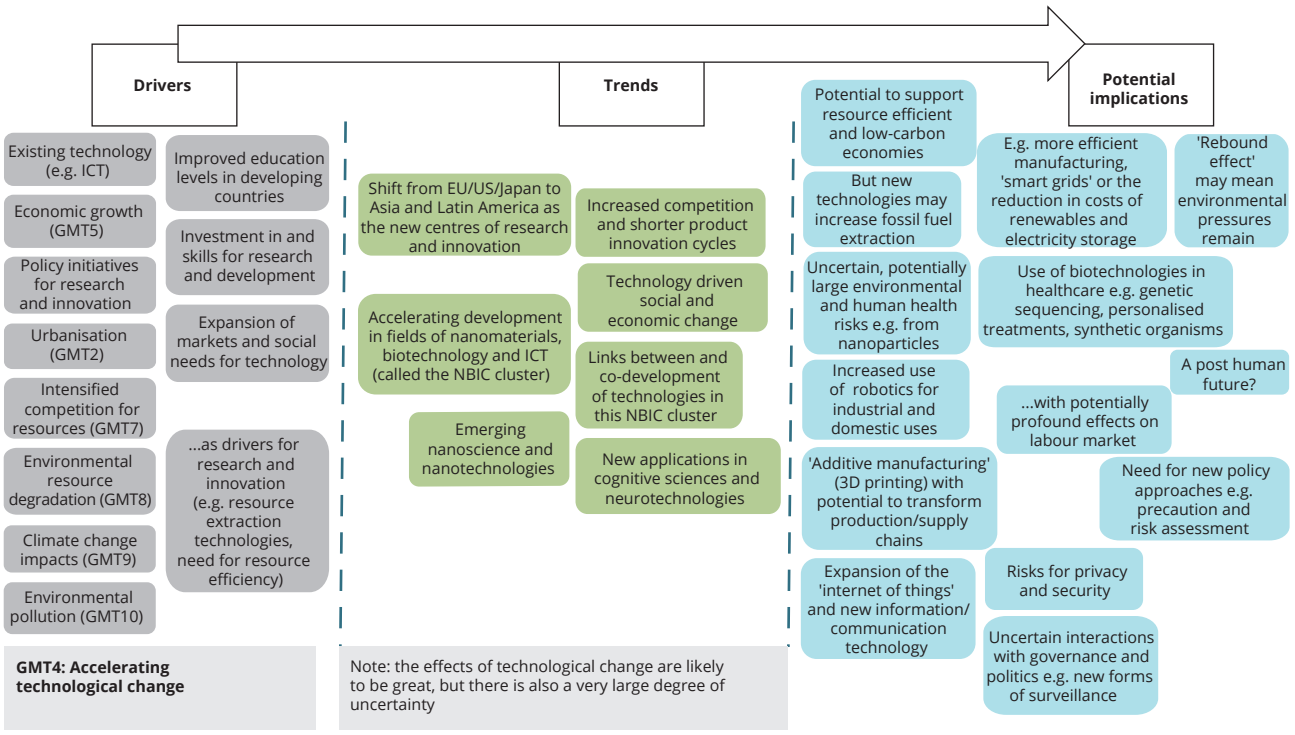
Note: Europe faces uncertain but increased exposure to possible future pandemics

GMT 4: Accelerating technological change

The pace of technological change is accelerating. The shifts in technological paradigms that once were separated by centuries or millennia — such as the development of agriculture or the industrial revolutions based on steam and then electric power — are now occurring within a single lifetime. Indeed, the pace at which new technologies are being adopted by the market and used in society has rocketed over the past century and a half. In the early 1900s, it took more than 30 years for a quarter of the US population to adopt telephones and radios; however, more recently, the World Wide Web reached this level in only 7 years.

Today, research and development around the world are accelerating —particularly for nanotechnologies, biotechnology, and information and computer technology. Moreover, the integration of techniques and knowledge across these three areas and closely related ones is speeding up the pace of discovery. The new products and innovations emerging from this 'NBIC cluster' could increase resource efficiency and support the shift to low-carbon economies. In this process, technological change may transform energy, manufacturing, health care and many other sectors over the coming decades.

Along with the opportunities, accelerating change will also create new risks for society, health and the environment. Institutional and policy innovations will be needed to minimise the emerging risks and promote technological change that supports public goals.

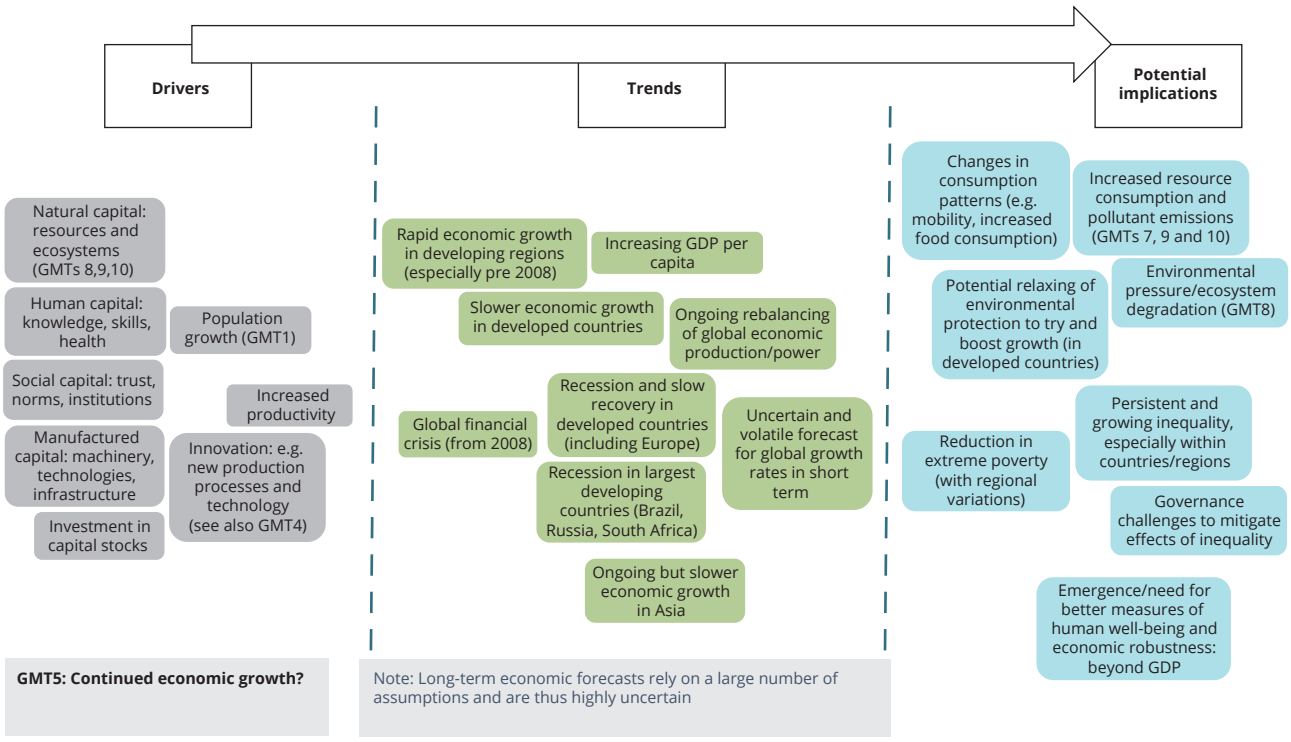


GMT 5: Continued economic growth?

The financial and economic downturn of 2008 and 2009 significantly reduced economic output in many developed countries, particularly in Europe. Although the impacts of the downturn are still felt across the world, virtually all mainstream outlook studies foresee economic expansion globally in the coming decades as Asia's and Africa's huge populations continue their shift towards Western patterns of production and consumption. The Organisation for Economic Co-operation and Development (OECD) projects that economic output will treble between 2010 and 2050, although growth is expected to decelerate in many countries as they become more prosperous.

The implications of this enormous increase in global economic output are numerous. Rapid growth has brought reductions in global poverty and increases in well-being, but it is also linked to growing inequality and escalating environmental pressures (addressed in GMTs 7–10). In Europe, a decrease in growth rate may put a strain on the public finances available for environmental protection and increase social inequality.

The negative environmental and social impacts associated with western consumption patterns have called into question prevailing models of development and the indicators that societies employ to quantify progress. In particular, the limitations of gross domestic product (GDP) as a measure of human well-being and the sustainability of growth have prompted international efforts to identify better measures.

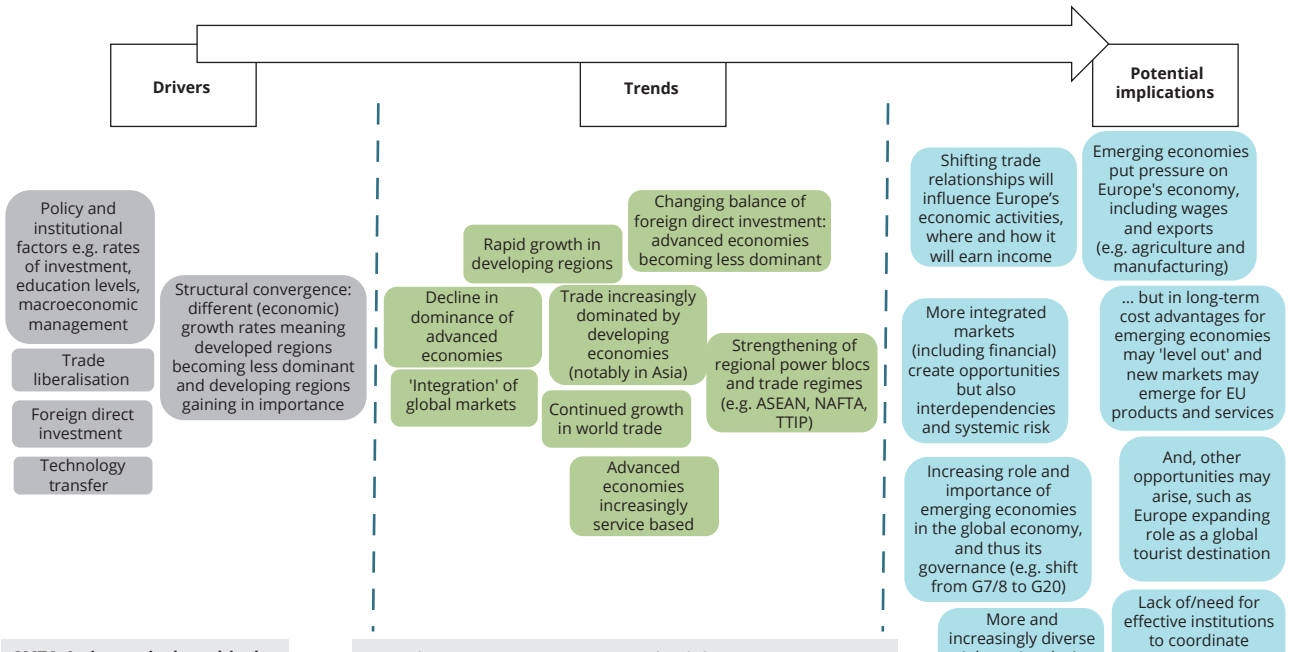


GMT 6: An increasingly multipolar world

Globally, economic power is shifting. During the 20th century, a relatively small number of countries, together accounting for about a fifth of the world population, have dominated global economic production and consumption. Today, a significant rebalancing of this power is under way.

Driven by structural change, fast-growing workforces and trade liberalisation, developing regions are rapidly increasing their share of global economic output, trade and investment. Economic and demographic projections suggest that the influence of today's wealthiest economies will continue to lessen as other countries and regional power blocs become increasingly important — economically, politically and diplomatically.

For Europe, this rebalancing presents competitive threats but also economic opportunities for meeting the demands of a fast-growing global middle class. The emergence of a larger and more diverse mixture of major economic powers may, however, complicate global efforts to coordinate governance, and growing economic interdependence will make it harder to manage the social and environmental impacts associated with globalised supply chains.



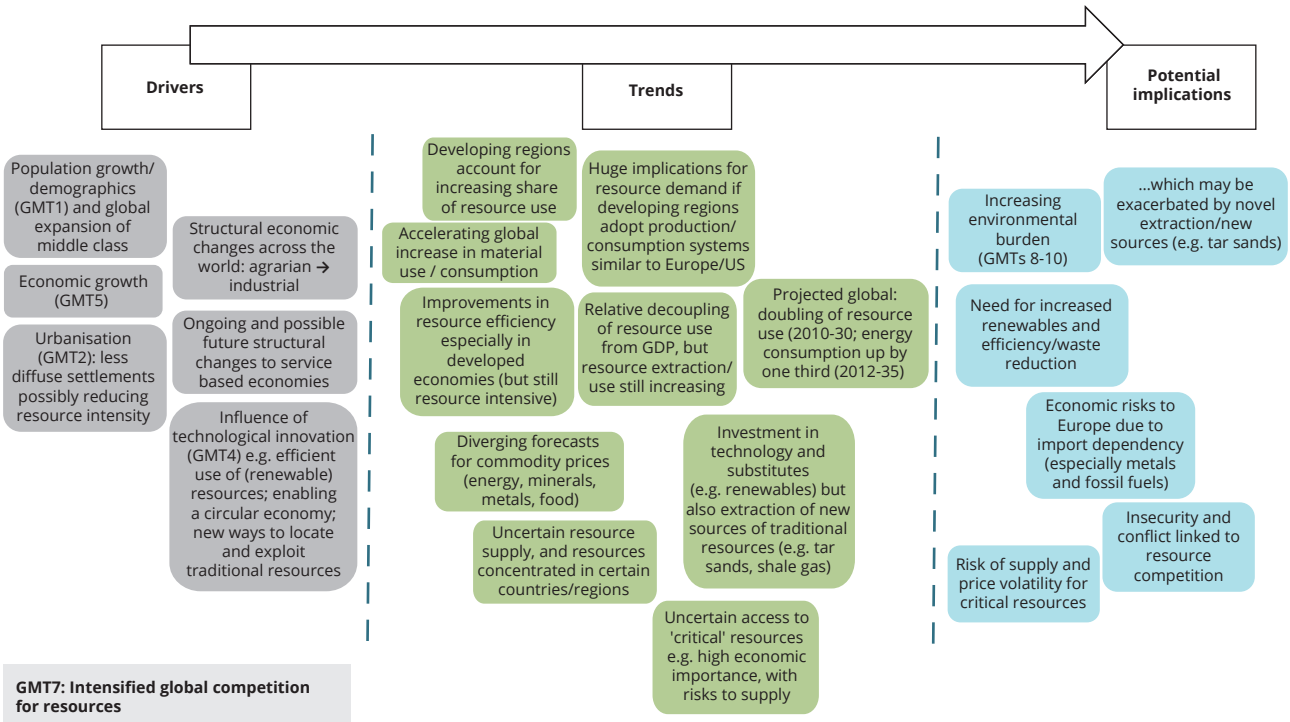
GMT6: An increasingly multipolar world

Note: There are many uncertainties in the shift to a more geographically balanced global economy e.g.: macroeconomic factors; changes in policy priorities; the impact of technological advances; socio-political development in developing countries

GMT 7: Intensified global competition for resources

As they grow, economies tend to use more resources — both renewable biological resources (see GMT 8) and non-renewable stocks of minerals, metals and fossil fuels. Industrial and technological developments, and changing consumption patterns associated with growing prosperity all contribute to this increase in demand. New technologies can create novel uses for resources and new ways to locate and exploit deposits, potentially increasing the burden on the environment. But innovations can also enable societies to reduce their use of finite and polluting resources and shift towards more sustainable alternatives.

The global use of material resources has increased 10-fold since 1900 and is set to double again by 2030, creating obvious risks. In addition to the environmental harm associated with resource extraction and exploitation, the world is a closed material system, and there are finite limits on the amounts of resources available. Even if resources are not scarce in absolute terms, they may be unevenly distributed globally, making access uncertain, increasing price volatility and potentially fostering conflict. Such concerns are particularly apparent with respect to a range of resources designated as 'critical raw materials'. For Europe, this is a major concern as its economy is structurally dependent on imports.



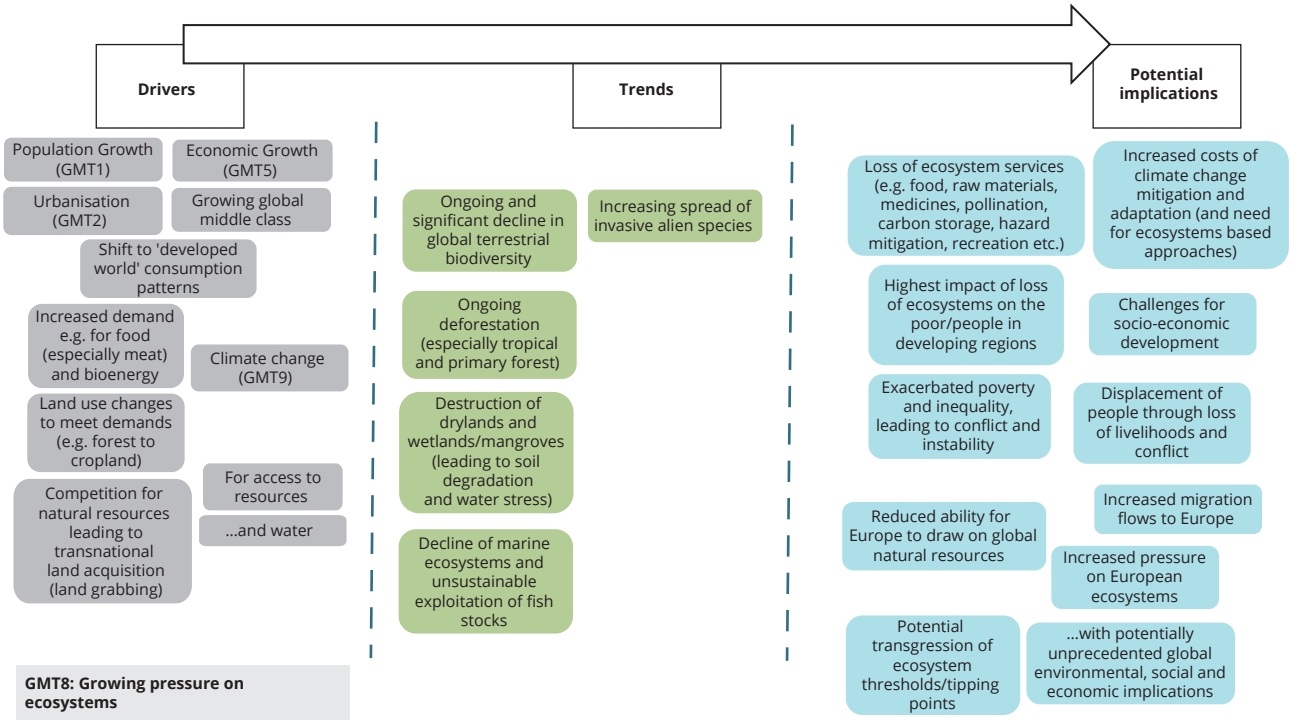
GMT7: Intensified global competition for resources

GMT 8: Growing pressure on ecosystems

Driven by global population growth and associated demands for food and energy, as well as evolving consumption patterns, the pressure on the Earth's ecosystems is continuously increasing. Despite some positive developments, such as a recent reduction in the rates of tropical deforestation, global biodiversity loss and ecosystem degradation are projected to increase.

Climate change is expected to exacerbate this trend by altering the environmental conditions to which species are adapted. In addition, the need to shift to alternative energy sources may create challenges for global land and freshwater resources, most notably related to increased bioenergy production.

Poor people in developing countries are expected to be those most strongly affected by the projected degradation of ecosystems and their life-supporting services. The sustainable management of ecosystems and socio-economic development are thus intertwined challenges. Continuing depletion of natural capital globally would not only increase pressure on European ecosystems, but also produce significant indirect effects, such as environment-induced migration.



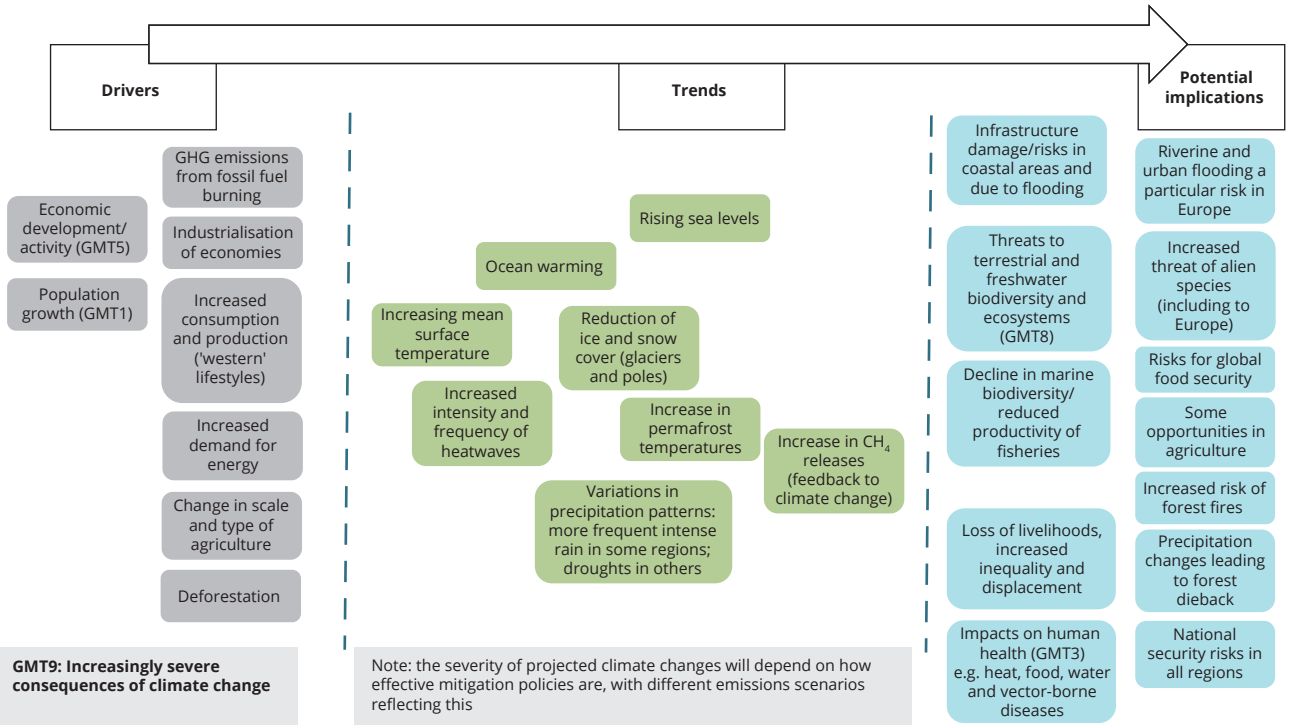
GMT 9: Increasingly severe consequences of climate change

In the past 150 years, the atmosphere and the oceans have warmed, snow and ice cover has decreased, sea levels have risen, and many extreme weather and climate events have become more frequent. This global warming and climate change are unprecedented over millennia.

The global mean temperature has increased by 0.85 °C since reliable measurements began in 1880 and is projected to increase further by the end of the 21st century — by between 1.0 °C, assuming strong emissions abatement, and 3.7 °C, assuming high emissions. This warming is expected to be accompanied by a global mean sea-level rise of up to 1 m, an increase of up to 2 °C in global upper-ocean temperature, a reduction of glaciers, ice sheets and sea ice, and an increase in the frequency of extreme weather events, such as droughts and floods, in many regions of the world.

Increasingly severe impacts of climate change are anticipated for the Earth's natural ecosystems, including substantial losses of biodiversity and increased rates of extinction. Of particular concern are ecosystems such as coral reefs, the Amazon forest and the boreal-tundra Arctic. Furthermore, climate change is likely to slow economic growth, erode global food security, increase global inequalities and adversely affect human health. These societal impacts are anticipated to be most severe in low-income countries and low-lying coastal areas.

Projected impacts directly affecting Europe include increased frequency of drought and water restrictions, increased damage as a result of flooding and increased impacts on human health from extreme temperatures.



GMT9: Increasingly severe consequences of climate change

Note: the severity of projected climate changes will depend on how effective mitigation policies are, with different emissions scenarios reflecting this

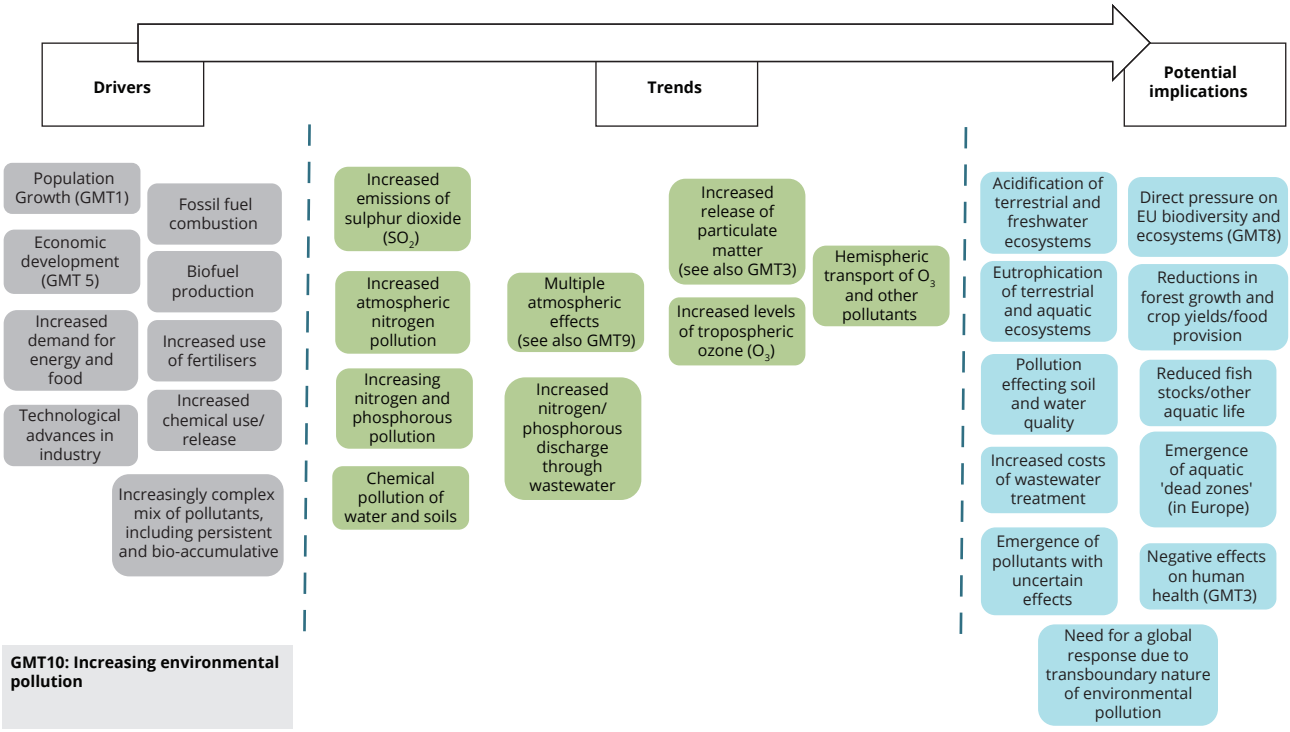
GMT 10: Increasing environmental pollution load

Across the world, ecosystems are exposed to critical levels of pollution in increasingly complex mixtures. Human activities (such as energy generation and agriculture), global population growth and changing consumption patterns are the key drivers behind this growing environmental burden.

Historic trends and business-as-usual projections suggest that, in the coming decades, pollution may reduce in some regions but could increase markedly in others. For example, emissions to air of nitrogen oxides, sulphur and tropospheric ozone are projected to decrease in Europe and North America but may increase significantly in Asia. The trends in Asia could, however, impact other world regions — including Europe — via the long-range transport of pollutants.

Nutrient effluents from agriculture and wastewater into the soil and oceans are projected to increase in most world regions, driven in part by the demand for increased agricultural production. The increasing complexity of chemical mixtures released into the environment is also a concern globally.

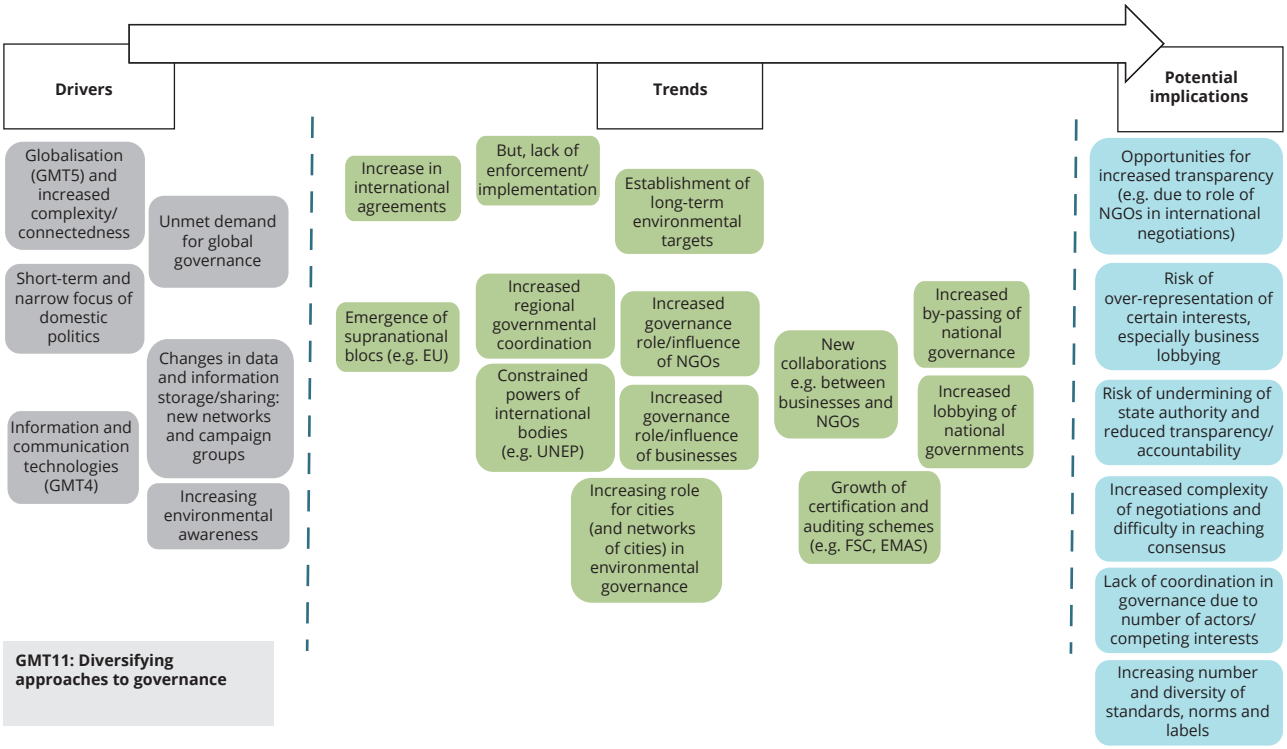
There is clear evidence of the detrimental effects of pollution on the natural environment, ecosystem services and biodiversity, for example through processes such as eutrophication and acidification. The number of marine dead zones due to eutrophication has increased markedly in recent years. Modelling suggests that, depending on crop type, between 3 % and 12 % of annual crop production is lost because of elevated ozone levels. Moreover, these rates may increase, particularly in Asia.



GMT 11: Diversifying approaches to governance

In the context of rapid globalisation, governments are facing a mismatch between the increasingly long-term, global, systemic challenges facing society and their more national and short-term focus and powers.

The need for more coordinated governance at the global scale has been reflected in the proliferation of international environmental agreements, particularly during the 1990s. More recently, businesses and civil society have also taken an increasing role in governance. This broadening of approaches is welcome but it gives rise to concerns about coordination and effectiveness, as well as accountability and transparency.



Annex 3 Implications listing and scoping template

Template table for noting implications and for recording scoping scores — this table can be amended and adapted to suit specific project needs

Working session 1: identifying potential implications			Working session 2: initial scoping of implications					
Implication title/ related to GMT(s)	**Description of implication**	**Why is the implication considered relevant?**	**Likelihood of implication**	**Relative magnitude of effect should implication occur**	**Over what timescale might the implication happen?**	**Notes on any key differences of opinion or uncertainties**	**Other notes**	**Implication ranking**
	Identify if positive or negative		High/low	High/low	Short term (up to 2020); medium term (2020–2050); long term (2050–2100)		For example, implications for specific receptors/ sectors or geographical areas (i.e. where the implication might happen)	**Important** (high likelihood/ high effect): **Potentially important** (either likelihood or effect is high) **Less important** (low likelihood/ Low effect)

Annex 4 Table for compiling relevant national information sources

One table should be completed for each implication. Note that information sources may be relevant to more than one implication. It may be easier to recreate the template below using Excel.

Title of implication: One-sentence title for implication (e.g. Increased exposure to transboundary air pollution)								
Relevant information sources								
Title and date of study/ indicator	**Reference and web-link**	**Responsible organisation**	**Time frame of study (e.g. to 2050)**	**Type of information (tick all that apply)**				
				Indicator/ data	**Outlook/ scenario study**	**Report or article**	**Policy/ strategy**	**Other**
				√		√		

Annex 5 Implication narrative template

Implication title	One-sentence title for implication (e.g. Increased exposure to transboundary air pollution)
Implication description	A couple of sentences/short paragraph describing the implication and what it means for the country. What effects are likely and what is likely to be affected? Are the effects positive or negative (or mixed)? Which GMT (or GMTs) are linked to the implication and in what ways? If an implication relates to more than one GMT, this should be noted together with reflections on interactions/ connections between GMTs
Summary of information sources available	List of information sources identified that relate to the implication: • indicators/data • reports and studies • foresight (outlooks, scenarios, etc.) • existing policy/strategy
Summary of existing evidence	Short narrative describing what the available evidence tells us about the implication: • current situation (up to 2020) • medium term (2020–2050) • long term (2050–2100)
Data gaps and needs	Short narrative describing where there are gaps in evidence or data, and any shortcomings in the data available What additional data would be needed to understand the implication?
Overview of existing policy/ strategy	List of existing policies/strategies/plans at the national level that relate to the implication
Policy gaps and needs/ vulnerabilities	Short narrative reflection on what policy/strategy gaps are evident

Annex 6 Suggested Step 3 report structure

1. Introduction

Include acknowledgements — a list of experts that contributed time and information.

2. Method description

Short overview of how the evidence was gathered, who was contacted, whether or not there were interviews, etc.

3. Implication narratives

Completed summary template for each implication (see Annex 5).

4. Summary and key messages

Any key messages, e.g. important gaps, emerging issues, GMTs that seem particularly important, etc.

Annex A

Include list of all sources of information/evidence identified.

Annex B

Include results of mind-maps and/or CLD modelling if used.

Annex 7 Template for recording discussions of risks and opportunities

Workshop participants can use the following template to record the outcomes of discussions of risks and opportunities. It is suggested that workshop discussion can be around the following questions, but these can be adapted or new questions added if preferred:

- What factors (environmental receptors, ecosystems, resource types, etc.) might be most affected, in what ways and when?
- Who (which groups in society, types of business, etc.) might be most affected?
- In what ways will these effects be seen at different spatial scales (regional, local, etc.)?

One table should be completed for each implication identified and selected through Steps 2 and 3.

Implication	**One sentence title for implication (e.g. Increased exposure to transboundary air pollution)**				
Risk/opportunity	**What is affected by the risk/ opportunity?**	**Who is most affected by the risk/opportunity?**	**Will the effects be seen a different spatial scales?**	**When will the risk/opportunity be experienced?** **Short term (up to 2020); medium term (2020–2050); long term (2050–2100)**	**Other notes/ reflections**
Note down the risks/ opportunities. One row for each risk/ opportunity	What factors (environmental receptors, ecosystems, resource types etc.) might be most affected, in what ways and when?	Who (which groups in society, types of business etc.) might be most affected?	In what ways will these effects be seen at different spatial scales (regional, local, etc.)?		Any other key discussion points, uncertainties, disagreements etc.

Annex 8 Template for the assessment of risks and opportunities

Implication	One sentence title for implication (e.g. Increased exposure to transboundary air pollution)									
Risk/ opportunity	**Short term (up to 2020)**			**Medium term (2020–2050)**			**Long term (2050–2100)**			**Notes on uncertainties and assumptions**
	Magnitude	**Likelihood**	**Overall assessment**	**Magnitude**	**Likelihood**	**Overall assessment**	**Magnitude**	**Likelihood**	**Overall assessment**	
Risks/ opportunities identified from workshop session 1 (as recorded using Annex 9) State in each case if it is considered a 'risk' or 'opportunity'	Magnitude score using criteria provided	Likelihood score using criteria provided	Use the assessment matrix to score the risk/ opportunity as 'High', 'Medium' or 'Low'	Magnitude score using criteria provided	Likelihood score using criteria provided	Use the assessment matrix to score the risk/ opportunity as 'High', 'Medium' or 'Low'	Magnitude score using criteria provided	Likelihood score using criteria provided	Use the assessment matrix to score the risk/ opportunity as 'High', 'Medium' or 'Low'	Record any key uncertainties, assumptions or disagreements

Annex 9 Template for assessing policy gaps and needs

Implication	One-sentence title for implication (e.g. Increased exposure to transboundary air pollution)
Risk/opportunity	Description of specific risk identified in working session 1 of the workshop Assessment score
Existing policy/ strategic planning	List existing policy/strategy/planning documents that relate to the risk/opportunity These should come from the Step 3 reporting/factsheets, but experts should also include any policies/ plans, etc. that they are aware of that were not identified in Step 3
Key gaps in policy/ strategic planning	To what extent do these policies or strategies address the identified risks and opportunities? What are the key gaps?
Suggestions for new policy/strategic planning	What new policy or changes to existing policy or planning might be needed to prepare for identified risks, and cope with them should they occur (recognising that not all risks can be prevented)? What new policy or changes to existing policy or planning might be needed to maximise opportunities?
Other notes	Record any other issues of interest arising in discussion, e.g. relevance of international processes, reflection on priorities and differences of opinion.

Annex 10 Suggested final report structure

1. Introduction

Include acknowledgements — a list of experts that contributed time and information.

2. Methodology and process

Short overview of what was done while completing the project: how the evidence was gathered, who was contacted, whether or not there were interviews, etc.

3. Identification of national GMT implications

Summary of the process and outcomes of Step 2.

Note any key areas of uncertainty and divergent views/ opinions.

4. Available evidence and information

For each implication, provide a summary of the evidence, data and reports from Step 3.

Note any key research/evidence gaps.

5. Risks and opportunities

Summary of the Step 4 workshop outcomes related to risks and opportunities, overview of risks and opportunities identified, and assessment outcomes.

Note any key areas of uncertainties and any divergent views/opinions.

6. Policy gaps and needs

Summary of Step 4 workshop outcomes related to assessment of policy gaps and needs.

Note any key areas of uncertainties and any divergent views/opinions.

7. Key messages and recommendations

What key messages has the process identified? What seem to be the most important implications of the GMTs, and what risks and opportunities to they pose? How well is the country prepared? What are the key uncertainties or future research needs?

Annex A

Completed scoping table (from Step 2).

Annex B

Implication factsheets (Step 3).

Annex C

Completed risk/opportunities assessment tables (Step 4).

Other annexes can be added as required, e.g. to include CLD outcomes and mind-maps.

Annex 11 Link to Forward-Looking Information System Glossary

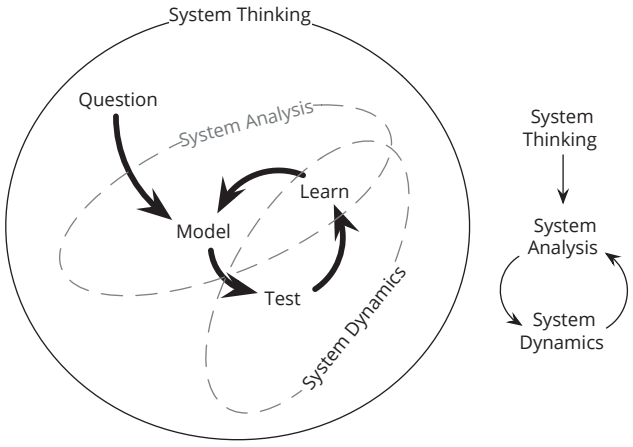
See FLIS glossary: http://forum.eionet.europa.eu/nrc-flis/portal_glossary/glossary

Annex 12 A brief introduction to causal loop diagram modelling

Introduction to 'systems thinking' and system modelling

The following is an introduction to 'systems thinking' and system modelling, an adapted text from Haraldsson (2004). Systems thinking is a concept that is commonly applied to understand how causal relationships and feedbacks work in an everyday problem. Understanding a cause and an effect enables us to analyse, sort out and explain how changes come about, both temporarily and spatially, in common problems. This is referred to as 'mental modelling', i.e. explicitly mapping the understanding of a problem and making it transparent and visible for others through CLDs. Systems thinking is the collective term for systems science and two other concepts, systems analysis (SA) and system dynamics (SD). In general terms, systems thinking is the science of structuring logic and asking the relevant questions, but it has practical applications through SA and SD, as shown in Figure A12.1.

Figure A12.1 System thinking



Note: The properties of a system can be learned through systems thinking, which involves a structural analysis (through SA) and reconstruction (through SD). Discovering, taking apart and reconstructing are the essence of systems science.

Souirce: Haraldsson, 2005.

Systems thinking is the mind-set and philosophy of thinking about whole worlds instead of symptoms and event sequences. Inherent in this is the identification of systems of causalities that give rise to events and histories. Important features of systems thinking are the willingness to take a 'birds' eye view' and the ability to define system boundaries as well as to communicate them. SA involves taking apart these worlds in order to understand the causalities, detect and discover their structural arrangement, and understand the effects emerging from the flows and accumulations from the causalities acting in the systems. SD is the use of the results of SA to reconstruct the system of causalities.

Mental models and feedbacks

Many failed policies stem from a misunderstanding of the problems and can be explained by the structure of the logic we use. We all have and use mental models in our daily work to simplify how the world around us works (Forrester, 1968; Dörner, 1996).

The human mind best understands models that are linear and static, and which describe a set of linear relationships that **do not change** over time. If, for instance, we are situated in a town centre during rush hour, we observe that almost everything is moving, but if we take a picture of the situation, we 'freeze' the moment (Grant et al., 1997), that is, everything is fixed at the particular moment of time at which we took the picture. Static models are 'frozen' models or so-called linear models for which time is not an independent variable. All 'movement' in static models is extracted as in the example, shown in Figure A12.2, of the correlation between the number of cars and traffic congestion.

Although the human mind can understand behaviour through time, it performs poorly when confronted with complex dynamic behaviour that incorporates many variables and time lags. Usually we have no problem grasping the behaviour of two to three dynamic variables. However, problems start to arise when variables exceed three or four components that move

Figure A12.2 Linear thinking implies direct causation, i.e. the 'number of cars' leads to 'traffic congestion' which, in turn, leads to an increase in 'travel time'. No distinction is made between the quantity or the information diagram

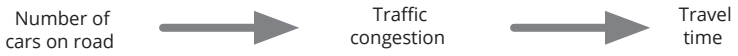


Figure A12.3 The CLD makes a distinction between information that is causing the action and the actor that is being influenced. The 'number of cars on road' is influenced by the 'decision (of persons) to take the car to work', which leads to 'traffic congestion' and increased 'travel time'. The feedback from 'travel time' to 'decision to take the car to work' is negative and thus results in a smaller 'number of cars on road', less 'traffic congestion' and a reduction in 'travel time'

dynamically. The mathematics are just too complex for us to understand, and the longer the time aspect, the greater the complexity (similar to the dynamics of the economy or the interactions in an ecosystem). At this stage, it is very important to structure our logic so that we can identify what, how and when to act in complex situations (Dörner, 1996). This is how and why systems thinking was developed in the first place.

When we work with systems thinking, we work with the concept of 'feedback'. Feedback is responsible for changes within systems, i.e. it is action causing. Feedback can be defined as a response to an action or an inverse flow of influence related to an action. It is any action that causes an effect on the starting point of the action (e.g. increased 'travel time' could lead to a decrease in the 'decision to take the car to work'). Feedback is thus both the cause and the effect, as illustrated in Figure A12.3.

The most important issue about the feedback perspective in systems thinking is the suggestion that **everyone shares responsibility for the problems generated by a system**. Thus, no 'one' factor is solely responsible for changes in a system (Forrester, 1961; Senge, 1990 and 1994). Using CLDs, it is possible to conceptualise and construct the circular connections and feedbacks in a problem. By drawing a mental model in such a way, the behaviour of a problem can be predicted.

Causal loop diagrams and their use in stakeholder modelling

The ability to ask the right questions depends on the ability to put together a group of people with sufficient background knowledge, in order to define the problem as correctly as possible. A CLD reflects the understanding of the problem, and therefore the problem definition and the questions asked concerning the problem are reflected in the CLD. This process is undertaken through group model building, as advocated in Vennix (1996 and 1999). When a group of people are faced with a specific issue, mental models are depicted differently by each person observing the problem. Miscommunication may exist within a group because of different points of view and, consequently, their different mental models will be pitched **against each other**. Group model building uses a process to bring together different mental models to find the common denominator; this allows group members to discover each other's mental models (Vennix et al., 1996). Group model building strives to create a shared mental model for the group. This process starts by **framing a question** for the problem (Figure A12.4). The question takes the form of a hypothesis for the group to work by, which is then either verified or refuted through several iterations as a continuous learning process called the 'Learning Loop' (Haraldsson, 2005; Haraldsson and Sverdrup, 2004).

Causal loop diagrams — Telling the story through causalities

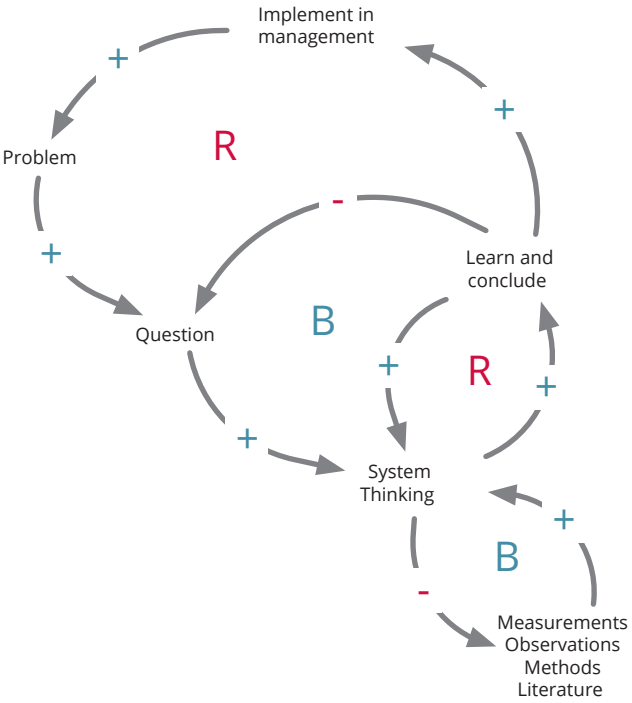
CLDs are used in an attempt to understand reality through causalities; there are benefits to observing the world in the context of feedbacks rather than linearly. It is desirable to observe repeated patterns that may be used to predict the behaviour related to a problem. In principle, all systems understanding is about understanding cause and effect. For example, if we consider a problem that is very familiar to all of us — filling a glass of water — from a linear point of view we could say 'I want to fill a glass with water', which, of course, sounds very logical but tells only half the story. We can control the rate of water flowing into the glass (as the statement implies), and the amount of water in the glass signals when to close the water tap. The traditional flow logic of reasoning is as shown in Figure A12.5.

If we use CLD language, we can use feedbacks to explain the process. We start by considering the initial problem: 'I want to understand how water flows into the glass and what I do to fill it up.' Instead of looking at the action from an individual point of view, where the 'I am' is the doer and the centre of focus, we can shift our perception to the structure of the action. The 'I am' simply becomes a part of the feedback process, and does not stand apart from it. Suddenly, the attention has shifted to the structure of the behaviour and we can observe that the structure is causing the behaviour. The CLD allows us to follow the action in detail, and we can read the 'feedback' in the CLD like a story. Since a certain amount of water must be added to the glass, the first step is to turn the water tap on (modified from Senge, 1990).

If the desired outcome is for the water level in the glass to be high, that will be the **intended** water level. First of all, the water tap is turned on so that the water starts to flow. This results in an increase in the water level in the glass. As the water level becomes higher, the perceived gap between the **current** water level and the **intended** water level changes. As a result of this changed 'gap' (i.e. a reduction in the difference between the current and intended water levels), the water tap position, etc., will be changed.

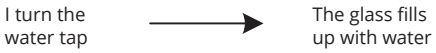
The traditional linear thinking of this example has now been transformed into a circular argument (Figure A12.6). There is a difference in perception between the original statement — 'I want to fill a glass with water' — and the one formed using the CLD — 'The action to fill the glass of water created a system that caused the water to flow in at low water level and to stop the flow when the water level reached my

Figure A12.4 The 'learning loop'



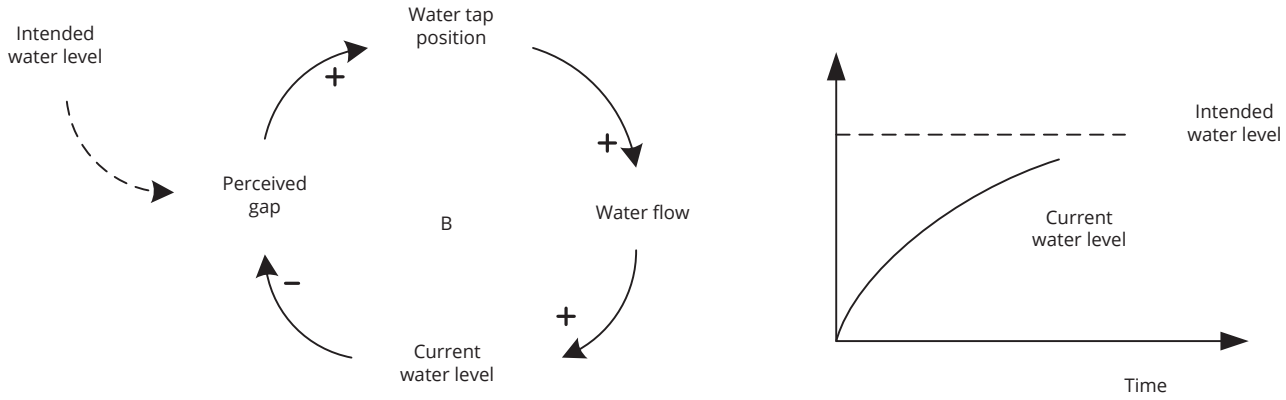
Note: The 'learning loop' is the basic scientific process trained for any type of problem-oriented work. All problem solving starts by asking the proper question and framing the task. Answering the question occurs through learning in an iterative process, through which 'problem solving' is carried out by analysing the feedback and relationships, and checking the understanding against observations and known principles

Figure A12.5 Traditional logical flow of reasoning



intended water level'. Both the statements express the same intention but describe the process in a different way. As observed, the effects of the final variable influence the input for the first variable (the one we started with); this results in the self-regulation of the system, as indicated with a 'B' for balancing in the middle of the loop. Systems always have a circular organisation and form feedback loops. The regulation of a system can result in either a self-reinforcing system or a self-balancing system. A reinforcing (or amplifying) system is a system that is in growth, such as bank account growth, economic growth or bacterial growth. Note that the intended water level and the current water level have been plotted against time: CLDs are always drawn on a temporal scale. This is expressed

Figure A12.6 Circular flow of reasoning



graphically as reference behaviour patterns (RBPs). A reinforcing system has an escalating effect because of equivalent influences between the components, which can be either a downwards or upwards spiral (Figures A12.7 and A12.8).

CLDs can also illustrate systems that have specific goals, such as the water in the glass example. In such a balancing system, there is a variable that hampers exponential growth or is a limiting factor with regard to the growth of the loop. Filling the glass of water is an illustration of a system that has a specific goal and is a balancing system, since the glass can hold only a certain amount of water. This type of system moves towards stabilisation or a balanced state (see below).

To put systems thinking into practice, several rules have to be followed so that 'cause' and 'effect' can be illustrated in the correct way (Figure A12.9).

To further illustrate Roberts' explanation of the causal loop concept, the variables at work in the loops can be considered more closely. For example, in a reinforcing system of a population that has a high birth rate and thus a net increase in population, we can use six steps to work out our CLD (Figure A12.10).

When determining causalities between variables, the links are always considered separately. Once the polarity ('plus' or 'minus' sign) has been marked on the loop, the small assisting arrows can be deleted. They are only there to help determine the loop behaviour. The shadowing above the links (Figure A12.10) indicates that only one link is considered at a time. Feedback from the final variable to the first variable (where we started) determines the behaviour of the loop. An increase in 'births' fed back to births (from 'population') as an increase. If the variable 'death' is added, we would work

Figure A12.7 A reinforcing system

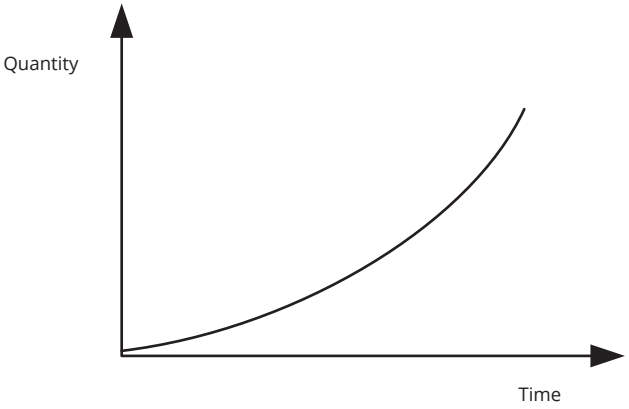


Figure A12.8 A balancing system

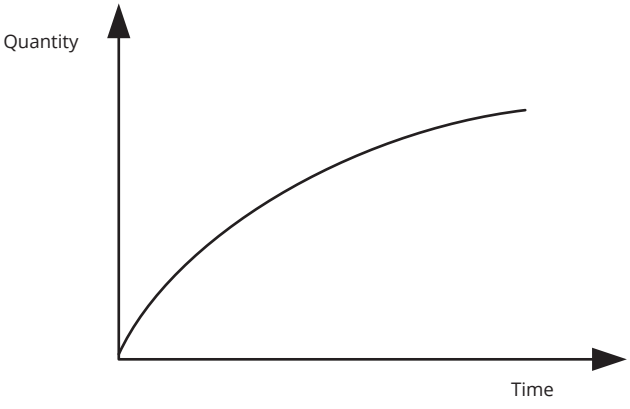
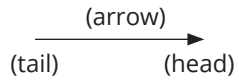


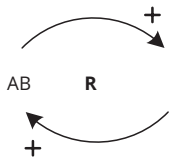
Figure A12.9 The 'causal loop' concept explained

The arrow shows a causality. A variable at the tail causes a change to the variable at the head of the arrow.

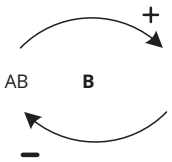


A plus sign near the arrowhead indicates that the variable at the tail of the arrow and the variable at the head of the arrow change in the same direction. If the tail *increases*, the head *increases*; it the tail *decreases*, the head de*creases*.

A minus sign near the arrowhead indicates that the variable at the head of the arrow change in the *opposite* direction. It the tail *increases*, the head *decreases*; it the tail *decreases*, the head *increases*.



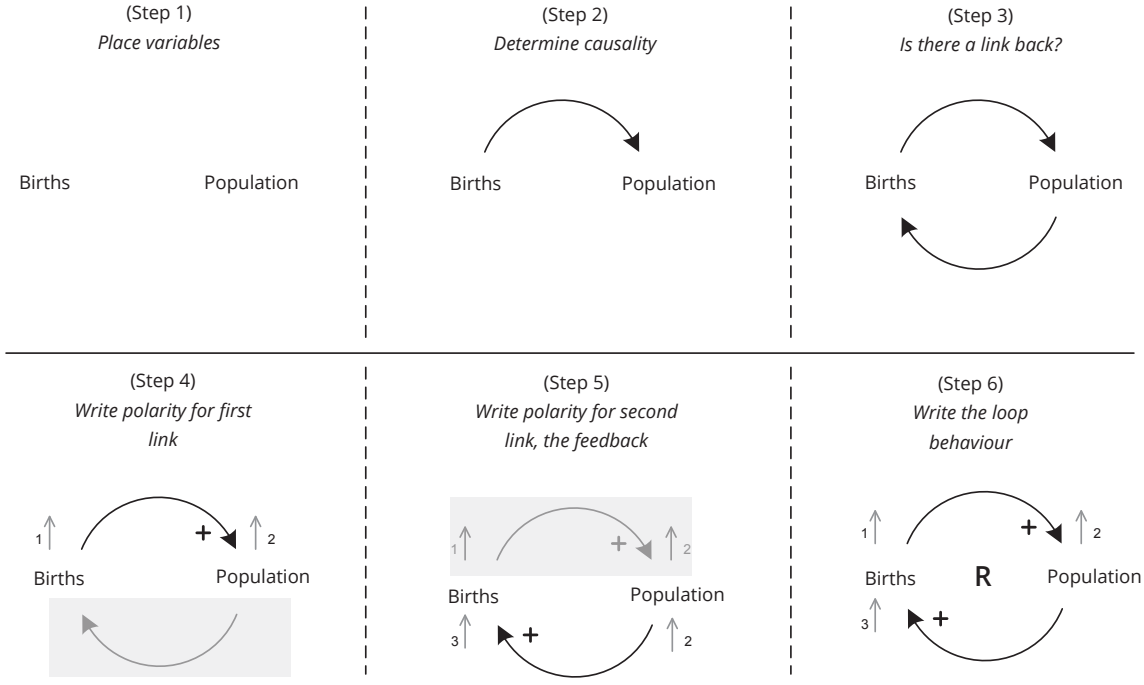
The letter **R** in the middle of a loop indicates that the loop is *reinforcing* a behavior in the same direction, causing either a systematic growth or decline. It is a behavior that is moving away from equilibrium point.



The letter **B** in the middle of a loop imdicates that the loop is *balancing* and moves the system in the direction *towards* equilibrium or a fluctuation around equilibrium point.

Source: Adapted from Roberts et al., 1983, p. 56.

Figure A12.10 Explanation 1: Connecting the links



with the loop as in Figure A12.10, but the 'death' variable could be added afterwards (see Figure A12.11).

In the actual situation, the death rate would balance the increase in population up to the point at which the number of births equals number of deaths. The first phase would be reinforcing and the second phase would restrict the population size. Despite the complexity of systems, it can be stated that reinforcing loops are always temporary: they will eventually be balanced out by one factor or another. The important thing to identify is how long the reinforcing situation will endure; it can last from minutes to millions of years depending on what we are observing.

A slightly more complicated CLD is required to consider urbanisation and job opportunities. People may move to a city if, for example, an industry has been established there. Therefore, we can consider the question 'What happens to job opportunities when people move to town?' Once the variables that are part of the system have been established, we can start to construct the diagram (see Figure A12.12).

We can read the 'story' from the loop in Figure A12.12. As the industry establishes in the town, industrial job opportunities are created (more industry, more job opportunities). This drives people to move to the town to take the new job opportunities (more people, less job opportunities). This is our first loop. The second loop stems from a secondary effect of people moving to the town. This influx of people creates demand for services, which in turn creates job opportunities in the service sectors (in order to service the industry workers) — again, 'more demand' causes 'more opportunities'. When the service job opportunities increase, this feeds back to the 'people moving to town' variable and causes more people to move to the town. These people also take jobs in the service sector and, thus, this reduces the number of service job opportunities. Therefore, there are three loops in Figure A12.12 that affect the variable 'people moving to town'. The variable 'industry' is not affected by any other variable in the loop and is thus an external factor in the system behaviour. It is an external factor simply because it was not part of the question 'what happens to job opportunities when people move to town?'

Figure A12.11 Explanation 2: Adding a second loop

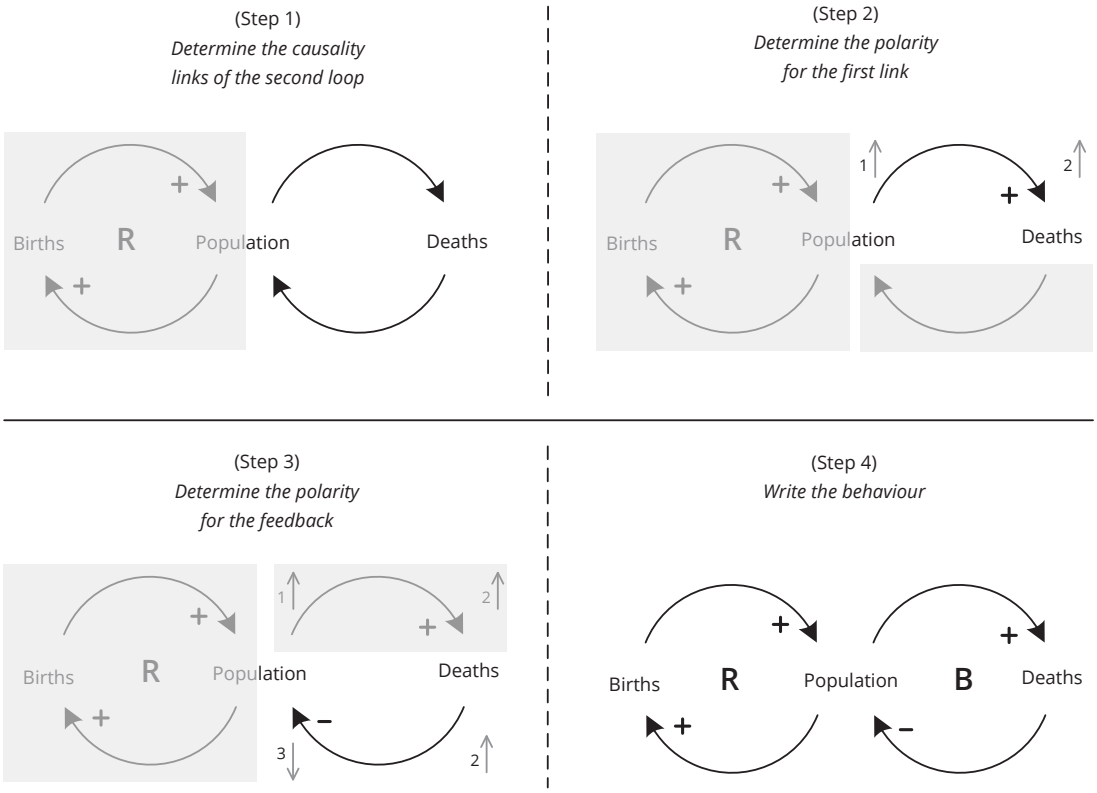
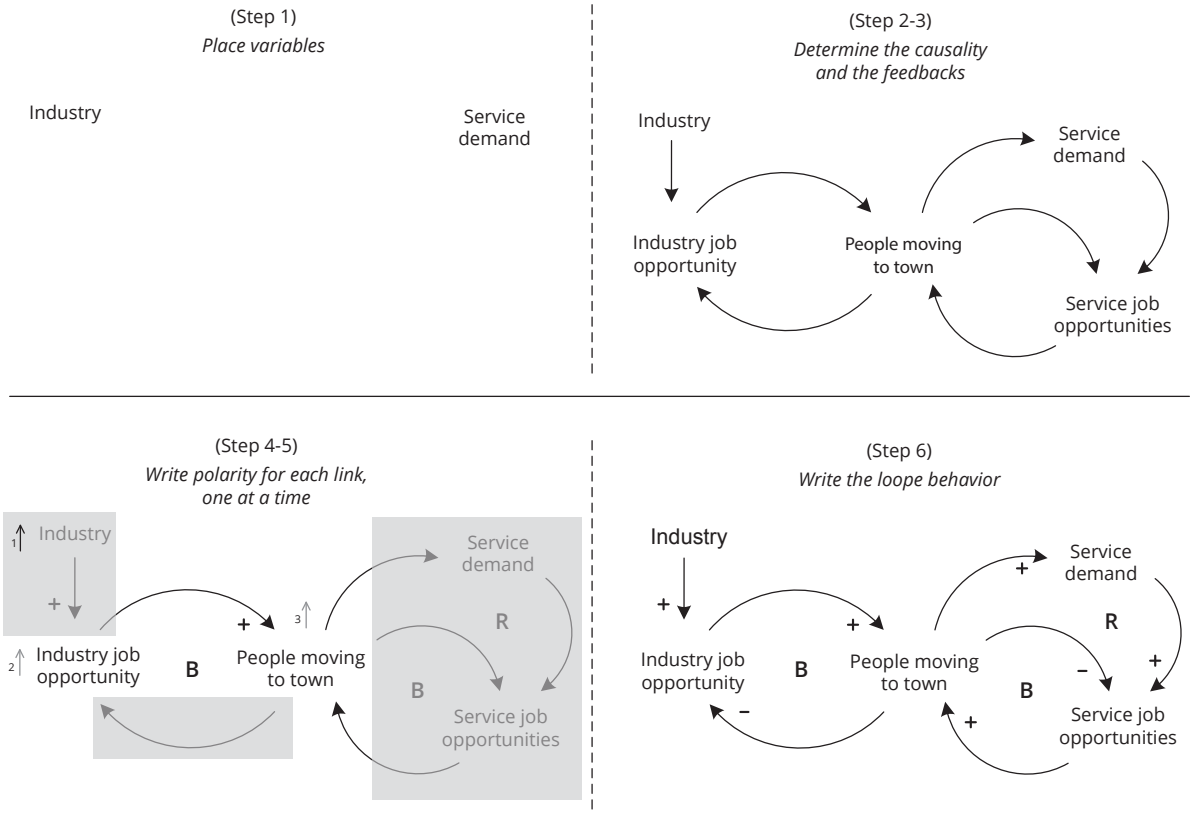


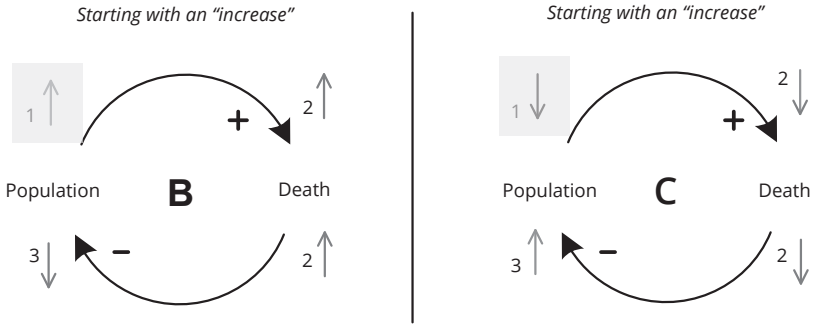
Figure A12.12 Explanation 3: Job opportunities and people moving to town



It is very important to understand that once we have put polarities on the causality links, they always stay the same. For example, 'reduced' births will reduce population, etc., i.e. the polarity is the same. Sometimes, if a causal loop is reversed, e.g. when starting with a decrease, we are faced with a situation in which the interpretation of a minus or plus sign can lead to some confusion. This is illustrated by the following example of population dynamics (see Figure A12.13).

The causal loop in Figure A12.13 suggests that the more people there are, the more deaths there will be. The connection with total population is that the more deaths there are, the fewer people there will be. This

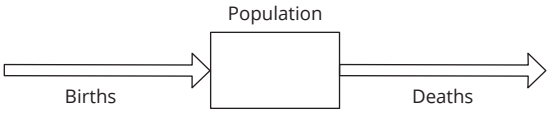
Figure A12.13 Explanation 4: How to read 'starting with a decrease'



sounds very reasonable, but we can also consider this in a reversed way, i.e. if there is a decrease in the total population. The CLD states the following: the fewer people there are, the fewer deaths there will be, and the fewer deaths there are, the more people there will be. However, is this necessarily true? If death rate goes down, does population actually rise? No it does not, unless the 'population' variable is connected with a birth loop. What this loop suggests is that the fewer deaths there are, the more people are left remaining in the total population. Alternatively, if the number of deaths decreases, the population may still decrease, but at a slower rate than before. It is important to use the right wording when explaining CLDs and to remember not to change the polarity once it has been set. A CLD should read correctly in either direction.

From causal loop diagrams to hard modelling

Figure A12.14 Stock and flow diagram



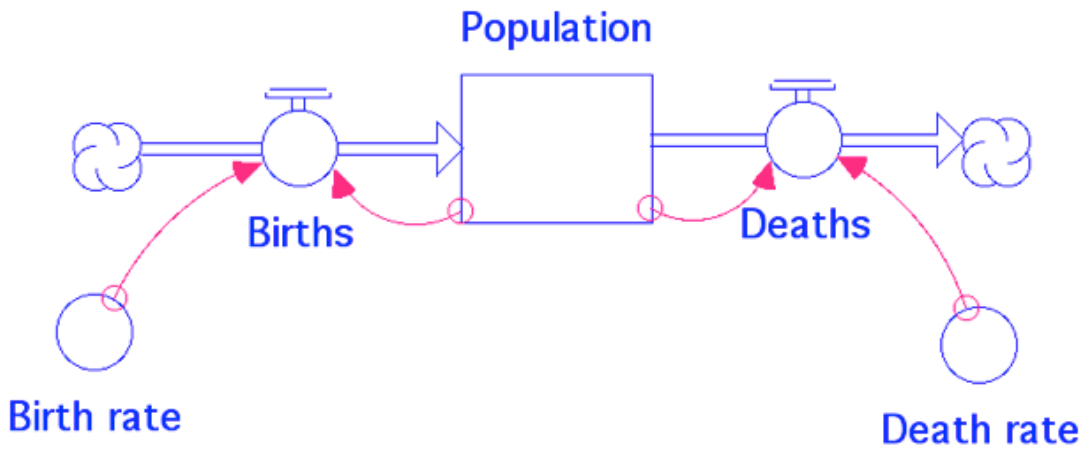
Note: Illustration of an SFD. 'Population' is indicated as a stock, since the number of people constitutes the quantity. The numbers of people being born flow as new individuals into the population, whereas the numbers of people dying flow out from the population

In this section, how to convert a mental model in the form of a CLD to a mathematical model is discussed. This is done by converting the CLD to a stock and flow diagram (SFD). The difference between the CLD and the SFD is that in a CLD, you do not have to worry about units, whereas an SFD shows quantities and flows. In mathematical modelling, you need to understand how quantities are being moved through a system. SFDs are used to show flow dependencies and how quantities are distributed within a system. Stocks hold quantities that are either subject to accumulation through inflows, or subject to reduction through outflows (Figure A12.14).

Converting a causal loop diagram to a stock and flow diagram

The combination of CLDs and SFDs allows us to create differential equation structures that can be checked against conceptual models. In SD education and research, SD tools are used to run the numerical simulations. These SD tools use system dynamics tool diagrams (SDTDs), which are graphical versions of the mental model, adapted for the numerical domain from the CLD and the SFD. The SDTD is a hybrid of the SFD and the CLD, and is used in SD tools to numerically simulate models (Haraldsson, 2005). The process of building a numerical model rests on a mental model, mapped through CLDs and SFDs. Using an SDTD as a continuation of the qualitative stage not only illustrates the feedback processes and causalities, but simultaneously illustrates the properties of the variables in the model (i.e. a stock or flow). The SDTD of the population example (Figure A12.11) as a 'hybrid' is shown in Figure A12.15.

Figure A12.15 Combining a CLD and an SFD reveals a system model diagram used by the SDTD packages



For each problem, there are five stages in the analysis phase (Haraldsson, 2005; Haraldsson and Sverdrup, 2005): (1) the situation picture illustrating the system state; (2) an SFD to identify pathways and quantities; (3) a CLD to identify the feedback loop structure; and (4) merging of the SFD and CLD into an SDTD to generate (5) the differential equations (Figure A12.16).

The application of causal loop diagrams to global megatrends

The approach of using systems thinking to understand how (global) megatrends function is an effective way of gaining a quick overview of how they behave and what impact they might have. Trends are manifestations of causes and effects and long-term feedback loops that are difficult to observe on a local level and in the short term (Lorenz and Haraldsson, 2014). The CLD feedback analysis of the megatrends enables a 'first' systematic framing of the trends. Therefore, a cause–effect analysis of a megatrend system should be a logical step for gaining an overview of how a megatrend may manifest on an overarching level.

This section demonstrates how a GMT, as described in SOER 2015 (EEA, 2015c), can be transferred to a CLD. Here we consider GMT 1, 'Diverging global population trends' (for more information on this GMT, see http://www.eea.europa.eu/soer-2015/global/demography).

GMT 1 describes demographic developments from a global perspective. Although the global population is still increasing, several sub-trends have been identified and these have very different effects. Demographic development is easy to capture in a systemic way.

The simplest way of describing population cohorts is using three age categories: 'young people', 'adults' and 'old people'. The reason for using such age categories is to allow the possibility to attach unique attributes to each group, such as 'fertility', 'mortality', etc. Thus, the basic population structure as shown in the example in Figure A12.17 is generic for all regions and even sub-regions of the world. If this generic structure is reproduced for different regions, it becomes apparent that the central factors are the in- and outflows (i.e. migration, birth and death rates). These flows can be very different in different regions of the world.

The example in Figure A12.17 focuses on migration towards Europe from African regions. If regional compartments are considered, the questions must be refocused: What influences the developments in Europe? What are the reasons for the migration movement towards Europe? What are reasons for certain developments within Europe?

The model in Figure A12.17 is certainly not complete, but it shows how the consideration of causes and consequences can be systematised and changed. The main drivers mentioned in the GMT 1 description of the EEA 'Diverging global population trends' are illustrated in Figure A12.17. This example demonstrates how such CLD modelling can help to organise and systematise the information.

For assessments of more complex (indirect) environmental impacts, further analyses would be necessary.

Figure A12.16 The five analysis phases

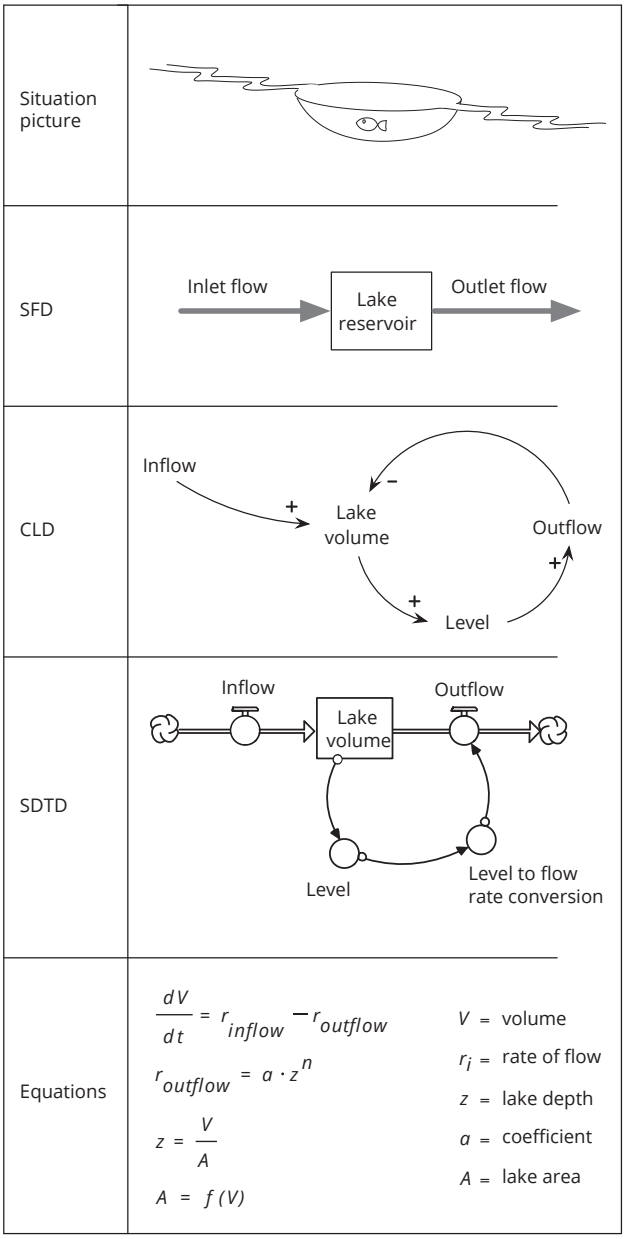
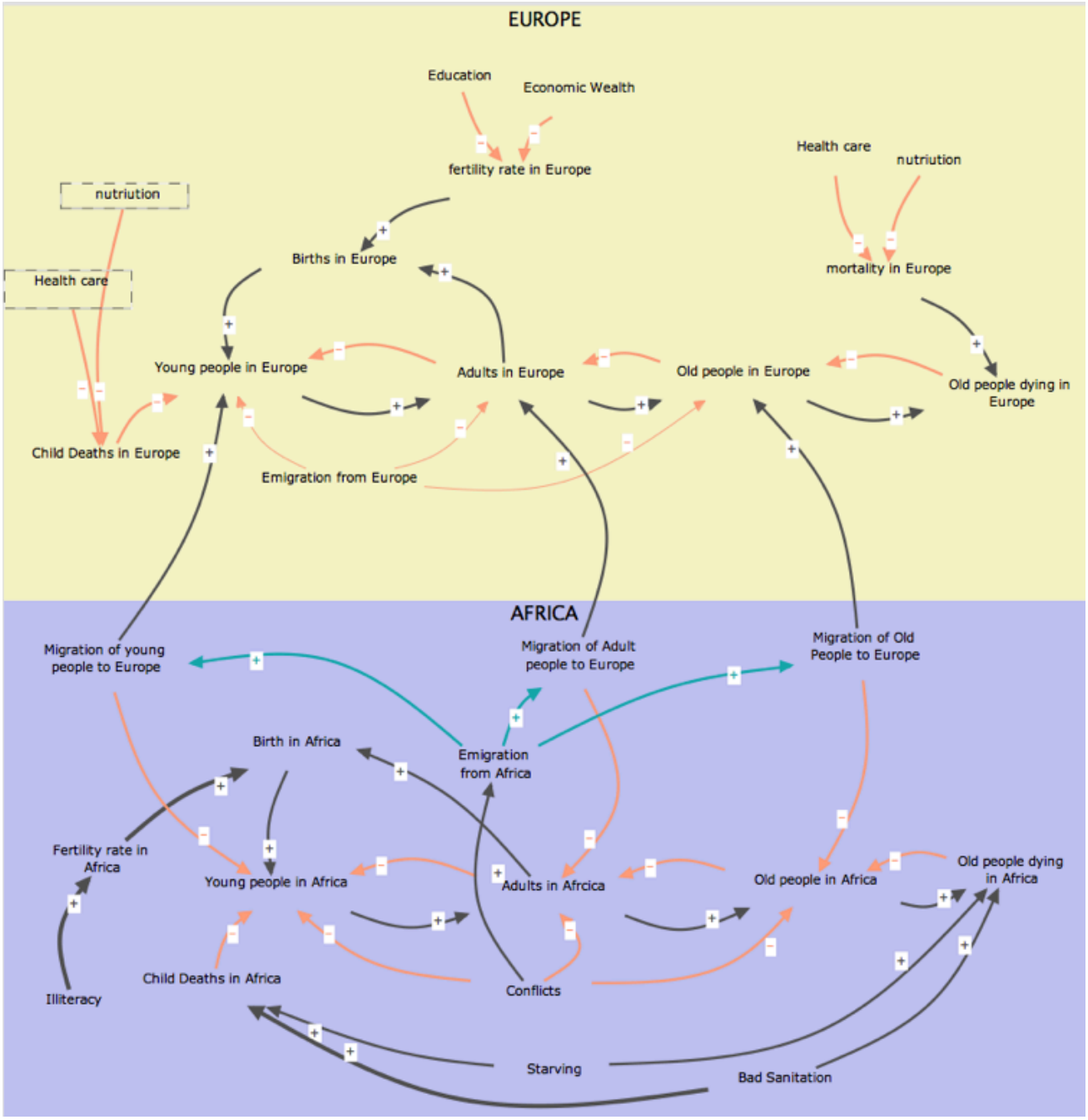


Figure A12.17 Illustrative model example of GMT 1 — Diverging global population trends



References to Annex 12

Dörner, D., 1996, *The logic of failure: Recognizing and avoiding error in complex situations*, Perseus Books, Reading, 222 p.

Forrester, J.W., 1961, *Industrial dynamics*, 4th edition, MIT press, Boston, MA, 464 p.

Forrester, J. W., 1968, 'Market growth as influenced by capital investment', *Industrial Management Review*, 9(2) 83–105.

Grant, E., Pedersen, E. K. and Marin, S. L., 1997, *Ecology and natural resource management: System analysis and simulation*, Wiley, New York, NY, 373 p.

Haraldsson HV. 2004. Introduction to Systems Thinking and Causal Loop Diagrams. *Reports in Ecology and Environmental Engineering*. Department of Chemical Engineering: Lund: 49 p.

Haraldsson, H. V. and Sverdrup, H. U., 2004, 'Finding simplicity in complexity in biogeochemical modelling', in: Wainwright, J. and Mulligan, M. (eds), *Environmental modelling: Finding Simplicity in complexity*, Wiley, New York, pp. 211-223.

Haraldsson, HV and Sverdrup H. 2005. On aspects of System Dynamic workflow. 23nd International Conference of the System Dynamic Society, Boston, System Dynamic Society.

Haraldsson, H. V., 2005, *Developing methods for modelling procedures in system analysis and system dynamics*, Department of Chemical Engineering, Lund University, Lund, 300 p.

Roberts, N., Anderssen, D.F., Deal, R.M., Garet, M.S. and Shaffer, W.A., 1983. Introduction to Computer Simulation. Productivity Press, Portland, 562 p. Lorenz, U. and Haraldsson, H., 2014, *Impact assessment of global megatrends: Two case studies connecting global megatrends to regional topics*, Report 6602, Swedish Environmental Protection Agency, Stockholm.

Senge, P., 1990, *The fifth discipline: The art and practice of the learning organisation*, Century Business, New York, NY, 424 p.

Senge, P., 1994, *The fifth discipline fieldbook: Strategies and tools for building a learning organisation*, Currency Books, New York, NY, 593 p.

Vennix, J.A.M., 1996. Group Model Building. Wiley, New York, 297 p.

Vennix, J.A.M., 1999. Group model-building: tackling messy problems. System Dynamics Review, 15(4): 379-401.

Vennix, J.A.M., Akkermans, H.A. and Rouwette, A.J.A., 1996. Group model-building to facilitate organizational change: an exploratory study. System Dynamics Review, 12(1): 39-58.

Annex 13 Pilot exercise — using a predefined causal loop diagram to connect global trends with local impact categories (UBA Germany)

Background

Without any doubt, the level of complexity related to dealing with GMTs is high, and there is no reason why it should or could be easy to deal with such high complexity. A thorough analysis of GMTs is complex and requires a high degree of attention and time.

However, in practice, depending on the level of hierarchy in organisations, the amount of time available for such kinds of analysis is often very limited. Therefore, there is a disparity between the necessary effort for an in-depth analysis of the possible impacts of GMTs on the one hand, and the available time of experts/hierarchies on the other.

The main objective of involving a variety of people (and hierarchies) in such assessment processes is to raise awareness of and sensitise relevant people to the possible challenges and opportunities, and, through this, (re)shape future research agendas and priorities in the relevant organisations and, in turn, governments. The whole strategic planning of an organisation might even be arranged around the analysis of GMTs. It is clear though that there is a wide spectrum between 'getting some ideas for research questions' and 'orienting strategic planning of an organisation', and clearly the resources required (time and number of experts) differ substantially.

Based on earlier experiences ([9]), the approach being used in the pilot exercise, described in this annex, is oriented towards a simplified and rather quick assessment. The foundation of this simplified assessment is the hypothesis that the systemic patterns of the impacts of GMTs are comparable in different settings and can therefore be prepared or pre-assessed. In addition, the simplified approach is based on the SA described in Annex 12.

Please be aware that this kind of assessment is a simplified and standardised approach with the main aim of sensitising and helping prioritise on a more strategic level, perhaps particularly in the context of a single organisation. A thorough analysis based on quantitative and qualitative empirical evidence, statistical approaches, simulations, or qualitative scenarios or qualitative modelling might be necessary if a more in-depth and scientifically robust analysis is required. In addition, more comprehensive communication processes across organisations and beyond might require a more in-depth analysis than the approach presented here can offer. However, it should be mentioned that this approach can also allow such a thorough analysis: on one hand, the predefinition and classification of GMTs and environmental impacts allow a quick assessment, and, on the other hand, the CLD model can be expanded and enriched to ensure that all scientific robustness criteria are met. As in all cases, a thorough analysis requires resources, especially time.

Approach

Introduction to the method

The simplified approach described in this annex is based on SA and uses the same kind of representation as CLDs. The connections between two factors are — in comparison with CLDs — further qualified with some fuzzy (i.e. relative to each other) information about strengths of impacts and delays.

A free copy of the predefined template of this assessment is available online ([10]). In this case, the software tool iModeler is used, which is designed for SA, as applied to this kind of assessment. For further information, please consult the provider of this tool. This kind of analysis could also be achieved with the help of other tools or even on paper.

Description of the template and rationale for this approach

The general idea of the whole exercise is to connect GMTs (i.e. global developments) with national or even local impacts. Although the GMTs are described in

([9]) See, for example, Lorenz and Haraldsson, 2014.
([10]) https://www.know-why.net/model/CJ_YVvKhHXXyNhEuuN4-hww.

the EEA SOER 2015 (EEA, 2015c) and the technical documents that supplement the central publication, the descriptions of environmental impacts and their categorisation are not systematically documented in relation to the GMTs.

There are many schemes that try to classify environmental impacts. These kinds of standardised categories of environmental impacts can be found mainly in life cycle assessments (LCAs) (e.g. ISO, 2006). However, in some cases, environmental burdens other than resource consumption and emission-based impacts (which are central to LCA) are of concern, such as freshwater depletion, global warming and acidification. For instance, nuisance (i.e. noise) can be relevant to transport systems. These non-material environmental concerns cannot be assessed using LCAs.

It was a central aim of UBA Germany to have a more comprehensive environmental assessment system, and a process is ongoing to develop a streamlined environmental assessment (StreamEA) system, in order to be able to quickly give recommendations on products or processes without the need for fully fledged LCAs (Berger and Finkbeiner, 2015). Based on StreamEA methodology, the environmental impacts are sorted by 'impact groups', 'impact categories' and 'example criteria'. The latter could and should be further expanded and specified. Table A13.1 gives an overview of the categorisation, which will be further used in this GMT assessment.

A knowledge of the GMTs (as presented in the EEA SOER 2015 (EEA, 2015c)) and the environmental impact categories predefines the setting for further analysis. The further analysis is based on the hypothesis that any global development is somehow linked to regional, national or local developments. In this way, it is assumed that the global development drives or triggers a national development or has, at least, a national equivalent.

In the case of GMT 1 — 'Diverging population trends' — the divergence itself has no real impact. It is the sub-

Table A13.1 Impact groups and categories considered in 'StreamEA'

Impact group	Impact category	Example criteria
Chemical impacts	Greenhouse gases	Use of fossil fuel energy
	Indoor emission	Use of wall paints
	Wastewater	Textile product systems
	Hazardous substances emitted to air	Combustion engines
	Diffuse emission of hazardous substances and nutrients	Agricultural products
Physical impacts	Nuisance	Traffic
	Radiation	High voltage lines
	Mechanical killing of animals	Hydropower
Biological impacts	Health risks from pathogens	Growth/spread of pathogens (e.g. lowering temperature in hot water systems)
	Biological invasion	Ship transport (ballast water)
Impacts on resources	Raw materials/energy carriers	Critical raw material
	Biotic resources	Wood
	Water consumption	Agricultural products
	Land occupation	Housing
Accidents	Accidents	High-risk technologies

Source: Based on Berger and Finkbeiner, 2015.

trends and/or the national equivalents that have an effect, e.g. immigration to Europe; an ageing society in Europe; or the spatial redistribution of people.

By considering GMTs and their environmental impacts in this way, one rule or convention for the 'SEIA-GMT' (simplified environmental impact assessment of GMTs) can be defined: GMTs are **always** connected to national trends, which are, in turn, connected to environmental impacts (see Figure A13.1).

Exploring the connections — expert workshop

In the approach described in this annex, this kind of analysis is applied in just one workshop, which could be half a day or maybe one day depending on how much discussion is wanted and necessary. The setting of the workshop could be focused on either live-modelling or 'classical' creative thinking with flip charts. Variants, using 'World Café' ([11]) settings or other creative thinking methodologies (e.g. brain writing), might also be considered, depending on the experience and knowledge of the facilitator and the expectations of the workshop participants.

In terms of effectiveness, direct 'working' on the model (with a projector centralised or decentralised on mobile units) is preferred, as there is no need for the additional task of transferring information and the participants have a higher degree of ownership of the outcomes.

The task in the workshop setting could be — depending on time and knowledge — the following:

- to identify national trends that are related to, driven by or are national equivalents of GMTs;
- to interconnect the national sub-trends;
- to connect national trends with environmental impacts.

If time is limited, the workshop could be used to simply read and verify the predefined connections (of course, missing information could be added and 'wrong' information should be corrected).

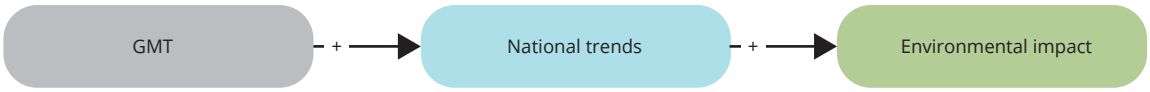
Figure A13.2 shows the basic structure presented in Figure A13.1 expanded to the various GMTs and the impact categories shown in

A . Please note, the blue 'GMT' box on the left is a supporting structural element in the model. Several rules/conventions should be followed:

- By convention, GMTs are always connected to national trends with the arrow head pointing to the national trend (not vice versa).
- National trends can (and must) be interconnected (as demonstrated later in this annex).
- There must not be a direct connection between a GMT and a regional/local environmental impact category. Even if the trend is 'identical' to the global development, it must be considered the national equivalent (which should be weaker than the global development anyway).

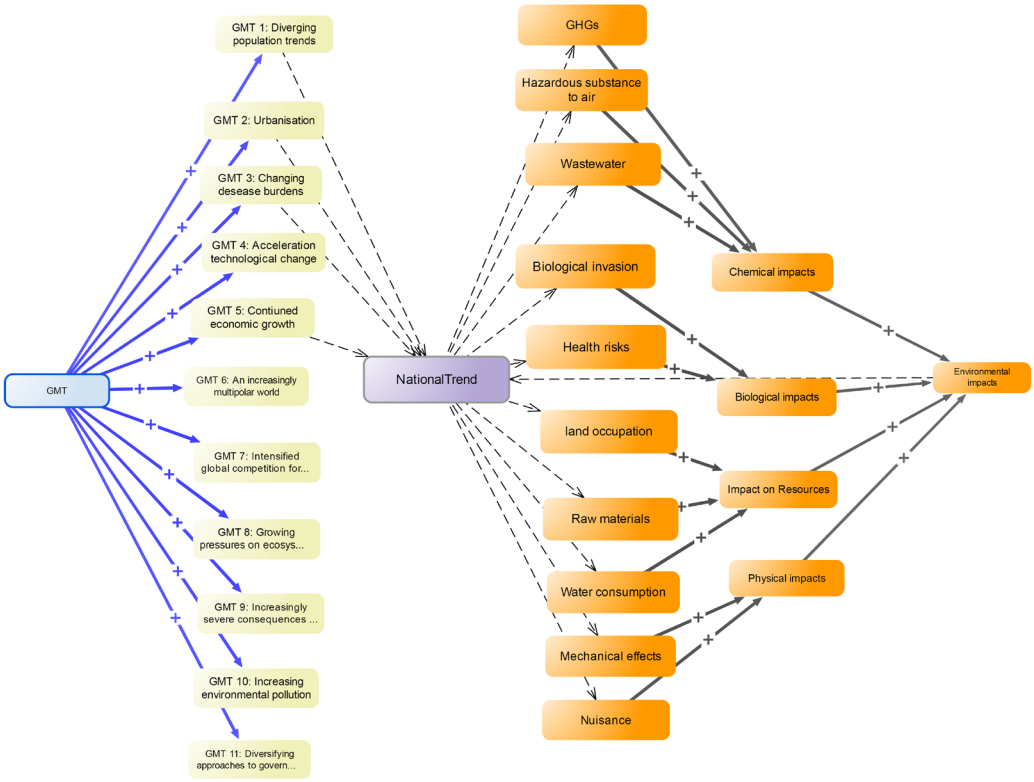
Please note, also by convention, national trends point to the environmental impact categories. In some cases, environmental impacts are part of the trend systems; in these cases, the impact category and the trend must be separated, in order to follow the rule that the categories always 'receive' incoming connections.

Figure A13.1 Visualisation of the connection between a GMT and its (national/local) environmental impact



([11]) See, for example, https://en.wikipedia.org/wiki/World_Caf%C3%A9_(conversational_process).

Figure A13.2 Screenshot from the iModeler template for SEIA-GMT



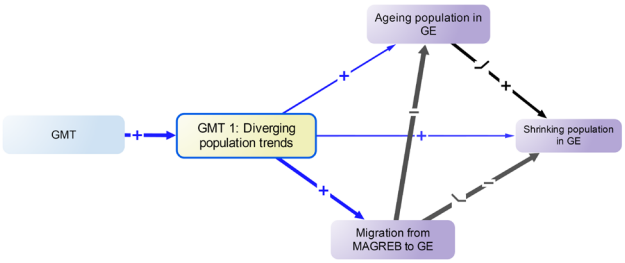
In the following section, examples illustrate these conventions/rules further.

Adding to the template — guiding questions

As mentioned in the previous section, in the workshop, participants will be asked to attach national developments (national sub-trends, equivalents, etc.) to GMTs. These national trends will and must be interconnected. Again, two possibilities for the workshop exist: a list of existing national trends from other sources could be presented and then participants asked to simply (inter)connect these trends; alternatively, if participants are already aware of trends, these could be added on the basis of the participants' own knowledge.

Figure A13.3 shows the national equivalents in the context of GMT 1. It is apparent from this figure that the trends are already interconnected and that additional information (+/–) has been added to these connections. In the workshop, participants can be asked to indicate any further consequences of each of the national trends. In this pilot exercise (with a focus on German developments), the 'ageing population' and the 'shrinking population' are coupled to 'people leaving the country side' and 'growing metropolitan

Figure A13.3 Example from pilot exercise showing the first level of national trends directly 'belonging' to GMT 1



areas'. This information should be added always with the aim of connecting the developments to environmental impacts, as shown in Figure A13.4.

Please note that in the screenshot shown in Figure A13.4, the first connections to environmental impacts appear. The increase in urban sprawl contributes to land use change (and also to an increase in traffic, which contributes to nuisance and air pollution (not shown in this screenshot)). In addition, the concentration of people in metropolitan conglomerates puts an extra burden on water consumption and wastewater treatment. It is likely that other factors and trends will be identified to add to this excerpt. However, please be aware that this case is built mainly on a German background and is not a fully verified in the pilot exercise.

It is immediately apparent from Figure A13.4 that demographic developments are very closely related to urbanisation developments (at least in this German case). If GMT 2, 'Urbanisation', is now considered, some national trends, already mentioned in the context of demography, are clear. However, more national developments can then be added, always with the aim of finding connections with environmental impact categories (see Figure A13.5).

Try to focus on questions such as:

- What are national pendants of the GMTs?
- What are similar or related trends in your country?

Once you have a first set of national trends, continue asking:

- Does this national trend already have a direct impact on the environment?
  - If yes, what is the impact?
  - If no, what trends are connected/driven by this trend and how are these trends connected to environmental impacts?

Figure A13.4 Screenshot from pilot exercise

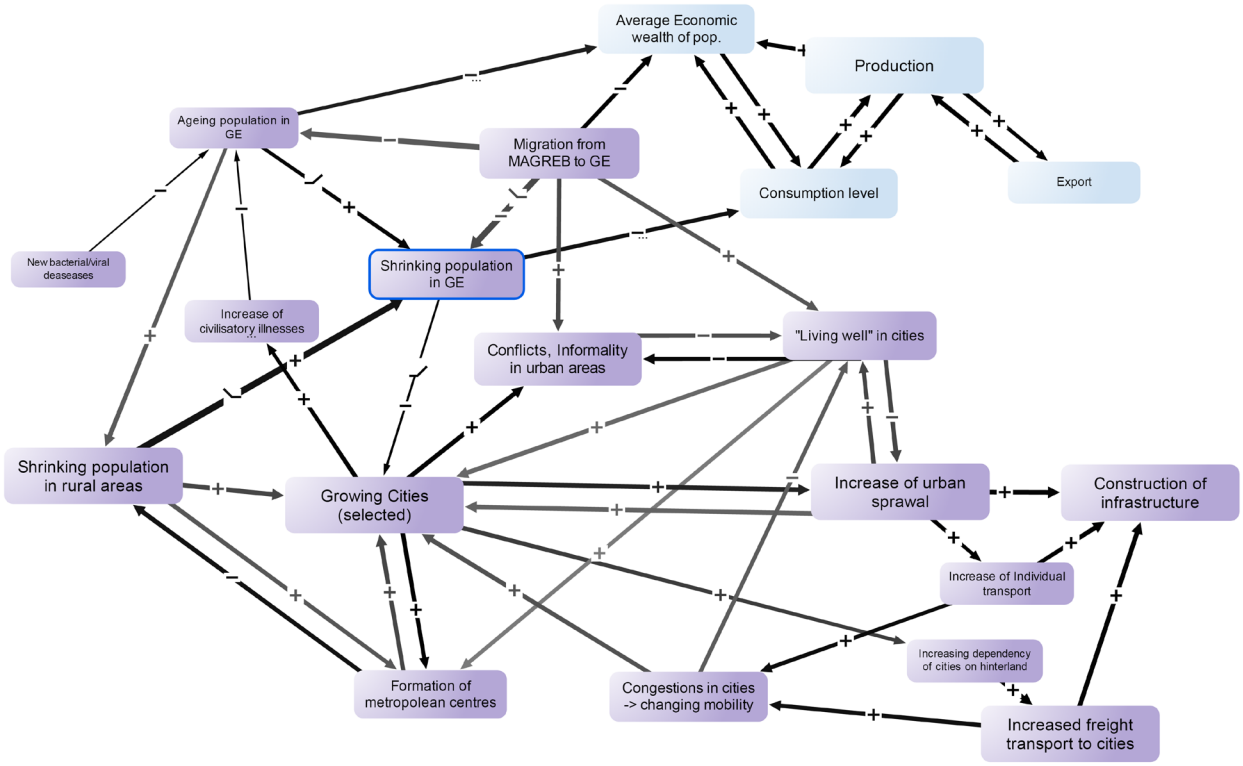
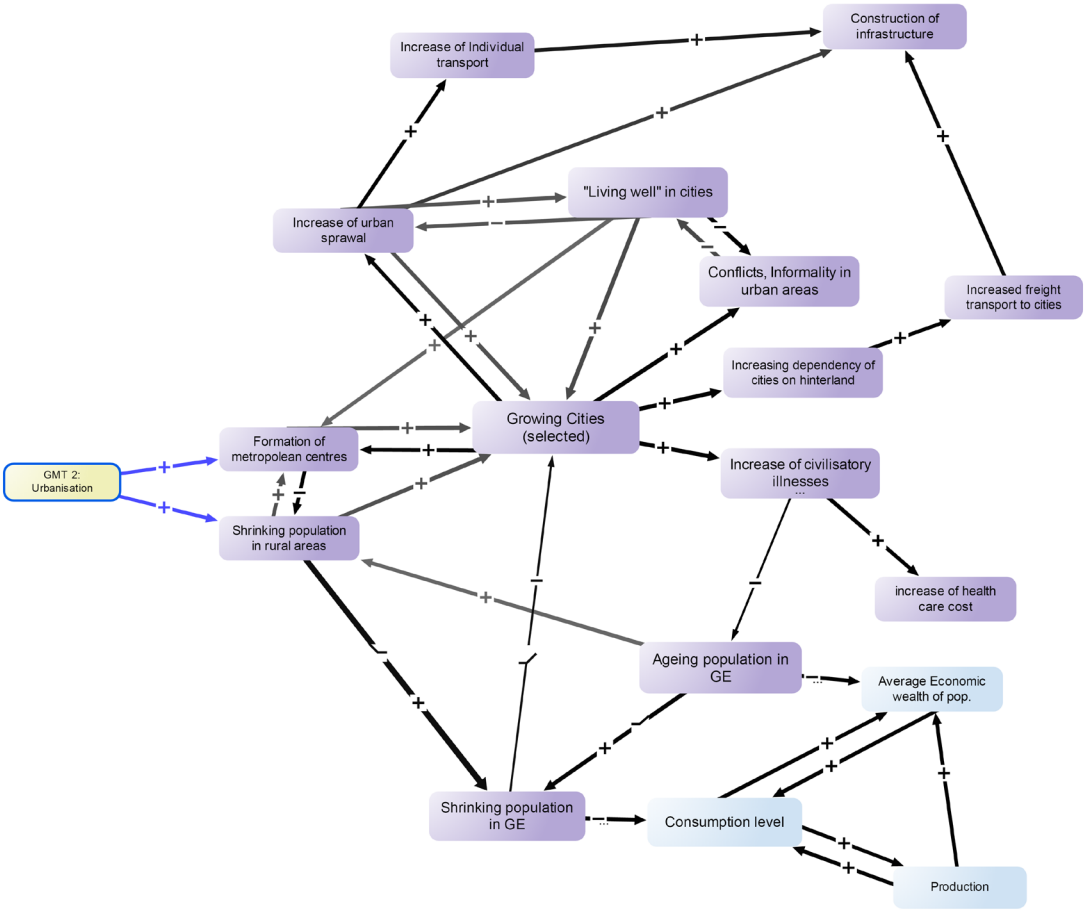


Figure A13.5 Excerpt from the pilot exercise showing GMT 2 with its connections to national trends



The information for this pilot exercise is not complete. For the purpose of demonstration, only three GMTs have been addressed.

National trends should and could be taken from trend reports, horizon-scanning exercises or other relevant publications if not from expert knowledge. It is important that any information added to the model can always be causally connected.

Some of the factors in Figures A13.2–A13.5 are depicted in light-blue boxes. These factors are 'linking factors' or system factors that help to explain how the trends are connected. Trends should always be tagged and described as 'something is increasing/decreasing/moving', while system factors could/should be more general, such as 'consumption level', which could be increasing or decreasing depending on various other factors.

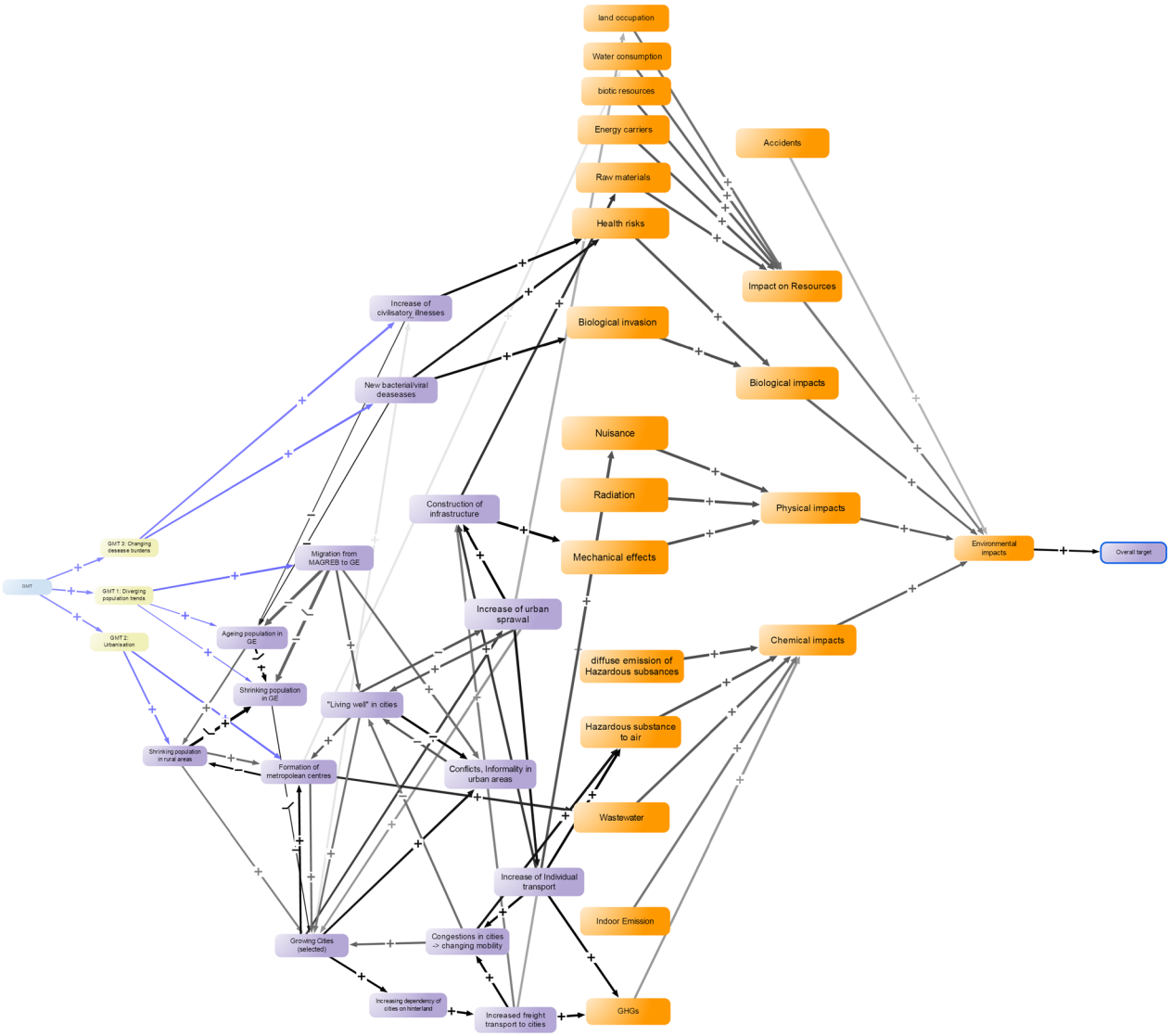
The full model with all three GMTs connected is shown in Figure A13.6.

Some example results

Even in this preliminary state, the model could be assessed using iModeler functions. The central question was 'What is the environmental impact of GMTs in the country?'. With the help of this tool, this question can be answered in different ways:

- Which GMT contributes to the environmental impacts (in general)?
- Which national trend contributes to the environmental impacts?

Figure A13.6 Full screenshot of all three GMTs that are currently connected to national trends and environmental impacts



- Which national trends contribute to which environmental impacts?

The model does not allow questions such as 'Which environmental impact is the most important in your country?' to be answered.

In the demonstration case, the evaluation might look as shown in Figures A13.7 and A13.8.

As only three GMTs are connected in the model, only these three GMT can be assessed. Please note, the position of each 'bubble' is relative but gives some indication of the relevance of the particular GMTs under comparison. The further to the right (green and yellow fields), the stronger the impact is on the environmental impact category. Currently, the model indicates that GMT 3 has the strongest environmental impact and that GMT 1 has decreasing environmental impacts.

The following insight matrix shows, in the green/yellow fields, national trends (bubbles) that possibly have increasing environmental impacts (in total), while the bubbles in the red/blue field indicate trends with decreasing environmental impacts. The national trends

Figure A13.7 Insight matrix of environmental impacts: GMTs 1–3

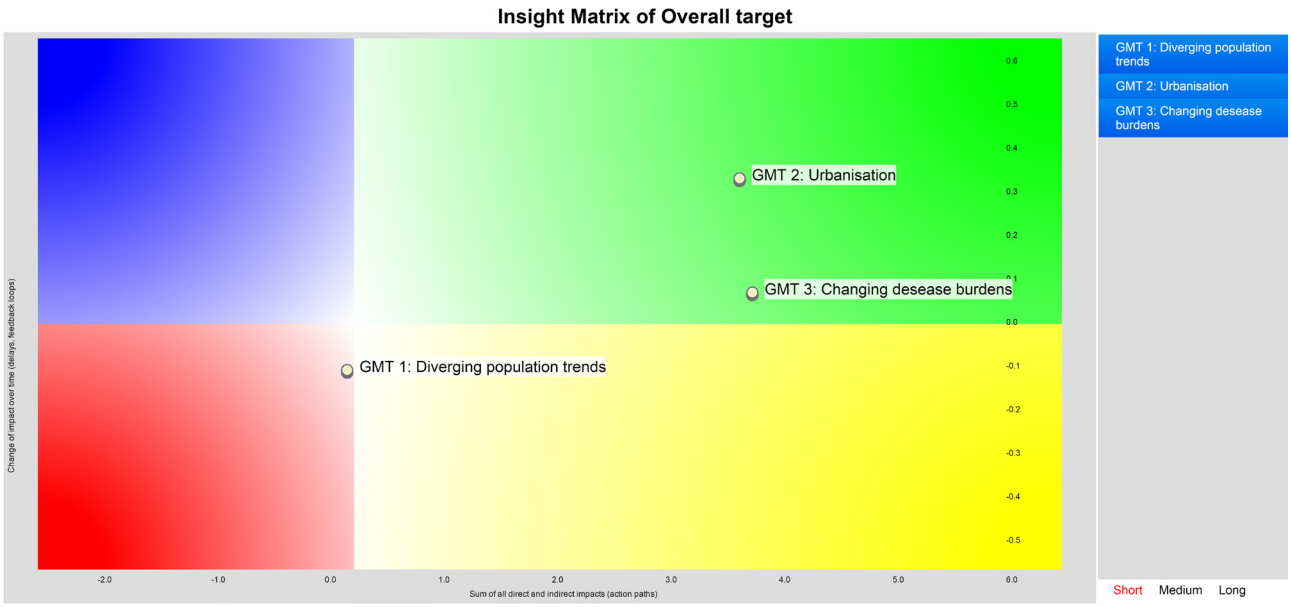
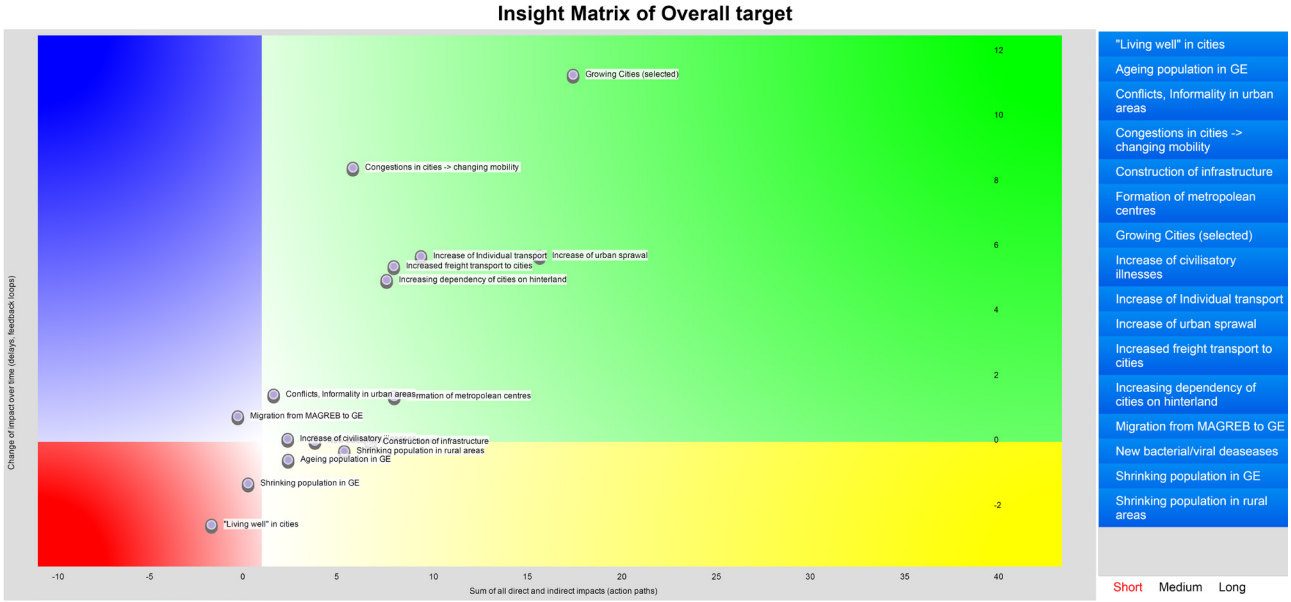


Figure A13.8 Insight matrix of environmental impacts:



that are already in the model are listed on the right side of the screenshot.

This kind of 'insight matrix' could be built for every factor and, by doing so, the driving forces behind each factor could be identified. For example:

- the driving national trends could be identified for each environmental impact category;
- which GMTs have — translated by national trends — an impact on each single environmental impact category could be identified;
- which national trends drive certain other trends could be assessed.

Discussion

The basic aim of the whole approach is to identify the possible impacts of GMTs on the environment at a national level. The predefined template facilitates a rather quick and more or less standardised procedure. The whole approach allows as many details as felt necessary to be added. References to literature or data could also be added, which would make it possible (as mentioned earlier) to either have a rather superficial first view of the topic or elaborate in-depth analysis of the problems.

From a cognitive point of view, the best case scenario is when participants in the workshop are surprised by the model results after having added their knowledge and points of view. A general rule (of logic) applies to this kind of model: if the single connections are correct, the whole model is correct. If one connection is questioned or wrong, it can and must be corrected. If all connections are agreed to be correct among the participants then, again, the results of the model are correct (for more details on the methodology, see Neumann (2013, 2014 and 2015)). If, for instance, as in the case presented here, GMT 3 plays a more substantial role than GMT 2, this is because, currently, the possible effect of new vectors and/or diseases has more of a direct impact on the category. Discussions during the evaluation of the model should also be pointed towards the possible weightings of the relevance of the impact categories. The result of this evaluation cannot be right or wrong, but it helps to direct any further discussions and/or attention towards a certain topic. In addition, questioning direct or indirect connections, or asking for missing links and additional factors, can change the quality of the discussions.

So far, very common critiques/questions regarding this approach are as follows:

- The selection of participants can shape and possibly 'blur' the perspectives of the model.
- How can we be sure you have added the relevant and/or crucial factors?
- There might be artificial effects in the model due to the tool.
- The background calculations are black boxes.

Of course, for any of the abovementioned critiques, there might be glimpses of truth. The selection of participants **always** shapes the outcome. Based on some empirical evidence, it is important to balance the disciplines of the participants, but there is a converging effect of getting new information and new participants. From a methodological and scientific point of view, it is important to make sure that the group owns the model, and that the model is checked — as in the peer-review process — by additional stakeholders. Additional stakeholders should be invited to question connections (but not the whole model) and to add new aspects. With such an approach, it must be ensured that the relevant and crucial factors are included. Of course, this also depends on the facilitation of the workshop: if you ask the right questions and steer the group to the blind spots in the model, the probability that the model will be nicely balanced and complete will be higher.

By applying this same principle, 'artificial' effects can also be minimised. In the abovementioned case, the dominance of GMT 3 could be an artificial effect. Instead of questioning the whole model, you should critically think: 'do the global developments directly influence the environment as shown in the model or not?' and 'does this direct impact have the same strength as other direct impacts?' If these questions are carefully considered, the quality of the results and the ownership of the model will increase.

If critiques are focused on the tool, please refer to the relevant publications and references (e.g. Neumann, 2013, 2014 and 2015), and consider possible alternatives. If mind maps, tables, text, etc., are used, whether or not the gaining of insight is as high as it would be if a joined or common mental model was developed should be considered (see also Vennix, 1996).

References to Annex 13

Berger, M. and Finkbeiner, M., 2015, 'Streamlined environmental assessments: picking the greenest option despite limited time and data at the Federal Environment Agency in Germany', *Journal of Environmental Assessment Policy and Management*, (17) 1550024.

ISO, 2006, ISO 14044:2006: *Environmental management — Life cycle assessment — Requirements and guidelines*, International Organisation for Standardization, Geneva, Switzerland.

Lorenz, U. and Haraldsson, H. V., 2014, *Impact assessment of global megatrends: Two case studies connecting global megatrends to regional topics*, Report 6602, Swedish Environmental Protection Agency, Stockholm.

Neumann, K., 2013, '"Know why" thinking as a new approach to systems thinking', *Emergence: Complexity and Organization*, 15(3) 81–93.

Neumann, K., 2014, 'Reflecting on complex challenges through qualitative modeling using the iMODELER', *Emergence: Complexity and Organization*, 16(2) 29–43.

Neumann, K., 2015, *Know why: Systems thinking and modeling: Gain insights for a happier life, more intelligent management and a better world*, Books on Demand, Norderstedt, Germany.

Vennix, J. A., 1996, *Group model building: Facilitating team learning using system dynamics*, John Wiley & Sons Ltd., Oxford, United Kingdom.

European Environment Agency

**Mapping Europe's environmental future:
understanding the impacts of global megatrends at the national level**

2017 — 81 pp. — 21 x 29.7 cm

ISBN 978-92-9213-843-1
doi:10.2800/06901

TH-AZ-17-001-EN-N
doi:10.2800/06901

European Environment Agency

Kongens Nytorv 6
1050 Copenhagen K
Denmark

Tel: +45 33 36 71 00
Web: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

Publications Office

European Environment Agency

Eionet — European Environment Information and Observation Network