PBL Netherlands Environmental
Assessment Agency

USING SCENARIOS FOR ENVIRONMENTAL, NATURE AND SPATIAL PLANNING POLICY

Guidance Document

Using scenarios for environmental, nature and spatial planning policy
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Using scenarios for environmental, nature and spatial planning policy: a guidance document

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

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1 Introduction

1.1 Long and rich tradition of using scenarios

The Netherlands has a long tradition of exploring the future. Both in the public and the private sector, scenario studies have been conducted and published, regularly, for many years. In addition to PBL Netherlands Environmental Assessment Agency and CPB Netherlands Bureau for Economic Policy Analysis, various other public organisations also regularly publish scenario studies, such as the Netherlands Scientific Council for Government Policy, the Rathenau Institute, and the Netherlands Study Centre for Technology Trends. In addition, large companies such as Shell, Philips, Rabobank and KPN, have been using scenario planning for years. Among the various consultancy firms that regularly carry out scenario studies are De Ruijter Strategy, Futureconsult, Savia, Berenschot and 360Foresight.[1] In the Netherlands, the *use* of scenario studies is also relatively well-institutionalised (EEA, 2011). For example, scenario studies are being used for policies on national water management, nature conservation, climate and the environment. Furthermore, the use of scenarios is supported by platforms that bring together developers and users, such as the *Strategieberaad Rijksbreed* ('nationwide strategic consultation') and the Dutch Future Society.

PBL Netherlands Environmental Assessment Agency is the national institute for strategic policy analysis in the fields of environment, nature and spatial planning (PBL, 2016). PBL's mission is to contribute to improving the quality of political and administrative decision-making by conducting outlook studies, analyses and evaluations in which an integrated approach is considered paramount and where policy relevance is the prime concern. PBL's studies not only serve as input for decision-making by the national government and parliament, but also are aimed at other governments, international organisations and civil society organisations. PBL conducts solicited and unsolicited research that is both independent and scientifically sound.

Based on this mission, PBL regularly publishes scenario studies on the environment, nature and spatial planning (e.g. *Nature Outlook 2010–2040* (PBL, 2012), *Netherlands in the Future* (PBL, 2010) and *Spatial Outlook 2019* (Snellen et al., 2019). Together with national and international partners, PBL also publishes scenarios on global climate change, spatial developments in the European Union, and spatial-economic developments in the Netherlands (e.g. *Climate change 2014* (IPCC, 2015)[2], the *ESPON scenarios* (IGEAT et al., 2006) and *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015). In fact, it is PBL's statutory duty to publish periodical outlook studies on the environment, nature and

spatial planning. PBL is therefore considered one of the most important players in scenario development in the Netherlands (EEA, 2011).

What are scenarios? Various definitions exist, but the aim of this guide for using scenarios – similar to the aim of our guide for developing scenarios (2019) – is to do justice to the various types of scenarios published. Therefore, this guide uses a broad definition: *Scenarios explore possible futures and the developments that may lead to these futures, and/or they explore desirable futures and the developments that are necessary to achieve these futures* (Dammers et al., 2019).

The scenario studies conducted by PBL are mainly aimed at supporting national and international policy-making in environmental, nature and spatial policy. However, they also zoom in on specific regions and take into account demographic, economic and environmental developments and resources, such as energy, food and water. Scenario studies are conducted for several reasons. Some studies are aimed at exploring future developments that are relevant to government policy and policy tasks arising from these developments. Others explore the ambitions that could be pursued by governments and organisations involved in government policy, and how these could be realised in the long term. Still others aim to structure policy discussions, for example, by exploring various future visions of an existing policy issue.

1.2 Scenarios not always used as intended

Various surveys show that, in the Netherlands, most policymakers working on a national level are familiar with scenario studies, and that these studies are widely used – including those published by PBL. For example, a survey held among the staff of government departments and related research institutes showed that nearly 100% of respondents were familiar with scenarios and that more than 90% were using them (Van der Duin, 2008).[3] These numbers were considerably higher than the familiarity and usage scores found for other forward-looking methods, such as the Delphi method (familiarity over 60%; usage almost 30%) and the 'Weak-Signals Method' (familiarity 35%; usage almost 20%).
A study by the Netherlands Scientific Council for Government Policy (WRR) puts these findings into perspective. The WRR found that, while futures studies are well-established in national government practice, there is little reflection on their use, and little exchange of – and learning from – experiences across government departments. As a result, there is limited insight into how and whether these studies are best used (Van Asselt et al., 2010).

A survey on the use of the scenario study *Welfare, Prosperity and Quality of the Living Environment* (2006) showed that policymakers and stakeholders used this study a great deal, but not always in accordance with the intended use of scenario studies (Hilbers and Snellen, 2010). For example, the former Ministry of Housing, Spatial Planning and the Environment used the full spectrum of scenarios from *Welfare, Prosperity and Quality of the Living Environment* only in a limited number of policy processes (e.g. in the spatial planning exploration *'Verkenning*

ruimtelijke opgaven', the national agenda for demographic shrinkage and spatial planning *'Rjksagenda krimp en ruimte'*, and the MIRT exploration of the corridor Antwerp–Rotterdam *'MIRT-verkenning Antwerpen-Rotterdam'*).[4] In other policy processes, the ministry has hardly made use of the various scenarios available. Important policy developments, such as the *urbanisation agreements* and the *new key projects*, are based on just one scenario or prognosis.

A similarly limited use of scenarios is observed in the *Randstad 2040 Structural Vision*. This policy strategy only takes into account two scenarios that assume high economic growth. Hence, when the economic crisis hit in 2008, it was not clear which of the planned investment projects would be socially profitable in a low-growth economy, which increased the risk of overinvestment. In the case of infrastructure-related air quality, ministries are even legally obliged to use the least favourable scenario, i.e. the scenario with the highest mobility growth. If mobility growth turns out to be lower, this will benefit the environment, but also increase the risk of overinvestment – in this case, in measures for air quality improvement.

This tendency is confirmed by a study on the use of scenarios from *Welfare, Prosperity and Quality of the Living Environment* for cost-benefit analyses (CBAs) of various motorway extensions in the Netherlands (Van Essen and 't Hoen, 2013). This study finds that most social CBAs present one scenario only, even if calculations were made for more scenarios. Again, the focus is on the scenario with the highest mobility growth, presented as the middle-range scenario or prognosis, which creates the impression of *probable* rather than *possible* mobility developments. Scenarios exploring low mobility growth, where motorway extensions involve lower investment costs but also lower social benefits, are not considered, in most cases.

Another study on the use of scenarios from *Welfare, Prosperity and Quality of the Living Environment* shows that policymakers are having difficulty not only with handling the full spectrum of scenarios, but also with understanding the way in which current government policy is incorporated in the scenarios (Schuur et al., 2012). Many policy documents and investment plans blindly copy the scenarios, without taking into account that the figures presented in these scenarios are based on the assumption that current national policy is continued. The reason behind this assumption is that scenarios are intended as future projections against which the effects of new policy can be compared. However, if the assumption of current policy continuation is overlooked, these effects cannot be properly assessed.

The abovementioned surveys as well as other studies show that policymakers have a variety of motives for using scenarios differently from the use intended by scenario developers. First, policymakers often find it difficult to take into account all the different possible futures presented by the scenarios, and struggle with the question of how to develop policy on that basis. This is partly due to the fact that many scenario studies do not offer practical guidelines or specific directions for their use. As a result, policymakers often experience scenario studies as 'gratuitous intellectual exercises' (Van Asselt et al., 2010b).

At the 2013 conference on how to make scenarios, participants indicated their interest in a guide on how to use scenarios.

Secondly, various policymakers have indicated that they find it too complicated to take a whole range of scenarios into account in political or administrative decision-making. According to them, the negotiation 'game' between the many public, private and social organisations involved in environmental policy requires a simple and clear picture of the future (Schuur et al., 2012). By focusing on one or few scenarios only, these policymakers try to avoid a cacophony of expectations, wishes and anxieties about the future.

Thirdly, most scenario studies not only include 'desirable' scenarios, such as developments in case of increasing prosperity, but also 'undesirable' scenarios, such as developments in case of economic stagnation. However, policymakers are often less receptive to (what they perceive as) undesirable scenarios. For example, as mentioned above, the *Randstad 2040 Structural Vision* only takes into account the two high-growth scenarios, based on the idea that high economic growth is not just a *possible* development to take into account, but also a *desirable* development to pursue (personal communication from the project leader). In this case, the underlying assumption is that economic growth is promoted by optimism (among investors and businesses, as well as governments), and that this optimism would be undermined by considering low-growth scenarios.

Finally, strategic considerations may also play an important role. Researchers who conduct cost-benefit analyses (CBAs) are sometimes pressed to make choices that will influence the results in a particular direction; for example, by calculating the costs and benefits of a motorway extension only for one or two scenarios assuming high mobility growth. The focus on high-growth scenarios will increase the political urgency of road expansion, which will shift the cost-benefit balance to a more positive outcome (Van Essen and 't Hoen, 2013).

1.3 Aims of this guide

This guide on how to use scenarios is a companion to our guide on how to make them (Dammers et al., 2019). When the Dutch version of the latter guide was published in 2013, a conference was held, where the participants – including policymakers from various departments involved in environmental policy – indicated their interest in and support for a guide on how to *use* scenarios.[5] Our assessment of scenario use (Section 1.2) shows

that policymakers often have difficulty using scenarios, and that scenarios are often used differently from their intended use. All in all, this is sufficient reason to publish a guide on how to use scenarios.

Furthermore, this guide provides supplemental information to the user guide for the scenarios from *Welfare, Prosperity and the Human Environment* (Renes and Romijn, 2015). That guide focuses on the use of *contextual* scenarios; in particular, on using contextual scenarios from *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015) for CBAs. In contrast, the present guide is devoted not only to the use of contextual scenarios, but also to the use of policy scenarios, such as *European Nature in the Plural* (Van Zeijts et al., 2017). The difference between the two is that contextual scenarios are descriptive, exploring how the world may change and how policymakers may respond to these changes, while policy scenarios have a normative character, exploring what policymakers may want to achieve and how they could succeed. Furthermore, the present guide not only looks at using scenarios in CBAs, but also explores other areas of application, such as vision building, transition governance and adaptive management, in which scenarios are used in different ways and have to meet different criteria.

The aim of this guide is to provide insights into the most important ways in which scenarios can be used in policy, focusing on policymakers involved in environmental policy and researchers carrying out scenario studies for this policy field. When we refer to policymakers, we also mean other stakeholders, such as representatives of businesses and social organisations involved in environmental policy.

In this guide we discuss the various ways in which scenarios can be used and their potential areas of application, the options for communicating scenarios, and the roles that scenario developers can play in scenario usage. Hence, this is not a *manual* prescribing fixed rules for how scenarios should be used. Based on the literature, our own experiences and those of others, we believe that there are 'several roads that lead to Rome': how scenarios are used depends on a range of factors, including the types of scenarios made, the area(s) in which they are applied, and the methods by which they are communicated.

In other words, there is no single best way to use scenarios. Instead, this guide aims to encourage policymakers to make informed choices when using scenarios, and to encourage scenario developers to make informed choices when promoting the use of scenarios among policymakers. Hence, it is not about policymakers using scenarios in every conceivable way or scenario developers encouraging scenario use in every conceivable way. In that case our guide would overshoot its mark.

Although various publications on the use of scenarios have been published in the Netherlands and abroad, this guide does fill a gap for policymakers and scenario developers. One reason is that many of the existing publications (e.g. Ascher and Overholt, 1983; Von Reibnitz, 1988; Wright and Goodwin, 1998) are already outdated and lack recent insights into the use of scenarios.

Secondly, some of the existing publications focus on scenario use in specific domains only. For example, Lindgren and Bandhold (2003), Nekkers (2006) and De Ruijter et al. (2011) focus on the use of scenarios within individual organisations – mostly in the private domain – and therefore do not apply to the use of scenarios in policy areas, such as environmental policy, in the public domain. An important difference between the two domains is that, in the public domain, the number and diversity of organisations involved in policy-making is high; as these organisations interact with each other in diverse ways, the use of scenarios in the public domain is much more diffuse than in the private domain. In addition, the public domain often lacks the hierarchy to impose a specific use of scenarios, which is more common in private companies. A case in point is Shell's policy to test all significant investment proposals against different scenarios before deciding on them (Van der Heijden, 1996). On the other hand, in the public domain it does sometimes happen that a minister or senior official gives their explicit support for the use of a specific scenario study. This was for example the case when Minister Nijpels gave his political support for using the national environmental assessment, *Zorgen voor morgen* (RIVM, 1988).

Thirdly, there are several PhD studies based on research into the use of scenarios in the public domain (Dammers, 2000; Van der Duin, 2008; De Man, 1987; Van der Steen, 2009), and these provide valuable insights into the practice of scenario use. However, these publications do not offer concrete suggestions on how policymakers can use scenarios or how scenario developers can facilitate scenario use.

Finally, there are also publications that reflect on the theory and practice of futures studies in the public domain, which also cover the use of scenarios (Van Asselt et al., 2010; In 't Veld, 2010; BZK, 2011). These publications provide valuable insights based on literature reviews, empirical research, essays by experts, and the authors' own knowledge and experience. However, when it comes to using scenarios in practice, they offer only limited suggestions. For example, they do not explain the different ways in which scenarios can be used in different areas, such as transition governance (providing inspiration to governments, businesses and social organisations) and cost-benefit analysis (testing project alternatives against different possible futures).

In this guide we have included the insights from the aforementioned publications as much as possible, especially those insights that are still current and relevant to scenario use within the public domain. Some of these insights are based on practice, while others are derived from theory. We have translated these insights into practical guidelines for using scenarios in environmental policy – i.e. the policy area for which PBL develops scenarios. Where necessary, the insights have been amended, specified and commented upon, based on interviews with policymakers and scenario developers (see Appendix) and our own knowledge and experience.

1.4 How to use this guide

This guide is primarily intended for staff of national government ministries involved in environmental policy and related policy fields, who are already using scenarios or consider doing so. This guide will provide them with insights about, for example, the areas of application, user possibilities, and factors that influence scenario use. Secondly, this guide is intended for staff of other governments (local, regional, and international) as well as advisory bodies, social organisations and companies involved in environment-related policy in the public domain, who use scenarios or consider doing so. Thirdly, the guide is aimed at PBL staff who are project leaders of scenario studies, who participate in these studies as project members, or who are involved in these studies as internal clients. Finally, the guide is also of interest to staff from other planning offices, universities, research agencies, consultancy firms and design studios who – in collaboration with PBL or otherwise – carry out scenario studies and want to promote scenario use. This guide may provide them with insights about, for example, the communication methods that can be used to promote the use of scenarios, and the roles that scenarios can play here. Although this guide was developed to support scenario use within the Netherlands, it will also be of interest to scenario users in other countries.
Notwithstanding the fact that this guide focuses on the *use* of scenarios, we do recommend to also consult it in the preparatory phase of scenario projects. After all, the project team, the internal client and the policymakers who will supervise the project need to think ahead about how to communicate and stimulate use of their scenarios, and this should be done at the time of project planning. In the project implementation phase and especially in the completion phase – when the pre-final and final versions of the scenarios are made and their publication and dissemination play an increasingly important role – the parties involved in the scenario project will benefit even more from this guide; here, it should be borne in mind that the project does not end with the publication of the scenarios.

To facilitate the use of this guide in various project phases, we have made a checklist and presentation to complement this guide. The checklist and presentation each provide a concise overview of all the topics covered in the guide, the choices that can be made regarding scenario use, and the underlying principles. The guide, checklist and presentation are structured in the same way and form a triad: the checklist and presentation are based on the guide, and the guide serves as background information for the checklist and presentation.

The presentation can be used at meetings of scenario teams from PBL and other knowledge institutions that work together which PBL, or in workshops or other meetings with staff of government ministries, other authorities, companies and social organisations involved in environmental policy. The authors of this guide will be glad to assist in the presentation. The checklist can be used to make sure that no relevant areas of application, user possibilities and communication forms are overlooked.

The guide is structured as follows. Chapter 2, *Preparing to use scenarios*, discusses in general terms whether or not to use scenarios, ways in which scenarios can be used, quality criteria for scenarios, and use of existing versus new scenarios. Chapter 3, *Identifying scenario application areas*, examines scenario use in more detail, by zooming in on the various areas within which scenarios can be used and the area-specific quality criteria for the scenarios. Chapter 4, *Selecting means of communication*, discusses the possibilities and limitations of a range of communication methods that can be used to promote scenario use. Finally, Chapter 5, *Defining the roles of scenario developers*, discusses the various roles that scenario developers can play and their influence on how scenarios are used.

We believe it is not necessary to read this guide from front to back; depending on the reader's interest, different sections may be selected. In particular, Chapter 3 (about the different areas in which scenarios can be used) and Chapter 4 (about the various communication forms for promoting scenario use) lend themselves well to a selective review. *To facilitate selective reading, each area of application starts with a short summary (Chapter 3), while the discussion of communication methods starts with an overview table (Chapter 4).*

Notes

1. For a more detailed overview, see e.g. BZK (2011), NTV and STT (2011) and Van der Duijn (2012).
2. *Climate Change 2014* is the fifth assessment report of the Intergovernmental Panel for Climate Change (IPCC). The report made use of scenarios to which PBL contributed.
3. These not only include scenario studies published by PBL, but also studies published by a range of other scenario developers.
4. MIRT stands for *Multi-Year Programme for Infrastructure, Spatial Planning and Transport*.
5. The conference participants also widely supported the suggestion to conduct more research on scenario use, but this was outside the scope of the present guide.

2 Preparing to use scenarios

2.1 Introduction

This chapter discusses the preliminary phase of scenario use, focusing on the most important choices to be made before starting to use scenarios: deciding whether or not to use scenarios (as compared to other options), determining the purposes of scenario use, defining the desired quality criteria, and deciding whether to use existing or new scenarios. For each choice in this preliminary phase, we discuss the main options and their possibilities and limitations (Table 2.1). While there is a certain logical order to the choices presented, we do not claim that this sequence should always be followed in practice. We conclude this chapter with some suggestions on how to organise the use of scenarios.

Table 2.1
Scenario use: Choices and options in the preliminary phase

Choices	Options
Using scenarios versus other methods	• Prognoses • Scenarios • Speculations
Determining the purposes of scenario use	• Gaining insight • Communication • Commitment
Defining the desired quality criteria	• Relevance • Plausibility • Imaginative power • Legitimacy
Using existing or new scenarios	• Existing scenarios • Updated scenarios • New scenarios

2.2 Using scenarios: Yes or no?

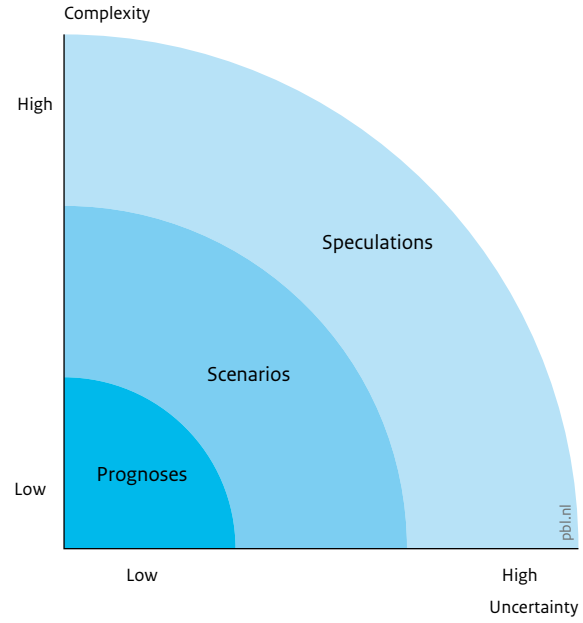
Environmental policy-making often involves taking decisions that have major consequences, while they are surrounded by great uncertainty. One example is the Dutch policy plan to build wind farms at sea. Major advantages of building offshore wind farms are CO_2 emissions reduction and job creation in the offshore industry. However, the disadvantages are that wind turbines affect fishing operations and entail high investment costs. In addition, there are effects of which little is yet known, such as increased bird mortality caused by wind turbines. The extent of the consequences of this policy plan are largely determined by new energy technologies, fossil fuel prices, European climate policy, climate awareness among citizens and other developments, of which the course over the next 25 years – the life span of wind turbines – is uncertain. Similarly, policy decisions related to nature development, flood risk management, urbanisation and congestion control often have major consequences and are surrounded by a great deal of uncertainty.

This uncertainty is primarily due to the fact that the issues underlying these policy decisions are so-called wicked problems, i.e. problems surrounded by both cognitive uncertainty (disagreement about relevant knowledge) and normative uncertainty (disagreement about preferred solutions) (Hisschemöller and Hoppe, 1996). Due to the combination of major consequences and great uncertainty, there is the risk that policy decisions will have suboptimal results or may even end in policy failure. A policy failure is a disinvestment, where budgets or time limits are far exceeded, where the unwanted effects by far dominate the desired effects, or where the policy is discontinued after major investments have already been made (Bovens and 't Hart, 1998; Van der Steen, 2016).

Scenarios can help to better underpin decision-making by making the uncertainty surrounding policy decisions better manageable. For example, scenarios can be used to systematically explore the possible future courses of relevant developments, or to compare the expected effects of policy alternatives. However, before policymakers (and stakeholders) decide to use scenarios to underpin their decisions, it is important to address the question whether scenarios should be used at all. After all, there are other methods of futures analysis that may be helpful for managing uncertainty (Dammers et al., 2019).

To determine whether scenarios are the most appropriate method, a relevant starting point is the dilemma that arises when exploring the future. On the one hand, scenario developers want to provide policymakers with statements about the future to help them make future-oriented decisions. On the other hand, the future is uncertain because it has yet to happen; thus, statements about the future can only be substantiated to a limited extent. In the absence of an empirical basis, futures studies make a leap from *actual* developments that have taken place in the past, to *possible* or *desirable* developments that may occur in the future. As a result, the statements provide insights, rather than knowledge, about the future (Van 't Klooster, 2007).

Figure 2.1
Distinction between prognoses, scenarios and speculations



Source: PBL

As mentioned, various methods are available to deal with the dilemma associated with future exploration. These methods can be roughly divided into three groups, each of which applies in different cases: prognoses scenarios and speculations (Van Vuuren, 2007) (Figure 2.1).

Prognoses are aimed at making the most accurate possible statements about future developments based on data and knowledge about the past. They usually include statistical confidence intervals with upper and lower limits and an indication of probability (De Beer, 2011). An example is the projected population size in the Netherlands in a few years.

Prognoses are typically used in cases where the future development involves low uncertainty, for example when its course is relatively steady or influenced by only a limited number of factors, or when the prognosis relates to a short to medium time frame only (5–10 years).

Scenarios make statements, based on data and knowledge about the past, about the various directions in which a combination of future developments may take place (Van der Steen, 2016). Scenarios concern developments that are considered possible, or desirable, or both.

In addition, scenarios may focus not only on autonomous social and physical-environmental developments, but also on policy developments controlled by policymakers.

Scenarios can be used in cases where uncertainty is present but still manageable – for example, when the number of factors influencing the developments in question is large but not too large, the course of the developments is dynamic but not chaotic, or the period over which statements are made is long but not very long. A case in point is urbanisation in the Netherlands over the next ten to fifty years. For steadily progressing developments, such as climate change, scenarios may cover a longer period, for example one hundred years.

Speculations are statements about the future based on expectations, wishes and, in particular, creative ideas. Knowledge and data about the past only play a limited role because they are less useful in this case. Like with scenarios, speculations may concern both possible and desirable futures, and both autonomous and policy developments. However, speculations often extrapolate developments to the extreme, or zoom in on new developments, or explore radically different directions in which developments could take place. This approach can be useful to explore the boundaries of developments and insights, and to promote out-of-the-box thinking.

Speculations are used in cases where developments are surrounded by great uncertainty; for example, for developments that have not occurred before, that are influenced by a large number of factors (existing or new), that have a chaotic course, or that are taking place over an exceedingly long period (Van der Steen, 2016). An example is the potential reversal of the North Atlantic Gulf Stream in the second half of the 21st century, which would result in a considerable drop in temperature in north-western Europe, overturning the expected temperature rise due to climate change.

2.3 Determining the purposes of scenario use

2.3.1 Using scenarios

When policymakers decide to use a scenario study, it is relevant to consider for what purpose(s) the scenarios are going to be used. Broadly speaking, scenarios can be used to generate insights, to support communication about future developments, and to increase policy commitment. In our guide for making scenarios (Dammers et al., 2019) we briefly discuss the use of scenarios in terms of the goals defined by scenario developers: i.e. the intended use. In the present guide we focus on the ways in which policymakers are using scenarios in actual practice, which includes both intended and unintended use. Table 2.2 gives an overview of the different purposes for which scenarios are being used; the text below provides an explanation.

Table 2.2
Different purposes for which scenarios are being used

Purpose	Details
Insight generation	• Different developments, their interrelationships and effects • Disruptive events and their effects • Policy alternatives, their feasibility and effectiveness
Communication	• Input for strategic conversations • Common reference points • Open discussions about the future
Commitment	• Support for preferred policy • Inspiration for taking a new direction

First, policymakers may use scenarios to derive all kinds of insights. For example, scenarios can generate insight into the possible future courses of relevant developments, the interrelationships between these developments, and the combined effect of these developments. Scenarios *'effectively organise a variety of seemingly unrelated economic, technological, political and social information and translate it into a framework for judgement'* (Wack, 1985: 146). In addition, scenarios can provide insight into the possible occurrence of disruptive events, such as an economic crisis or a technological breakthrough, and their expected effects. Furthermore, they can provide insight into different policy alternatives, their feasibility under different circumstances, and their expected effectiveness. Based on these insights, policymakers may redefine existing policy issues, identify new policy issues, and or develop new policy.

Second, scenarios can be used to improve communication about future developments. For example, they can provide the basis for 'strategic conversations' with actors to discuss expectations and wishes about the future (Van der Heijden and Schütte, 2000; Nekkers, 2006; De Ruijter et al., 2011). Since scenario studies present a range of alternative future visions that explore different directions of developments and/or different policy alternatives, all actors will be able to find at least some of their expectations and wishes represented, which promotes their receptiveness to the study. In addition, since the different scenarios share certain dimensions (e.g. they explore the same theme and same developments, though in different directions) they can serve as common reference points shared by all actors in the strategic conversation. In general, scenario studies are more suitable for open discussions about the future than policy visions or plans, because they provide room to discuss alternatives and are less formal in the sense that they do not require immediate decisions.

Third, policymakers may use scenarios to increase policy commitment. For example, scenarios can be used to justify existing policy (Jansen Schoonhoven and Roschar, 1989): with a scenario study in hand, policymakers may try to convince others of a development they themselves already anticipate, or to support a policy strategy they themselves already favour. Scenario studies may also inspire policymakers to take a new direction. For example,

a scenario study could show that a policy issue will get out of hand if current policy is continued and provide policy alternatives to more effectively anticipate or respond to the developments underlying the issue in question. In all these cases, scenarios are mainly used as a tool to convince others (Dammers, 2000).

The abovementioned ways in which scenarios are being used often go hand in hand with each other. For example, using a scenario study to convince other policymakers (commitment) will only be successful if these policymakers subscribe to at least some of the study's statements – for example about the possible course of developments and their expected effects (insight generation) – and if the scenarios facilitate an open discussion about the policy issue at stake (communication).

2.3.2 Unintended use and non-use of scenarios

As discussed above, scenarios are being used for different purposes. However, in some cases they are not used at all ('non-use'). Scenario developers regularly point to the lack of interest among policymakers for their studies, while policymakers themselves often indicate that scenario studies do not provide enough directions for use (Dammers, 2010). Furthermore, as noted in Chapter 1, there are cases where scenarios are used in different ways than intended by the developers ('unintended use').

For policymakers, working with scenarios is often difficult (In 't Veld, 2010). One reason is that scenario studies are almost never perfectly tailored to the specific questions that policymakers are dealing with. For example, they may not cover a particular sector that is relevant for the policy issue at stake, or their scale may not fully match the scale relevant to the policy question. Therefore, in order to use scenario studies, policymakers often have to do some work first.

In addition, it is often difficult for policymakers to take multiple futures into account. As a result, they tend to zoom in on one particular scenario. Especially when several parties are involved in the policy process and the ensuing policy decisions will be binding, it is complicated enough already to agree on a series of figures. Here, the need arises for a simple and clear picture of the future, with figures that describe the 'most likely' future in an evidence-based way.

For policymakers, working with scenarios is often not only difficult but can sometimes also be frustrating. The main motivation of policymakers is to *shape the future*, which is not immediately compatible with *exploring uncertainty about the future*. Hence, from their perspective, policymakers are more inclined to look for what they do know, rather than what they do not know about the future. In addition, scenario studies may show that certain developments desired by policymakers are unlikely to be achieved, which may curb political and policy ambitions. Scenario studies may also draw attention to futures that are undesirable to policymakers, which could leave the impression that these studies undermine current or planned policy.

A study by Dammers (2000) on the use of scenarios in national energy policy confirms that scenario use is often selective and instrumental. It was found that policymakers regularly base their policy visions or plans on those scenarios that outline developments they themselves consider most likely or desirable. Hilbers and Snellen (2010) showed that policymakers often do consider a range of scenarios in the policy preparation phase, but stick to one, or at most two scenarios in the policy decision-making phase. In practice, the selected scenarios are often those with the highest economic growth – not only because economic growth is considered desirable, but also because it is strategic to focus on the high-growth scenario, as it lends greater urgency to, for example, road expansion (Van Essen and 't Hoen, 2013) (Chapter 1).

It also happens that scenario studies are not being used at all: *'... in practice governmental scenario studies often ... panned out into nothingness and were not actually used in policy making'* (Van der Duin, 2006: 245). For example, policymakers may ignore scenario studies because the new insights provided by the scenarios are incompatible with the prevailing frames of reference (frames) (In 't Veld, 2010). Such frames consist of a combination of values and views, and are strongly linked to identity. For policymakers, insights about the future that conflict with their own frame are often not welcome and therefore ignored.
Sometimes scenario use is merely symbolic. For example, when policymakers cannot or do not want to make a certain policy choice, it can be tempting to commission a scenario study 'to better prepare the necessary policy change'. In that case scenario use provides the pretext to postpone or even frustrate efforts to address a policy issue (Dammers, 2000).

When policymakers do not adopt the results of a scenario study, this does not necessarily mean that the scenarios did not contribute anything to policy development at all (In 't Veld, 2010). Policymakers may reject the scenarios based on well-reasoned arguments, thus improving the articulation of their own expectations and wishes about the future and providing a stronger foundation for the policy under development.

2.4 Defining quality criteria

Once policymakers have determined the purposes for which they will be using scenarios, the next question is to define the quality requirements for these scenarios. The literature on the role of knowledge in policy-making distinguishes three quality criteria: *relevance, credibility and legitimacy* (Cash et al., 2003; Turnhout and Haffman, 2014; Kunseler et al., 2017). These criteria are used for knowledge about ongoing developments and are aimed at reducing uncertainties and multiple interpretations.

The same criteria can be applied to scenario studies, with some slight modifications, particularly with regard to the credibility criterion. After all, reducing uncertainty in scenario studies is impossible because the future is inherently uncertain (Dammers, 2000; In 't Veld, 2009). Because of the specific nature of insights (as opposed to knowledge) about the future, we have replaced the credibility criterion with two new criteria:

Table 2.3
Main quality criteria for scenarios

Quality criteria	Explanation
Relevance	The scenarios cover the same theme and similar spatial scales and time horizons as the policy in question
Plausibility	The scenarios are plausible, logically consistent and coherent, and contain sufficient detail
Imaginative power	The scenarios explore, in novel and creative ways, future developments considered possible and/or desirable
Legitimacy	The scenarios do justice to the different perspectives of actors, and have been developed through stakeholder participation, among other things

plausibility and imaginative power. Table 2.3 provides an overview of the quality criteria with a brief description; the text below provides a more detailed explanation.

2.4.1 Relevance

A scenario study will only be used if it is relevant to the policy in question. The policy relevance of scenarios is mainly determined by their scope: the theme focused on, and the scales and time horizons addressed (Bakkes, 2012b). It is important that the scenarios cover at least the themes targeted by the policy for which they will be used. If this is not the case, additional scenario studies are needed. For example, the scenario study *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015) is relevant to economic, mobility and agricultural policy in the Netherlands, but not for shipping, food production or nature policy in the Dutch North Sea territory. Hence, PBL conducted an additional scenario study (*The Future of the North Sea*; Matthijsen, Dammers and Elzenga, 2018) to support the ministries of Infrastructure and Water Management, Economic Affairs and Climate Policy, and Agriculture, Nature and Food Quality in developing an environmental policy vision that covers both land and sea (*National Environmental Vision*, to be published in 2019).

It is not uncommon for scenario studies to have a broader thematic scope than the policy for which they are being used. In that case, the advantage is that the scenarios can provide insight into the interrelationships between the policy issue in question and other relevant policy issues. For example, the scenario study *European nature in the plural* (Van Zeijts et al., 2017) focuses not only on biodiversity, but also on agricultural greening, sustainable tourism and circular economy, showing the existing and potential relationships between these policy issues. However, the disadvantage of a broad thematic scope is that the scenarios may become either too complicated or too superficial, resulting in insights that are of limited use [to policymakers].

In addition to thematic scope, the relevance of a scenario study for policy-making depends on the scales at which the themes are addressed. The scenario studies carried out by PBL (alone or in collaboration with other organisations) focus mainly on the national, European and global level; i.e. the scales that apply to the policy issues addressed in these

studies. For example, the scenario study *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015) addresses spatial-economic development in the Netherlands, *Eururalis* (PBL, 2008) addresses European agriculture and rural areas, and *Climate change 2014* (IPCC, 2015) addresses global climate change. Although these studies each focus on a specific scale, they also include other scale levels in their analysis. For example, *Delta scenarios for 2050 and 2100 [Deltascenario's voor 2050 en 2100]* (Deltares, 2013) focuses on flood protection and freshwater supplies in the Netherlands, but also zooms out to European and global levels, taking into account European water policy and global climate change. Conversely, the spatial outlook study on urbanisation, infrastructure and mobility *[Ruimtelijke verkenning 2019]* (Snellen et al., 2019), focuses on the national level, but also zooms in to the city level to analyse these issues at the local scale. In the Netherlands, regional and local levels have gained importance due to the decentralisation of spatial, environmental and nature policy.

Scenario studies that focus on a particular scale, for example the national level, are only of limited use for policy issues taking place at higher scales. For example, *Nature Outlook 2010 - 2040* (Van Oostenbrugge et al., 2012) has only limited significance for European nature policy, because the study focuses on one EU Member State only. While this national study can serve as a source of inspiration for European policy, it does not provide insight into future biodiversity developments across Europe. Conversely, scenario studies at the national scale can be used for policy issues at the lower regional level, albeit only indirectly; their results first have to be 'translated' to the regional level. This can be done through a complementary study, which explores how developments at the national level (e.g. population development, urbanisation) unfold at the regional level (taking into account regional characteristics) and what this means for policy issues at this level. The results can then be used by regional policymakers.

Finally, there is the matter of matching time horizons. In scenario studies the time horizon is the future period covered by the scenarios, which is usually long-term, looking ahead ten to fifty years. It is important that this time horizon is tailored to the policy theme for which the scenarios are developed. For example, the *OECD Environmental Outlook to 2050* (OECD, 2012) looks several decades ahead, because it takes years for investments in sustainable energy supply to be prepared and implemented, and because energy supply facilities have a lifespan of several decades. The scenario study *Climate change 2014* (IPCC, 2015) looks nearly 100 years ahead, because climate change is a very slow process.

The time horizon of a scenario study also depends on the intended use of the scenarios. If the main intention is to inspire policymakers to consider alternative policy pathways, a long time horizon is the most obvious choice. However, if the scenarios are mainly intended to explore how best to achieve existing policy objectives, they often have a shorter time horizon. Scenario studies intended to support a range of different policy decisions usually cover more than one time horizon. For example, *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015) focuses on two time horizons, to support policy decisions aimed at the medium term as well as the long term.

Last but not least, it is important that scenario studies include relevant key messages. Clear statements that are derived from the scenarios by the scenario developers and that are linked to the policy theme in question will help policymakers to find concrete starting points for policy (Henrichs et al., 2010). If a user manual is included, policymakers themselves can also derive messages from the scenarios (Strengers et al., 2013). For example, *Perspectives on the future of nature in Europe* (Dammers et al., 2017) contains elaborate instructions on how to derive a policy vision from the scenarios included in this study.

2.4.2 Plausibility

In order to be useful for policymakers, scenarios have to be not only relevant but also plausible. In other words, they have to be conceivable, even if they may not be likely; they have to be imaginable and, in some cases, possible. A plausible story about the future unites three elements: the story is logically consistent, developments in the story are interrelated, and the story includes sufficient detail. Note that the story details do not necessarily have to be 'true' (Wagenaar, 1997).

Scenario plausibility also depends on the quality of the sources used. Data provided by a respected research institute or from publications written by renowned researchers help to increase plausibility. The methodological thoroughness of the scenario study is also relevant (Habegger, 2010). For example, a combination of different methods, such as stakeholder participation, literature review and model calculations, allows to compare the results of the various methods and to compensate their limitations (Dammers et al., 2018). Transparency and reproducibility of the sources and methods also play a role (Strengers et al., 2013). Finally, quality control is important. For example, a scenario study that has been subject to external review is more likely to be accepted as plausible than a study that has not been reviewed.

2.4.3 Imaginative power

In general, scenarios developed for policy support contain not only scientific insights, but also practical insights and the necessary imagination (Bakker, 2003). Imaginative power refers to the ability to imagine possible or desirable situations that do not (yet) exist. Since scenarios explore different future developments and their possible effects, imagination plays an important role in scenario development. Scenarios should be positively surprising, i.e. provide novel insights about the future, rather than be too predictable and lean too much on (knowledge of) the past and present. At the same time, scenarios should not be too imaginative, i.e. be too far removed from the frames of policymakers. In the latter case, policymakers will find it difficult to identify with the scenarios and will tend to reject them.

2.4.4 Legitimacy

In addition to being relevant, credible and imaginative, it is important that a scenario study is considered legitimate. This means that it has taken into account, and has carefully weighed, the various perspectives that different policymakers have on the future (Cash et al., 2003). In other words, legitimacy is about unbiased and impartial analysis of different

perspectives on the future. Due to the uncertainty regarding the future, policymakers have all kinds of different perspectives on possible and desirable futures, and in theory all these perspectives are legitimate. To assess the legitimacy of individual perspectives, it is important to gain insight into where they come from; for example, a perspective may have been derived by logical inference, or may be based on emerging developments that could become dominant future trends, such as algae farming for producing bio-based raw materials.

The legitimacy of scenario studies is further promoted by stakeholder participation, especially when a significant number of policymakers from diverse fields have been involved in developing the scenarios (EEA, 2011). However, while participation increases a study's legitimacy among the participants, this may not be the case among policymakers who did not participate, for example when the latter lack trust in some of the participants (Kunseler, 2017).

In practice, there are often trade-offs between the criteria, with scenarios scoring high on one criterion but low on the others (Van 't Klooster, 2008; Turnhout and Haffman, 2014). For example, scenario studies with a heavy focus on exploring new developments are often criticised for lacking policy relevance and being implausible 'science fiction'. Conversely, scenarios that score high on plausibility often score low on imaginative power, because they hardly digress from past and current developments. Such studies may then be criticised for 'simply extending the present into the future, adding a little here and subtracting a little there' (Dammers, 2000). The key is to identify the optimum balance between the criteria, which depends on the purpose for which the scenarios will be used and the area in which they will be applied (Chapter 3).

2.5 Using existing or new scenarios

Once the desired quality criteria have been defined, the next choice to be made is whether to use existing or new scenarios. In principle, policymakers can choose from three options: use existing scenarios, update existing scenarios before use, or develop and use new scenarios (Table 2.4).

If a recent scenario study is available that meets the desired quality criteria, then policymakers can make use of this existing study. However, since scenario studies almost never exactly match the questions of policymakers (Section 2.3), it is often necessary to adapt the scenarios before they can be used. For example, before the Delta scenarios could be used for an adaptive approach to drinking water supply management, Deltares first had to adapt them to include water demand for drinking water, industry and energy (Deltares et al., 2013). And in order to use the *Nature Outlook 2010–2040* (Van Oostenbrugge et al., 2012) for developing a nature policy vision for the province of Drenthe, the scenarios first had to be translated from the national to the provincial level.

Table 2.4
Options and conditions for using existing versus new scenarios

Options	Conditions
Use existing scenarios	The available scenarios are recent and meet the desired quality criteria
Update existing scenarios before use	The available scenarios do not fully meet the quality criteria, due to new developments or insights.
Develop or commission new scenarios	The available scenarios are outdated, due to significant new developments and insights, or due to improved data and models.

If a scenario study is available that meets the desired quality criteria but is not very recent, the question arises whether the study needs to be updated before it can be used. The decisive factor is not so much how long ago the scenario study was published, but whether, since then, new developments or new insights have occurred that make the scenarios partly or wholly outdated (Renes and Romijn, 2015). For example, the climate agreements reached in Paris in late 2015 required an update of the BUSY scenario (one of the Delta scenarios) because the new climate agreements were more ambitious than the policy assumed in the original scenario.

A scenario study can be updated by revising one of the scenarios, or by adjusting one or more elements in all scenarios. For example, a significant change in global fuel prices can be a good reason to revisit a study's assumptions about fuel price development, and to recalculate factors such as energy consumption, productivity development and CO_2 emissions in the various scenarios of the study. However, to prevent scenario use from becoming too complicated, scenarios should not be updated too often. It should also be kept in mind that short-term fluctuations that fall outside the scenarios' range need not necessarily indicate new long-term trends (Renes and Romijn, 2015).

An update revises and improves existing scenarios but does not produce new ones. A new scenario study is called for if significant developments, major events or important new insights have occurred or if relevant new data or models have become available, as a result of which the existing scenarios have become outdated (Schuur, 2013). For example, CPB and PBL published the new scenario study *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015) as a follow up to their study from 2006, because it was likely that the financial and economic crisis would have significant long-term consequences, because new insights had been gained into the relationships between prosperity and environmental quality, and because the available models had been improved based on new data and insights.

2.6 Organising scenario use

As noted in Section 2.3, it is not self-evident that policymakers always make use of scenarios, because they often find scenario use difficult and sometimes even frustrating. In addition, environmental policy development usually involves not just one government organisation but a large number of governments, businesses, knowledge institutions, social organisations and citizen groups, with actors operating in various sectors and at different scales.

Hence, in order to optimise scenario use for policy development, it is important to consider scenario use as a joint rather than individual undertaking that requires careful and deliberate organisation. When organising scenario use, it is key to distinguish scenario development and policy-making as two different activities, and subsequently strengthen the interactions between them.

2.6.1 Scenario development and policy-making

Scenario development and policy-making are different activities that involve not only different ways of working, communicating and acting, but also different motives, rules of the game and ways of thinking (Dammers, 2010). Scenario development is concerned with developing insights about possible and/or desirable futures. It is mainly a cognitive process, in which both scientific and practical insights are used. Policy-making also makes use of insights about the future; these are not limited to insights from scenario studies and scientific research, but also include insights from policy visions and consultations, as well as personal expectations and wishes. As such, policy-making is mainly a political process, in which insights about the future can play a smaller or larger role.

Scenario developers often take a systematic approach to generating insights about the future and tend to express these insights in a fairly abstract, sometimes mathematical, language. For them, it is important that the statements about the future are scientifically justified. In contrast, policymakers work mainly from experience and practical knowledge, and their language is much more concrete and less formal. For them, it is important that insights about the future can be used in practice; for example, to put policy issues on the agenda, to underpin policy decisions, and to increase commitment to policy.

Scenario developers tend to focus on the long term; usually, they look 10 to 25 years, sometimes even 50 or 100 years ahead. Since the long-term course of many social, economic and physical-environmental developments is highly complex and dynamic, exploring uncertainty is the very nature of their work. In contrast, policymakers are largely occupied with short-term issues. Even when dealing with long-term issues, policymakers are primarily concerned with the implications of these issues for the 'here and now'. Factors such as accountability pressure, election cycles and budgetary cycles play an important role (EEA, 2011; Van der Steen and Van Twist, 2013).

Jointly developing key messages for the National Environmental Vision using the North Sea scenarios.

Scenarios are about realities that do not yet exist, and therefore it is impossible for scenario developers to make 'hard' statements that are based on empirical knowledge; instead, they generate 'soft' insights about the future. Policymakers operate in a context in which different and often conflicting viewpoints, wishes and expectations are exchanged, weighed and negotiated. To play this political-strategic game well, they often have a need for hard, empirical knowledge (Dammers, 2000).

Scenario developers have been trained to explore the different directions that social, economic and physical-environmental developments may take and to examine the different wishes about the future and policy alternatives that may realise these wishes. However, policymakers have less room for thinking in very different directions. This is mainly the result of their focus on the shorter term, but is also due to the fact that existing policy cannot easily be changed and tends to have lasting effects. Furthermore, policy is usually the result of compromises to which policymakers have committed themselves after many consultations and negotiations.

Although scenario development and policy-making are different activities, they are not completely separate; in fact, they interact in various ways, and it is a two-way street more than a one-way street. Increasingly, scenario developers are inviting policymakers to exchange ideas about the content and process of scenario studies, for example during meetings of feedback groups and scenario workshops. Similarly, policymakers increasingly ask scenario developers to facilitate scenario use in policy-making, for example through bilateral consultations or scenario user workshops. Hence, although there are clear differences between scenario development and policy-making, there is no absolute 'gap' between the two activities; rather, they are more or less intertwined in a dynamic interaction (Turnhout and Haffman, 2014).

2.6.2 Strengthening interactions between the two processes

Interactions between scenario development and policy-making can be strengthened by creating conditions that promote exchange. One way to achieve this is to organise a series of informal dialogues. These dialogues can be held when the scenario study is still ongoing, for example in workshops to support scenario development, but also after the study has been completed, for example in workshops to promote scenario use.

An important function of informal dialogues is to promote unexpected encounters (Dammers and Hajer, 2011). By organising encounters between a wide range of policymakers from various sectors and administrative levels, their different expectations and wishes about the future can be brought together, discussed and challenged. In this context, policymakers are considered in the broad sense of the word, including not only government employees but also representatives of businesses, social organisations, knowledge institutions, consultancy firms and citizen groups.

In dialogues held during scenario development, policymakers can think along with the developers and exchange ideas about the various parts of the scenario study: the baseline scenario, the contextual scenarios, the policy scenarios and the key messages (see the guide for making scenarios: Dammers et al., 2019). For policymakers, an important advantage of participating in these dialogues is that they can contribute their insights, expectations and wishes about the future to the various parts of the study. For scenario developers, the advantage is that the participating policymakers become familiar with the scenarios early on; furthermore, participation promotes a sense of ownership which increases policymakers' receptiveness to the scenarios.

Dialogues that take place after completion of the scenario study provide a means for policymakers to discuss the final scenarios with one another and use the scenarios to exchange and reflect on their various expectations and wishes about the future. These meetings allow participants to find common ground and reach a shared understanding of possible and/or desirable futures. They can also discuss the most important policy challenges and how these could change over time. For example, in a number of workshops organised within the framework of the Delta Programme, participants used the Delta scenarios to discuss the minimum and maximum sea level rises and river water discharges in the years up to 2050 and 2100, and the challenges these developments could pose for flood protection policy.

Informal dialogues may be organised prior to, or in parallel with, formal decision-making. Although no formal decisions are taken within the informal dialogues, the dialogues can help to prepare such decisions. Dialogue participants who hold strategic positions within their organisations (managers, advisors) can act as ambassadors between the informal dialogues and formal decision-making (Latour, 2013); they can disseminate the dialogue results within their organisations and inform dialogue participants of the decisions taken within their organisations.

The key to success of informal dialogues is to organise them regularly and over an extended period of time (Van der Steen and Van Twist, 2012); for example, every few months over a period of one or two years. The format and content of the dialogues strongly depend on the scenarios' area of application, as discussed in more detail in the next chapter. For participants the dialogues are a time investment, but their effort will pay off as the formal decision-making process will be smoother and less time-consuming.

The adage 'By taking time you save time' (Evers and Susskind, 2006) certainly applies in this context.

In addition to the above, there are several other factors that contribute to the success of dialogues. For example, it is important to invite policymakers who are used to thinking beyond their own sector. In addition, participants should be encouraged to speak on their own behalf, rather than on behalf of their organisations. Furthermore, it is important to create an open atmosphere in which the different insights and wishes about the future – and their possible conflicts and synergies – are all given due consideration. And finally, it is crucial to create a safe atmosphere in which participants feel free to bring unconventional ideas to the table.

3 Identifying scenario application areas

3.1 Introduction

The previous chapter discusses scenario use in environmental policy in general terms; in this chapter we zoom in on some specific areas in which scenarios can be used. The purpose of this chapter is to provide an overview of the various application areas within environmental policy, and to provide insight into the specific ways in which scenarios can be used within each of these areas. This analysis will make it easier to assess how and for what purpose scenarios can be used and what their possibilities and limitations are. In describing the application areas of scenarios, we focus on the methodological steps rather than on actual practice, to provide more insight into the possibilities for scenario use. As a consequence, these descriptions are more systematic than the various applications are often carried out in practice.

We start our discussion with two application areas that are aimed at strategy development in a general sense, i.e. vision building and policy advice. These are the application areas that scenario developers and policymakers (and stakeholders) usually have in mind for using scenarios. Next, we discuss scenario use in three specific forms of strategy development: transition governance, risk governance and adaptive management. Of these three, the first two involve strategy development towards specific objectives (achieving a transition, dealing with environmental risks), while the third concerns a structured approach to strategy development (developing adaptive policy). We then discuss the use of scenarios in ex-ante policy evaluation, i.e. cost-benefit analysis (CBA) and environmental impact assessment (EIA). In many countries, CBAs and EIAs are legally required for most policy plans and projects that relate to the physical environment. Finally, we discuss scenario use for policy support, especially for research programming. Table 3.1 provides an overview of the different application areas and the chapter sections in which they are discussed.

Each section discusses an application area in terms of its main characteristics and activities, the use of scenarios in these activities, and the scenario qualities required for this use. To enable the reader to quickly assess whether the application area is relevant to their own practice, each section starts with a summary and provides a schematic overview of the most important activities, the use of scenarios in these activities, and the scenario characteristics required in this context.

Table 3.1
Application areas of the scenarios discussed in this chapter

Category	Application area	Section
Strategy development in a general sense	• Vision building • Policy advice	3.2 3.3
Specific forms of strategy development	• Transition governance • Risk governance • Adaptive management	3.4 3.5 3.6
Ex ante policy evaluation	• Cost-benefit analysis • Environmental impact assessment	3.7 3.8
Policy support	• Research programming	3.9

3.2 Vision building

In environmental policy, visions outline the main qualities of the spatial area concerned, the tasks and ambitions regarding this area, and the measures [to be] taken to realise these ambitions. In order to give meaning and direction to the actions of all parties involved and to motivate them to take action, it is important that visions provide inspiring stories and compelling images. Scenarios can help to build visions that are future-proof and that inspire and unite the various parties involved. In order to achieve this, the scenarios need to have imaginative power, provide an integrated view, and be rich in visual images.

3.2.1 Characteristics of vision building

Visions have always played an important role in environmental policy. Examples include spatial-planning, environment-, and area-related visions and area agendas, which are often developed in collaboration with business and civil society organisations. From 2020 onwards, the new Environment Act requires the national government and provincial governments to draw up environmental visions. Municipalities can develop environmental visions as well but are not legally required to do so. An environmental vision is an integrated, strategic plan for the development of the human environment in the longer term. It covers all areas of the physical environment, including housing, working, transport, water, air quality agriculture and nature.

An environmental vision focuses on the main ideas of the spatial development proposed and the environmental policy to be pursued. It is an integrated strategic plan, not a loose collection of policy visions for different sectors. The parties involved in the vision agree on their future actions and what they can do for each other (Nekkers et al., 2017). In this way, a vision gives meaning and direction to the actions of all parties involved and motivates them to take action.

In addition to describing the spatial development proposed and policy to be pursued, environmental visions often present a number of designs. A design is an integrating, solution-oriented approach that provides a spatial translation of an area's qualities and related tasks and ambitions, using visualisations such as sketches, drawings, analogue maps or digital maps, artist's impressions and 3D landscapes. 'Design thinking' translates abstract insights and ideas into spatial patterns and makes them concrete (Nijhuis et al., 2017). Design research helps to inform and validate the design and to discover and visualise new possibilities. The visualisations in the designs are global impressions that give direction to actions, rather than detailed images of desired end states. The latter would do little justice to the uncertainties surrounding the future development of the area in question, and could evoke resistance rather than enthusiasm among the parties involved.

3.2.2 Activities and scenario use in vision building

There are many different ways to develop visions. The methods used are hardly institutionalised and are often not applied in a systematic way (De Jonge, 2009). Nevertheless, a number of activities can be distinguished in vision building: analysing the current situation, exploring the tasks involved, developing the vision, taking formal decisions, and implementing the vision. Scenarios can play an important role in three of these activities: exploring the tasks, developing the vision, and taking formal decisions (Table 3.2).

Exploring the tasks involved

The tasks for an area are related to the problems and challenges faced by that area, such as the need to improve air quality or to deal with increasing economic competition. Because visions refer to an area's long-term development, it is important that they provide answers to future-oriented questions, such as the possible consequences of expected changes in the economy or the ageing of the population. After all, it cannot be assumed that today's tasks will be the same as tomorrow's tasks: expected developments may accelerate, slow down, or take a different direction, such that the tasks may become bigger, smaller or change entirely. For example, increasing international competition may influence an area's economy in terms of decreasing activity in the industrial sector, increasing activity in the services sector, or forcing a shift towards a knowledge economy.

When exploring the tasks for an area, scenarios are useful because they provide insight, in a coherent manner, into the possible future courses of autonomous developments. Scenarios also show the expected ranges of these developments, the size of the possible tasks involved, and the spatial locations where these tasks will be most important (opportunity maps, risk maps). For example, they may show that between 2015 and 2050 the level of the North Sea is likely to rise by 15 to 35 centimetres, leading to increased flood risk especially in the western part of the Netherlands. In terms of the spatial location of the tasks involved, scenario studies can clarify where the tasks will be similar between scenarios, or different, or of a different size. Furthermore, scenarios can provide insight into the possible occurrence of unexpected developments with a major impact on the area

Table 3.2
The role of scenarios in vision building: relevant activities and scenario characteristics required

Activities	Role of scenarios	Scenario characteristics required
Exploring the tasks involved	• Provide insight into future developments and events and their effects on the tasks for the planning area • Promote open and structured discussions on future tasks • Put tasks on the political or policy agenda, or move them up the agenda	• Descriptive and normative • Highly explorative • Mainly qualitative • Integrated • Participatory
Developing the vision	• Develop a vision that is robust and flexible under different circumstances and that inspires and commits the various parties involved to implement the vision	
Taking formal decisions	• Provide insight into future developments and events and their effects on the tasks for the planning area • Offer starting points for amending the vision if necessary • Help to raise votes in favour of the vision, or in favour of an alternative vision	

(known as 'wildcards' or 'black swans') (Steinmüller and Steinmüller, 2003; Taleb, 2012); for example, a sudden rise in electric car use and how this will positively affect urban air quality.

In addition, scenarios facilitate communication between the parties involved by promoting open and structured discussions about future challenges. For example, discussions about the consequences of expected sea level rise will be easier if the participants can refer to scenarios that they are all familiar with, such as the Delta scenarios (Deltares et al., 2013).

Finally, scenarios can help to move tasks higher on the political or policy agenda, or to add new tasks. For example, a scenario study in which all scenarios show a further decline of biodiversity if current policy is continued, gives grounds to move biodiversity higher on the agenda and/or to add new tasks, such as exploring how businesses and citizens could contribute to nature restoration.

Figure 3.1
Strategy in all scenarios and per scenario

Source: PBL

Developing the vision

After exploring the tasks as described above, the parties involved develop a joint vision for the intended development of the area and the environmental policy to be pursued. In this vision they respond to the tasks identified in the previous step and indicate their ambitions regarding these tasks. In general, developing a vision involves the following steps: 1) generating a number of alternative visions; 2) selecting one of these visions, or combining several visions into one vision; and 3) elaborating the selected or combined vision in more detail. To this end, the parties involved generate ideas for the vision, discuss these ideas with each other and elaborate these ideas in text, images and figures. In this process they also pay attention to possible conflicts and synergies between ideas, and how to respectively overcome or achieve these.

This process results in a coherent picture of the main ambitions for the area. These ambitions are often summarised in one or more spatial planning concepts; for example, in the *National Policy Strategy for Infrastructure and Spatial Planning [English summary of the Dutch report Structuurvisie infrastructuur en ruimte* (2011)], the Dutch Ministry of Infrastructure and the Environment summarises the national interests for which the government is responsible in a 'national spatial strategy'. A joint vision can be developed in a series of 'design dialogues' between policymakers, designers and researchers (De Jonge, 2009).

Scenarios help to take into account different possible developments and hence to build a joint vision that is future-proof, i.e. both robust and flexible (Figure 3.1). In addition, they help to combine different ambitions and hence to create a vision that challenges and inspires all stakeholders to contribute to achieving these ambitions.

In this context it is important to be aware of the difference between contextual scenarios and policy scenarios. The former focus on the possible courses of autonomous developments and their effects on the tasks for an area, while the latter focus on desired changes in an area and how to achieve the states considered desirable. Since policymakers have virtually no influence on autonomous developments, they are not allowed to choose one contextual scenario over another; in principle they must take into account all scenarios. However, since they do have an influence on the conditions considered desirable for the area, they can choose from the policy scenarios, selecting either one scenario or combining parts of different scenarios.

With contextual scenarios, the parties involved can develop a robust and flexible vision by first considering, for each scenario, what ambitions they think they can achieve and what measures they want to take to achieve these ambitions. Next, they can explore which of these ambitions and measures apply across all scenarios (the core strategy) and which ones apply in scenario A, but not in scenario B or C (the contingent strategies) (Von Reibnitz, 1987). In the context of housing programmes, an example of a core strategy is the minimum number of houses required across all scenarios, including the scenario with the lowest population growth (building within city limits). Here, the contingent strategies are defined by exploring the additional or other ambitions and required measures for the other scenarios, such as an additional quota of houses in the scenario with moderate population growth (building in the suburbs) and an extra quota in the scenario with high growth (building outside the city, in other municipalities). The next step is to monitor whether the actual population development is moving in the direction of scenario A, B or C, in order to determine whether the core strategy is sufficient or whether one or both of the contingent strategies must also be applied. This goes beyond 'wind tunnelling', where a strategy is adjusted to be successful under different circumstances. In the latter case the aim is to make the strategy robust, but not to make it flexible (Dammers et al., 2019).

With policy scenarios, the parties involved can develop a robust and flexible vision by identifying those parts of the scenarios that they want (and are able) to combine, and those that they do not want (or are unable) to combine. The former belongs to the core strategy and the latter belong to the contingent strategies. For example, a scenario study for a nature reserve may explore what are the possible or desired states of the area and what measures are needed to achieve these states; scenario A may focus on extending the reserve to create more room for natural processes, scenario B on making the reserve more accessible to visitors, and scenario C on improving ecosystem services such as water absorption and retention. Based on these scenarios, the parties involved may develop a core strategy that combines 'the best of three worlds': for example, an extended nature

reserve where only the outer zones are made more accessible to visitors, and where heavy rainfall can be absorbed to reduce flooding in the surrounding agricultural areas.

In Text Box 3.1, we discuss the role of design in using scenarios for environmental vision building.

Text Box 3.1 The role of design in scenario use for environmental vision building

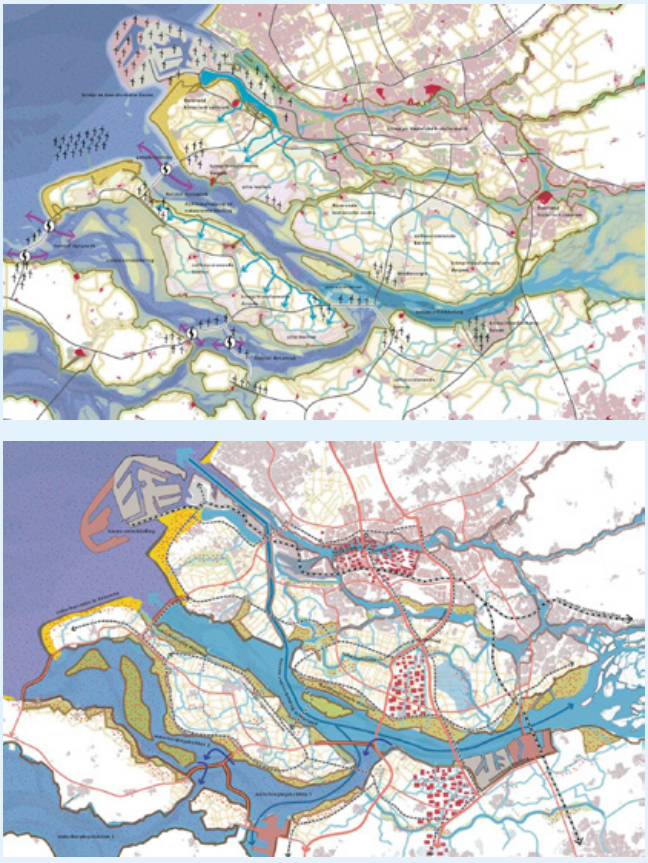
Design usually plays an important role in environmental vision building. This is also the case when scenarios are used. After all, design enables to visualise spatial developments or the spatial effects of other developments (Dammers et al., 2019). In this way, designs can show the spatial patterns that could develop if no measures are taken, such as urban sprawl, or patterns that could be pursued through policy, such as compact cities. The expected changes are presented as the differences between two images, for example between a map of the current situation and a map of a future situation (De Jong, 2012). The maps that visualise the scenarios are helpful in making the maps for illustrating the vision. Since design is mainly seen as the creative freedom of the designer, it is difficult to make the methodology explicit.

For the design process it makes a difference whether contextual scenarios or policy scenarios are used. This point can be illustrated with the Delta scenarios (contextual scenarios) and the European Nature Outlook (policy scenarios).

The Delta scenarios have been used in the project 'Integrated Planning and Design in the Delta'. Here, the national-scale Delta scenarios have been translated to the regional scale of the southwestern delta, working out the region- and sector-specific details for this area using two scenarios: one based on low economic growth and moderate climate change (the 'Rest' scenario) and one based on high economic growth and rapid climate change (the 'Steam' scenario) (Van Nieuwenhuize et al., 2014). The resulting maps show, for each scenario, the expected changes in subregions of the southwest delta, and how these changes are anchored in the past and present. This makes it possible to translate the scenarios into spatial planning tasks for the region and subregions, with the scenarios providing a starting point for the designers.

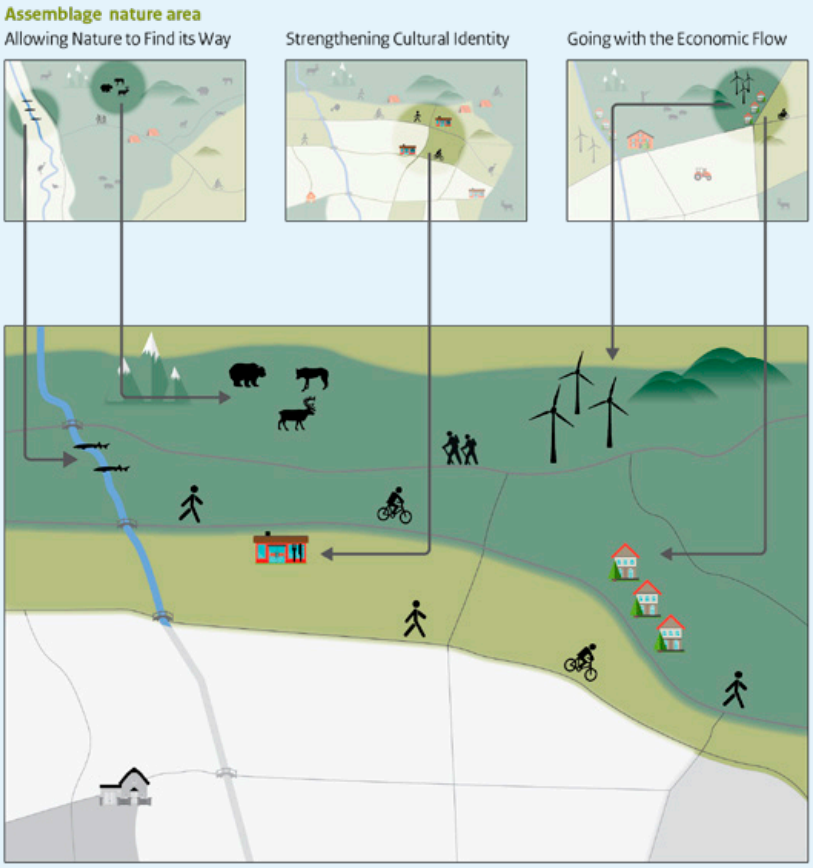
Comparing the regional maps from the 'Rest' and 'Steam' scenarios provides a number of relevant insights; for example, that three kinds of subregions can be distinguished. Firstly, there are subregions that change little or not at all in both scenarios, or where (more or less) the same tasks apply. For example, freshwater management is an important task in both scenarios: in 'Rest' because the water basins are becoming saline and the water intakes can no longer be used, and in 'Steam' because the demand for freshwater is increasing. Both these issues require similar interventions, which can be included in the robust part (core strategy) of the

environmental vision for this region. Secondly, the comparison shows that there are subregions that change little or nothing in one scenario, while changing considerably in the other scenario. For example, in the 'Rest' scenario little change is expected in the central area of the Hoekse Waard polder, while the 'Steam' scenario foresees considerable urbanisation here. Hence for this subregion it is important that the vision does not include interventions that would impede measures required in the case of 'Steam'. Thirdly, the comparison shows that there are subregions that change in both scenarios, but where the nature and extent of the change varies between the scenarios. For example, in 'Steam' the island shores near the large inlets face increased urbanisation and require an upgrade of the flood defences. However, in 'Rest' this subregion more likely qualifies for wind energy parks and new nature areas. Hence, the development programmes and spatial planning requirements for these subregions differ between the two scenarios. These 'crucial subregions' can be covered in the flexible part of the vision.



The southwestern delta in the 'Rest' scenario (top) and 'Steam' scenario (bottom).

The example described above concerns contextual scenarios, but design and vision building can also be based on policy scenarios. For example, the report *Perspectives on the future of nature in Europe: storylines and visualisations* describes how policy scenarios can be translated into a vision through design (Dammers et al., 2017). Visualising the policy scenarios – into maps, sketches and artist's impressions – provides building blocks for the vision. These visualisations allow the parties involved in vision building to take some or all of the policy scenarios as a starting point, to use different parts from the visualisations of the scenarios and to link these elements together in the vision. This mainly concerns the different spatial uses as explored in the scenarios and presented in the visualisations. Take, for example, a region that includes a nature reserve, and where policymakers agree that the decline of biodiversity in the region must be halted, that ecosystem services must be enhanced, and that local residents and visitors must be 'more connected with nature'. In order to realise these ambitions, the various spatial uses explored in the scenarios can be assigned to the nature area and be made compatible with each other, resulting in an area with a multifunctional character. For example, the scenario 'Allowing nature to find its way' (priority for nature's intrinsic value) could generate the idea of extending the nature reserve to create sufficient habitat for natural processes and viable species populations. The scenario 'Strengthening cultural identity' (priority for cultural history and inhabitants) could generate the idea of making the nature reserve more accessible to visitors, e.g. by creating a limited number of well-developed walking trails, treetop paths and marsh walkways. And from the scenario 'Going with the economic flow' (priority for the freedom to choose how to relate to nature), the idea could be derived of having a limited number of luxury residences built on the margins of the nature reserve in order to generate funds for nature conservation. These ideas combined could form the robust part of the vision. Depending on the preferences of the parties involved, the flexible parts of the vision could be developed for other locations in the region, inspired by individual scenarios and elaborated at a later stage together with stakeholders



Taking formal decisions

Depending on the vision's status - informal, formal or legal – the parties involved will take informal or more formal decisions about the vision. This also differs per organisation, depending on its powers and its commitment to the vision. In the case of governments, these decisions are made by the national parliament, the provincial council or the municipal council; in the case of business and civil society organisations, by the management or the board. In the formal decision-making process, a more or less definite choice is made for approving and implementing the vision. This choice is usually prepared and elaborated within the organisations concerned. All kinds of choices also have to be made both in the preparation and the implementation of the formal decisions, and the vision may change in the course of this process.

In this decision-making process, scenarios can provide relevant insights into possible future events and developments and their effects on (the tasks for) the planning area, as well as into the desired states of the area and the efforts required to achieve these states. In this way, scenarios can offer starting points for amendment proposals prior to a decision, e.g. to amend a vision proposed by the national government or municipal executive. During the decision-making process scenarios can also help to raise the number of votes in favour of the proposed vision or an alternative vision instead.

3.2.3 Scenario characteristics required for vision building

For vision building, scenarios will be most useful if they have the following characteristics:
Descriptive and normative. Descriptive scenarios (contextual scenarios) are relevant for exploring autonomous developments and unexpected events, and their possible effects on the tasks for an area. Normative scenarios (policy scenarios) are important for exploring possible alternative visions and efforts required to realise these alternative visions.

Highly explorative. Vision building requires scenarios with great imaginative power. Hence the scenarios should have a highly explorative character and not be moderately explorative or merely explore dominant trends. Only scenario studies that truly explore widely divergent developments and events and different ideas can contribute to a future-proof vision that inspires and commits the various parties involved to implement the vision.

Mainly qualitative. In order to obtain support for the selected or combined vision or to develop alternative visions, it is important that the scenarios tell inspiring stories about desirable futures. It also helps if the scenarios are properly visualised, for example by using maps to indicate where the main spatial developments or spatial effects of other developments will take place. The added value of scenarios with inspiring storylines and good visualisations is that they facilitate communication with other parties involved in vision building. However, to explore the policy tasks involved and evaluate the feasibility of policy ambitions, it is also important that the scenarios indicate orders of magnitude, for example, the ranges of population growth or population decline that should be taken into account in the next few years. In other words, it is important that the scenarios provide not only qualitative but also quantitative information.

Integrated. Since environmental visions, area visions and other visions integrate many different aspects, the scenarios used for vision building should also provide integrated information. This means that the scenarios should explore a wide range of developments that potentially have an impact on the area concerned, including political, economic, socio-cultural, technological and environmental developments. In addition, the scenarios should explore the effects of these developments on a wide range of policy tasks for the area. Scenarios that explore a limited number of developments or effects on a few sectors make it difficult to develop an integrated vision. For this reason, the scenario study *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015) is less suitable for vision building than *Welfare, Prosperity and Quality of the Living Environment* (CPB and PBL, 2006).

Participatory. When using scenarios for vision building, it helps if the parties involved in vision building have also participated in developing the scenarios (e.g. by participating in scenario workshops). This allows the parties involved to familiarise themselves with the scenarios at an early stage and to contribute their own ideas about the future, which enhances the legitimacy and relevance of the scenarios developed.

3.3 Policy advice

Policy recommendations issued by advisory bodies are usually aimed at addressing strategic issues related to environmental policy. They provide knowledge for policy-making and offer directions and suggestions that can be taken into account when developing, for example, an environmental policy vision. Scenarios can be useful in all activities that are part of policy advice; this applies to both normative and descriptive scenarios and to both qualitative and quantitative scenarios.

3.3.1 Characteristics of policy advice

Policy advice can be issued by advisory councils, advisory committees, consultants, think tanks, lobby groups and other bodies (Van Twist, 2010). This section focuses on policy advice from advisory councils. Advisory councils can be composed of scientific experts tasked with translating current scientific knowledge into practical guidelines for policymakers. In the Netherlands, the Scientific Council for Government Policy (WRR) has this function. However, advisory councils can also have the task to stimulate position formation on strategic policy issues and increase support for policy measures. For example, in the Netherlands the Socio-Economic Council (SER) has this task. In this council, input from business and civil society organisations and negotiation of policy alternatives play important roles.

The Dutch Council for the Environment and Infrastructure (Rli) occupies an intermediate position. The recommendations of this council are based on both scientific and experiential knowledge and are aimed to contribute to societal discussions and political decision-making, mainly through making visible the considerations, dilemmas, values and principles associated with the policy considered. The members of this council come from public administration, business and academia.[1] They are appointed in a personal capacity, based on their broad social knowledge and experience.

Advisory councils provide both solicited and unsolicited policy advice. Their recommendations are intended for politicians, civil servants, and representatives of business and civil society organisations, and are aimed at addressing strategic issues such as urbanisation, climate change and the energy transition. These recommendations can be taken into account, for example, when developing an environmental policy vision (Section 3.2).

Table 3.3
The role of scenarios in policy advice: relevant activities and scenario characteristics required

Activities	Role of scenarios	Scenario characteristics required
Analysing the policy issue	• Provide insight into the different definitions of and perspectives on the issue, the future course of the issue, and the factors and uncertainties involved	• Both descriptive and normative • Moderately to highly explorative • Both qualitative and quantitative • Integrated
Clarifying considerations and arguments	• Provide an overview of the various considerations regarding the issue, and substantiate arguments regarding the future course of the issue and the factors and uncertainties involved	
Analysing policy alternatives	• Help to identify and develop policy alternatives, and to assess policy alternatives under different circumstances	
Comparing and evaluating policy alternatives	• Help to assess public support for policy alternatives and their effectiveness under different circumstances	
Formulating recommendations and points for consideration	• Help to substantiate the recommendations and points for consideration	
Presenting the policy advice	• Help to identify the uncertainties underlying the recommendations and points for consideration	

The councils' recommendations can be aimed at putting a strategic issue on the agenda, but also, for example, at redefining an issue or contributing to a more effective policy to address an issue. The knowledge, considerations and other input provided in the recommendations can be adopted by policymakers, for example if they feel that the advice helps to improve policy. But they can also reject the recommendations (with a justification), for example if the advice does not suit them politically.

3.3.2 Activities and scenario use in policy advice

Policy recommendations are drawn up in various ways, depending mainly on the specific tasks of the advisory bodies and their profile, approach and working methods (Karoonen, 2016). Nevertheless, the following activities usually play a role in policy advice: analysing the policy issue, clarifying considerations and arguments, analysing policy alternatives, comparing and evaluating policy alternatives, formulating recommendations, and presenting the policy advice. Alongside with other sources of knowledge and information, scenarios can be used in all these activities (Table 3.3).

Analysing the policy issue
Drafting policy advice usually starts with describing the strategic issue on which the advice is focused. This involves analysing the issue itself, the underlying factors and current policy. In addition to the issue's current status it is also analysed how the issue arose in the past and how it may change in the future.

Strategic policy issues are often wicked problems, characterised by widely divergent views on both the nature and solution of the issue in question (Hisschemöller and Hoppe, 1996; Tuinstra and De Wit, 2014). The same applies to what policymakers want to achieve and what approach they consider necessary or desirable. In drafting policy advice, not only different kinds of scientific and experiential knowledge play a role, but also different opinions and values, depending on the type of advisory council and the type of advice. As mentioned in Section 3.3.1, the various councils have different tasks and profiles and give different types of advice.

Policy scenarios help to identify and discuss the different ways in which a policy issue can be defined and valued. For example, based on the scenarios in *Nature Outlook 2010-2040* (Van Oostenbrugge et al., 2012), the Rli Council argues in its advisory report on sustainability, *Onbeperkt houdbaar,* (2013a) to consider nature in the Netherlands beyond its tangible, physical characteristics and focus on ecosystem services (for human health, economy, species conservation etc). According to the council, this will help to focus discussions about nature policy and make it easier to connect with different stakeholders.

Contextual scenarios provide comprehensive insight into the possible future course of the policy issue in question, the social and physical developments that influence the issue, and the underlying uncertainties. For example, the freight transport scenarios of the Organisation for Economic Cooperation and Development (OECD) show that CO_2 emissions from international transport between 2010 and 2050 could increase by a factor of 1.5 to 2.5 (Hummels, 2009), with the main factors being the growth in transport volume, new technological developments and the price of CO_2 emissions. This study also shows that the uncertainty surrounding the future breakthrough of new technologies and the future price of CO_2 is high. Contextual scenarios such as these also help to structure discussions about the policy issue within the advisory council, for example because council members can refer to the scenarios when discussing their assumptions about the possible future course of the issue.

Clarifying considerations and arguments
In this activity, the various considerations and arguments of the individual council members are summarised and clarified. The main focus is on the arguments why a particular phenomenon should be considered a strategic issue, why public policy should play a role in addressing the issue, and if so, what that role should be (e.g. a stimulating, regulating or facilitating role). Clarifying these arguments helps to identify not only the different sides and aspects of the strategic issue, but also the policy alternatives available to address the issue.

Policy scenarios can help to generate a clear overview of the different considerations and the underlying arguments, because they present different value orientations towards the issue. For example, the policy scenarios in *European nature in the plural* (Van Zeijts et al., 2017) explore what efforts are needed to create nature areas that provide room for natural processes (intrinsic value of nature), that are easily accessible to people (cultural and recreation value), that provide ecosystem services (sustainability value), and that generate income and limit management costs (utilisation value).

Contextual scenarios can help to clarify arguments in the same way as they help to analyse the policy issue (see previous step). Here, the insights they provide – into the future course of the issue, the social and physical developments that influence the issue, and the underlying uncertainties – can help to clarify and substantiate the various arguments and considerations of the council members.

Analysing policy alternatives

Policymakers can develop policy alternatives and ask advisory councils to advise on these alternatives, but advisory councils can also propose policy alternatives themselves. This depends not only on the specific wishes of the policymakers who have requested the advice, but also on the council's profile and working approach. For example, the Rli council devotes a great deal of attention to analysing the advice request and placing the question in a social context and long-term perspective. Their advisory report on the policy theme of 'housing construction and energy transition', for example, includes an analysis of economic factors (e.g. the state of the construction sector), household characteristics (e.g. obstacles for low-income families), and long-term developments in housing construction (e.g. green building techniques). This broad approach helps the council to consider a wider range of policy alternatives when preparing the advice. Analysis of policy alternatives is generally not the core of their advisory work but is done in some cases. The council does no quantitative assessment of the policy alternatives, while PBL sometimes does.

Policy scenarios can help advisory councils to analyse policy alternatives in the ways discussed above. In addition, policy scenarios can help to develop new alternatives. After all, policy scenarios describe not only the futures that are considered desirable, but also the strategies that are necessary to realise those futures.

Contextual scenarios can help advisory councils to assess how future-proof the different policy alternatives are, i.e. how robust and flexible they are under different developments. In addition, contextual scenarios provide insights that can help to formulate suggestions for making the alternatives more future-proof. The ways in which this can be done are described in Section 3.2.

Comparing and evaluating policy alternatives

For some advisory councils, the core of their policy advice is to provide arguments for or against specific policy alternatives. To evaluate the pros and cons of these alternatives, they draw on scientific and practical knowledge and on the views and opinions of the

organisations and groups represented in the council (Bekkers et al., 2004). For other advisory councils, the core of their work is to make visible the considerations, dilemmas, values and principles associated with the policy in question. Also in this case, arguments are important. These councils rely mostly on scientific and practical knowledge, and less on views and opinions.

Policy scenarios can help advisory councils to identify which societal values and views are in line with the policy alternatives, and hence can help to assess public support for these alternatives. This is possible because these scenarios are based on analyses of societal discourses about specific issues and the various arguments used in these discourses. Policy scenarios can also provide insights that can help to adapt a policy alternative (e.g. by including elements from other alternatives) in order to increase public support. For example, the scenario study *Nature Outlook 2010–2040* shows how large nature areas can be made more accessible to visitors without disrupting natural processes, while at the same time improving ecosystem services such as carbon storage, and generating revenue for conservation management.

Contextual scenarios can help to clarify how effective the various policy alternatives are under different circumstances. For example, compared to a scenario exploring low socio-economic growth, a scenario exploring high growth may show greater competition for space and encroachment on nature reserves (due to stronger urbanisation), but lower environmental pressure (due to more advanced technological development) and higher budgets for nature conservation policy (due to higher tax revenues). If policy alternatives are robust under different conditions, this will improve both their feasibility and effectiveness.

Formulating recommendations

Advisory councils will formulate their recommendations and points for consideration based on the results of the previous step – the comparison and evaluation of policy alternatives. When translating these results into recommendations, they will take into account the various target groups of their report, as well as the council's function and profile. As mentioned in Section 3.3.1, their advice can be aimed at putting the issue on the political or policy agenda, at redefining the issue, or at contributing to a more effective policy to tackle the issue.

In this process, councils make use of all kinds of knowledge and insights – including those derived from scenario studies – to formulate their own recommendations. For example, in their advisory report on sustainability, *Onbeperkt houdbaar* (2013a), the Rli council used the scenario study *Nature Outlook 2010–2014* to substantiate their recommendation to create larger nature areas in which natural processes can run their course, and to create buffer zones to better protect nature areas from agricultural encroachment.

Presenting the advice

Councils have different ways of presenting their advice, depending on who requested the advice, the council's profile, and the target groups of the advice. Important factors are the

form and timing of the advice, the presentation format, and whether the advice contains recommendations or points for consideration. For example, if the target groups have very different views on the issue, it is more common to present points for consideration instead of recommendations. Points for consideration highlight matters that are important for policy-making, such as dilemmas, considerations, values and principles, but they do not suggest solutions. This makes it easier for policymakers with widely differing views to adopt the advice.

When councils are presenting their recommendations or points for consideration, it is important to explicitly mention the inherent uncertainty of future developments. For example, in their advisory report on logistics *[Nederlandse logistiek 2040]* (2013b), the Rli council states that the CO_2 reduction targets of the Dutch transport sector will not be met, and that the cost-benefit balance of internalising external costs (such as environmental pollution) has different economic outcomes depending on the scenario used. In addition, the council states that these outcomes are surrounded by uncertainties, such as the breakthrough of new technologies and future carbon price.

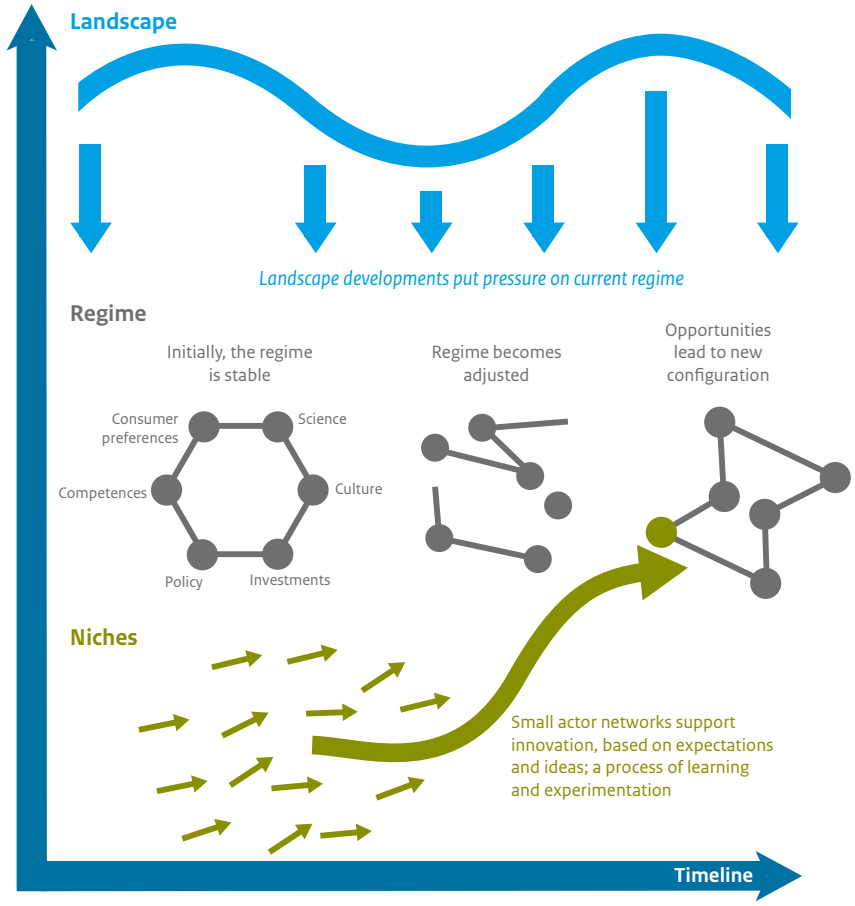
3.3.3 Scenario characteristics required for policy advice

For policy advice, scenarios will be most useful if they have the following characteristics:
Both descriptive and normative. For most of the activities discussed above, both normative scenarios (policy scenarios) and descriptive scenarios (contextual scenarios) can be used. Both types of scenarios play particularly important roles in the analysis, comparison and evaluation of policy alternatives, and in formulating recommendations or points for consideration.

Moderately to highly explorative. For the advice to include policy alternatives that are genuinely different it is important to use scenarios that are highly explorative, rather than moderately explorative or dominant. However, to assess the feasibility and effectiveness of the policy alternatives under different circumstances, it is better to use scenarios that are moderately explorative. In dominant scenarios the circumstances do not differ enough to evaluate the alternatives, while in highly explorative scenarios, the circumstances differ so much that the alternatives are easily effective in one scenario (high dynamics) but absolutely ineffective in the other (low dynamics).

Both qualitative and quantitative. Qualitative scenarios are particularly suitable for making explicit the advisory councils' considerations regarding the policy alternatives and arguments for or against these alternatives, and they also allow the target groups to reflect on these considerations. Thanks to their narrative character, qualitative scenarios are easier to communicate and invite more reflection than quantitative scenarios. Conversely, quantitative scenarios have the advantage of providing insight into the order of magnitude of future policy issues, the developments affecting these issues and the policy required to address them. In this way, quantitative scenarios are more informative than qualitative scenarios.

Figure 3.2
Multi-level perspective of transition governance



Source: EEA, 2016

Integrated. When the council's advice concerns a vision, it is important that the scenarios integrate a wide range of developments to match the integrated nature of the vision. Such integrated scenarios are less important if the advice is focused on specific elements of environmental policy. However, also in this case the advice will often relate to policy issues that cross individual sectors (e.g. the case of climate adaptation). Even if the advice concerns a specific sector, such as agriculture, it will inevitably take into account the relationships with other sectors, such as nature, recreation and water management. Although these kinds of advice do not require integrated scenarios, they do require scenarios with a broad scope.

3.4 Transition governance

The transition to sustainable energy, mobility and food production requires radical and irreversible system changes. Transition governance is aimed at stimulating, adapting and guiding these changes. Here, scenarios can help to activate 'transition arenas', to make transition tasks explicit, to explore transition directions, and to identify transition pathways. This imposes specific requirements on the scenarios used: transition governance requires third-generation outlook studies that explore both cognitive and normative uncertainty.

3.4.1 Characteristics of transitions and transition governance

Transitions are radical and irreversible changes of societal systems (Rotmans, 2012). They are the result of economic, cultural, technological and institutional developments that interact with and reinforce each other, and of the efforts of pioneers who experiment with new techniques and practices. For example, the energy transition is not only driven by increasing fossil fuel prices and climate change, but also by all kinds of initiatives from businesses and citizens ('the energetic society': see Hajer, 2011).

Transitions can take a long time, because they require a fundamental change of existing behaviour, relationships and institutions. Transitions often involve a number of stages: 'pre-development' (the system's current dynamic equilibrium), 'take-off' (changes start to happen), 'acceleration' (changes continue and become embedded) and 'stabilisation' (new dynamic equilibrium of the system). Due to their great complexity and dynamics, transition processes are usually difficult to predict. Unexpected, disruptive events may cause a transition to suddenly accelerate, slow down, or fail.

New technologies and new working practices are considered crucial to system change, but they often fail to gain ground because governments, businesses, civil society organisations, knowledge institutions and citizens are tied to established ways of thinking and acting, i.e. the established *regime*. Two things are needed to change the dominant system (EEA, 2016; 2018): *niches*, i.e. micro-level spaces where pioneers can experiment with innovative technologies and practices, and *landscapes*, i.e. macro-level exogenous developments that disrupt the system and allow innovative technologies and practices to become mainstream. Figure 3.2 schematically shows how transitions can unfold.

Governance of sustainability transitions is aimed at combining innovations in the short term and structural change in the longer term (Rotmans, 2003). It is motivated and legitimised by the observed consequences of unsustainability. Transitions can be influenced, in the sense that they can be stimulated, adjusted and guided, but they cannot be fully governed or controlled because they are too complex, and the uncertainties are too great. Some transitions are planned while others occur spontaneously, depending on the circumstances and new insights. The key is to create conditions that foster innovations at the right time through the right initiatives; hence it is about transition *governance*, not transition *management*. Important aspects of transition governance are:

ensuring that niches can develop at the micro level, linking these niches together, building visions at the macro level, stimulating the establishment of new 'regimes', and promoting coordination across the levels (Rotmans, 2012).

Although governments may impede innovative technologies and practices through 'lock-ins' (existing policies standing in the way of new policies), they can also play a key role in the governance of transitions, given their duties, powers and resources (EEA, 2016; 2018). For example, they can formulate joint visions and societal objectives, provide political guidance and direction, and phase out technologies and practices that stand in the way of a transition (Loorbach, 2014). Transition governance requires policy measures that stimulate the whole of society to contribute to the transition process. These interventions should obviously be aimed at challenging the dominant regime (e.g. by setting increasingly strict environmental standards) and fostering innovation (e.g. by providing legal room for experimentation and offering start-up subsidies for innovation projects) (Geels, 2016).

3.4.2 Activities and scenario use in transition governance

Transition governance cannot be summarised in a definitive step-by-step plan, because it is too dynamic and complex. Nevertheless, a number of activities can be distinguished: organising the multi-actor process, defining the transition issue, identifying problem perceptions, building a long-term vision, exploring transition pathways, and evaluating learning outcomes (Rotmans, 2003; 2012). Among these activities, scenario use can play an important role in organising the multi-actor process, identifying problem perceptions, building a long-term vision, and exploring transition pathways (Table 3.4).

Organising the multi-actor process

In transition processes many new forms of collaboration can emerge. Sustainability leaders can work together in a variety of ways, for example in conducting research and field tests, developing products, and creating new markets. For transition governance the key is to create conditions that enable the forerunners to move the transition forward. This can be achieved by creating 'transition arenas': dynamic, temporary networks that offer room for exploration, experimentation and learning (Rotmans, 2012). Activities undertaken in transition arenas include bringing together different players in 'surprise' meetings, stimulating innovative experiments, creating room for experimentation within existing regulations, and setting up a supporting organisation for the transition arenas.

Stakeholder participation in scenario studies provides various relevant opportunities for the organisation of transition arenas. For example, scenario workshops can be used to bring together sustainability pioneers (Dammers et al., 2019) to jointly explore the various possible and/or desirable futures. In this way, an existing transition arena can be activated, or a new arena can be created.

Table 3.4
The role of scenarios in transition governance: relevant activities and scenario characteristics required

Activities	Role of scenarios	Scenario characteristics required
Organising the multi-actor process	• Help to activate an existing transition arena or to create a new one	• Highly explorative • Mainly normative • Mainly qualitative • Diachronic • Participatory
Identifying problem perceptions	• Provide insight into the transition tasks, and make explicit the various perspectives on these tasks	
Building a long-term vision	• Explore different transition directions and stimulate innovative thinking	
Exploring transition pathways	• Provide an overview of transition pathways, their stages and measures involved	

Identifying problem perceptions

Transition issues are perceived from different perspectives depending on the parties involved. For example, in the case of sustainable energy supply, one party may emphasise the reduction of environmental costs, another may focus on supply reliability, and a third may give priority to affordability. In order to understand all sides of an issue, it is important that these different perspectives are articulated and that the underlying values and views are made explicit. This will pave the way to a shared problem definition, in which the different perspectives all have a place.

Scenarios explore long-term developments and identify possible future discontinuities. Discontinuities are unexpected events with a major impact; for example, the breakthrough of autonomous driving and its effect on urban traffic. Scenarios provide insight into the transition tasks associated with these developments and discontinuities, i.e. the problems and challenges that the transitions are to address. The different problem definitions of the parties involved can be explored in different scenarios. This helps to make the different perspectives explicit, to reflect on them, to discover where they match, overlap or conflict, and to explore how conflicts can be resolved.

Building a long-term vision

Once a shared problem definition is agreed, it can be translated into a long-term vision that indicates the desired direction of the transition. To build this vision, parties work together to create transition images that are innovative, inspiring and imaginative. These images are intended as signposts indicating the direction of the transition; they are not prescribing or detailing the end result. In this way, the vision offers a challenging outlook for initiatives implemented in the short term, and places short-term changes in a long-term perspective. Transition images will evolve over time as a result of learning effects and new insights gained.

In building a long-term vision, scenarios can help to explore various transition directions and to stimulate the innovative thinking required for achieving transitions (Rademaker and Dirven, 2011). For example, a scenario study for a delta area may explore transitions towards a 'sustainable delta' (focus on economic, social and ecological sustainability), an 'energetic delta' (focus on energy supply), and a 'self-sufficient delta' (focus on local sourcing and production of raw materials). Such scenarios also make explicit the fundamental values and views underlying the transitions.

Exploring transition pathways
For each transition image there are different transition pathways that could lead towards that image. In outlining these pathways, it is important to indicate, for each pathway, the different stages of the transition and the intermediate objectives associated with these stages. In addition, for each pathway the right mix of existing and new measures towards realising the transition image needs to be identified. Furthermore, it is important to clarify which parties are responsible for which measures. Over time, based on learning effects and experiences gained, it will become clear which of the pathways are viable, and which should be abandoned.

Scenarios help to explore the different pathways that can be taken towards realising the desired transition. For example, the transition towards a 'sustainable delta' could be realised via government taxes on environmental pollution caused by businesses and citizens, via sustainable area development, or via local initiatives. Scenarios also provide insight into the various stages of transitions. In addition, they shed light on existing and new measures that could help to achieve the transition; for example, gradual tightening of CO_2 emission regulations to promote renewable energy, using temporary subsidy schemes to support innovations that are not yet profitable, and launching joint public-private companies to create markets for new ecosystem services.

3.4.3 Scenario characteristics required for transition governance

Using scenarios in transition governance imposes specific requirements on the scenarios and the way in which they are developed. In particular, transition governance requires third-generation future studies that are aimed at exploring both cognitive and normative uncertainty. These studies succeed first-generation future studies (*forecasting*), which focus on certainty, and second-generation studies (*outlook*), which focus on exploring cognitive uncertainty (Sondeijker, 2009).

Highly explorative. Because transitions involve fundamental system changes, it is important that the scenarios show the scope for change. This means that the scenarios must pay sufficient attention to the uncertainties surrounding the future course of autonomous developments and possible discontinuities. In addition, the scenarios need to explore the various transitions that could be undertaken to meet present and future challenges, including transitions that are currently not considered feasible or not seriously thought of. After all, it is almost impossible to achieve fundamental system changes within existing institutions (Loorbach, 2007).

Mainly normative. Exploring the various possible transitions is primarily a normative process. Thus, there is an important role for normative scenarios (policy scenarios), since these explore situations considered desirable and possible measures towards achieving these situations. Nevertheless, descriptive scenarios (contextual scenarios) are also important in this context. After all, the latter explore the future course of autonomous developments and possible discontinuities, hence providing insight into possible transition tasks.

Mainly qualitative. Qualitative scenarios that include 'strong stories' and 'visionary images' about possible transitions and transition pathways provide important building blocks for a long-term vision and help to mobilise different groups and organisations for the transition process. At the same time, it is important that the parties involved find the scenarios plausible, and that the scenarios provide insight into the order of magnitude of the tasks, objectives and efforts needed to realise the transitions. This requires scenarios that include quantitative information from model calculations, where possible.

Diachronic. For transition governance it is important that the scenarios take a diachronic approach, meaning that they describe the pathways in detail in terms of the patterns of change and different stages involved: pre-development, take-off, acceleration, and stabilisation (Rotmans, 2012). However, as mentioned before, new developments and discontinuities can cause a transition to suddenly accelerate, slow down or even fail. Hence diachronic scenarios give indications about patterns of change without pretending to be able to predict the exact course of transitions.

Participatory. For transition governance, scenarios are important not only as a product but also as a process, in terms of how they are developed (Rademaker and Dirven, 2011). Stakeholder participation in scenario development plays an important role, because it allows to bring together pioneers to jointly develop ideas and scenarios. In this way, scenario studies can present various opportunities to activate existing transition arenas or create new ones. Participatory scenario development, in particular, can contribute to exploring, learning and experimenting in transition arenas and broaden the perspectives of the actors involved (Sondeijker, 2009).

3.5 Risk governance

Risk governance is aimed at limiting unacceptable risks, without pretending that the risks can be fully controlled by a single authority. Here, scenarios mainly help to identify possible future risks, to evaluate risks in different ways, and to explore new options to limit risks. Depending on the type of risk, the scenarios used in risk governance should be moderately or highly explorative, quantitative or qualitative, and descriptive or normative.

3.5.1 Characteristics of risks and risk governance

Society and the environment are occasionally exposed to safety incidents such as chemical spills, floods and veterinary disease outbreaks. These events can have significant negative consequences for people, businesses and ecosystems (World Economic Forum 2014). Such incidents are, to a large extent, inherent to highly developed societies. According to Beck (2001), the 'industrial society' has made way for the 'risk society', in which economic production and technical developments are constantly producing numerous unintended side effects. According to Beck, these side effects are so pervasive in the risk society that social conflicts have gravitated from the *distribution of goods* to the *distribution of bads*.

A risk is an uncertain (and usually adverse) consequence of an event or activity that affects something that people value (IRGC, 2005). This involves not only objectively measurable characteristics but also social constructs (De Hollander and Hanemaaijer, 2003). After all, risks are often perceived in very different ways, both in terms of their likelihood and the potential dangers they present. Evaluating risks is based on both analytical and affective and associative processes, where the latter two often play a decisive role (De Hollander, 2012). People sometimes accept large risks, such as air pollution caused by fireworks, and sometimes worry about relatively small risks, such as electromagnetic radiation from high-voltage power lines. Factors that play an important role in how people perceive risks include their need for personal freedom, the extent to which they have a choice to expose themselves to the danger in question, their sense of justice, and the predictability of the damage (IenM, 2014).

Different types of risks can be distinguished (IRGC, 2005). For *simple risks*, such as industrial fires, it is relatively easy to identify and quantify the risk factors, their interrelationships and effects. For *complex risks* this is much more difficult: think, for example, of the risks of environmental pollution for vulnerable ecosystems. In the case of *uncertain risks*, scientific knowledge and technical data are lacking or unclear; this applies for example to natural disasters. Finally, *ambiguous risks* concern risks whose nature and severity are perceived in very different and often conflicting ways; for example, people have very different ideas about the risks of genetically modified food.

Risk governance is a framework for identifying, assessing, managing and communicating risks within a broad context (IRGC, 2005). It covers all the actors involved in risk governance, their interactions and relationships, the activities they perform, the procedures they use, and the rules they follow. The broad context covers issues such as organisational capacity (resources, skills), political and policy culture (different styles of legislation and regulations) and the social climate (risk culture, public trust in regulatory bodies).

The distinction between different risks is important for developing appropriate risk governance strategies (IRGC, 2005; De Hollander, 2012). *Simple risks* can be managed on the basis of routine strategies such as legislation and regulations. *Complex risks* involve applying the best available scientific expertise to develop informed and robust strategies. In this context, 'robust' refers to the reliability of measures taken to withstand impending

Table 3.5
The role of scenarios in risk governance: relevant activities and scenario characteristics required

Activities	Role of scenarios	Scenario characteristics required
Preliminary risk appraisal	• Highlight possible future risks and early warning signs, and help to frame risks	Depending on the type of risk: • Moderately or highly explorative • Quantitative or qualitative • Descriptive or normative • Participatory
Risk estimation	• Identify the possible nature and extent of the risks and their possible causes and effects	
Risk classification and evaluation	• Help to assess, from different perspectives, whether or not risks are acceptable or tolerable	
Risk management	• Inspire to consider a wide range of risk mitigation options	
Risk communication	• *Help to structure discussions about possible future risks and risk evaluation, and to increase public trust*	

incidents or processes that are not yet fully understood or not yet anticipated. *Uncertain risks* are best governed by strategies based on the precautionary principle and resilience. Finally, *ambiguous risks* are primarily governed through discourse strategies. These strategies focus on increasing tolerance and mutual understanding of conflicting values and attitudes with the aim of ultimately reconciling them.

3.5.2 Activities and scenario use in risk governance

Risk governance includes a number of activities: preliminary risk appraisal, risk estimation, risk classification and evaluation, risk management, and risk communication. In practice, these activities do not always occur in the order mentioned; often they happen side by side. Scenarios can be helpful in all activities (Table 3.5).

Preliminary risk appraisal

In risk governance, preliminary appraisal refers to the early detection and framing of a (specific) risk in order to define the problem and how it should be addressed. This activity clarifies the different perspectives on the risk and defines the issues to be focused on, including the threats and opportunities, the various risk dimensions, the framing of the risk by different stakeholders, the organisational capacities to address the risk, and the possibilities and limitations of existing regulations and legislation.

Scenarios that pay attention to discontinuities (risks and opportunities) can point to the possible future risks involved – for example, accidents with self-driving cars. Those scenarios also address the conditions that would lead to future risks, indicating the events and developments that can be considered early warning signs – for example, frequent

failures in autonomous car computers, or repeated hacking of these systems. Such insights help to anticipate future risks in a proactive manner.

Some scenarios are based on different world views, and they can provide insight into the various ways in which risks are framed. For example, risks can be framed as being one's own responsibility (an individualistic world view), as a collective responsibility (a hierarchical world view), as a question of justice (an egalitarian world view) or as something to be accepted as a fact of life (a fatalistic world view) (Thomson, Ellis and Wildavsky, 1990).

Risk estimation

Risk estimation provides the knowledge base for making a decision whether to accept the risk in question and, if so, how to mitigate the risk as much as possible. Risk estimation not only looks at the physical and other characteristics of the risk and its causes, but also examines the (positive and negative) consequences that stakeholders attribute to the risk. Among other things, this activity looks at the potential damage caused by adverse effects, the risk's causes as far as these can be identified, the societal response to the risk, and the roles of existing institutions in the articulation of societal concerns.

Scenarios that explore future discontinuities can give stakeholders a sense of the possible nature and magnitude of the risks involved, because they identify the conditions under which these events occur and their effects. However, scenarios do not provide a definite answer regarding the probability of these risks and effects (Van Asselt, 2007). After all, scenarios focus on long-term developments and the future is too uncertain in the long term to be able to make definitive statements about probabilities.

Risk classification and evaluation

In this activity the scientific findings regarding the physical and other characteristics of the risk are combined with a thorough understanding of societal values and perceptions. This step is particularly important for making a decision whether a risk is acceptable, tolerable or intolerable – a decision that is potentially controversial. In the case of acceptable risks, no restrictive measures are needed; in the case of tolerable risks, restrictive measures will be taken but the risk is still accepted because of social, economic or other trade-offs; and in the case of intolerable risks, the risk in question must be avoided.

In a similar way as in the preliminary risk appraisal, scenarios based on different world views are useful for risk classification and evaluation, because they can help to make the various value orientations explicit. These scenarios can also help to evaluate the risks from the different perspectives. Such an evaluation makes it easier for policymakers to decide whether the risks are acceptable, tolerable or intolerable.

Risk management

For all risks that policymakers have classified as tolerable, it is important to develop an adequate form of risk management. Risk management consists of preparing and

implementing the measures and actions needed to avoid or at least limit the risks (IRGC, 2005). This involves generating, evaluating and selecting suitable options to limit risks, implementing measures, monitoring the effectiveness of these measures, and adjusting decisions where necessary.

Scenarios based on different world views inspire to consider a wide range of risk mitigation options. For example, a hierarchical world view can be used as a starting point to look for measures that control risks, an egalitarian world view to look for measures that equalise risk levels, an individualistic world view to look for measures that increase freedom of choice for citizens and businesses, and a fatalistic world view to look for measures that increase risk acceptance.

Risk communication
Communication forms an important part of risk governance: it helps policymakers to better understand risks, it clarifies the roles of policymakers in governance processes, and it gives stakeholders a voice in these processes. Effective communication is indispensable for building trust. This is particularly important in the case of ambiguous risks, because these involve different and often conflicting value orientations.

Scenarios that explore future discontinuities help to structure discussions about the nature and effects of the potential risks involved and the conditions under which they occur. As these scenarios present a wide range of possible risks and their different characteristics, policymakers can refer to the scenarios in their discussions, which facilitates communication. Scenarios that are based on different world views help to make explicit the different value orientations towards risks, to recognise and discuss these different perspectives, and hence to increase mutual trust.

3.5.3 Scenario characteristics required for risk governance

For risk governance, scenarios will be most useful if they have the following characteristics:
Moderately or highly explorative. Scenarios that are moderately explorative are generally sufficient for a routine approach to simple and complex risks. These scenarios explore different directions of future developments and the risks involved, but the directions explored are not radically different. The latter is more important in the case of uncertain and ambiguous risks, where highly explorative scenarios are needed to provide an overview of the wide range of possible future risks and the different ways in which they can be perceived. After all, risks can take many forms and there is a great deal of uncertainty about their probability and (perceived) severity.

Quantitative or qualitative. Quantitative scenarios are important for the scientific analyses that are part of risk estimation. These scenarios indicate orders of magnitude, which is especially relevant in the case of simple and complex risks. In the case of uncertain and ambiguous risks, qualitative scenarios are more important. The cognitive and normative uncertainties associated with these risks are so large that the possibilities for quantification are limited. New risks can only be explored in a qualitative way, due to lack of quantitative data.

Descriptive or normative. The literature on risk governance focuses mainly on the role of descriptive scenarios (contextual scenarios), i.e. scenarios that explore possible future events and developments and the risks they may entail. However, normative scenarios (policy scenarios) can play an important role in identifying different options for risk management. For example, scenarios based on different world views can inspire to consider less obvious measures and help to explore new directions in risk governance.

Participatory. Participation of policymakers plays a major role in risk governance, especially for risks characterised by ambiguity. Participation not only contributes to a more inclusive definition of the risks, but also helps to devise more effective and legitimate measures. By allowing policymakers involved in risk governance to participate in scenario development, they can contribute personal insights and expectations regarding possible risks to the scenarios. In addition, they become familiar with the scenarios and gain a sense of ownership, which makes them more receptive to using the scenarios later on.

3.6 Adaptive management

Adaptive management is an approach to dealing with uncertainties in long-term strategic investments (such as investments in flood defences) to allow a flexible response to future developments and leave room for future decisions. Here, scenarios can be used to determine, among other things, the earliest and latest point in time when an 'adaptation tipping point' will occur, and the effect of additional or alternative measures on delaying these tipping points. Adaptation tipping points are situations or points in time when current policy objectives (e.g. meeting a certain flood protection standard) can no longer be achieved with existing measures. Quantitative, contextual scenarios that include time series are the most suitable for identifying tipping points.

3.6.1 Characteristics of adaptive management

Adaptive management is a method that has been developed, in part, in the context of the Dutch Delta Programme. The Delta Programme consists of measures to ensure flood protection in the Dutch delta in the short term and provides a basis for preparing for flood risks in the future. Adaptive management aims to support policymakers involved in strategic long-term investment decisions to better deal with the uncertainties inherent in the future. Although the Delta Programme focuses on flood risk management and freshwater supply, the adaptive management approach developed in this programme is also suitable for other policy areas that require strategic investment decisions, such as energy and transport.

One of the characteristics of strategic investment decisions (e.g. upgrading flood defences) is that they have a long-term impact. Investments such as flood defences have a long life span, and the cost of changing decisions is high. The future course of developments that influence the investment decisions and determine their success is often uncertain, especially in the long term. Examples are climate change and its impact on river discharges; land use changes; and changes in population densities in flood-prone areas.

Table 3.6

The role of scenarios in adaptive management: relevant activities and scenario characteristics required

Activities	Role of scenarios	Scenario characteristics required
Describing the decision-making context	• Explore, in a systematic way, the possible future course of autonomous developments and associated uncertainties	• Descriptive • Moderately to highly explorative • Mainly quantitative • Diachronic
Identifying adaptation tipping points	• Provide insight into the possible future course of developments, their mutual relationships and their influence on achieving policy objectives; Help to identify adaptation tipping points and follow-up measures	
Exploring adaptation pathways	• Provide insight into the minimum and maximum delay (time window) of adaptation tipping points if additional or different sets of measures are taken (alternative adaptation pathways)	
Evaluating adaptation pathways	• Help to make scorecards for different sets of measures (adaptation pathways) using criteria such as effectiveness, robustness and flexibility under different conditions	
Developing an adaptive plan	• Help to take into account different conditions in order to develop a plan that is robust and flexible	
Monitoring developments	• Suggest relevant developments, events and indicators to be monitored, and provide insight into critical values, trigger values, and early warning signs	

Adaptive management is aimed at developing flexible responses to autonomous developments and leaving options open for future decision-making (Haasnoot, 2013). The two key elements of the approach are a) developing an adaptive plan based on scenarios, and b) during implementation, use monitoring to track the course of developments that could necessitate adaptation of the plan. In this way, adaptive management helps to prevent strategies from being adjusted too late to meet changing conditions. For example, by monitoring relevant developments and taking into account the lead time for investments, it is possible to switch in time from repeated upgrading of river embankments to improving the water storage capacity of the floodplains.

3.6.2 Activities and scenario use in adaptive management

Adaptive management is a cyclical process, involving seven key steps: describing the decision-making context, identifying adaptation tipping points, exploring adaptation pathways, evaluating adaptation pathways, developing an adaptive plan, implementing the adaptive plan, and monitoring developments.[2] Each step provides room for adjusting parts of the plan, leading to increased flexibility. Scenarios can be helpful in all activities; only in the implementation of the adaptive plan is scenario use less obvious (Table 3.6).

Describing the decision-making context

The first step in adaptive management is to describe the context in which the decision-making is to take place, including the system characteristics, objectives, current constraints, and potential future constraints (Haasnoot et al., 2018). The resulting 'definition of success' is a specification of the desired outcomes in terms of targets and indicators. These are used in subsequent steps to evaluate the performance of actions and adaptation pathways, and to explore when, and under what conditions, adaptation tipping points could occur.

During this activity the major uncertainties and conflicts that play a role in the decisionmaking process are also specified. Here, scenarios can provide relevant insights, since they systematically explore the possible future course of social, physical and other autonomous developments, and the uncertainties surrounding these developments. In this case it is important that the scenarios not only present final images (end states), but also show the developments that can lead to those final images. Scenarios that present such time series are also called *transient scenarios* (Haasnoot, 2015).

Identifying adaptation tipping points

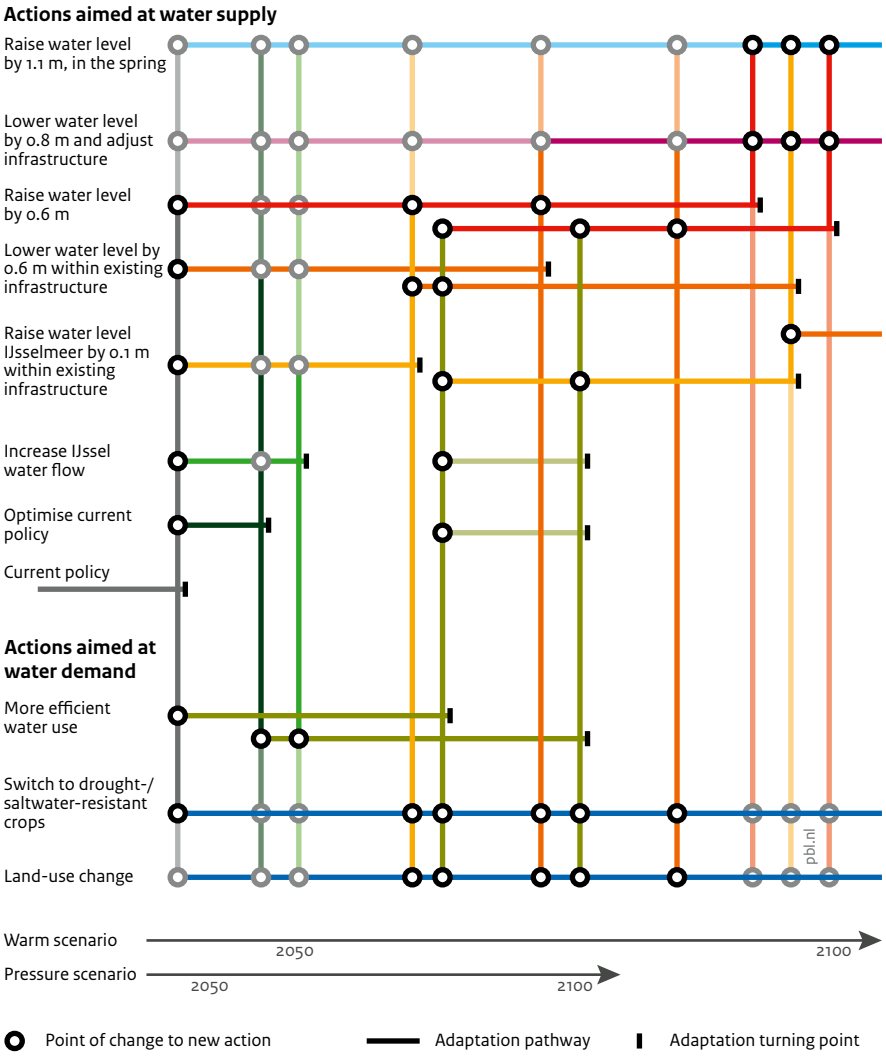
This step consists of determining the adaptation tipping points and exploring when they may occur. An adaptation tipping point is a situation or point in time when current measures are no longer sufficient to achieve the current policy objectives, such that additional or alternative measures are needed. For example, to meet flood protection standards, embankments can be raised, and raised again, but at some point this solution may become too expensive, bringing into view alternative measures such as widening and deepening the floodplains. Incidentally, this step is not only meant to identify vulnerabilities (tipping points) but also to discover opportunities, such as improved cost-benefit ratios and innovation.

Once an adaptation tipping point has been clearly and adequately defined, it can be explored when the tipping point would be reached and thus how much time is left to take measures to prevent the tipping point from actually occurring. In the case of flood protection, this moment depends, among other things, on future changes in river discharge, land use and population density.

Here, scenarios can help to determine when the tipping points will be reached. For example, in the case of flood risk management, scenarios provide systematic insight into developments that influence flood safety, the possible future courses of these developments, and the ways

Figure 3.3

Example of adaptation map freshwater resources



Source: Haasnoot, 2013

in which these developments affect each other and flood safety. In addition, they provide an indication of the expected ranges (upper and lower limits) of these developments: among the Delta scenarios, the 'Rest' scenario explores developments in the case of low dynamics, while the 'Steam' scenario explores the case of high dynamics.

To determine the timing of the adaptation tipping point in this example, the expected changes in (peak) river discharge are compared with the current flood protection standard, in each scenario. If the expected peaks exceed the current standard, this indicates an adaptation tipping point. By doing this comparison for two or more scenarios, the earliest and latest moment at which the tipping point is expected to occur can be identified. For example, in the 'Steam' scenario this point may be reached in five years' time, while in the 'Rest' scenario it may be reached in twenty years' time. It is also possible that a scenario does not show any tipping point. In that case, the current measures are sufficient for the conditions, developments and time period covered in the scenario in question.

Exploring adaptation pathways

Adaptation pathways consist of sets of measures that can be taken in the future to achieve a specific policy goal (e.g. ensure flood protection). Adaptation pathways can be explored by making an adaptation pathways map (Haasnoot, 2013). This map clearly shows which sets of measures are possible, where the adaptation tipping points lie, and which follow-up measures can be taken (Figure 3.3). In addition, the map shows which pathways are flexible and which ones lead to *lock-ins*. In this context, a *lock-in* is defined as a 'non-adaptable' pathway that can only be abandoned for another pathway at high economic or costs. An example is an embankment that cannot raised or repositioned because it borders on a densely built-up area.

When the adaptation tipping point is reached, new measures are needed to ensure that the policy goal can still be achieved. This moment is usually anticipated with proactive measures to prevent the tipping point from actually occurring. These measures – for example, building a flood wall on top of the embankment, or creating an overflow area – have to be considered well in advance. If the policymakers involved identify these measures together, they can also agree who takes responsibility for which measures.

The effect of these measures is that the adaptation tipping point is postponed, and that the policy objective can be achieved across a longer time period. This extension can be translated into a lead time for taking new measures. To achieve this, the expected increase in peak discharge (cubic metres per second) must be estimated first. Based on the possible future peak discharges explored in the scenarios, it can then be estimated by how many years the measures would postpone the tipping point at least (in the scenario with the highest dynamics) and at most (in the scenario with the lowest dynamics) (Van Rhee, 2012). This is called the time window. The adaptation pathways map is constructed by placing the measures along the Y-axis and the different time scales (which are scenario dependent) along the X-axis. Each measure moves the adaptation tipping point forward in time (to the right).

Evaluating adaptation pathways
Each adaptation pathway has certain advantages and disadvantages that policymakers can consider in the final choices they make. This is done by evaluating the pathways against a number of criteria: effectiveness, side effects, costs, implementability, and robustness and flexibility. The key is to evaluate the pathway as a whole, rather than individual measures. This is to avoid focusing too much on the short term; after all, what is favourable in the short term could be unfavourable in the long term. For example, certain measures may be low-cost in the short term but lead to a *lock-in* in the long term, requiring follow-up measures that are much more expensive.

The criteria scorecards for the adaptation pathways usually differ per scenario. For example, the effectiveness of raising an embankment is greater for urban areas than rural areas, because urban areas have a higher population density and building density. The criterion 'robustness and flexibility' explicitly takes this difference into account. Robustness refers to the performance of an adaptation pathway across different scenarios: if the criteria scores vary widely between scenarios, the pathway is less robust than if the differences are small. One pathway will be more flexible than another, if the measures of the former can be more easily adapted (stepped up, stepped down, postponed, advanced), or can be more easily combined with other measures. The level of detail in the scoring depends on the time horizon considered. The further in the future, the greater the uncertainties and the more general the scores.

Developing an adaptive plan
This step consists of making an adaptive plan in which the desired short-term actions and long-term options are described (Haasnoot et al., 2018). The adaptive plan summarises the results of the previous steps and combines the adaptation pathways that are preferred by the parties involved. The adaptation pathways map developed during the step 'Exploring adaptation pathways' plays an important role in this process. The robustness and flexibility of the plan are increased by contingency planning, i.e. identifying corrective actions to keep the preferred adaptation pathways on track, and anticipatory actions to keep desired long-term options open for as long as possible. In this process, scenarios help in the ways described above to take account of different future developments and to develop a plan that is truly robust and flexible.

Monitoring developments
The most important developments to monitor are those that influence the adaptation tipping points (as identified in the step 'Identifying adaptation tipping points'). In addition, developments that are critical for keeping the preferred pathway on track should also be monitored. If the preferred pathway approaches a tipping point, actions must be taken to stay on track or switch to another pathway. It is also relevant to monitor developments that could make such a switch impossible.

In order to monitor developments, one or more concrete indicators must be identified for each development. These are then combined into sets of indicators in order to maintain

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an overview. Scenarios can help to identify relevant indicators based on the developments described in the scenarios, and to assess whether they meet the criteria. This is mainly done by qualitative interpretation of the developments described and the possible directions they can take according to the scenarios.

Monitoring the indicators provides insight into how fast an adaptation tipping point is approaching and which developments are moving it closer. This insight provides information on critical trends and enables timely anticipation. It is also important to specify critical values, trigger values and early warning signals where possible. A critical value is the indicator value at which an adaptation tipping point is reached or switching to a different pathway becomes impossible. A trigger value is the indicator value that provides a warning well before the critical value is reached, allowing enough time to take measures. Early warning signals indicate at a very early stage whether a development that could move a tipping point closer is about to happen. Similarly to identifying indicators, scenarios can help to identify relevant critical values, trigger values and early warning signals.

In addition to developments that follow a more or less steady course, there can also be unexpected, disruptive events, for example, an embankment failure in Germany leading to flooding in the east of the Netherlands. Due to the combined effect of a disruptive event and ongoing developments that advance the tipping point, it can happen that the tipping point is suddenly exceeded. This may be acceptable if the situation is temporary, but new measures will be needed if the recovery time is too long. Scenarios that not only explore developments but also consider disruptive events will help to take this into account.

3.6.3 Scenario characteristics required for adaptive management

For adaptive management, scenarios will be most useful if they have the following characteristics:

Descriptive. Adaptive management is generally based on the use of descriptive scenarios (contextual scenarios), not normative scenarios (policy scenarios). Descriptive scenarios often assume that existing policy (and policy objectives) will be continued. Their insights into possible future developments and events are needed to explore adaptation tipping points, to formulate adaptation pathways, and to develop preferred pathways. However, these steps may reveal that existing policy objectives are not achievable or that they are not ambitious enough. Hence it is important to keep in mind that descriptive scenarios,

though 'policy poor', are not 'policy free': although these scenarios focus on autonomous developments, the adaptation pathways based on them will include sets of measures that assume a continuation of existing policies.

Moderately to highly explorative. For adaptive management, moderately explorative scenarios are sufficiently diverse to explore different adaptation pathways and tipping points. If they were more radically different it would become impossible to take account of time windows (because these would be too far apart) or to map out preferred pathways (because it would be too hard to devise robust sets of measures). Moderately explorative scenarios do pay attention to disruptive events, but do not cover extreme events (such as deadly epidemics). In this respect they differ from dominant scenarios, which tend to be completely 'surprise-free'. In adaptive management, highly explorative scenarios are used, for example, to gain insight into discontinuities (wild cards, black swans) and to identify contingency measures to address these.

Mainly quantitative. Adaptive management makes use of qualitative methods (e.g. expert judgment) as well as quantitative methods (e.g. model calculations). The storylines provided in qualitative scenarios help to explore adaptation pathways. However, in many of the steps discussed above, quantitative scenarios clearly offer added value. For example, only quantitative scenarios will allow to estimate, with a certain degree of accuracy, the start and end year of a time window. Quantitative scenarios are also important for evaluating sets of measures in terms of their effectiveness, side effects and other criteria.

In this context, it should be kept in mind that scenarios usually present orders of magnitude rather than exact figures. Given the uncertainties surrounding the course of future developments, exact figures would provide false certainty. Not all developments and relationships between developments are quantified in the scenarios; some are only described in a qualitative way. In addition, there are developments that cannot be quantified at all, such as the changing relationships between different levels of government, or between government, business and civil society organisations.

Diachronic. For adaptive management it is important that the scenarios take a diachronic approach, showing not only the end states but also the steps towards these states, and differentiating between periods in which developments have different dynamics. For example, some developments will be slow at first and then accelerate (e.g. the expected pattern for climate change if no additional measures are taken), while other developments may fluctuate over time (e.g. the boom-and-bust cycle of economic growth). For adaptive management a scenario study is most useful if each of its scenarios contains time series that reflect the course and dynamics of relevant developments over time, for example in five-year time steps. Such scenarios are known as transient scenarios (Haasnoot, 2013).

3.7 Cost-benefit analysis

Cost-benefit analysis (CBA) provides an answer to the question of whether a policy measure contributes to social well-being. In the Netherlands, CBAs are mandatory for large infrastructure investment projects within the Multiannual Programme for Infrastructure, Spatial Planning and Transport (MIRT Programme). CBAs are used not only as a basis for *go/no-go* decisions, but can also provide reasons to optimise or postpone measures or show that alternative measures are more effective in solving a particular problem. Scenarios help to anticipate future developments and limit the risk of wrong decisions being taken. CBAs mostly use scenarios that are descriptive, quantitative and moderately explorative.

3.7.1 Characteristics of cost-benefit analysis

Cost-benefit analysis (CBA) is a tool for ex ante evaluation of policy measures. In principle, CBAs can be applied to any policy measure in any policy area. The method is used to substantiate decisions regarding large infrastructure investment projects, such as embankments, roads and urban extensions, but also, for example, in the policy areas of environment, public health and social affairs. In the Netherlands, CBAs are mandatory for large infrastructure investment projects within the Multiannual Programme for Infrastructure, Spatial Planning and Transport (MIRT). In these projects, CBAs are used in the planning phase to compare and assess alternatives; for example, widening a motorway versus investing in public transport or implementing road pricing (IenM, 2010). CBAs that are carried out for or by the government must comply with the guidelines and regulations as described in the general guidance (Romijn and Renes, 2013).

In order to decide on a policy measure, a multitude of dissimilar advantages and disadvantages have to be weighed against each other – for example, shorter travel times and lower transport costs versus increased exposure of local residents to noise pollution and damage to nature areas, as a result of motorway expansion. CBAs provide an overview of the effect of taking no measures (baseline), or several alternative measures, the associated risks and uncertainties, and the resulting advantages (benefits) and disadvantages (costs) for society as a whole. By quantifying the advantages and disadvantages and expressing them in monetary terms (monetising) as much as possible, CBAs provide insight into how proposed measures would affect social well-being, as shown by the balance of benefits minus costs (expressed in euros). This balance includes the costs and benefits of the effects on social well-being that have no market price, such as the effect of motorway expansion on travel times, the health of local residents, and on plant and animal species in nearby nature areas.

Ideally, CBAs should express the effects in monetary terms, as much as possible. This makes the effects mutually comparable, and provides clear information on the basis of which policymakers can weigh the advantages against the disadvantages. In this way, CBAs can provide an answer to the question of whether the benefits of a proposed policy measure outweigh the costs. In practice, it is often not possible to express all effects in monetary terms, but quantifying them in other units also provides valuable information. Even when

Table 3.7
The role of scenarios in cost-benefit analysis: relevant activities and scenario characteristics required

Activities	Role of scenarios	Scenario characteristics required
Conducting the problem analysis	• Provide insight into the future course of the problem (baseline) and its causes	• Mainly descriptive • Moderately to highly explorative • Mainly quantitative
Defining the baseline alternative	• Provide insight into the future development of relevant markets and help to define the baseline alternative	
Identifying policy alternatives	• Help to extend the range of policy alternatives considered	
Analysing alternatives and risks	• Help to identify the uncertainties surrounding the expected effects of alternative measures	
Presenting the results	• Help to present the uncertainties in a fair and clear manner	

applying only its basic principles, policy preparation can already benefit from the CBA approach.

In the evaluation of proposed policy measures, CBAs are used not only for supporting *go/no-go* decisions, but also for policy optimisation, i.e. for fine-tuning policy measures to achieve a positive or more positive cost-benefit outcome. For example, the costs of a motorway expansion can be reduced if the lanes are narrowed to minimise the total amount of space required. Furthermore, CBAs can provide arguments to postpone a measure, or to implement it in steps (phased implementation).

The idea is to use a 'light version' of CBA, early in the decision-making process, as a framework for structuring policy preparation. In this process, questions such as 'What is the problem?', 'How will the problem develop if no new policy is implemented?' and 'What are possible solutions?' help to make the discussions on policy measures more focused and matter-of-fact. A full-blown version of CBA can be applied later on in the decision-making process.

3.7.2 Activities and scenario use in CBA

CBAs follow a number of steps that run more or less parallel with policy preparation. According to CPB and PBL's guidelines for preparing CBAs (Romijn and Renes, 2013), these steps are as follows: 1) conducting the problem analysis, 2) defining the baseline alternative, 3) identifying policy alternatives, 4) assessing the benefits, 5) assessing the costs, 6) analysing alternatives and risks, 7) making an overview of the costs and benefits,

and 8) presenting the results. Steps 1 to 3 are preparatory steps, steps 4 and 5 form the core of the method, step 6 relates to dealing with risks and uncertainties, and steps 7 and 8 conclude the analysis. Scenarios are used mainly in steps 1 to 3, 6 and 8 (Table 3.7).

Conducting the problem analysis

Problem analysis is aimed at describing the problem (or challenge or opportunity) for which a solution is being sought, including its expected future course and underlying causes. In addition, it defines the problem boundaries and indicates why the government should play a role in addressing the problem and what kind of role this could be.

Contextual scenarios provide insight into how the problem may evolve in the future and the underlying causes. Specifically, they explore the possible future courses of developments that likely contribute to or cause the problem, their interactions, and their possible effects on how the problem will evolve in the future. Contextual scenarios show, for example, how the problem of traffic congestion may grow over time as a result of possible economic, demographic, technological and other developments. Furthermore, they provide insight into the underlying uncertainties, by indicating the expected ranges (upper and lower limits) of these developments based on comparing the scenarios with the lowest growth and the highest growth. The 'Low' and 'High' scenarios of the study *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015), which compare low versus high socioeconomic dynamics, have been developed for this purpose.

Defining the baseline alternative

The baseline alternative is the most likely development if no measures are taken (e.g. increased motorway congestion), considering all markets relevant to the CBA. It takes into account existing policy, proposed measures and minor interventions that reduce but do not solve the problem. The baseline alternative serves as a reference against which the effects of new policy measures can be compared, which helps to pinpoint the effects produced by these measures. The baseline is primarily determined by the course of developments that influence the problem in question. In addition, it takes into account existing policy, as well as planned policy that is close to being implemented and minor interventions that reduce the problem but do not constitute a policy alternative (e.g. ramp metering to manage traffic at motorway access points).

Contextual scenarios are helpful in defining the baseline alternative in the same way as in conducting the problem analysis. In addition, they provide insight into the expected future course of markets relevant to the CBA and the factors influencing these developments. Relevant markets are not only those markets at which the measure is targeted (direct effects), but also those markets where the measure is likely to have significant indirect effects. Furthermore, scenarios help to determine how policy may develop if the measure in question is not implemented. Contextual scenarios usually account for 'minimally differentiated policy trends' (Dammers et al., 2019). These trends assume that the main policy lines from recent years and lately adopted policy will be continued (also beyond the

period covered by the policy), with a slightly different emphasis in each scenario in order to ensure plausibility and consistency.

Identifying policy alternatives
Policy alternatives consist of measures that are expected to contribute to solving the problem and that are analysed in the CBA. Motorway expansion, extra investments in public transport, and road user charges are examples of policy alternatives for addressing traffic congestion. Here, it is important to clearly define which measures belong to which alternative, and to describe the different components of the measures in as much detail as possible.

The CBA literature mainly focuses on the use of contextual scenarios. However, policy scenarios can also play a useful role, particularly in identifying policy alternatives, because they explore different possible policy strategies and hence can generate ideas for alternatives. In addition, policy scenarios can help to check whether the range of alternatives considered is broad enough. Components from the general strategies explored in the scenarios can be translated into concrete policy measures to be included in CBAs (Koopmans, 2012). This helps to extend the range of alternatives being considered, to assess the feasibility of lesser-known alternatives, and to further develop these alternatives. In this way, less obvious options such as waterborne transport (next-generation water taxis) and airborne transport (next-generation zeppelins) can be brought into the picture when looking for policy alternatives to address traffic congestion.

Analysing alternatives and risks
Because the future course of autonomous developments and their influence on a measure's costs and benefits are uncertain, estimates of these costs and benefits come with uncertainty ranges (Koopmans, 2004). The analysis of alternatives and uncertainties can give reason to supplement the defined policy alternatives with (more) flexible alternatives that take these uncertainties into account, for example, by postponing the measure or opting for phased implementation (Text Box 3.2).

Scenarios provide insight into uncertainties by exploring, in a coherent way, the long-term course of autonomous developments. In this way, scenarios can contribute to assessing the robustness of CBA outcomes in the light of these uncertainties. By analysing a measure's costs and benefits in different scenarios, insight is gained into the possible welfare effects of this measure under different circumstances. This makes clear to what extent such effects are uncertain and shows the critical factors of success or failure.

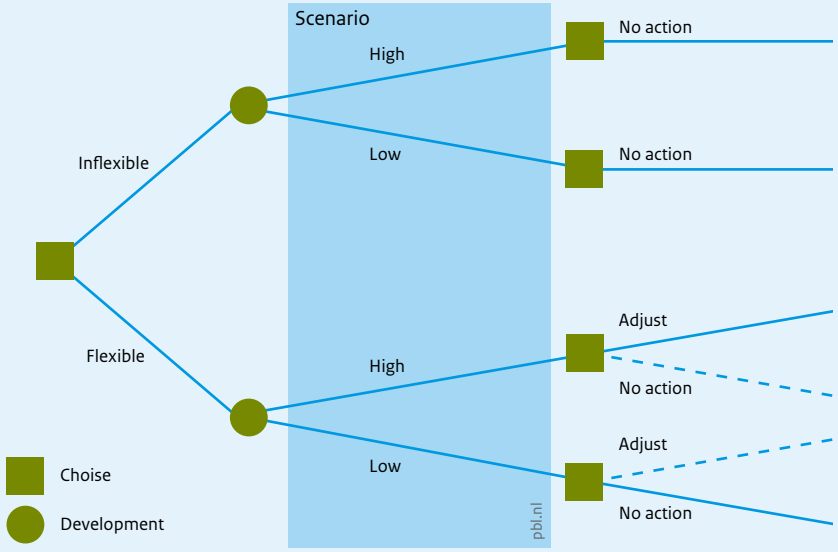
If researchers find it too labour-intensive to analyse a measure for three or more scenarios, they can choose to focus on the two scenarios that cover the upper and lower limits of the developments explored. It sometimes happens that they use only one scenario and limit their sensitivity analysis to a few crucial developments. This approach is less labour-intensive but has the drawback that it provides only ad-hoc insight into uncertainties as the interactions between developments are not considered. It also happens that

researchers use only one scenario and do not perform any sensitivity analysis. This is often due to political pressure to present the measure considered most desirable as being the only or inevitable choice (Van Essen and Van 't Hoen, 2013). The drawback of the latter approach is that it ignores uncertainties, misrepresents the cost-effectiveness of the policy measure and underestimates the risks involved (Romijn and Renes, 2013). Hence, the practice of focusing on one scenario only (whether with or without sensitivity analysis) is not in line with the CBA guidance or the user guide of the WLO scenarios[3] (Renes and Romijn, 2015).

Text Box 3.2 Real options

Infrastructure investments often have a long life span and are difficult to adapt or to be switched to other uses (Bos et al., 2016). By building flexibility into the policy alternatives, the uncertainties associated with future developments can be better anticipated, and the risk of taking wrong decisions can be reduced. Flexibility can be increased by delaying investments or phasing them over time. For example, investments can be delayed in anticipation of new techniques that provide better or cheaper solutions, such as the breakthrough of self-driving vehicles that could increase motorway capacity. Phasing investments over time has the advantage that the most urgent problem can be solved first, and that a more comprehensive and expensive solution can be applied at a later date only when needed (e.g. the phased construction of additional motorway lanes).

Figure 3.4
Example of decision tree



Source: Bos et al., 2016

To include the costs and benefits of flexibility into the CBA, 'decision trees' can be drawn to provide a clear overview of the successive investment decisions in different scenarios. Figure 3.4 shows an example of a decision tree with two decision moments. The first decision moment is to choose between a flexible and a non-flexible option. This choice creates two branches, each of which splits into two further branches for when either the low-growth or high-growth scenario becomes a reality. Here, the flexible option has a second decision moment: in the high-growth scenario it is cost-effective to adjust the policy alternative, while this is not the case in the low-growth scenario. This is an example of a deferred, optional investment that has value under specific conditions; such investments are known as 'real options'.

Presenting the results

A good CBA report meets the following requirements: it provides a clear and accessible presentation and justification of the results, presents useful building blocks for answering the questions that policymakers consider relevant for their decision-making, and offers a clear interpretation of the results. Furthermore, it presents the most important results in a summary table, showing the expected costs, benefits, and cost-benefit balance for each policy alternative. Last but not least, it clearly explains the story behind these numbers.

A clear and accessible presentation and justification of the results includes addressing the uncertainties surrounding the estimated costs and benefits of the policy measures analysed. This can be done by showing, in the summary table, the uncertainty ranges of the estimates as derived from the scenarios. However, not all CBA reports actually show these ranges. As noted in Section 1.2, it sometimes happens that CBA reports for infrastructure projects present only one scenario, even if calculations were done for several scenarios (Van Essen and Van 't Hoen, 2013). The scenario focused on in these reports is that with the highest mobility growth, whereby it is suggested that this is the middle-range scenario. The drawbacks of this approach have already been discussed above (see 'Analysing alternatives and risks').

3.7.3 Scenario characteristics required for CBA

Scenarios used in CBAs, preferably, have the following characteristics:

Mainly descriptive. Descriptive scenarios (contextual scenarios), which explore the possible future course of autonomous developments and their effects on the policy problem, play a dominant role in CBAs. In large infrastructure investment projects in the Netherlands, it is standard practice to use the descriptive scenarios from *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015), also known as the WLO scenarios.[3] These scenarios, which assume continuation of current policy, play an important role in identifying the uncertainties surrounding future developments. They are also relevant for determining the baseline alternative and for presenting the results. Normative scenarios (policy scenarios), which explore alternative policy strategies, can also play a role in CBA; in particular, they can provide inspiration and ideas when identifying policy alternatives, both before and during the CBA.

Moderately to highly explorative. Scenarios used in CBA are usually moderately explorative. Highly explorative scenarios would be less suitable for analysing the costs and benefits of policy measures because of the greater differences between scenarios. In extremely high-growth scenarios many investment projects would have a favourable CBA outcome: if the problem keeps growing (e.g. longer and longer traffic jams), the benefits of the solution (e.g. motorway expansion) will soon outweigh the costs. Conversely, in extremely low-growth scenarios many investment projects can never become cost-effective: the problem will hardly increase or perhaps even decrease, such that the costs of the solution will far outweigh the benefits. *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015) therefore contains two 'moderate' scenarios, 'Low' and 'High', which explore developments based on average trends.

However, when exploring real options (Text Box 3.2) it is more important to use scenarios that are highly explorative, because they make clear the benefits of a flexible approach. Highly explorative scenarios are also useful for identifying policy alternatives, particularly when they vary widely; such scenarios can point to alternatives that are less obvious and that have not yet been considered.

Mainly quantitative. When carrying out a CBA, ideally the aim is to quantify and monetise, as much as possible, the proposed policy measures and their possible effects. To support these calculations, it is important that the scenarios used are also quantified where possible. The advantage of quantitative scenarios over qualitative scenarios is that they not only provide numerical insights into the course of autonomous developments and their effects on the problem and welfare outcome of the possible solutions, but also quantify and make explicit the assumptions used in this context (De Beer, 2011). At the start of the decision-making process – when only the broad outlines of the problem, baseline and policy alternatives are known – the CBA philosophy can be used to structure the process. In that case, the cost-benefit analysis will be more qualitative than quantitative and hence, qualitative scenarios can be useful at that stage.

3.8 Environmental impact assessment

Environmental impact assessment is a method for ex ante policy evaluation that, in the Netherlands and many other countries, is legally required when preparing plans and projects that are likely to have significant adverse effects on the environment. In the Netherlands, this requirement also applies to physical investment projects within the Multiannual Programme for Infrastructure, Spatial Planning and Transport (MIRT).
In environmental impact assessment, scenarios help to account for different conditions and to develop different alternatives. This is especially useful in preparing the environmental assessment report but also in other steps of the assessment. Both descriptive and normative scenarios play a role. The former will be most useful if they are quantitative and the latter if they are highly explorative.

3.8.1 Characteristics of environmental impact assessment

There are various methods for environmental assessment (EA), which have many similarities but should not be confused (Jäger et al., 2007). Traditional 'State of the Environment Reporting' (SoR) focuses on the state of the biophysical environment and human pressure on environmental resources and analyses environmental trends. Integrated Environmental Assessment (IEA) covers both environmental and social and economic aspects in an analysis of environmental states and trends linked with policy analysis (Boileau et al., 2017).

Strategic Environmental Assessment (SEA) is a systematic and comprehensive process of evaluating, at an early stage, the environmental effects of a policy, plan or programme. Environmental Impact Assessment (EIA, abbreviation not to be confused with IEA) is a tool or framework for evaluating the possible environmental risks and effects of a proposed activity (plan, project). This section focuses on EIA and is also relevant for SEA, because these methods use scenarios. (In SoR, this is usually not the case, but it may include 'horizon scanning'; and IEA focuses on scenario development, rather than scenario use).

Similar to cost-benefit analysis (CBA), environmental impact assessment (EIA) is a method for ex-ante evaluation of policy proposals. It helps to ensure that environmental concerns are fully taken into account when preparing plans and projects (EIA Commission, 2017). In the Netherlands, as in the other EU Member States, EIAs are required by law for government-commissioned plans and government decisions about public and private initiatives and activities that may have significant adverse effects on the environment. Examples include airport expansions, embankment reinforcements, and setting up chemical plants. The starting point for an EIA is to explore a broad range of environment-friendly solutions.

In the Netherlands, the EIA requirement also applies to projects carried out within the Multiannual Programme for Infrastructure, Spatial Planning and Transport (MIRT). Like CBAs, EIAs are used to select a preferred alternative from a number of policy alternatives (RWS, 2010). In the preliminary phase, promising alternatives are compared in a 'plan EIA'. The preferred alternative is subsequently elaborated, in more detail, in what is called a 'project EIA'.

When a government body has to take a decision about a plan, project or permit, it may use EIA results to support the decision-making process. Before the government body (competent authority) can start this process, the initiator of the project must describe all the related environmental effects. In EIA reports, projects are referred to as 'the intended activity'. Such reports must also present the environmental impact of a number of alternative solutions. Furthermore, the environmental effects of the intervention must be compared to the expected future situation without the intervention ('reference situation'). In this way, the initiator, the competent authority and the public will be able to gain insights, in advance, into the environmental effects of a plan or project and its various alternatives.

Table 3.8

The role of scenarios in environmental impact assessment: relevant activities and scenario characteristics required

Activities	Role of scenarios	Scenario characteristics required
Consultation with advisors and relevant government bodies on the scope and level of detail of the EIA	• Provide insight into the future size of the task or problem addressed by the plan/project, if the plan/project is *not* implemented (reference situation) • Inspire the initiator, competent authority, EIA Commission and other stakeholders to consider a broader range of alternatives in the EIA	• Descriptive and normative • Qualitative and quantitative • Moderately to highly explorative • Participatory
Competent authority calls for views on the scope and level of detail		
EIA Commission advises on the scope and level of detail		
Competent authority advises on the scope and level of detail		
Preparing and publishing the EIA report	• Provide insight into what would happen or change without the intended activity or alternatives • Help to develop genuinely different alternatives • Help to determine environmental impacts under different conditions	
Competent authority calls for views on EIA report	• Help the competent authority, EIA Commission and parties submitting views to verify whether the EIA has accounted for genuinely different conditions and has considered clearly different alternatives	
EIA Commission assesses whether the EIA is accurate and complete		
Competent authority decides on the plan / takes a decision (including a justification)		

3.8.2 Activities and scenario use in EIA

The EIA procedure is laid down by law (EIA Commission, 2017). The full version of the procedure is required for plans such as spatial planning visions and zoning plans, and also for complex projects such as projects requiring a tailored assessment or where the initiator and competent authority are the same party (e.g. embankment reinforcement projects and road project route decisions). The short version applies to permits, such as environmental permits and soil excavation permits.

The EIA procedure consists of the following steps: 1) the initiator informs the competent authority[4] and notifies the public (the latter is mandatory only in the full procedure), 2) consultations are held with advisors and relevant government bodies on the scope and level of detail of the assessment (mandatory in the full procedure), 3) the competent

authority invites submission of views on the scope and level of detail (mandatory in the full procedure), 4) the EIA Commission can be asked to give advice on the scope and level of detail (not mandatory), 5) the competent authority gives advice on the scope and level of detail (only if the competent authority is not the initiator), 6) the EIA report is prepared and published, 7) the competent authority invites submission of views on the EIA report, 8) the EIA Commission verifies whether the EIA report is correct and complete (mandatory in the full procedure), 9) the competent authority decides on the plan or takes a decision (including a justification) 10) the plan/decision is published, and 11) the EIA is evaluated.

Scenarios can play an important role in almost all of the steps above, except step 1 (initiator informing the competent authority), step 10 (publishing the decision and final plan) and step 11 (evaluation) (Table 3.8).

Consultation with advisors and relevant government bodies on the scope and level of detail of the EIA
The competent authority consults with advisors and government bodies involved in the decision-making on the scope and level of detail of the assessment. This activity (which is known as 'scoping') mainly concerns identifying the reasons for the plan or project, and the possible alternatives and environmental impacts to consider. Whether these elements are elaborated in a concise or detailed manner depends mainly on whether it concerns a new plan, or an existing plan of which the broad outlines have already been decided and assessed in a previous EIA.

The competent authority calls for views on scope and level of detail
The competent authority announces that it is preparing a plan or decision and invites all interested parties to submit their views on the scope and level of detail of the EIA.

The EIA Commission advises on the scope and level of detail
It is not mandatory to ask the EIA Commission for advice, but this commission may be consulted on a voluntary basis. When asked for advice, the commission will set up a working group and publish their advice in writing.

The competent authority advises on the scope and level of detail
If the competent authority is not the same party as the initiator, it will advise on the scope and level of detail of the EIA. In the four steps outlined above, scenarios can be useful for all parties involved: the initiator, the competent authority, the advisors, the EIA Commission and interested parties submitting a view. Contextual scenarios can provide insight into the potential future size of the task or problem addressed by the plan or project if the plan or project is *not* implemented; for example, the traffic problems that may arise in the future if a road is not widened. These scenarios also give an indication of the expected range of the task or problem, for example the minimum and maximum level of traffic congestion to be expected based on low versus high mobility growth. These insights help to substantiate or put into perspective the usefulness and necessity of the plan or project.

In addition to contextual scenarios, policy scenarios are also useful in these steps: they can provide inspiration to the initiator, competent authority and other parties involved to consider a broader range of alternatives in the EIA than they had in mind beforehand. For example, in the context of solving traffic congestion, policy scenarios can point to the possibilities of water transport, ramp metering and road user charges as alternative options for motorway expansion. Policy scenarios can also draw attention to environmental impacts to be considered in the EIA with regard to the alternatives.

Preparing and publishing the EIA report

The initiator (which may be the same party as the competent authority) is responsible for drawing up the EIA Report. The different parts of the report where scenarios can be helpful are discussed below: the intended activities and alternatives, the current situation and autonomous developments (reference situation), the environmental effects, the comparison, the mitigating and compensating measures, and the summary.

Intended activity and alternatives. This part of the EIA report describes the plan or project that the initiator proposes to develop or undertake, and the alternatives that can reasonably be considered in this context. Here, 'reasonable' means that the alternatives are technically feasible and affordable and in principle would achieve the same goal as the proposed activity. The initiator also gives a justification for the choice of alternatives. Identifying and developing alternatives is a crucial part of the EIA, because this determines the scope for the final decision: what is not included in the EIA cannot be included in the decision either. Moreover, exploring alternatives can reveal unexpected options for optimising the plan or project.

Contextual scenarios can contribute to developing plans or projects whose effects are likely to be influenced by socio-economic or physical-environmental developments (Bakker, 2015). These scenarios help to identify the relevant developments, provide insight into the directions these developments may take, and give an indication of the uncertainties involved. With regard to the latter, it is important that the expected range of a development can be identified by comparing the scenario with the lowest dynamics to the scenario with the highest dynamics. For example, the Delta scenarios (Deltares et al., 2013) show that, if current policy is continued, flood safety in the Netherlands will be affected by rising sea levels, economic growth, population development and urbanisation. Specifically, they indicate that, by 2050, the North Sea level will have risen by 15 to 35 centimetres, economic growth will be 1.0% to 2.5%, population size will be 15 to 20 million, and urban areas will cover 21% to 25% of the country.

Policy scenarios, particularly those that are strongly divergent, provide inspiration to develop alternatives that uncover new options. For example, scenarios based on different world views can help to derive leading principles for the different alternatives. This allows to cover a broad spectrum of viewpoints with a manageable number of alternatives, and to structure the critical components of each alternative. For example, the water outlook study *Waterplanverkenning* (De Groen et al., 2008) presents three scenarios, each based on a

different world view: 'Build on what's good' (hierarchical world view), 'Growing along together' (egalitarian world view) and 'Seize the opportunities' (individualistic world view). These perspectives can help to develop alternative strategies for flood protection: technical solutions carried out by the government (hierarchical), collaborative solutions in which different stakeholders work together (egalitarian), and market-driven solutions and services offered by commercial parties (individualistic). Examples of measures in the first category are embankment reinforcements and flood walls; in the second, river bypass channels, 'green rivers' and overflow areas; and in the third, elevated homes, floating offices and flood insurance.

Current situation and autonomous development. This part of the report describes the present state of the environment (focusing on those elements that would be affected by the intended activity or alternatives), and the likely development of this environment if the activity or alternatives are *not* implemented. Describing this 'reference situation' is necessary to determine the environmental effects of the intended activity and the alternatives, and helps to make clear to what extent they would contribute to the total environmental burden on the area concerned. The reference situation is based on the assumption that existing government policies will be continued and that projects that have already been approved will be implemented.

Contextual scenarios, such as *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015) can be used to gain insight into the likely developments if a plan or project is *not* realised. These scenarios are focused on exploring the possible future course of social and physical-environmental developments, based on the assumption that established government policy will be continued and that projects that have already been approved will be implemented (i.e. the same assumption as for the reference situation in the EIA). In this way, contextual scenarios can provide insight into the expected environmental burden – and underlying uncertainties – if the intended activity or alternatives are not implemented.

Environmental effects. This part of the report describes the potential environmental impact of the intended activity and the alternatives. This includes, for example, their possible effects on public health, greenhouse gas emissions, and cultural heritage and landscape, and the interaction between these effects. The effects can be positive or negative, direct or indirect, temporary or permanent, and cumulative or synergistic, and they may occur in the short, medium or long term. The report must include a justification for the methods used for assessing and describing these effects and indicate if (and which) environmental standards will be violated.

If contextual scenarios have been used for describing the intended activity and alternatives and their results under different conditions (in the preceding part of the report), it is obvious that the description of their environmental effects should indicate which effects are expected under which scenario. This can be done by consistently showing the expected range of each effect, where possible.

Comparison. This part of the report systematically compares the possible environmental effects of the intended activity and alternatives with the effects that may occur in the reference situation. This comparison forms the heart of the EIA. The results are presented in an overview table, in which the intended activity and alternatives are compared based on various environmental aspects, including effects on public health, greenhouse gas emissions and cultural heritage. Again, if contextual scenarios have been used for describing the intended activity and alternatives (in the preceding part of the EIA report), it is obvious that this comparison should indicate which effects are expected under which scenario. This can be done by presenting two overview tables, where one presents the environmental effects as expected in the low-dynamics scenario, and the other shows these effects for the high-dynamics scenario.

Mitigating and compensatory measures. This part describes the possible measures to prevent, reduce or offset the most important adverse effects of the intended activity on the environment. Elements from the alternatives can be included in the intended activity to reduce its impact. For example, instead of raising a river embankment along its entire length, the plan can be changed to raise only some sections (where there are no historic buildings on the embankment) and to improve flood protection in other sections by relocating the embankment (where there are historic buildings) or digging a secondary channel (wider floodplain).

Here, contextual scenarios can help to explore the environmental effects of the mitigating and compensatory measures under different conditions, and hence to assess how effective these measures are under these conditions.

Summary. The summary of the EIA report serves to provide sufficient information to enable the general public to judge the EIA and the environmental effects of the intended activity and alternatives described in the report.

If contextual scenarios have been used to explore the possible effects and results of the intended activity and alternatives under different conditions, this should also be reflected in the summary. This can be done by presenting a matrix showing the performance of the activity and alternatives in the low-dynamics versus high-dynamics scenario.

The competent authority calls for views on the EIA report
In this step, the competent authority announces the EIA report and the permit application or (draft) decision, and makes these documents available for inspection. Any interested party can submit a view, both on the report and the application or decision.

The EIA Commission verifies the EIA's accuracy and completeness
The EIA Commission advises the competent authority on the EIA conducted. In particular, the committee verifies the accuracy and completeness of the assessment.

The competent authority decides on the plan / takes a decision, including a justification
In this step the competent authority takes a decision and provides a justification for the decision taken. This means that the competent authority explains how they have considered and weighed the environmental effects described, the alternatives considered, the views submitted, and the advice received from the EIA Committee. They also indicate the ways in which citizens and civil society organisations have been involved in plan development. In addition, they lay down the evaluation procedure (how and when).

In the three steps above, contextual scenarios can help the parties involved (competent authority, EIA Commission and anyone wishing to submit a view) to verify whether the EIA has truly taken into account different conditions or focuses only on conditions that have a favourable environmental outcome. Policy scenarios can help these parties to check whether the EIA has considered truly different alternatives or whether certain options, such as market-based solutions, have been left out. For parties wishing to submit a view, it is important that the summaries of the EIA and the scenarios are published widely and that these summaries are clear and comprehensive.

3.8.3 Scenario characteristics required for EIA

For environmental impact assessment, scenarios will be most useful if they have the following characteristics:
Descriptive and normative. In the EIA procedure, both descriptive scenarios (contextual scenarios) and normative scenarios (policy scenarios) can be used. Contextual scenarios can help, for example, to take into account different developments that may influence the environmental effects of the intended activity and alternatives. Policy scenarios can help, for example, to select and develop a small (i.e. manageable) number of alternatives that together cover a broad spectrum of solutions.

Both qualitative and quantitative. It is important that the scenarios used in the EIA procedure are both qualitative and quantitative. Policy scenarios with clear storylines help to develop truly different alternatives and to structure their critical components. Quantitative scenarios help to indicate orders of magnitude when describing the future state of the environment in the reference situation. In addition, quantitative information is important in order to calculate the environmental effects of the intended activity and alternatives under different conditions. Usually, these calculations are based on models, with the quantitative input being provided by the scenarios.

Moderately to highly explorative. Contextual scenarios that are moderately explorative are the most suitable for exploring the environmental effects of the intended activity and alternatives under different conditions. Dominant scenarios differ too little to provide sufficient insight into the different conditions that may occur, while highly explorative scenarios differ too much to make a meaningful comparison of environmental effects under different conditions. However, policy scenarios are the most suitable if they are highly explorative. After all, these provide the imagination and creativity required for developing alternatives that bring to light new options. In particular, policy scenarios that

are widely divergent and based on clearly different principles can help to select and develop a small (i.e. manageable) number of alternatives that together cover a broad spectrum of solutions.

Participatory. As mentioned before, it is important to invite the general public at an early stage of the EIA to participate in the process. After all, EIA is not only a matter of knowledge and legal requirements but is also about balancing the interests of stakeholders. Confidence building therefore plays an important role. It is also very useful if representatives from the general public can participate in developing the scenarios that are used in the EIA. The resulting scenarios can then be viewed as part of a shared knowledge base.

3.9 Research programming

Scenarios can be helpful in research programming in various ways. In the Netherlands, the main tool used in recent years for programming environmental research is horizon scanning. Compared to this method, scenarios can identify new issues and developments in a more integrated way and the underlying uncertainties in a more systematic way. One important condition is that the scenarios used are highly explorative, i.e. that they explore widely different futures.

3.9.1 Characteristics of research programming

Research programming is done by individual knowledge institutions, such as national assessment agencies and universities, but also by organisations funding research, such as government ministries and research foundations (e.g. the Netherlands Organisation for Scientific Research (NWO)). Research programming chiefly plays a role in strategic policy research, which is carried out by national assessment agencies (among others), and fundamental research not directly linked to policy-making, which is mainly carried out by universities (Van der Wouden and Dammers, 2006). Both types of research involve complex subjects that require long-term studies; for example, circular economy research and climate change research. Applied research carried out by research agencies focuses more on meeting an immediate demand for knowledge.

Research programming is based on an inventory of the demands for knowledge by researchers, policymakers and/or stakeholders with regard to a number of subjects. This inventory can be focused on scientific research topics or on issues that are considered relevant for society or policy. In the former case, the demand for knowledge is mainly explored within the academic community itself; in the latter case, the political or social demand for knowledge is translated into research questions via interactions between knowledge seekers (government organisations, businesses, civil society organisations, citizens) and knowledge providers (assessment agencies, universities and other research institutions).

In the 1990s, a Consultative Committee appointed by the Dutch Ministry of Education, Culture and Science recommended the systematic use of scenarios for programming publicly funded research. According to this committee, using scenarios would help to identify new research themes and to obtain a more integrated understanding of the role of research in tackling societal and policy issues.

However, this advice was not given much consideration in subsequent research programming. The main tool used in recent years for programming environment-related research is horizon scanning, aimed mainly at identifying the demand for knowledge arising from a number of policy issues. Horizon scanning is the systematic exploration of possible issues and developments and the potential threats and opportunities they may present. This involves looking beyond the usual time horizons and beyond the margins of individual policy areas and scientific disciplines (Verlaan et al., 2007).

An example of a horizon scan is the national trends study, *Rijksbrede trendverkenning*, published by the Dutch national strategic council in 2013. This study was conducted not only to explore the long-term trends that are relevant for national policy, but also to provide a basis for a national research agenda. The national agenda never materialised, but the trends study was applied more widely than anticipated. For example, Interdepartmental Knowledge Councils were set up to address a number of specific themes.

Although it did not result in a national research agenda, the national trends study was used by various government ministries to define their own strategic research agendas. For example, in 2012, the Ministry of Infrastructure and the Environment (IenM) selected six trends from that study to develop a Strategic Knowledge and Innovation Agenda (SKIA). Based on contrasting the selected trends with existing policy objectives, this agenda highlights seven research and innovation themes. Various departments of the Ministry have drawn up separate SKIAs for their specific policy areas. Together, these SKIAs form the basis for research programming within the Ministry and associated knowledge institutions, including PBL. The SKIAs also serve as a basis for research programming by the Dutch Research Council (NWO) and other research funding organisations.

The example above shows that horizon scanning is a useful tool for research programming. Nonetheless, scenarios will offer more possibilities because they identify new issues and developments in a more integrated way, and the underlying uncertainties in a more systematic way. After all, scenarios explore multiple developments in conjunction with each other, rather than focusing on single developments. And they show the different directions that these trends may take, rather than assuming one direction only, give or take a margin of uncertainty mentioned in a footnote. Thus, scenarios can shed more light on emerging research questions, and hence we believe that the Consultative Committee's 1990s' recommendation to use scenarios for programming publicly funded research is still relevant.

3.9.2 Activities and scenario use in research programming

Research programming is done in different ways and structured to a greater or lesser degree. Ideally, the following activities are included (De Wit, 2005): defining the area of interest ('scoping'), identifying research needs, making an inventory of the current research supply, comparing research supply and demand, setting research priorities, presenting the research programming, evaluating the research programming, and organising feedback. For drawing up knowledge and innovation agendas, the steps of determining current research supply and contrasting research needs with current supply are often omitted.

In the present discussion we make a distinction between research programming within scientific and technical disciplines versus research programming to address social and policy issues, because of their differences in scope, degree of complexity, and extent to which stakeholders are involved. Scenarios can play a useful role in both types of research programming, particularly in the following activities: identifying research needs, comparing research supply and demand; and setting research priorities (Table 3.9).

Identifying research needs

Programming research within specific scientific disciplines is often primarily a matter to be addressed by scientists who know the developments in their field of expertise. Within the framework of their research group, they focus on certain themes based on personal research interests, available expertise, and the group's international profile. Committees of Experts exploring future research needs often focus on intra-disciplinary trends that point towards possible new research themes, and on the strengths and weaknesses of current research compared to other national and international research groups.

Whether these explorations also pay attention to the social and policy impact of the research depends on the discipline and the theme(s) considered. In some disciplines, the development of science and technology is not only a matter for scientists. Particularly when the research pertains to technologies with potentially far-reaching social impact – such as biotechnology, nanotechnology, information technology and communication technology – the social and moral aspects are more likely to be taken into account when exploring research needs. Here, scenario studies can help to explore, in a coherent way, existing and new themes that may become (more) important in the medium or long term.

Scenarios used in research programming are most useful if they pay explicit attention to the new demand for knowledge that arises from relevant developments (and the threats and opportunities these present). If this is not the case, then such demand for knowledge needs to be inferred from the scenarios. The latter applies, for example, to scenario studies that are primarily intended to stimulate public discussion or to make policymakers aware of possible developments; for example, a scenario study on the future of nanotechnology.

The latter type of scenario studies can be used by the scientists and policymakers involved in research programming to derive the research themes that are likely to become relevant

Table 3.9
The role of scenarios in research programming: relevant activities and scenario characteristics required

Activities in research programming	Role of scenarios	Scenario characteristics required
Identifying research needs	• Provide insight into future research themes and their social and policy relevance • Provide insight into future social and policy themes, different perspectives on these themes, developments and measures that influence these themes, and emerging research questions	• Highly explorative • Descriptive and normative Qualitative and quantitative • Participatory
Comparing research supply and demand	• Based on the insights mentioned above, help to make a focused and systematic inventory of the knowledge supply from different organisations and disciplines	
Setting research priorities	• Based on the insights mentioned above, help to underline the importance of research themes, to promote stakeholder participation in setting research priorities, and to structure stakeholder discussions	

in the coming years. In addition, they can be used to underline the societal or scientific importance of these themes, based on the insights they provide, for example, into the possible size of the policy issue, the measures required to address the issue effectively or more effectively, the uncertainty surrounding the future course of the issue, and the emerging knowledge gaps.

Research programming for social and policy issues requires a great deal of effort from the parties involved, because these include non-scientists. The latter are involved, for example, to identify the demand for knowledge by governments, businesses, civil society organisations and citizen groups, to identify ongoing research that could meet these needs, and to prioritise these needs. To address a social or policy issue often requires a combination of different forms of knowledge from different disciplines and institutes.

Scenarios can help to identify research needs for social and policy issues in different ways. If there is *cognitive* uncertainty about the future course of the issue, contextual scenarios help by providing insight into the social, economic and physical developments that influence the issue and its future course. Contextual scenarios also identify the uncertainties surrounding the future course of these developments, their interrelationships and joint effects on the course of the issue, and the associated threats and opportunities. In this way, they can help to identify any new demand for knowledge arising from these uncertainties.

If there is *normative* uncertainty about the perceived importance and solution of the issue (e.g. flood protection, circular economy transition), then policy scenarios are more helpful. Policy scenarios make explicit the different ways in which an issue is viewed and rated. These scenarios also show how the issue could be addressed in the future and what forms of collaboration and measures would then be needed. By providing insight into the different views and possible measures, policy scenarios can give an indication of the emerging demand for knowledge.

Comparing research supply and demand

By linking the research needs identified in the previous step to data on recently completed, ongoing or planned research, it becomes clear what are genuine knowledge gaps, or where useful knowledge can be created with additional research, or where a new research approach is needed (De Wit, 2005). When determining the current research supply, both national and international research should be considered, as well as research carried out by public and private organisations.

The current research supply can be determined in various ways; e.g. by consulting with domestic and foreign experts, talking to intermediary organisations (e.g. the Netherlands Enterprise Agency), checking national and international databases (e.g. the European Science Foundation), searching the Internet, and reviewing the research programmes of different knowledge institutions. However, publications that provide a comprehensive overview of recently completed, ongoing and planned research into social and policy issues are hard to find. One of the main reasons for this is that research is spread over multiple institutions and scientific disciplines, leading to fragmented information.

Here, scenario studies can help, for example, by providing insight into the social and policy themes that are likely to become important in the future, and the main new demand for knowledge that could arise in relation to these themes. These insights help to focus on specific themes and questions, and also offer a starting point for a targeted and systematic survey of current knowledge supply across different organisations and disciplines.

Setting research priorities

Scientific research can be steered by prioritising specific areas of research and allocating funding to these areas. Research prioritisation can be based on internal assessment procedures initiated by a department, a funding body or a university, but also on societal and policy needs. The former was the main approach of NWO for many years. In recent years, however, NWO has been paying increased attention to 'research valorisation', in which the demand for knowledge by businesses (including access to scientific knowledge) plays an important role.

Again, scenarios can help by providing insight into the social and policy themes that are likely to become important in the future and the new demand for knowledge that could

arise in relation to these themes. When setting priorities for scientific research, these themes and the demand for knowledge could be given priority over other research topics.

Participation of government, industry and civil society representatives is essential to identify research topics that are considered relevant for society and policy, and to increase acceptance of research and its results. This is particularly true when the topics are socially and politically sensitive and surrounded with uncertainty, such as genetic modification of food. If policymakers are to play a role in research prioritisation, it is important that they are involved at an early stage of the research programming process to gain early insight into the various ways in which social and policy issues can be viewed and defined.

In research prioritisation, both contextual and policy scenarios can help to structure discussions between scientists and non-scientists, such as policymakers. Contextual scenarios provide a clear overview of the research themes that are likely to become important in the future, and the social, economic, technological and other developments that could influence these themes. Policy scenarios visualise the different ways in which social and policy themes can be viewed, which facilitates a structured discussion on how different perspectives lead to different research priorities.

3.9.3 Scenario characteristics required for research programming

For research programming, scenarios will be most useful if they have the following characteristics:

Highly explorative. The scope for research programming is often not considered in terms of 'future developments that can vary widely'. This is partly due to the generally short time horizon addressed in research programming. However, if the programming aims to explore research themes that could become important in the long term or issues that are subject to widely different views, the scenarios used should be highly explorative: scenarios that present a range of genuinely different images of possible or desirable futures are the most useful for highlighting new research themes and structuring discussions about different value orientations.

Descriptive and normative. The scenarios used in research programming are usually descriptive (contextual scenarios). They provide insight into future social, physical-environmental and other developments, and help to identify the demand for knowledge emerging from these developments. However, normative scenarios (policy scenarios) also offer valuable insights, as they highlight different value orientations. This is particularly useful in the case of research programming aimed at social and policy issues involving widely different views.

Qualitative and quantitative. Qualitative scenarios point to social and policy themes that may become more important in the long term, and explain the underlying developments using concise and clear storylines. Quantitative scenarios help to substantiate the importance of research related to a specific social or policy issue, as they show not only what efforts are needed to address an issue, but also how big these efforts should be to be effective. For

example, quantitative scenarios indicate the extent to which CO_2 emissions must be reduced in order to meet the Paris climate agreements and the efforts that must be made in the areas of energy saving, renewable energy and CO_2 storage. This information can be used to underline the relevance of the research needs linked to these areas.

Participatory. As mentioned above, participation of policymakers is important in research programming related to social and policy issues. Participation is facilitated if the scenarios used for research programming have been developed in a participatory manner. Participatory scenario development allows policymakers to discuss the issues and emerging demand for knowledge in a more informal way, since at this stage no decisions have to be taken yet about a specific research programme. Participation in scenario development also helps to prepare the discussions on research programming, as the participants become familiar with each other's views and expectations before they start the research programming process.

Notes

1. See https://en.rli.nl/about-the-council
2. This description is based on Van der Brugge (2016). Alphenaar et al. (2017) provide more details on the use of scenarios in adaptive management.
3. WLO stands for 'Welvaart en Leefomgeving' (*Welfare, Prosperity and Quality of the Living Environment*), a scenario study carried out in 2006 (CPB and PBL, 2006). The scenarios from *Welfare, Prosperity and the Human Environment* (CPB and PBL, 2015) are known as the 'new WLO scenarios'.
4. Only if the competent authority is not the same party as the initiator.

4 Selecting means of communication

4.1 Introduction

In the previous chapter we discussed the different application areas of scenarios. In this chapter we provide an overview of the various means of communication that can be used to promote scenario use in these areas, focusing on the less common methods and discussing their most important possibilities and limitations (Table 4.1). The more standard approaches, such as multiple reporting, presentations and conferences, are covered in our guide for making scenarios (Dammers et al., 2019).[1] Many means of communication are conceivable, more than we can discuss in this chapter. We hope that the discussion in this chapter also leads to the use of other, related methods.

The following means of communication are discussed in this chapter: bilateral contacts (Section 4.2), secondments (Section 4.3), user groups (Section 4.4), user workshops (Section 4.5), serious games (Section 4.6), video (Section 4.7), theatre (Section 4.8) and exhibitions (Section 4.9). These methods can be used separately but various combinations are also possible. We discuss these where relevant.

4.2 Bilateral contacts

4.2.1 Characteristics of bilateral contacts

Usually, scenario developers maintain regular contacts with individual or groups of policymakers and stakeholders while they are working on the scenarios. These bilateral contacts are used for discussing, among other things, the progress of the study, the expected results and usage possibilities of the scenarios. The contacted parties are mainly users in the primary target group, for example the staff of one or more government ministries. Bilateral contacts may be continued after publication of the scenarios, in order to support the policymakers (and stakeholders) in using the scenarios.

The contacts after scenario publication can take different forms. Examples include consultations between the scenario team project leader and the head of a policy directorate to discuss the follow-up of the scenario project; consultations between a member of the scenario team and a research team working on a cost-benefit analysis to

Table 4.1
Means of communication to promote scenario use

Means of communication	Areas of application*	Possibilities	Limitations
Bilateral contacts	All areas	Allow to discuss politically sensitive outcomes and specific technical issues	Reach only a small group of users
Secondments	Vision building, CBAs and policy advice	Allow in-depth discussion of specific technical issues and to build bridges between the 'worlds' of policy-making and outlook studies	Require a significant time investment and impact only part of the host organisation
User groups	All areas	Allow to discuss with users the scenario qualities and usage possibilities required	Reach only a limited number of users
User workshops	All areas	Allow users to practise with scenario use; Provide insights, support communication and help to gain commitment	Produce only general and preliminary results, and may require the necessary investments in terms of people, time and money
Serious games	All areas	Allow intensive practice with scenario use: provide insights, support communication and help to gain commitment	Produce only general and preliminary results, and may require significant investments in terms of people, time and money
Video	Vision building, transition governance, policy advice and research programming	Reach a large audience, help target groups to envision and relate to the scenarios and broaden their mindset	May require significant investments in terms of people, time and money
Theatre	Vision building, transition governance, policy advice and research programming	Help target groups to envision and relate to the scenarios and broaden their mindset	May require significant investments in terms of people, time and money
Exhibitions	Vision building and transition governance	Reach a large audience, help target groups to envision and relate to the scenarios and broaden their mindset	May require significant investments in terms of people, time and money

** See Chapter 3 for details*

identify and discuss scenario results relevant to the analysis; and consultations between a member of the scenario team and a policymaker, to identify and discuss scenario results relevant to specific policy (e.g. outcomes of model calculations that can be used to quantify the effects of flood protection measures in the context of adaptive management). Bilateral contacts are also useful for encouraging more people to use scenarios in their

thinking and actions aimed at the future, and for creating a demand for the specific future insights offered by scenarios.

4.2.2 Suitability for different application areas

In principle, bilateral contacts are suitable for all areas of scenario use. They are particularly useful in application areas that involve many specific issues and technical questions, such as adaptive management, risk governance and cost-benefit analysis.

4.2.3 Possibilities and limitations

Bilateral contacts allow scenario developers to gain insight into the policy issues that have political and policy priority and the various ways in which these issues are defined by policymakers. This enables them to better align the scenarios and scenario messages with the key issues and thus to promote the users' receptiveness to the scenarios. In addition, bilateral contacts allow to confidentially discuss politically sensitive results before the scenarios are published. This gives users the opportunity to prepare an official response to the publication and reduces the chance that they will distance themselves from the scenario study if some of the results are politically inconvenient (Ascher and Overholt, 1983). Furthermore, bilateral contacts allow a direct and intensive exchange of information, in which specific issues and technical questions related to the scenarios can be discussed in detail.

Maintaining bilateral contacts generally requires only a limited amount of time from both the scenario developers and users in question. However, the downside of bilateral contacts is that they reach only a small number of users directly. Therefore, they are typically combined with other means of communication that involve more users, such as user groups and user workshops. Bilateral contacts can also provide a stepping stone to secondment (see next section).

4.3 Secondments

4.3.1 Characteristics of secondments

Secondments offer a form of collaboration that is more structural than can be achieved in bilateral contacts. Here, a member of the scenario development team will be temporarily employed by an organisation involved in vision-building, adaptive management or other application area of scenarios. This host organisation can, for example, be a government ministry or provincial authority. Secondment allows intensive communication on a long-term basis, whereby scenario developers can share insights from the scenario study, discuss usage possibilities together with users, and collaborate in the actual application of the scenarios. It should be kept in mind that the host organisation will employ the scenario developer as a policy officer. To avoid conflicts of interest and loyalty issues, it is important to have a clear agreement about responsibilities.

Secondment the other way round is also possible. In that case, a policy officer is temporarily employed by the organisation developing the scenarios to assist in the scenario study. This form of secondment allows policy officers to contribute their policy expertise and policy networks to the scenario project on a long-term basis, which will benefit the qualities and usage possibilities of the scenarios developed. After completion of the scenario project, the seconded officers can help to disseminate the results throughout their home organisation and help their colleagues in using the scenarios.

4.3.2 Suitability for different application areas

In principle, secondment is a suitable means of communication for all areas of scenario use. It is particularly useful in areas where the activities have a defined duration, such as vision building, environmental impact assessment and policy advice. In application areas where the activities are more prolonged or not time defined, such as in transition governance, secondment may focus on certain elements of these activities, such as developing a long-term vision or exploring transition pathways.

4.3.3 Possibilities and limitations

As with bilateral contacts, secondments allow direct and intensive exchange of information, whereby specific issues and technical questions related to the scenarios can be discussed in detail. In the case of secondment, this exchange is even more intensive and also covers a longer period of time. Scenario developers who are seconded to a policy organisation become familiar with the world of policy-making, in addition to their own world of outlook studies, and extend their networks in both worlds. Their increased familiarity with the different ways of thinking, speaking and acting in both worlds enables the secondees to act as a bridge builder.

There are certain limitations on secondments, as it requires a significant time investment from the side of the secondee and considerable financial resources from the host organisation. In addition, secondment will serve only one of many organisations using scenarios, although the chosen host organisation will likely belong to the primary target group of the scenario study in question. Even then, secondment may reach only one of the departments of that host organisation. Therefore, like bilateral contacts, secondments are often combined with other means of communication such as user groups and user workshops.

4.4 User groups

4.4.1 Characteristics of user groups

In some projects, scenario developers invite the main users (prospective or potential) of their study to participate in a number of meetings while the project is ongoing. In these meetings the users are given the opportunity to think along with the developers, for example to identify scenario quality criteria, to check whether the scenarios meet these criteria, or to discuss the timing of publication. Text Box 4.1 gives an example of a user group.

Text Box 4.1 User group for Delta scenarios

The Delta scenarios were developed by a consortium led by Deltares and with PBL as one of the project partners. The scenarios were developed within the framework of the Delta Programme, an initiative of the Dutch Government to protect the Netherlands from flooding, to ensure sufficient freshwater supplies, and to contribute to spatial planning for climate change adaptation.2 The Delta scenarios were intended, among other things, to contribute to adaptive management, cost-benefit analysis and joint vision building within the Delta Programme.
The scenarios initially published by the consortium (the 'first-generation' Delta scenarios) were based mainly on existing economic and climate scenarios. At the request of the Delta commission the consortium developed a second generation of scenarios tailored to different regions of the country and different sectors such as agriculture, nature conservation and shipping. To support this process a user group was created, including staff from the Delta Commissioner's office and representatives from various sub-programmes of the Delta Programme and Rijkswaterstaat (Ministry of Infrastructure and Water Management; Rijkswaterstaat). The scenario developers organised five meetings with this group.

During each of these meetings the scenario developers gave an update on the project and preliminary results of the scenarios, followed by a discussion in which the users could respond to the results presented. Unfortunately, not all users were able to attend all five meetings because of their full schedules. This shows that user group meetings are not always easy to organise. Apart from this point of concern, there were many positive experiences. For example, the meetings helped policymakers who were not yet familiar with scenarios to better understand their use. Among other things, it became clear to them that the Delta scenarios are contextual scenarios and not policy scenarios, and that this makes a difference as to how they are used (i.e. that you have to consider all contextual scenarios when preparing for different future situations, while you can choose from policy scenarios when considering different ambitions that may be realised in the future). In addition, the user group discussions helped to refine and adapt the Delta scenarios. For example, when the IPCC (Intergovernmental Panel on Climate Change) published new climate scenarios, the user group proposed to update the Delta scenarios. Furthermore, the user group meetings helped to manage expectations. The time and funds available to the project were not sufficient to achieve all ambitions with regard to scenario development, and the meetings helped to set priorities. Finally, the discussions with the user group have contributed to the practical relevance of the Delta scenarios. During the meetings the scenario developers sometimes focused too much on scientific details, but then were reminded of the fact that policymakers mainly viewed scenarios as a tool for making policy choices. This experience helped the scenario developers to make the Delta scenarios more practice-oriented.

Group work in a workshop on using scenarios to develop a vision for nature policy in the province of Drenthe.

The main users to invite are representatives of the primary target groups of the scenario study, for example the government ministries most involved in the application area in question. However, secondary target groups, such as other public authorities, businesses and civil society organisations may also be invited if they play an important role in the application area concerned. In this way, scenario developers can gain a better insight into the diverse quality criteria that different users impose on the scenario study.

During the meetings the users can indicate, for example, that the scenarios must be adequately substantiated to enhance plausibility, or that they must be sufficiently different to provide true inspiration, or be more tailored towards the application area to be usable. In addition to defining specific quality criteria and checking whether the scenarios meet these criteria, the user group also discusses the application areas targeted by the scenario study and the ways in which the scenarios can be used in those areas. In this way, the participants not only become familiar with the scenarios and gain a sense of ownership, but also think ahead about their own use of the scenarios before the study is actually published.

4.4.2 Suitability for different application areas

User groups are suitable in all areas of scenario use. In fact, for any scenario study of some size it is advisable to organise a user group. User groups are especially important if the application area is still in development, such as adaptive management. They are also important when users have specific requirements, for example, that the scenario study provides users with data files to enable further calculations, or that the scenarios contain enough visual images to make an optimal contribution to joint vision building.

4.4.3 Possibilities and limitations

As mentioned above, user groups allow to discuss the scenario quality criteria required, to check whether the scenario study meets the criteria defined, and to discuss different possibilities for using the scenarios. Organising a user group requires only a small time investment from the scenario developers and users involved. For the latter, this mainly consists of attending the meetings and reviewing the preliminary results. This investment is easily recovered because the resulting scenarios will be tailored to the needs of the users, who will be well-prepared to apply the scenarios once they are published. A limitation is that only a small number of potential users can participate in a user group.

4.5 User workshops

4.5.1 Characteristics of user workshops

In contrast to user groups, user workshops are generally held *after* a scenario study has been completed. User workshops consist of one or more meetings in which policymakers or other users discuss a scenario study and practise working with scenarios, for example as part of a vision building or transition governance activity. A guiding principle is that effective communication of scenarios requires active involvement of users and that discussion meetings are crucial to achieving this (Van der Heijden, 1996). User workshops offer participants the opportunity to not only acquaint themselves with the scenarios but also to explore the usage possibilities and – with help from scenario developers and process facilitators – to gain hands-on practice with using the scenarios. This is important because policymakers often find it difficult to account for different futures, and may get frustrated if these futures are undesirable (as discussed in Section 2.3).

In user workshops, participants can use the scenarios for different activities, for example, making a start with vision building. In the case of descriptive scenarios, they can use the scenarios to identify future policy challenges or to assess whether the draft vision is achievable under different future conditions. In the case of normative scenarios, they can use the scenarios as a basis to discuss and negotiate a shared vision or to gather support for the vision or vision parts they prefer. In this way, they can use scenarios to develop a joint vision (Section 3.2.2).

By organising a series of user workshops, scenario developers can serve different target groups and initiate 'a conversation about the future' (Van der Heijden, 1996). The advantage of organising workshops for specific target groups is that the exercises can be tailored to the target group in question. However, workshops for mixed target groups have the advantage that different stakeholders can discuss the scenarios with each other and practise working with the scenarios together. In the latter case, it is important to create an environment of openness and trust, in which the participants can speak freely and are not afraid to have divergent views on the future.

User workshops can be set up in different ways. After explaining the goals, programme and rules of the game, the workshop usually starts with a presentation of the scenarios. During this session the participants can ask informative questions about the scenarios, give comments, and familiarise themselves with the scenarios.

Next, the participants can discuss the applications they want to focus on during the workshop, for example to use the scenarios to explore if an existing policy vision is achievable under different future conditions or to develop a new policy vision. In the former case, the participants need to agree on the main policy objectives to be assessed (e.g. 'improving flood protection', 'meeting freshwater needs', or 'making the rivers more navigable'). In the last case, they need to list the policy themes to be included in the new

strategy (e.g. 'nature and biodiversity', 'nature and the leisure sector', 'nature and agriculture' or 'nature in the cities').

After this discussion the participants are divided into smaller groups, where each group will work on a specific policy objective or policy theme with the help of the scenarios (which will be available in the form of posters or handouts). In the case of assessing existing policy objectives, each group will explore what measures must be taken to achieve a specific objective in scenario X (e.g. a high-dynamics scenario) and then repeat this exercise for scenario Y (e.g. a low-dynamics scenario). Each group will work on a different objective. Next, each group discusses which of the measures identified are needed in both scenarios and which apply only in one and not in the other scenario. In this way, they gain insight into the policy efforts required under different conditions and thus how feasible 'their' policy objective is.

In the case of exploring new policy themes, each group will select the scenario that they feel is the most obvious choice for elaborating the policy theme in question – for example, the 'Vital Nature' scenario for elaborating the theme 'Nature and biodiversity'. Based on the scenario selected, the group discusses possible ways to develop the theme – for example, 'Creating large nature reserves'. Here, the selected scenario serves as a source of inspiration; other sources, ideas and insights can also be included. Next, the group selects a second scenario to further develop the theme – for example, the scenario 'Functional Nature' could prompt the idea to use carbon capture in nature areas to generate funds for nature management. This exercise is repeated with a third and possibly fourth scenario. To promote creativity the group can choose to select the least obvious scenario directly after using the most obvious scenario in the first round. There is a good chance that the former scenario will yield the most innovative ideas for the policy theme – for example, the scenario 'Flexible Nature' may generate the idea to build a limited number of luxury residences on the margins of a nature reserve in order to generate funds for nature conservation.

After this exercise the groups will summarise their working approach and results, preferably both in words and images, in the form of a poster. The groups will present their work to each other, reflect on the results together with the workshop facilitators, and discuss the relationships between the results. The latter can be synergistic (e.g. restoring meadow bird populations will also enhance landscape value and biodiversity) or antagonistic (e.g. building recreational facilities in a nature reserve may have a negative impact on biodiversity in the area).

4.5.2 Suitability for different application areas

Because they can be organised in different ways, user workshops are generally suitable for all application areas discussed in Chapter 3. However, it should be kept in mind that the scenarios used in these workshops are unlikely to be perfectly tailored to the application area, topic and target group of the workshop in question. The reason for this is that scenarios are usually made to serve several application areas, topics and target groups at

once. Thus, policymakers must first 'translate' the scenarios to their own practice in order to be able to actually use them. User workshops can be an important step in this process.

The workshops can be customised to the needs of scenario users in different application areas. For example, in the case of vision building, workshop participants can use the scenarios to explore whether an existing policy vision is achievable or to generate ideas for a new vision (see example in Section 4.5.1 above). In the case of adaptive management, they can use the scenarios to identify the most important developments influencing the issue in question, explore the uncertainties underlying the future course of these developments, and generate ideas about tipping points and adaptation pathways. For cost-benefit analysis, workshop participants can use the scenarios to explore possible alternatives for the policy option in question and gain insight into the costs and benefits of these alternatives under different conditions. And, in the case of research programming, the participants can use the scenarios to identify research needs and set research priorities.

4.5.3 Possibilities and limitations

The preceding section focused on ways in which user workshops can help participants to generate ideas on the basis of scenarios; in other words, how they can help to develop insights. However, user workshops also offer other possibilities, particularly for improving communication and enhancing commitment. For example, workshops offer participants the opportunity to discuss their expectations and wishes about the future with each other and to develop shared concepts, which is particularly useful when the workshop is attended by different stakeholders. In this way, the workshops facilitate communication about the future and the implications of future developments for policy practice. Furthermore, participants can use the workshop to seek support for the policy, policy vision or policy objectives they favour, or for a new vision, a new objective or a new measure. User workshops regularly lead to new forms of collaboration and new coalitions.

One of the added values of user workshops is that participants engage each other in a conversation about the future. Another added value is that participants, with help and encouragement from the scenario developers, get to work with the scenarios and gain hands-on practice. As mentioned previously, using scenarios is no easy task. Encouragement and support by the scenario developers (and process facilitators where applicable) can help policymakers to further their use of scenarios.

One limitation of user workshops is that they are mainly focused on using scenarios to generate ideas. Hence, the results are mostly preliminary, leaving the participants with a lot of work to do after the workshop: they will need to select the most relevant ideas for their vision, strategy or policy plan, elaborate and substantiate these ideas based on their own expertise and existing or new research (reality check) (Nekkers, 2006) and possibly perform model calculations if quantification is important. For the scenario developers, the drawback is that the time investment required for organising a series of user workshops can be considerable.

4.6 Serious games

4.6.1 Characteristics of serious games

Serious games are also called simulations or games for short. There is no sharp dividing line between entertainment games, which are played for the sake of entertainment, and serious games, which are played for the sake of learning (Mayer, 2016). For example, entertainment games can contribute to learning and innovation, and serious games can be fun to play.

In a serious game, a group of policymakers are invited to participate in a simulated situation where they have to take decisions together (Dammers et al., 2004). The simulation involves applying game principles (e.g. challenge, roles and feedback) and/or game technology (e.g. monitors, head sets, virtual reality). The decision to be made can relate, for example, to the construction of a flood defence, the introduction of an environmental policy measure, or the development of a new residential area. Game technology makes it possible to connect simulation models, spatial data, learning systems and other tools to form a game environment.

Scenarios can be used as input for the game, for example, to show participants the possible future courses of relevant social and physical developments and the associated challenges for decision-making. Next, the participants form coalitions, start negotiations and take decisions to counter the threats indicated in the scenarios and to make use of the opportunities. The results of this process can be unexpected and counter-intuitive (Mayer, 2015). After all, individual rational behaviour does not necessarily lead to rational results at group level. The scenarios can be introduced by sending them to the participants prior to the game, by presenting them at the beginning of the game, and/or by highlighting them as the game unfolds. The results during the game can be visualised in various ways, for example via digital scoreboards, digital maps, or board maps with wooden game pieces (Text Box 4.2).

Text Box 4.2 The Urban Network game

The Urban Network game is a serious game that was developed in the early 2000s by TBM (TU Delft) and RPB (one of the precursors of PBL) and which has been used for planning the urban network *BrabantStad*. Urban networks are partnerships between cities that are spatially separated but connected by infrastructure. *BrabantStad* is such a network, connecting the five largest cities in the Dutch province of Noord-Brabant (Dammers et al., 2004; Mayer, 2016). The Urban Network game was conducted to gain insight into the possible spatial development of this network under different scenarios. The game offered a learning environment in which the administrative and physical reality was simulated and which allowed the participants to experiment with different ideas (Carton, 2007). During the game, the participants could implement innovative spatial projects and ideas for the urban network and try out new forms of administrative collaboration. In this way, the game provided insights into the different possible directions in which the urban network could be developed.
The game was conducted over two full-day gaming sessions. On the first day, the starting point was the scenario 'Brabant as a place for production' (high economic growth; low environmental awareness), and on the second day the scenario 'Brabant as a place to experience' was used (moderate economic growth; high environmental awareness). These scenarios were based on two scenarios of the *SCENE* study (Dammers et al., 2003), which had been translated from the national to regional level by RPB prior to the game. The aim of these scenarios was to encourage participants to anticipate future socio-economic developments, to analyse the challenges arising from these developments, to explore innovative ideas for urban network planning for BrabantStad, and to identify the implications for administrative collaboration.

Urban network game for BrabantStad.

The approximately 50 participants were representatives of the province of Brabant, larger and smaller municipalities, civil society organisations, businesses and design studios. The roles played by the different participants matched their functions in real life as much as possible. Their job was to come up with innovative visions and projects that aligned with the demographic, economic and other developments described in the scenarios and the planning tasks associated with these developments, for example in terms of housing, office space and recreational areas. The projects were symbolised by coloured wooden pieces that were placed on a large printed map of Brabant in the centre of the hall where the game was played.

On the first day the participants placed many different projects on the map, mostly in the form of red projects (urbanisation) and grey projects (infrastructure). The focus on urbanisation and infrastructure was in line with the tasks under the scenario 'BrabantStad as a place for production', which provided the context for the first day. There was little coordination or cohesion between the projects. On the second day fewer projects were placed on the map, but the projects were larger in scale. In addition to red and grey projects, the participants also placed a number of green projects (nature and recreation) and blue projects (water) on the map. These results were more in line with the tasks under the scenario 'BrabantStad as a place to experience', which provided the context for this day. This time, the projects were better coordinated. The Urban Network game allowed the participants to experience and practise with planning in view of future developments, to anticipate different developments and try out different forms of collaboration.

For example, in a serious game about flood risk management and land use, participants can decide to build a multifunctional embankment to counter the threat of increased flood risk (due to higher peak discharges) and to meet the growing demand for housing and office space near water (an opportunity arising from changing trends in living and working). Next, they can decide to take alternative measures (e.g. relocating the embankment, digging a flood retention area, creating a 'green river corridor') and compare their effectiveness in addressing the threats and opportunities.

Serious games that use scenarios as input are usually 'open simulations'. The participants are or play actual policymakers and enact existing or expected decision-making situations. As the game unfolds, they discover the results of the simulated interactions; in other words, these results are not defined in detail beforehand. The games can be supported by computer technology, such as touch tables with interactive GIS maps of the area in question, which provide insight into the area's spatial characteristics and the spatial implications of the decisions taken; or system dynamic models, which mimic elements of an actual decision-making situation in a digital environment and calculate and visualise the effects of the decisions taken by the different players (Van Uden, 2009).

Serious games offer participants the opportunity to work with the policy challenges (threats and opportunities) explored in the scenarios, in an informal and realistic manner. In addition, they allow the participants to simulate decisions and experiment with policy alternatives to explore possible answers to the policy challenges in question. In this way, the participants gain more insight into the different alternatives and their effects under different scenarios (Mayer, 2016). Furthermore, serious games offer participants the opportunity to discuss their different wishes and expectations about the future, to form new coalitions, and to build commitment to specific policy alternatives.

Scenario developers can also use serious games to support participating policymakers in dealing with future uncertainty. For example, they can ask the participants to come up with measures based on scenario A (first round) and scenario B (second round), discuss the results after each round together, and then identify which measures were useful in both scenarios or only in scenario A or B. By playing this game, the participants become familiar with the scenarios and practise developing a core strategy and contingent strategies (Section 3.2.2).

Serious gaming has developed rapidly in recent years, and increasingly makes use of technologies such as virtual reality and augmented reality. Virtual reality (VR) uses projected environments and/or headsets to produce realistic images, sounds and other sensations that stimulate users to immerse themselves in an imaginary environment (Text Box 4.3). In the case of augmented reality (AR), virtual components such as sound, video, graphics or GPS data are used to enhance the experience of a real-world environment.

In addition, there are serious games that can be played on the internet. These web-based games can reach a large audience, provide a fun way to learn about different scenarios and make target groups more aware of policy dilemmas. For example, the scenario study on public health in the Netherlands, *Een gezonder Nederland* (RIVM, 2014), served as the basis for a quick and simple web-based game in which players can make policy choices about future health care and then see for themselves what the effects of their choices are. These effects are summarised in infographics showing, for example, healthy life expectancy, participation of socially vulnerable groups, patient autonomy, and healthcare financial sustainability.

Text Box 4.3 Geomagine technology

Geodan Go (a subsidiary of the Geodan company) has developed a geo-referenced digital experience technology ('Geomagine') that allows policymakers and other stakeholders to virtually experience and test simulated future versions of a location or area together. This technology can help governments and other organisations to optimise their spatial planning decisions for addressing current and future challenges in the human environment.
Geomagine's geo-referenced experience technology enables users to experience a future reality at a real location. The virtual environment created is not static, but one in which the users can move around, alone or together with other users, and where they can interact with life in a specific future (people, traffic, energy, technology, housing, climate, economy, etc.).
Geomagine technology can be used in many ways. It provides a virtual format to jointly explore the future, try out new ideas risk-free, build joint visions, and experience and analyse future developments under different scenarios.
Rijkswaterstaat used this technology in its 'Imagine!' project to explore how their organisation can better anticipate a future with changing mobility, big data, environmental sustainability and new forms of collaboration.

Virtual image of future city created with Geomagine Technology

4.6.2 Suitability for different application areas

Serious games can be used in all areas of scenario use. For example, the Urban Network game (Text Box 4.2) illustrates how a serious game can be used in vision building. In a similar way the method is suitable for transition governance and adaptive management. In the case of transition governance, serious games can be used to simulate various stages of one or more transitions, whereby the scenarios provide insight into different possible future developments that influence the course of the transition. This allows the players of the game to develop a shared understanding of transition success and failure factors. In the case of adaptive management, serious games allow players to simulate decisions regarding the choice of adaptation pathways. Here, scenarios can provide insights into, for example, the time frame of adaptation tipping points.

In the case of policy advice and research programming, serious games can be used to prioritise policy issues and research themes, respectively, based on the future developments and policy alternatives explored in the scenarios. The games can help to identify, for example, a need for policy advice on multifunctional embankments or a knowledge gap regarding the effectiveness of certain policy alternatives. In these application areas, the participants could consist of key decision-makers and leading advisors from knowledge institutions, advisory councils, funding agencies, clients, (other) crucial users and principal partners in collaborations and consortia.

In the case of risk governance, serious games can be used to simulate decision-making on measures to mitigate the threats (risks) associated with the future developments and discontinuities explored in the scenarios. The game can add an extra challenge by introducing the discontinuities (wildcards) at different times during the game. This helps the players to get familiar with possible future surprises and ways to deal with them (Van Uden, 2009).

Serious games can also be used to support scenario use in cost-benefit analysis and environmental impact assessment. For example, Delft Hydraulics developed an interactive game for *Rijkswaterstaat* and RIZA (the 'PKB Blokkendoos', see Stolker and Dijkman, 2003), which allows players to assemble different sets of river expansion measures and to visualise and analyse their effects on, for example, river water level, implementation costs and ecological qualities ('nature values'). Scenarios can provide the input data for this game, such as river peak discharge and building density. Games like these help to identify different alternatives at an early stage, to gain basic insight into the future effects of these alternatives, and to take into account different possible futures.

4.6.3 Possibilities and limitations

The preceding discussion shows that serious games offer a range of possibilities to promote scenario use in various application areas. However, they also have a number of limitations. One of them is the potentially significant investment required, in terms of both time and money, to develop and organise a game. A second limitation is that games where players have to get together to simulate decision-making situations will reach only a small audience. However, this problem is less relevant if the participants are people who occupy key positions in policy and decision-making. Web-based games do reach larger audiences, but their limitation is that they are often simple games, which are played only briefly so the insights do not 'stick'. Finally, policymakers may be reluctant to participate in a serious game with others, because they are used to acting in a formal, risk-avoiding environment where people tend to hold their cards close to their chest (Mayer, 2016).

Video adaptations of the scenarios 'Going with the economic flow', 'Strengthening cultural identity', 'Allowing nature to find its way' and 'Working with nature' from the scenario study European nature in the plural (Van Zeijts et al., 2017).

4.7 Video

4.7.1 Characteristics of video

Scenario development for future exploration has always had a link with the film industry. In fact, it is from the film industry that the concept of 'scenario' has been derived. In film, scenarios describe the sequence of scenes that result in a moving picture (Bransen, 2000). However, there are important differences between film scenarios and future scenarios: a film scenario is a single scenario that creates its own reality with own rules and patterns and a clearly defined end; while future exploration is about developing multiple scenarios that cannot fully determine reality and which have no fixed end points.

The use of video as a means to communicate future scenarios is still in full development. There are various possibilities for communicating scenarios or their underlying messages

via video, including animations with moving images and voice-overs, short videos in which actors tell stories about the future supported with background images, or productions in the form of documentaries. Examples include the animations with voice-overs based on the scenarios from the *Prelude* study (EEA, 2015), the short videos with actors and moving images based on *European nature in the plural* (Van Zeijts et al., 2017),[4] and the documentary *The Netherlands later* which highlights the main messages of the scenario study of the same title (MNP, 2007).[5]

Short videos about future scenarios (generally lasting only a few minutes) can support communication about alternative futures or the key messages derived from them. Short videos not only provide a fast, concrete and visual means to convey insights about the future, but also add an emotional dimension, enable viewers to envision and relate to the future, and provide entertainment ('cinema experience'). The key is that these videos appeal to the associative part of the brain and thus promote creative thinking and imagination. In this way, they help to advance the societal conversation about the future and the joint development of a new story about the future based on scenarios.

The videos can be placed online in order to reach a large and diverse audience for the scenarios and their messages. However, they can also be used in a more targeted way, for example, by showing them at the beginning of a presentation, conference or user workshop to help participants to visualise the scenarios, engage with the futures presented, and gain insight into the scenarios and their key messages in a quick and easy manner.

The filming of scenarios is usually done by professional studios experienced in adapting future scenarios into video scenarios, who have their own equipment and can hire actors and camera and sound crews. Filming future scenarios involves the following steps: defining the key characteristics of the scenarios, making storyboards, shooting the video, and editing the video. It is important that the video's style is compatible with the scenarios to be communicated, and that the stories, characters, visuals and sound reinforce each other and make a united whole; for example, the music's rhythm should correspond with the pace of the images. Translating a future scenario into a video scenario is no easy task. For each scenario, it is necessary to (Van Rijn and Van der Burgt, 2012):

- concisely summarise the key points;
- present a clear storyline;
- build on the perceptions of the target groups;
- engage emotions that help target groups envision the future presented;
- allow target groups room for interpretation and creativity.

In order to achieve this, the scenario developers and video makers have to work closely together. This requires a significant investment from the scenario developers involved, not only in terms of money but also time and people.

4.7.2 Suitability for different application areas

Communicating future scenarios through video is particularly useful in areas where it is important that target groups can envision and relate to the futures presented in the scenarios, for example to broaden their mindset, to raise awareness about new policy issues, or to develop alternative solutions. This is particularly the case in vision building, transition governance, policy advice and research programming. Video seems less suitable for application areas where scenarios are mainly used for their quantitative and analytical insights, such as cost-benefit analysis and environmental impact assessment. In application areas that are prone to conflicting views, such as risk governance, videos that engage emotions could in fact overshoot the mark.

4.7.3 Possibilities and limitations

As mentioned above, videos are a valuable tool for communicating scenarios because they help scenario developers to reach a large audience, help target groups to envision and relate to different futures, and help scenario users to quickly and easily assimilate the main messages of the scenarios. Because videos appeal to the imagination and engage emotions, they can help to broaden conceptual frameworks and mindsets, which is an important advantage in several application areas. The downside is that video-making requires significant resources, not only in terms of money (to hire a professional agency) but also in terms of people and time (because the scenario developers have to be closely involved). It should be noted, however, that animated videos usually cost less time and money than videos with actors, especially if they consist of moving stock photos with voice-overs.

4.8 Theatre

4.8.1 Characteristics of theatre

Theatre is a means of communication in which the scenarios are enacted in drama. The actor or actors play one or more scenes per scenario, with or without stage scenery. Together, the scenes convey the essence of each scenario. As with the short videos discussed above, the duration of each scene is limited to a few minutes. An important difference between the two is that video focuses on visualising the scenarios, while theatre emphasises the interaction between actors (read: agents, stakeholders) in the scenarios. Examples of such interactions include competition (e.g. between different land users), collaboration (e.g. stakeholders working together to design an economically, ecologically and socially sustainable area), and conflict and resolution (e.g. between project developers and nature organisations who eventually manage to find common ground).

Just like video, theatre provides a means to support communication about possible or desirable futures. Theatre invites its spectators to picture themselves in different futures and to experience what these futures could look like. This is achieved through different scenes, dialogues and expressions of emotions. These effects can be enhanced if the actors occasionally turn to the audience and actively engage them in the play (a drama

technique known as the 'alienation effect', where actors step out of their roles and address the audience directly).

The enactment of future scenarios in short plays is often combined with other means of communication. For example, theatre can be used during a conference, user workshop or serious game to introduce the scenarios to the participants in a concise and lively format and to kick-start conversations about the future. Theatre was used in this way at a national conference about the scenario study on public health in the Netherlands, *Een gezonder Nederland* (RIVM, 2014), where actors introduced the four main scenarios ('Best of Health', 'Everyone Participates', 'Taking Personal Control' and 'Healthy Prosperity') in short scenes. This provided a starting point for group discussions on the future of health care in the Netherlands.

For scenario developers who want to use theatre as a means of communication, it is important to hire a professional agency that has experience with adapting future scenarios into short plays. These agencies can also hire the actors and producers and organise the necessary equipment (lighting and sound). Turning future scenarios into short plays involves the following steps: identifying the essence of each scenario, writing the scripts, creating the sets, and practising the scenes with the actors. To reach a wider audience, the performances can be video recorded and posted on the internet. However, in that case the theatrical experience is limited and interaction between actors and audience is no longer possible.

Translating future scenarios (which explore general developments) into stage scripts (that describe concrete interactions) is a challenge and requires thoughtful planning and implementation. The key content of each scenario has to be translated into a format that is theatrically effective, such as a dialogue in well-designed stage setting. For example, for a scenario taking a liberal-economic perspective on vocational education, the play can consist of a conversation between two education brokers. Unlike in 'regular' theatre, developing a play to communicate scenarios is not about the emotional development of characters. Here, the same five principles apply as for video productions (Section 4.7.1). The stage setting can be used to visualise the scenario in the background, but can also be a more abstract decor based on key features of the scenario, or be omitted entirely to focus the attention of the audience on the dialogues.

4.8.2 Suitability for different application areas

Theatre is a suitable means to communicate scenarios in the same application areas as discussed for video, and for the same reasons (Section 4.7.2). Theatre is especially useful in application areas where it is important that target groups can envision and relate to the futures presented in the scenarios; this is the case in vision building, transition governance, policy advice and research programming. Here, theatre can help to broaden policymakers' conceptual frameworks and mindsets, raise awareness about new policy issues, and inspire alternative solutions. Theatre is less suitable for application areas that focus on quantitative and analytical insights about the future, such as cost-benefit

At the Rotterdam International Architecture Biennale 2016, the project '2050 - An Energetic Odyssey' featured a room-size animated map and image projections to illustrate possibilities for large-scale renewable energy production in the North Sea. (https://iabr.nl/nl/film/2050_webvideo)

analysis, adaptive management and environmental impact assessment. In application areas that are prone to conflicting views, such as risk governance, drama could overshoot the mark.

4.8.3 Possibilities and limitations

As mentioned above, theatre is an effective tool to introduce scenarios at conferences, user workshops or serious games, where short plays can help participants to engage with the scenarios and to quickly and easily assimilate the main messages. Because theatre appeals to the imagination and emotions of the audience, it can stimulate participants to broaden their mindset. One limitation of using theatre is that it only reaches a small audience, i.e. only the participants in the workshop, serious game or conference at which the short plays are performed. This disadvantage can be overcome by video recording the performances and posting these on the internet. A second limitation is that theatre productions may require significant resources, not only in terms of money (to hire a professional agency) but also in terms of people and time (because the scenario developers have to be closely involved).

4.9 Exhibitions

4.9.1 Characteristics of exhibitions

Like videos and plays, exhibitions help to bring scenarios to life and show policymakers and other target groups what the future could look like in an engaging manner. By presenting scenarios in the form of an exhibition, they can be communicated to a large audience and reach diverse target groups including the general public. Due to their concrete and tangible means of presentation (such as maps and scale models), exhibitions provide an easily accessible format to introduce scenarios and promote their use. A key advantage is that exhibitions are major events that generate considerable publicity.

Exhibitions offer visitors the opportunity to experience the scenarios in a narrative, visual, auditory and often interactive way. Visitors can literally step into the different futures presented, with each future evoking a unique atmosphere. Exhibitions can draw attention to the scenarios as a whole, the main messages derived from the scenarios, and

the implications of certain policy choices. In this way, they make the visitors familiar with the scenarios, let them experience the scenarios, and make them think about possible policy challenges and solutions. Exhibitions thus stimulate visitors to broaden their perspective and start a conversation about the future. Mobile exhibitions, in particular, offer the opportunity to reach a wide audience and or specific target groups.

An example of a major exhibition on future scenarios is '*New Netherlands 2050*' *[Nieuw Nederland 2050]*, which was held in 1987 (See Text Box 4.4). A more recent example is the exhibition organised in 2016 by the Urban Futures research programme of Utrecht University. This exhibition was held in the Transwijk neighbourhood of the city of Utrecht and addressed the question how to realise one million new homes in the Netherlands. The themes included 'Transit oriented development' (linking spatial development and public transport), 'Endless energy' (producing renewable energy at home) and 'Overvecht' (living in a deprived neighbourhood).

Text Box 4.4 Exhibition of scenarios from New Netherlands 2050

In 1987, the exhibition *Nieuw Nederland 2050* was held at the Beurs van Berlage in Amsterdam. The exhibition was organised by NNAO *(Stichting Nederland Nu Als Ontwerp;* 'Foundation Netherlands Now as Design'). Earlier that year, NNAO had published the *Nieuw Nederland 2050* study, which presented four scenarios for the future spatial planning of the Netherlands. Three of these scenarios were based on the dominant political ideologies at the time, namely 'Careful' (Christian-democratic), 'Dynamic' (liberal) and 'Critical' (social-democratic). The fourth scenario, 'Relaxed' (libertarian), was added as an alternative direction by the project initiators. For each scenario a design was made at country level and then elaborated in regional designs, which in turn were translated into concrete projects.
The scenarios and exhibition were inspired by the spatial policy of the time, which, in the eyes of the initiators, relied too much on statistics and data and offered too little room for design and intuition. NNAO hoped to restore the role of design-driven approaches and architecture in urban and spatial planning (Salewski, 2012). The aim of their scenario study was to stimulate a broad public discussion about the spatial planning implications of political choices. The associated exhibition was intended to support this public discussion.
At the exhibition, the scenarios were presented in 35 design projects, each of which highlighted different spatial aspects and planning implications of the scenarios. Together, the design projects displayed a wide range of plans, scale models, audiovisual presentations, drawings and images that helped to communicate the scenarios and their spatial implications in a highly visual and engaging way.

In addition to the more traditional methods, there are all kinds of new digital and interactive techniques that allow visitors to experience the different futures and to contribute to the conversation, design and stories about the future. Examples include the use of digital image projection to enhance scale models, virtual reality, digital design tools, and interactive screens. The Rotterdam International Architecture Biennale (IABR) and the Landscape Triennial also regularly organise exhibitions. Although these are more about architectural, urban and landscape designs than about future scenarios, their techniques can also be used for scenario exhibitions.

A new approach is to organise digital exhibitions that can be visited online. For example, Pantopicon (a 'foresight and design studio' from Belgium) developed a digital exhibition about a fictional city, called Reburg, that shows what life in a circular economy can look like. This is shown in a digital multimedia model of the city, including touchpoints and short videos highlighting special places and commentary by future professionals explaining important elements of the circular economy in this city.[6]

As with video and theatre, communicating scenarios through exhibitions requires experienced professional agencies. After all, it is quite a challenge to translate insights from scenarios into concrete displays, objects and images for an exhibition. It is also important to give the exhibition a unifying theme and style, and to design the exhibition space in such a way that objects are displayed to their maximum effect, where the focus is on creating an overall visitor experience. In order to ensure that the exhibition does justice to the content of the scenarios and their intended use, it is important that the scenario developers and the staff of the exhibition agency work closely together.

4.9.2 Suitability for different application areas

As with video and theatre, exhibitions are particularly useful in application areas where it is important that the target groups can experience what the different possible or desirable futures could look like. In addition, they are especially useful in areas where it is important to reach large target groups, including the general public. The combination of these two requirements mainly applies to vision building and transition governance. Exhibitions are less useful in application areas that focus on quantitative and analytical insights about the future, such as adaptive management, cost-benefit analysis and environmental impact assessment.

4.9.3 Possibilities and limitations

Exhibitions offer a concrete, tangible, accessible and informal setting in which policymakers can experience and engage with the scenarios, and which can inspire them to use the scenarios in their policy practice. Exhibitions also allow to reach large target groups and to promote a broad conversation about the future. Mobile and digital exhibitions, in particular, offer the possibility to reach a wide audience. Furthermore, exhibitions can be set up in such a way that they provide room for visitors' contributions and enable direct feedback and conversation between visitors and scenario developers.

An important limitation, however, is that organising an exhibition requires significant resources, not only in terms of money (to hire professional agencies and exhibition space) but also in terms of people and time (because the scenario developers have to be closely involved). In addition, while they can provide a good overall impression of the scenarios, exhibitions are less suitable for communicating scenario insights in detail. Visitors are generally not inclined to linger too long at individual exhibits or websites. This can be partly solved by using a layered exhibition structure, in which prominent objects and images are used to draw general attention and panels and screens provide information at a more detailed level. Furthermore, exhibitions cannot guarantee that the intended target groups are actually reached. For example, the *New Netherlands 2050* exhibition (Text Box 4.4) was mainly visited by professionals, and not so much by the general public (Salewski, 2012). The same was observed for the 2016 Rotterdam International Architecture Biennale. In contrast, the online exhibition about Reburg and the circular economy has reached a broader audience.

Notes

1. See Section 5.4 ('Dissemination of results') in *Developing scenarios for the environment, nature and spatial planning: a guide* (Dammers et al., 2019).
2. https://english.deltacommissaris.nl/delta-programme
3. http://themasites.pbl.nl/natureoutlook/2016/news-2/what-is-your-perspective- on-nature-watch-the-videos.
4. http://www.reburg.world/fabcities

5 Defining the roles of scenario developers

5.1 Introduction

This final chapter discusses the different roles that scenario developers can play, both in the development and communication of scenarios. The aim of this chapter is to help scenario developers as well as users to recognise the different roles in practice and thus to manage expectations and avoid confusion about how scenarios are made, what they can achieve, and how they are communicated. First, we provide an overview of the roles (Section 5.2), and then discuss each role in detail: the pure scientist (Section 5.3), the science arbiter (Section 5.4), the issue advocate (Section 5.5), the honest broker (Section 5.6) and the participation expert (Section 5.7). Next, we explore how these roles relate to the various scenario application areas (Section 5.8) and, finally, we discuss the possibilities for combining roles (Section 5.9).

5.2 Different roles

A role can be understood as: 'a set of expectations that govern the behaviour of persons holding a particular position in society; a set of norms that defines how persons in a particular position should behave' (Stark, 2007). This implies that the position of actor A is linked to the positions of other actors (B, C, D, E, etc.) and to specific functions and tasks. If the functions and tasks of an actor have been officially described in the form of rights and obligations, this will raise certain expectations among other actors. In addition to formally defined functions and tasks, informal agreements and commitments will also raise certain expectations about the behaviour of the actor in question. Within these boundaries, actors can actively shape their role. The actual role played by actor A is the result of negotiations between actor A and the other actors. In this way, actor A transforms the role expectations into concrete behaviour (Herrmann et al., 2004).

The above definition of 'role' can also be applied to scenario developers. How scenario developers think and act and what products they produce is subject to expectations from other scenario developers as well as scenario users. Scenario developers can come from different disciplines where different criteria may apply regarding the quality and usability of results. In addition, they can have widely different orientations: a university employee may be driven mainly by scientific curiosity, while a consultant may be driven mostly by

Table 5.1
The different roles of scenario developers and their possibilities and limitations

Roles	Orientation	Possibilities	Limitations
Pure scientist	Content-oriented	Supply of reliable and independent expert insights	Supply of insights may not align with the demand
Science arbiter	Politically neutral	Demand-driven supply of insights	Supply is limited to the questions and policy choices of policymakers
Issue advocate	Politically driven	Recommendations can be politically welcome	Insights and recommendations can be politically biased
Honest broker	Argument-driven	Supply of insights is not exclusively demand-driven but also offers alternative options	Policymakers may find the alternative options undesirable
Participation expert	Process-oriented	Policymakers are more likely to accept the insights if they participated in scenario development	Policymakers who did not participate may find the insights biased

their clients' demand for knowledge. In this context, expectations will be mainly related to the methods used for scenario development (e.g. stakeholder participation) as well as to the quality of the end products (e.g. scientifically founded, integrating current insights) and/or their compatibility with policy processes (e.g. the extent to which the scenarios are tailored to environmental policy practice).

Communication between scenario developers and scenario users is shaped by both formal and informal rules. The relationship between the organisation employing the developers and the organisation(s) employing the users plays an important role in this respect (WRR, 2010; Jakil, 2011). For example, it makes quite a difference whether the scenario developers work for a ministry department that provides future insights to policymakers and stakeholders on a demand-driven basis, or for an external consultancy firm commissioned by a ministry, or for a national assessment agency that maintains links with policy circles but at the same time keeps some distance from daily policy practice.

Various typologies have been developed for the roles of scientists working at the interface of policy and research (e.g. Pielke, 2007; Hoppe, 2008; Broekhans and Turnhout, 2014). These can also be applied to scenario developers. In this guide, we distinguish five roles that scenario developers can play in the development and communication of scenarios (Table 5.1). In the followings sections we describe each role in detail, including their dominant orientation, possibilities and limitations. These depend on the situation and how the situation is perceived by the scenario developers and users.

In our view, the roles of scenario developers are strongly linked to the level and scope of communication with users and intended users. Therefore, we have ranked the roles in order of increasing communication (Table 5.1). The final role in this list (participation expert) is linked not only to the most frequent and intensive communication, but also to the 'broadest' communication in terms of number and diversity of users reached. In addition, in this role the communication between scenario developers and users is most frequently a two-way process. However, this ranking does not mean that the role of participation expert is the best or only role to be played. After all, the participation expert is strongly process-oriented, but not so much content-oriented. The point is that a team of scenario developers play different roles that complement and reinforce each other.

5.3 The pure scientist

The pure scientist is focused on content. He or she provides 'facts' about the future, for example by extrapolating data from past and present trends to the future, using model calculations. The pure scientist does not attempt to derive policy recommendations or points for consideration; this is left to the policymakers.

In the 1960s, explorers of the future got the idea to develop a new scientific discipline. These pioneers called themselves 'futurologists' and were particularly interested in science. Exploring the future was an autonomous, 'stand-alone' activity that hardly involved interactions with policymakers. The assumption was that scientific explorations of the future would speak for themselves. These explorations mostly focused on extrapolating demographic, economic, urbanisation and other trends from the past and present to the future. In those years, urban and spatial planning was largely based on this kind of foresight.

The pure scientist's role is important for providing reliable and independent expert insights and ensuring that the scenarios are plausible and legitimate. A limitation of this role is that the insights produced are not always relevant to the questions that policymakers may have about the future; in other words, the supply does not always match the demand. In addition, due to the pure scientist's focus on extrapolating trends, the imaginative power of the insights is often limited.

5.4 The science arbiter

The science arbiter provides the same insights as the pure scientist, but acknowledges that policymakers may have specific needs for future insights. Based on the scenario study produced, the arbiter delivers messages to policymakers in the form of 'if these are the policy objectives, then these are the policy options'. The orientation is politically neutral: the science arbiter is not an advocate for a particular policy option.

The Intergovernmental Panel on Climate Change (IPCC) is an example of a global body that communicates scenario-based policy *messages* and hence plays the role of science arbiter. The IPCC does not make policy *recommendations;* those are issued by the Conference of the Parties.[1]

The IPCC's task is to present the latest scientific insights on climate change and to make statements about the probability range of climate change and its consequences for, for example, sea level rise and extreme weather events. Through interactions with policymakers, the IPCC tries to respond to their specific needs for future insights. In addition, the scenarios are discussed with policymakers worldwide and the reporting includes special summaries for policymakers. When Dutch policymakers ask PBL to quantify different policy options – for example, under different IPCC scenarios – they ask the assessment agency to play the role of science arbiter.

The role of arbiter allows to supply future insights that align with the specific needs that policymakers have for such insights. This means that the insights supplied are not only highly plausible and legitimate, but also highly relevant. The downside is that the insights are often limited to the questions of policymakers, and this may somewhat limit their scope and imaginative power.

5.5 The issue advocate

The issue advocate not only provides future insights, but also uses these insights to formulate policy tasks and possible solutions for these tasks. The advocate translates scientific insights about the future into advice about what measures could be taken. The issue advocate is politically driven and therefore has a normative point of view with regard to policy development.

A well-known example of scenario developers who played the role of issue advocate are the authors of *The Limits to Growth* (Meadows et al., 1972). Partly because it was commissioned by the prestigious Club of Rome, this scenario study resonated around the world. The publication was intended as a wake-up call to politicians, policymakers and the general public, to persuade them to take action before the world would run out of finite resources and environmental pollution would get out of hand. These scenario developers were worried about the future, and influencing the political agenda was their main objective.

The role of issue advocate offers the possibility to convince the public, politicians and policymakers of the urgency of certain issues, and to formulate recommendations that eventually will be considered politically desirable. Hence, this role contributes to scenario studies that are highly relevant. The advocate's scientific prestige can also lend legitimacy to these studies. However, the downside is that their recommendations can come across as strongly biased, which is at the expense of plausibility.

5.6 The honest broker

The honest broker indicates which insights are relevant, which options are worth considering in the given situation, and how to decide on the options. The broker makes an effort to establish contacts between the scenario developers, policymakers and stakeholders. The honest broker's orientation is mainly argument-driven.

Some scenario studies are specifically intended to provide strategic policy options for policymakers. An example is the study *Getting into the right lane* (PBL and SRC, 2009), which was carried out together with the Stockholm Resilience Centre (SRC) at the initiative of PBL and intended for the European Commission. This study identified policy options for achieving long-term energy and climate goals in the EU. The authors assumed the role of honest broker; they not only quantified the effects of current policy, but also suggested alternative policy options. The latter is typical of the role of broker.

The role of honest broker allows to provide more policy options than the policymakers asked for, including unexpected or creative solutions that can help to spark the policymakers' imagination. However, policymakers may find these additional options undesirable, which can make them less inclined to use the scenario study.

5.7 The participation expert

The participation expert (facilitator) is process-oriented. He or she encourages and supports the interactions between scenario developers and policymakers in their joint production of future insights. The participation expert promotes the development of transdisciplinary future insights: in their view, scenario developers and policymakers all produce relevant insights, whether from different scientific disciplines or practical experience, and these should be integrated in the scenarios.

In the scenario study on sustainable cities *Duurzame stad* (PBL, 2010), participation of policymakers was considered crucial for developing a number of alternative future visions on sustainable urban development in the Netherlands and designing different policy options based on these visions. This required scenario developers to play the role of participation expert. In this case, the consultancy firm *De Ruijter Strategy* was hired to fill this role.

The role of participation expert allows to promote participation of policymakers in scenario development, and hence helps to increase the likelihood that policymakers will accept and use the results of the study. Policymakers who themselves participated in developing the scenarios are most likely to regard the scenario study as legitimate. However, policymakers who did not participate in the study may find the results biased, and therefore may regard the scenario study as less legitimate.

Table 5.2
Roles of scenario developers in different application areas

Roles	Application areas
Pure scientist	• Research programming (scientific disciplines)
Science arbiter	• Adaptive management • Risk governance
Honest broker	• Vision building • Cost-benefit analysis • Environmental impact assessment • Policy advice
Issue advocate	• Transition governance
Participation expert	• Research programming (social themes) • Vision building

5.8 Objectives and areas of application

The preceding discussion shows that the different roles of scenario developers partly depend on the goals pursued. The role of issue advocate is most suitable if the primary aim of the study is to influence the political agenda; but if the aim is to develop inspiring future visions together with policymakers, the role of participation expert is more obvious. The role of science arbiter or honest broker fits better if the main aim is to evaluate (and, if necessary, improve) the feasibility and effectiveness of proposed policy. The role of pure scientist is mostly played by university researchers who conduct scenario studies for academic purposes. The pure scientist is not a likely role for employees of national assessment agencies such as PBL, whose focus is on policy-oriented research.

In addition to the goals of the scenario study, the roles of scenario developers also depend on the application areas for which the scenarios are intended (Table 5.2). In the text below, we discuss which roles are most suitable in different application areas, and which roles can be combined, without pretending to cover all the possibilities.

The role of pure scientist is particularly appropriate for research programming with regard to specific scientific disciplines: here, the scenario developers can rely on their own research experience and scientific insights, on literature reviews and or insights from other scientists. The role of science arbiter is more suited to adaptive management and risk governance, because in these areas it is important that the scenarios provide answers to specific questions of policymakers about future developments. The role of honest broker is most suitable for vision building, cost-benefit analysis, environmental impact assessment and policy advice: in these areas it is important that the scenario study provides insights beyond those requested by the policymakers (e.g. additional policy alternatives). The role of issue advocate is most relevant in transition governance, where the objective is to achieve fundamental change. Since such changes can only be achieved in the long term, it is important that the advocate develops scenarios that show pathways

towards the long-term goal in question (e.g. sustainable energy supply). Finally, the role of participation expert is particularly suitable for vision building and research programming focused on social themes: these are the areas in which participation is essential, both in terms of the quantity and diversity of policymakers and stakeholders involved.

5.9 Combining different roles

The typology of roles described above can help to better understand the different relationships between scenario developers and scenario users. It is important to keep in mind that these roles are not static: they can change during the course of the scenario project or after its completion (Turnhout, 2013). In practice, scenario developers have to deal with changing ideas about the level of involvement, conflicting values and contradictory insights, all of which will influence their roles.

It is also important to keep in mind that, in practice, the roles are not always clearly fixed. For example, an honest broker may get overenthusiastic and inadvertently switch to being an issue advocate. Similarly, a participation expert who gets involved in a discussion about content (rather than process), unintentionally takes the role of science arbiter or honest broker. In many cases, scenario developers will play different roles at the same time. This need not be a problem and actually may have advantages. For example, the role of participation expert can be more effective if it is occasionally combined with the role of science arbiter.

However, not all roles work well in combination. When policymakers request scenarios for the purpose of evaluating specific policy options (asking the scenario developers to play the arbiter's role), they may not like it if the scenarios also show alternative options (scenario developers assuming an honest broker's role) because the latter may pose a 'threat' to the options for which they have already built commitment. This could make them less inclined to use the scenario study. Similarly, a participation expert should refrain from playing an issue advocate's role, because this could undermine the confidence of the participating policymakers in the scenario study. After all, the task of a participation expert in the development and communication of scenarios is to ensure that the different expectations and wishes about the future are all taken into account, and not to give certain expectations or wishes priority over others.

The typology can also help to discuss and align mutual expectations about the roles of scenario developers. In practice, the views of scenario developers about their roles do not always correspond with the expectations of policymakers, and this may cause friction (De Wit et al., 2014). For example, when policymakers expect scenario developers to play the role of science arbiter (who provides policy *messages*) they will not like it if they get an issue advocate (who gives policy *recommendations*) or a pure scientist (who gives neither) instead. That is why it is important that scenario developers are aware of the roles they can play, that they make a well-considered choice for a specific role or combination of roles, that they regularly discuss their role(s) with policymakers, and that they regularly reflect on the roles and their implications together.

Note

1. Climate sceptics are of the opinion that the IPCC plays the role of issue advocate.

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