Framework for guiding monitoring and evaluation of climate adaptation policies and projects

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Floating house design by Piet Boon, Veerse Meer, 2008

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Summary

In the last years adaptation to climate change has become increasingly important in (long term) planning policies. Almost all European countries have adopted or are formulating National Adaptation Strategies (NAS). Recognizing that having a strategy and a policy requires a sound implementation plan, several countries have recently started to work on monitoring and evaluation programs for climate adaptation policies. The problem, however, is that, internationally, there is no common ground to set up such a monitoring and evaluation program. In this report we present a detailed framework of what could become a generally applicable monitoring and evaluation method to assess the effectiveness and efficiency of implementation of climate adaptation policies.

We approach monitoring as a necessary step to be able to evaluate the success (or failure) and progress of policy plans and to be able to learn from others so that policy plans can be improved. To make monitoring useful, the monitoring organization will have to address operational questions that policy makers are confronted with: what exactly should be monitored, who should monitor and how should it be monitored. These questions cannot be answered generally, but should be elaborated on the appropriate scale. The framework is intended guide policy makers in answering these questions. The framework consists of four building blocks:

1. Requirements for an institutional body responsible for monitoring;
2. Method for defining the system of interest;
3. Method for selection of indicators;
4. Proposed monitoring and evaluation procedures.

In addition, the framework is applied to assess the monitoring efforts of climate adaptation policy in a number of European countries. Our study has revealed that the climate adaptation framework is a useful basis for the analysis of adaptation monitoring and evaluation programmes on national scales. The framework has provided a good structure to compare the different monitoring approaches in England, Germany and Finland.

Our study has indicated that the following aspects of monitoring and evaluation of climate adaptation can still be considered as weak and requiring additional research:

- The effect of dependence/independence of the monitoring body on the learning effect of monitoring.
- The effect of different ways of involving stakeholders in monitoring.
- The creation of indicators for adaptive capacity.
- The creation of indicators for mainstreaming with other policies.
- The creation of unambiguous outcome indicators.
- The pro's and con's of using existing data and indicators in adaptation monitoring.
- Clear procedures for an adaptive monitoring and evaluation system.

Our analysis has raised the potential of this framework for setting up a monitoring programme, but this should be further tested.

1 Introduction

1.1 The role of monitoring in adaptation to climate change

In the last years adaptation to climate change has become increasingly important in (long term) planning policies. Almost all European countries have adopted or are formulating National Adaptation Strategies (NAS). Several countries recently started to work on monitoring and evaluation programs for climate adaptation policies. However, there is no common ground internationally to set up such a monitoring and evaluation program. In this report we present a detailed framework of what could become a generally applicable monitoring and evaluation method to assess the effectiveness and efficiency of implementation of climate adaptation policy. This framework is intended for use by both governments and other stakeholders.

In this report we will often mention monitoring and evaluation as a combined activity. Of course, there is a difference between the two: monitoring comprises the planned, regular collection of data and the technical interpretation of those data (e.g, judging the quality of the data, processing the data in a model and/or producing a visually interpretable result like a graph, table or map), while evaluation comprises the normative interpretation of the monitoring results (a discussion if the goals have been achieved; if not, is this bad, and if it's bad, what are the causes and how could it be improved?). In this report, the emphasis is more on the monitoring than on the evaluation part of the process. We intend to lay out the technical foundations for the process of monitoring; but always with the end goal of evaluation in sight; we want to avoid 'monitoring just for the purpose of monitoring'.

1.2 Views on monitoring of adaptation in the literature

In this paragraph we will briefly explore the literature on monitoring in general, monitoring of adaptation, and indicators for monitoring of adaptation. This will result in a list of challenges for monitoring of adaptation.

In the literature, there is debate on the utility of monitoring and how it should fit within the practice of policy making. In one view, which is explained well in a paper by Pahl-Wöstl et al. (2007), monitoring and evaluation is part of a policy cycle, providing the necessary feedback loop that leads to a new round of policy making (see Figure 1.1). This policy cycle model has been criticized in the literature as overly simplistic, especially in the case of complex (unstructured) problems such as adaptation to climate change. Critics claim that policy making and implementation is not an orderly process but is characterized by disagreement, ambiguity, drawbacks, occasional breakthroughs, and, in general, unpredictability (Teisman, 2000).

Alternative models are the streams model, in which problems, solutions and actors are coupled only by coincidence; and the rounds model, in which the chaotic process can be divided into rounds which are separated by important, shared decisions (Teisman, 2000).

Accepting the chaotic nature of policy processes does not make monitoring and evaluation a superfluous exercise. In a young policy field such as adaptation to climate change learning can be useful within projects as well as between projects. Systematic data collection around new adaptation solutions can show which of those measures are effective, and can help to select efficient options in terms of natural and financial

resources. Furthermore, systematic monitoring can provide information for accountability requests that can be expected at the national, European and global scale (e.g. UNFCCC).

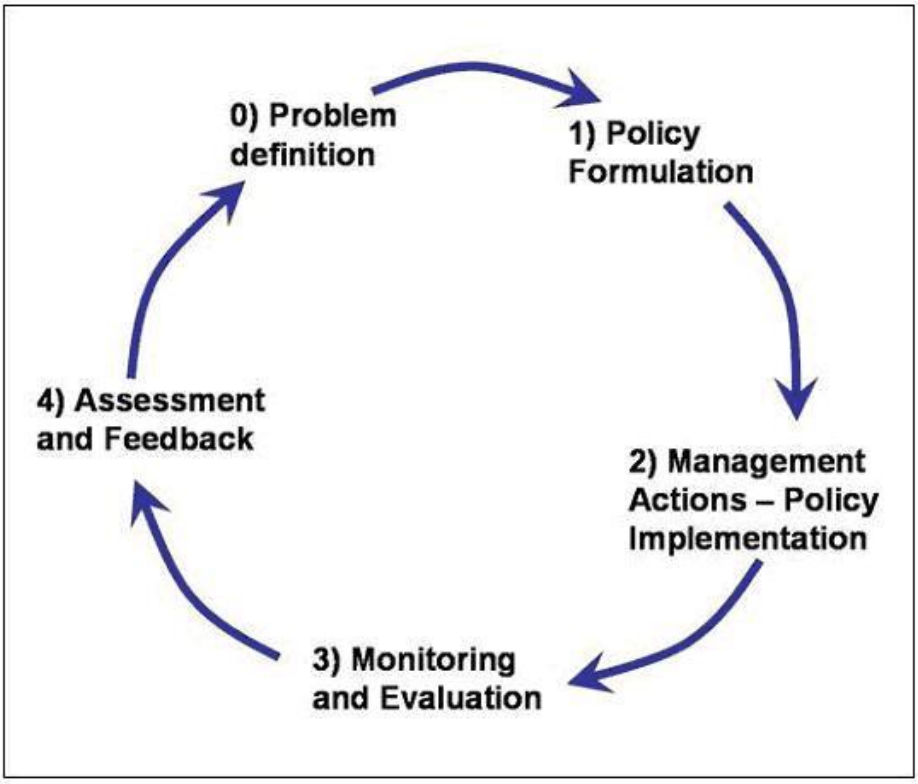


Figure 1.1: Iterative cycle of policy development and implementation in adaptive management (Pahl-Wöstl, C, et al. (2007))

According to Sabatier (1993), policy learning can be defined as *a relatively enduring alteration of thought or behavioural intentions that are concerned with the attainment (or revision) of the precepts of a policy belief system*. It is useful to distinguish further between three types of policy learning based on Argyris and Schön (1978) and Kemp and Weehuizen (2005):

- Single loop learning or instrumental learning: Technical learning to achieve set goals. The single loop consists of a fixed norm (e.g. a number of birds' nests in a nature park), a check on this norm, and a measure to work towards this norm;
- Double loop learning: Not only the achievement of the norm is monitored (one loop), but the norm itself is also regularly updated (the second loop). For example, is the achievement of that amount of birds' nests still realistic considering the northward migration of habitats? Double loop learning can be subdivided further in:
    - Conceptual learning or problem learning: seeing things from a different evaluative viewpoint; it tends to be accompanied with the development or adoption of new concepts, principles and images.
    - Social learning: learning about values, norms, responsibilities, goals, and the framing of issues in terms of causes and effects.

Because adaptation is both a complex and a long term issue, double loop learning is considered to be important.

Definition of monitoring

In the remainder of this report, we closely connect to a recent definition of monitoring: *systematic collection of data on pre-defined project or programme indicators, enabling the stakeholders involved to check whether an initiative is on track in achieving set objectives* (Lamhauge et al, 2012).

From the perspective of policy learning, this definition implies a single loop learning type of monitoring. Again, the fact that double loop learning exists, does not make the single loop learning effort superfluous. On the contrary, one could say, because single loop data collection may provide important evidence to support double loop learning.

Goals of monitoring

According to Harley et al (2008) the purpose of (adaptation) monitoring is:

- to share information on good practice in adapting to climate change impacts;
- to measure progress in implementing adaptation measures;
- to measure effectiveness of resource commitments.

In the UK, the national Adaptation Sub-Committee has identified three core objectives for monitoring (Harvey, 2011):

1) To advise on the development of the UK's Climate Change Risk Assessment and accompanying Adaptation Economic Assessment;
2) To assess the preparedness of the UK to meet the risks and opportunities arising from climate change; and
3) To promote effective actions to adapt to climate change by society as a whole.

Brooks et al (2011) are looking at adaptation monitoring from a development perspective. According to them, present monitoring efforts focus on process-cased indicators ('the capacity of institutions, government and civil society to understand climate change and to integrate adaptation into decision making') and on outcome indicators for the short term ('the extent to which climate adaptation keeps development 'on track''). The authors end with a critical remark that process and short term indicators are not enough. Indicators should be found that operate on a longer timescale, even if it is hardly possible to see very far into the future. A long term outlook is necessary because business at usual successes may harm the livelihoods of the future.

Lamhauge et al (2012) state that "Adaptation remains a rather vague concept whose boundaries have yet to be defined." This does not stop them from formulating a goal for monitoring and evaluation that aims for accountability: "bilateral development agencies require the use of rigorous monitoring and evaluation practices in order to ensure efficient use of taxpayers' money and to demonstrate that development objectives are met". Next to ensuring efficiency and effectiveness, monitoring and evaluation of adaptation actions are needed for ensuring equity, according to Lamhauge et al. (2012). Monitoring and evaluation help to realize the benefits of interventions and to improve the design of future interventions.

The goals mentioned by these authors mainly fall in the category of single loop learning, although Brooks et al and Lamhauge et al mention that the long term / the future should not be forgotten. It is likely that in the future the understanding of the problem, and

therefore the goals of adaptation, have changed. Double loop learning is not proposed as a goal by these authors, however.

Methods, frameworks and indicators for monitoring of adaptation

Lamhauge et al (2012) have analysed 106 documents of development organizations evaluating adaptation. They conclude that Result Based Management, the Logical Framework Approach and the accompanying logframe are the most common monitoring and evaluation approaches used for adaptation. Result Based Management (RBM) focuses on performance (implementation of activities in an adaptation work plan) and achievement of outputs, outcomes and long term impacts. The latter three terms are further specified as follows:

- Output: immediate products, capital goods and services resulting from a development (adaptation) intervention;
- Outcome: intermediate effects of an intervention's outputs;
- Impact: long-term effects produced by a development (adaptation) intervention, directly or indirectly, intended or unintended.

The Logical Framework approach is used for the assessment of these outputs, outcomes and impacts by setting objectives, developing indicators, defining targets, monitoring performance and comparing results with targets. A simplified logframe is shown in the table below. The purpose of such a logframe is to ensure a complete and systematic approach.

Table 1.1: Simplified logframe (based on Lamhauge et al 2012). The idea of the logframe is that all the items in the table need to be filled in to guarantee a systematic approach.

Narrative summary	Indicators	Means of verification	Assumptions
Goals	Measures	Methods and sources of information	Conditions beyond control
Outcomes	Measures	Methods and sources of information	Conditions beyond control
Outputs	Measures	Methods and sources of information	Conditions beyond control
Activities	Measures	Methods and sources of information	Conditions beyond control
Inputs	Resources	Resources	Resources

Lamhauge et al 92012) have found that it is important to make a clear distinction between outcomes, outputs and activities. A warning is given that different understandings exist of much used terms like impacts, outcomes and outputs, even within the expert community (Harmeling et al, 2012). Therefore, these terms always have to be specified.

In an AEA report (Harvey, 2011) the concepts 'drivers' and 'impacts' from the DPSIR framework and the climate change literature are used to build a framework, consisting of three categories of drivers (climate drivers, controllable and contextual non-climate drivers) and two categories of impacts (intermediate and major impacts, see also Chapter 3). Adaptation should influence the controllable non-climate drivers and the intermediate impacts. The AEA report states that in the short-term process-based indicators are more logical; for the long-term a preference is given to outcome-based indicators.

In Brooks et al (2011) a framework is developed that looks at process indicators from a top down perspective (policy implementation and institutional capacity at global, national, regional and local level) and at performance indicators from a bottom-up perspective (development performance and climate vulnerability of individuals, households and sectors). Furthermore the framework consists of the following basic set of questions:

1 To what extent have adaptation interventions resulted in the integration of climate risk management into development policy and planning?
2 To what extent have adaptation interventions increased the ability of individuals, communities and institutions to pursue their own adaptation strategies and measures?
3 To what extent have adaptation interventions reduced the vulnerability of individuals and households to hazards associated with climate variability and change?
4 To what extent have adaptation interventions increased the resilience of key sectors and natural/managed systems on which human populations depend?
5 To what extent have adaptation interventions helped to keep development 'on track', where climate change and variability make the achievement of these targets more difficult?

Mees et al (2012) present a framework that might be used to define process-indicators, based on the Deming cycle (Plan – Do – Check – Maintain) (see table). Their idea is that to have some idea about the phase in which the adaptation process is will help to map the steps that have been taken.

Table: Framework of Mees et al. on adaptive actions in different phases of policy making.

Phase	Activity types	Examples
Policy-making (PLAN)	Agenda setting Knowledge creation Initiation of policy Target setting	Convincing politicians Acquiring information on climate effects Bringing together stakeholders Setting targets for flood security
Policy implementation (DO)	Strategy making Information provision Financing of measures Physical implementation	Strategies for mitigating flood risk Active sharing of information to the public Compensating damages inflicted by climate Building a dyke
Policy evaluation (CHECK)	Monitoring of results Enforcement Policy adjustment	Geographic information system Establishing fines for not adapting Making relevant changes to the policy based on the evaluation

Policy maintenance (MAINT)	Maintenance after instalment	Inspecting dykes and repairing when necessary

Looking at these methods, we see that most authors choose a classical, systematic approach to monitoring, taking the plan as the starting point. Most authors insist that both process and outcome / output should be measured. This is again mainly a support for single loop learning. Lamhauge et al. point out that the concepts impacts, outcomes and outputs can have different meanings. If we combine this idea with the generic questions by Brooks et al, using other concepts that have a range of meanings like adaptation, vulnerability and resilience, this may create a framework that allows for some learning and future changes in the perception of adaptation.

Criteria for monitoring programs, indicators and data

A monitoring program should provide policy makers and stakeholders with useful information about adaptation policies and projects (Timmerman et al., 2011). Useful information is defined as information that is 1) salient and context sensitive; responding to the specific information demands, 2) credible; perceived by the users to be accurate, valid and of high quality, and 3) legitimate; the production of information is perceived to be unbiased.

Some criteria for a monitoring program according to Harley et al (2008):

- Fit within the concept of adaptive management.
- Focus on monitoring progress rather than measuring effectiveness.
- Be sectorally distinct.
- Include checklist-type indicators.
- Include process-based and outcome-based indicators.
- Include narrative reporting alongside quantitative indicators (to provide context and explanation).
- Not duplicate pre-existing indicators.

Criteria for existing datasets are: availability, relevance and quality (Harvey, 2011)

Monitoring frameworks for adaptation should combine qualitative, quantitative and binary indicators (Lamhauge et al, 2012). According to Harley et al (2008) adaptation indicators should be:

- precise,
- robust,
- transparent,
- objective,
- simple and easy to understand.

Generally, indicators are expected to meet SMART criteria (Specific, Measurable, Attainable, Relevant, Time bound) (Harmeling et al, 2012).

Most of the criteria are classical requirements for any monitoring program, trying to combine the somewhat contradictory goals of reliability of the monitoring results with the

communicative potential. Some criteria from Harley are supportive of the learning process that is needed for adaptation monitoring: fitting with adaptive management, monitoring progress rather than effectiveness, and providing a narrative with an explanatory value.

Identified challenges

In the literature a number of challenges for monitoring and evaluation of adaptation has been mentioned.

Long timescales: Firstly, the timescales associated with climate change and adaptation form a challenge for monitoring because the effectiveness of measures may only become measurable in the future (Brooks et al, 2011). Harley et al (2008) emphasize the need to address the uncertainties and potential surprises implicit in planning for multidecadal climate change. The measurement of flexibility and/or resilience factors may be an intermediate solution (Brooks et al, 2011).

Shifting goals: Related to the timescale challenge is the problem of shifting goals: evaluation is likely to happen against the backdrop of a changing norm (Harley et al, 2008). The climate and the environment will change, and therefore, an indicator showing a stable number may actually indicate an improvement (Brooks et al, 2011). This would mean that the climate itself also should be monitored, so that the adaptation measures can be normalized against this background.

Multiple metrics: Brooks et al (2011) consider the fact that multiple metrics are needed for monitoring of adaptation as a challenge. Harley et al (2008) mention the diverse, multi-sectoral nature of adaptation and the involvement of a large number of responsible organisations with different requirements for indicators and their own appropriate monitoring and evaluation systems. In the AEA report, the selection of a manageable set of indicators is mentioned as a crucial step in adaptation monitoring (Harvey, 2011). For example, 87 indicators were proposed for five prioritized sectors in the UK.

Attribution of effects: Harley et al (2008) stress the importance of 'mainstreaming' adaptation; this can lead to ambiguity of monitoring results because attribution of an effect to adaptation measures will be difficult. These authors also identify a challenge in addressing scale interactions: for national adaptation monitoring, the indicators have to fit with national policy; while for monitoring at European level, indicators have to be comparable across member states.

Stakeholder involvement: Bauer et al (2012) identified the following challenges for the adaptation policy field:

(i) how to better integrate adaptation policies horizontally across policy sectors,

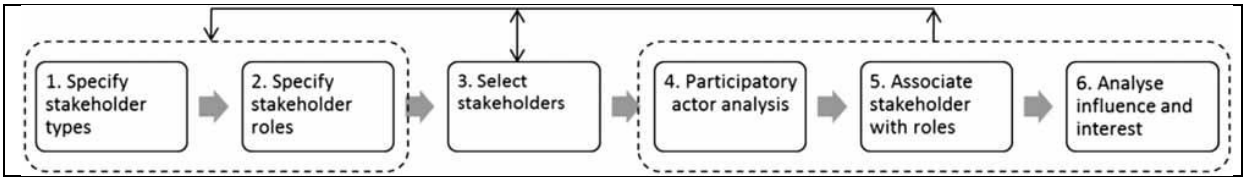
(ii) how to better integrate adaptation policies vertically across jurisdictional levels,

(iii) how to integrate relevant knowledge in adaptation policy decisions, and

(iv) how to involve a broad range of non-state actors who are affected by climate change but often lack the capacities necessary to adapt.

Stakeholders need to be involved in the monitoring process (Harvey, 2011): from the design of the monitoring program, selection of indicators, data collection, interpretation of the results and follow up. Because of the complexity of the adaptation field André et al (2012) propose a participatory method for selection of the stakeholder or rather, description of the stakeholder landscape.

Figure 1.2: Method for selecting stakeholders (André et al, 2012)



Next to the challenges mentioned by these authors we identify a lack of methods to support **double loop learning** in the adaptation process.

1.3 Method and research questions

From the literature summarized above we conclude that the methods and criteria developed for classical monitoring and evaluation apply to monitoring of adaptation as well and that monitoring is an accepted and useful step in policy planning. Having said this, policy makers will be confronted with operational questions: what exactly should be monitored, who should monitor and how it should be monitored? A framework can help policy makers in answering these questions.

In order to arrive at a robust framework we go through the following steps in this report:

- Design of a framework for development of a monitoring program;
- Assessment of existing monitoring programmes with the framework;
- Conclusions on the use and potential improvement of the framework.

In the next chapter we present a framework for monitoring and evaluation of adaptation to climate change. In chapter 3 the framework will be applied to the efforts of three pioneering countries in monitoring of adaptation. Chapter 5 will summarize the conclusions.

2 Framework for monitoring and evaluation of adaptation

2.1 Design of a general framework

Here we describe a monitoring framework of adaptation policies and projects that is applicable for different kinds of users. Therefore, we start with the questions that policy makers may be confronted with: **who should monitor; what should be monitored, and how should it be monitored?** The framework provides building blocks forming the basis of a monitoring program. The four building blocks are:

1. Requirements for an institutional body responsible for monitoring
2. Method for defining the system of interest
3. Method for selection of indicators
4. Proposed monitoring and evaluation procedures

We do not intend to provide a blueprint for monitoring of adaptation. Climate change adaptation is context specific and the field is under development, so flexibility of the framework is needed in order to address the needs of individual adaptation projects and policies. In the following chapters we discuss the building blocks.

2.2 Requirements for an institutional body responsible for monitoring

According to Swart et al. (2008) it is important to install a responsible body that will take care of collecting useful information on climate adaptation regularly. Monitoring information is useful if it is reliable, verifiable and gathered on a regular basis. Therefore, these bodies need to be established as permanent institutions and be equipped with sufficient resources. Resources can comprise authority, human resources and financial resources (Gupta et al., 2010).

It is also important that an institutional body responsible for monitoring is accepted by the stakeholders. The institution needs to have a reputation of trustworthiness (Timmerman et al., 2011). The choice for a certain institution and its (in)dependency influences if stakeholders perceive the institutions' reports are as credible and legitimate.

An example of an institutional body responsible for monitoring is the Adaptation Sub-Committee (ASC) in the UK. The ASC was established under the Climate Act in order to assess the progress and outcome of the UK Adaptation Strategy.

The automatic thought is that a monitoring organization should be external and independent. However, there is no reason to rule out internal monitoring and evaluation efforts. Reflection on the process and double loop learning may even be easier to realize through an internal process by the organization that implements adaptation. A combination of internal and external monitoring would also solve the inherent conflict between monitoring for learning and monitoring for accountability.

We conclude that it is important to decide who is going to monitor and when. When someone sets up a monitoring institution it is important to address the following requirements:

- Formulating the rules and level of independence of the institution.

- Complementing an external accountability program with an internal monitoring program to enhance internal learning.
- Equipping the institution(s) with resources
- Deciding on the frequency of reporting
- Guarding the quality and independence of the monitoring program
- Improving acceptance of the information by stakeholders

2.3 Method for defining the system of interest

An adaptation strategy can involve many different measures for a range of policy sectors. Therefore, it is useful to start a monitoring program with a good description of what should be monitored. We introduce the *system of interest* as a tool to structure, simplify and focus an adaptation policy and project in order to monitor it efficiently. The system of interest 1) defines the adaptation context of a policy or project in a model-based structure; 2) simplifies and focuses the problems of climate change and the solutions by adaptation; and 3) defines the monitoring objectives and information needs of the adaptation monitoring program. In this way the system of interest allows policy makers and stakeholders to understand the adaptation context and prioritize monitoring objectives and information needs.

2.3.1 Adaptation context

Adaptation is depends on the context in which it takes place. The adaptation context can be seen as a combination of the physical situation, the social-economic conditions, adaptation objectives and the involved sectors and actors. Therefore, there is not a 'one size fits all' approach for monitoring of adaptation (UKCIP, 2011). Monitoring programs should be tailored around the adaptation project or policy and take into account the specific objectives, relevant spatial and temporal scales and the interest of the involved stakeholders. Because climate adaptation is context specific, the climate adaptation context within the policy or project should be defined.

Climate adaptation is built around concepts of vulnerability, resilience, impacts and adaptive capacity. Although these terms are widely used by the life sciences and social sciences, these terms often have different foci and different meanings (Gallopín, 2006). It is important that every climate policy or project defines how they conceive and define adaptation. Some of the mainstream definitions and models are presented below.

Adaptation to climate change is the adjustment in natural or human systems in response to actual or expected climatic stimuli, to moderate harm or exploit opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation *(*www.ipcc.com, 2007*)*. According to the EEA (2008) adaptation aims at increasing the *resilience* for natural and human systems for current and future impacts of climate change. Resilience is the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change (IPCC, 2007). *Vulnerability* is defined as the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity *(*www.ipcc.com, 2007*)*. *Adaptive capacity* is the whole set of capabilities, resources and institutions of a country or region to implement effective adaptation measures (www.ipcc.com, 2007).

Furthermore, it is important to define the spatial and temporal scale of the system of interest. Impacts, vulnerabilities and solutions can vary at different spatial and temporal scales, and the appropriate indicators will also be different. For example, a national-level indicator to measure flood risks may differ from a local level indicator (van Minnen et al., forthcoming).

Adaptation projects are generally interdisciplinary projects. This makes it important to consider the broader context in which adaptation takes place. The system of interest might include information on relevant social, spatial and temporal factors, on relationships with drivers of change and with other indicators, and on cross-sectoral dependencies (van Minnen et al., forthcoming). The broader context helps to improve the explanatory value of monitoring results over time. This step also provides the basis for the monitoring of mainstreaming climate adaptation.

2.3.2 Focus on problems and solutions

The conceptual model of adaptation by Füssel and Klein (2006) provides a basis for describing the system of interest, because it simplifies and structures the problems of climate change and the solutions by adaptation. This framework links the climate system, climate impacts, and adaptation. According to this model a description of the adaptation context should reveal information on exposure, sensitivity, potential impacts, adaptive capacity, vulnerability and adaptation action.

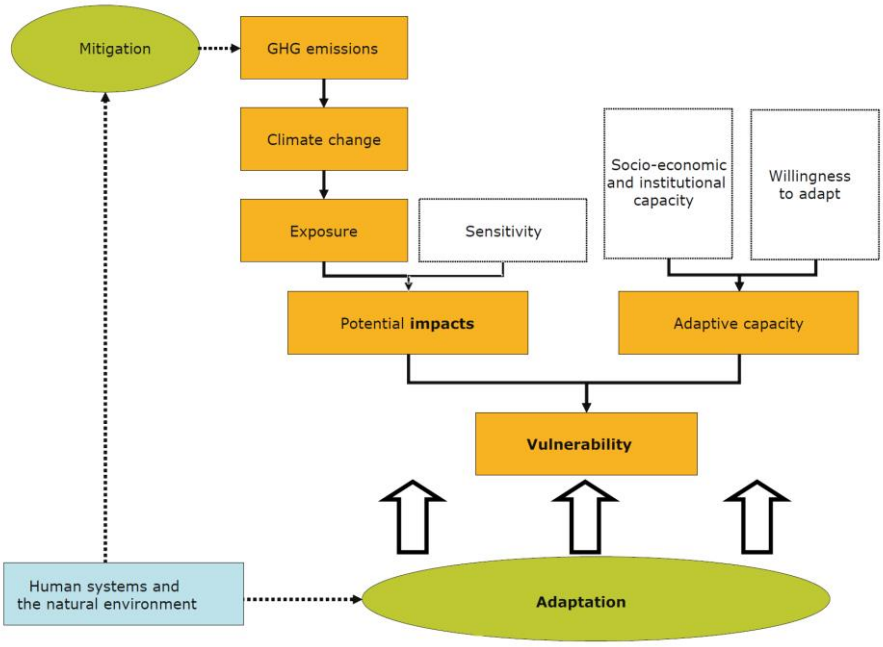


Figure 2.1. Conceptual model for climate change impact, vulnerability and adaptation (Füssel and Klein, 2006).

Another framework that can provide a basis to describe the system of interest is DPSIR (Figure 2.2). This framework is developed to monitor environmental policies (OECD, 1993; EEA, 1995). Many indicators sets presently used by nations and international bodies are based on this DPSIR-framework (Gabrielsen, 2003). The DPSIR framework divides indicators into the following classes; driver, pressure, state, impact and response. Driving forces indicators describe the needs of humans. These needs result in human activities that cause pressures on the environment. The pressures have an effect on the

state of the environment. Changes in the state of the environment will impact ecosystems and human welfare. The deteriorated state of the environment can induce human society to respond with measures. Such a response can aim at any part in the DPSIR chain between driving force and impact.

When we apply DPSIR to the problem of climate change the chain becomes thus: the drivers are the human needs for fuel, food and so on, that result in the release of greenhouse gasses (pressure). This leads to a greenhouse effect and changes in the global climate (state). Climate change then leads to impacts such as sea level rise and an increased urban heat island effect. Responses are mitigation (aiming at the drivers and the pressures) and adaptation (aiming at the impacts).

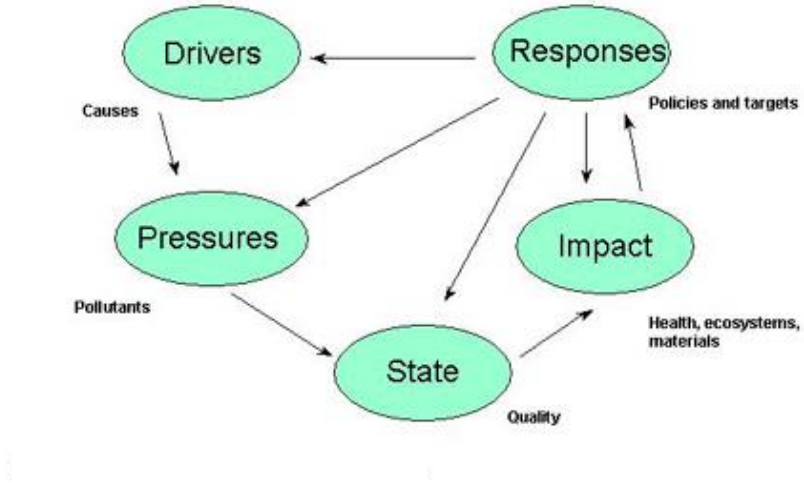


Figure 2.2. The DPSIR assessment framework (Kristensen, 2004)

Finally it is important to define adaptation action and the effects of this action as a part of the system of interest. This last step shows the adaptation action planned or taken and the assumed effects. Monitoring can be used to learn about the effects but also to see how cost effective the project or policy is.

2.3.3 Adaptation objectives

Information needs are linked to the objectives, aspirations or desired end-point of the adaptation policy or project (van Minnen et al., forthcoming). If, for example, an objective is to mainstream adaptation into other policies, an indicator will be required to monitor the mainstreaming process. The type of indicator(s) used will also depend on the nature of the policy, measure or action. In the case of flood protection, for example, the aspiration that "no-one dies in a flood" is different from "everyone is protected equally from flooding", so the types of indicators chosen would be quite different. If it is possible to frame the adaptation strategy in terms of technical and practical decisions (such as the average height of a sea defence structure), then outcomes can be quantified with relative ease. If they are framed in a more general 'social' sense, then indicators would be subjective and outcomes will be difficult to quantify (van Minnen et al., forthcoming).

In order to get most out of the monitoring and evaluation process it is important to understand the purpose of the monitoring and evaluation. According to UKCIP (2011) the purposes of monitoring adaptation can vary widely. The most common purposes are to measure effectiveness, to measure efficiency, to understand equity, to provide

accountability, to assess outcomes, to improve learning and to compare future interventions with other interventions. A monitoring program can include several monitoring objectives that may be complementary or conflicting. By understanding the synergies and tensions at the planning stage of a monitoring program a more balanced and effective monitoring program can be built (UKCIP, 2011).

2.3.4 Conclusions

The system of interest 1) includes the adaptation context of the policy or the project in a model-based structure; 2) is simplified and focuses on the problems of climate change and the solutions by adaptation, and 3) defines the monitoring objectives and information needs of the adaptation monitoring program. In this way the system of interest allows policy makers and stakeholders to understand the adaptation context and prioritize monitoring objectives and information needs. On the basis of the conceptual model for adaptation by Füssel and Klein (2006) and the DPSIR model we conclude that a description of the system of interest consists of the following aspects;

- Climate system; description of the current and future state of the climate. Preferably on the basis of downscaled climate models.
- Climate impacts; description of the most important climate impacts. Climate impacts include both exposure and sensitivity.
- Social, environmental and economic vulnerability; a description of vulnerability that links climate impacts to the adaptive capacity of the social and economic system.
- Description of the temporal and spatial scales of the adaptation policy or project.
- Mainstreaming context; description of inter-linkages with other policy domains and opportunities and challenges for mainstreaming.
- Adaptation action (measures, policies).

Furthermore, every monitoring program should define the information needs and the purpose of the evaluation in a clear and transparent way. The information needs follow from the objectives, aspirations or desired end-point of the adaptation policy or project. The purposes of the evaluation can vary widely from measuring effectiveness to learning more about the effects of adaptation. For the use of monitoring results it is important to agree on the monitoring objectives and information needs with the involved stakeholders.

2.4 Method for selection of indicators

As adaptation must address a range of risks across many sectors, multiple indicators might ideally be needed to provide the big picture. However, it will not be possible to capture the entire spectrum of measurable parameters. Instead, the challenge is to identify criteria to prioritise, combine or aggregate indicators to give an overall picture of preparedness (van Minnen et al, forthcoming). The process of selecting a subset of impacts on which to focus is the most significant decision in the development of adaptation indicators (van Minnen et al., forthcoming). As was mentioned above the selection of indicator(s) depends on the system of interest and must be tailored around the policies and projects.

Here we provide an overview of different developments in order to help policy makers and stakeholders select indicators that deliver useful information.

In 2008 EEA published a framework for defining climate adaptation indicators for monitoring (Harley et al., 2008). The framework recognizes both process-based and

outcome-based indicators. Process based indicators monitor the process in implementing adaptation policies and measures, and this includes building adaptive capacity. Outcome-based indicators measure the effectiveness of adaptation policies and actions. Harley et al. (2008) suggest that both types of indicators are needed to monitor progress in adaptation, given that adaptation is still in an early stage of development. Process based indicators are more easy to establish initially, but in a later stage outcome-based indicators will become more important. Several other authors have come to similar conclusions. Cundill and Fabricius (2009) point out that monitoring programs for complex systems should pay attention to intended and unintended outcomes of an intervention and capture tangible, and therefore measurable outcomes, and intangible outcomes. Capturing intangible outcomes it is necessary to both monitor the process of the implementation and the outcomes. UKCIP (2011) states that assessing progress and performance is fundamental to most evaluations.

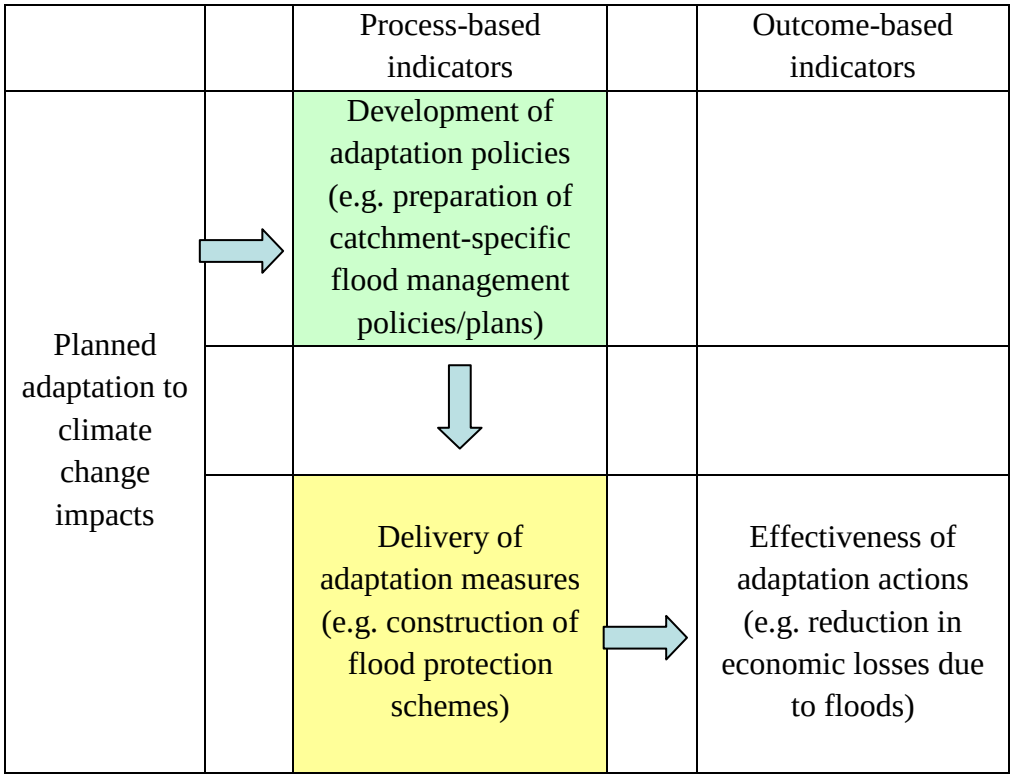


Figure 2.3: EEA framework for adaptation indicators (Harley et al., 2008; Harley & van Minnen, 2009)

The EEA framework is linked to the implementation process of adaptation. According to the framework the monitoring of adaptation starts with process-based indicators to measure how adaptation policies evolve. When policies are in place adaptation monitoring uses process-based indicators to measure the delivery of adaptation actions. Finally adaptation monitoring uses outcome-based indicators to measure the effectiveness of the adaptation actions. This framework gives insight which indicators are appropriate during different stages in the adaptation process.

The EEA framework recognizes that adaptation can be planned or autonomous. Planned adaptation can aim at building adaptive capacity or delivering adaptation action. Autonomous adaptation refers to the responses of citizens, farmers, entrepreneurs and

other stakeholders on already experienced climate change impacts such as a longer growing season, more severe rainstorms or more frequent heat waves. Autonomous change can increase resilience, for example, when new crops are introduced, but it may also lead to mal-adaptation, for example, when air conditioning devices become abundant. According to Harley et al. (2008) in cases of planned adaptation we can use process-based indicators to measure efforts to build adaptive capacity. The EEA framework focuses on planned adaptation and links building adaptive capacity to delivering adaptation actions. For adaptation actions we can both use process-based and outcome-based indicators.

The next sections will describe process-based and outcome based indicators in more detail.

2.4.1 Process-based indicators

Process-based indicators monitor the process of climate adaptation, building adaptive capacity and mainstreaming. Process indicators can also be used as benchmark for subsequent monitoring, review and compliance efforts (Swart et al., 2008).

We distinguish three types of process-based indicators. The first type indicates to what extent adaptation action is undertaken. The EEA framework distinguishes two phases; the development of adaptation policies and the delivery of adaptation actions. We categorize this type of indicators as "initial adaptation stage" indicators.

The second type of process-based indicators measures adaptive capacity. Undertaking adaptation action leads to building adaptive capacity, and adaptive capacity could also be measured by process-based indicators. The literature gives many definitions on adaptive capacity. A much used definition is Adaptive Capacity – The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. (IPCC, 2001).

According to the Executive Summary of Working group II of the IPCC (IPCC, 2001) the determinants of adaptive capacity are:

1. The range of available technological options for adaptation,
2. The availability of resources and their distribution across the population,
3. The structure of critical institutions, the derivative allocation of decision-making authority, and the decision criteria that would be employed,
4. The stock of human capital including education and personal security,
5. The stock of social capital including the definition of property rights,
6. The system's access to risk spreading processes,
7. The ability of decision-makers to manage information, the processes by which these decision-makers determine which information is credible, and the credibility of the decision-makers, themselves, and
8. The public's perceived attribution of the source of stress and the significance of exposure to its local manifestations.

For the institutions that structure society, mentioned under point 3, an additional method has been developed. According to Gupta et al,. 2010 adaptive capacity of institutions encompasses;

- the characteristics of institutions that enable society to cope with climate change

- the degree to which such institutions allow and encourage actors to change these institutions to cope with climate change

The Adaptive Capacity Wheel (Gupta et al, 2010) assesses the inherent characteristics of institutions to enable the adaptive capacity of systems and society. Based on a literature review the adaptive capacity wheel recognizes 6 dimensions; variety, learning capacity, room for autonomous change, leadership, resources and fair governance. These dimensions together indicate the adaptive capacity of institutions. The six dimensions are subdivided further into 22 criteria. This wheel can help academics and social actors to assess if institutions stimulate the adaptive capacity of society to respond to climate change (Gupta et al., 2010). Table 2.1 shows the six dimensions of the adaptive capacity wheel. The method does not provide a quantitative measurement.

Table 2.1 The dimensions of the Adaptive capacity Wheel

Criteria	**Description**
Variety	Indicates how many room there is for multiple frames of reference, opinions and problem definitions. It also shows the involvement of different actors at different policy levels
Learning capacity	Indicates the ability of institutional patterns to learn from past experiences and improved scientific knowledge. It also shows if institutions are open to uncertainties and if institutions promote mutual respect and trust
Room for autonomous change	Indicates the ability of institutions and actors to adjust their behaviour to environmental change autonomously
Leadership	Indicates how institutions encourage their leaders to build adaptive capacity with vision, entrepreneurship and collaboration
Resources	Indicates the ability of institutions to generate financial, human and authority resources
Fair governance	Indicates the fairness of governance structures

Measuring mainstreaming is the final category of process-based indicators we identified. Mainstreaming climate adaptation has become an important strategy to implement adaptation. If this strategy is chosen it makes sense to measure the level and success of mainstreaming. Mainstreaming requires adaptation to be framed within the context of the environmental or sectoral policy. Existing sectoral policy institutions should allow for adaptation. Termeer et al. (2011) assessed if involved governmental institutions meet the basic requirements to face climate adaptation. The conclusion is that institutions often meet the basic requirements, however face five institutional weaknesses; lack of openness towards learning, strong one-sided reliance on scientific experts, tension between top-down policy development and bottom-up implementation, distrust in the solving capacity of civil society and wickedness of reserving funding for the long time. According to Adelle and Russel (2013) mainstreaming fits within the concept of policy integration. The PEER project proposed criteria to assess policy integration (Mickwitz et al, 2009). These criteria are shown in Table 2.2.

*Table 2.2 The criteria of measuring mainstreaming/ policy integration (*Mickwitz et al, 2009)

Criterion	Description
Inclusion	To what extent have climate change policy objectives been covered? To what extent have direct as well as indirect climate change adaptation impacts been covered?

Consistency	Have the contradictions between the aims related to climate change mitigation and adaptation and other policy goals been assessed and have there been efforts to minimize revealed contradictions?
Weighting	Have the relative priorities of climate change adaptation (and mitigation) impacts been compared to other policy aims and are there procedures for determining the relative priorities?
Reporting	Are there clearly stated evaluation and reporting requirements for climate change adaptation (and mitigation) impacts (including deadlines) ex ante and have such evaluations and reporting happened ex post? Have indicators been defined, followed up and used?
Resources	Is internal as well as external know-how about climate change adaptation (and mitigation) impacts available and used and are resources provided?

A problematic aspect of this framework is its implicit assumption that mitigation and adaptation objectives tend to be harmonious, whereas there may be conflicts in particular cases.

2.4.2 Outcome based indicators

Outcome based indicators measure the effectiveness of adaptation policies and actions (Harley et al., 2008). Outcome based indicators should be linked to a theoretical concept or model of climate adaptation. On the basis of the conceptual model for adaptation by (Füssel and Klein, 2006) and the DPSIR model we conclude that outcome based indicators can be put into the following categories.

- **Climate system indicators** measure the state of the climate system. Information on the actual climatic changes provides insight in the accuracy of the climate projections that formed the basis of the adaptation policies or projects. Climate adaptation policies and projects may have to be adjusted on the basis of this kind of information. Climate system indicators give insight climate averages and in the actual exposure of an area, sector or stakeholder to extreme events.
- **Climate sensitivity indicators** measure the sensitivity of social, economic and environmental systems to climatic events. Social economic drivers might lead to increased sensitivity, for example, when houses are built in an area where floods are predicted to occur quite often in 2050. These houses may experience more flood damage than houses built in a more secure area. An example of an indicator measuring climate sensitivity is the total value of property built in floodplains. According to Füssel and Klein (2006) vulnerability is the combined effect of sensitivity and exposure.
- **Climate impact indicators** measure the effect of climatic changes on the environment and the social economic system. For example, heat waves can cause casualties within the human population. The impact indicator could be the number of heat related casualties within Rotterdam city.
- **Adaptation impact indicators** measure the impact of adaptation action (measures, policies) in reducing the climate impacts, sensitivity or exposure. Adaptation impact indicators could also measure the effect of adaptation measures on areas, sectors and stakeholders that are not an implicit part of an adaptation strategy but can have an adaptive effect. For example, more green in the city is often discussed as an adaptation measure for the Urban Heat Island effect. The expansion of a city park could be measured for its adaptation impact. The effectiveness of this measure could

be measured with indicators such as the reduction of temperature in the city and the reduction of heat related casualties in the city.

It is important to realize that attribution of outcomes to climate change and adaptation measures is difficult. According to UKCIP (2011) attribution can be problematic for a number of reasons. Firstly, adaptation takes place over long time lags. This means that a variety of factors may have shaped the outcomes, of which the adaptation actions may be only a small part. It is, for example, difficult to assess the effect of an action plan to prevent casualties during heat waves, when at the same time the population ages and becomes more sensitive. Secondly, attribution becomes an issue when adaptation is implemented through mainstreaming. When adaptation is embedded within existing governance processes it may be difficult to filter out the effect of adaptation actions.

2.4.3 Conclusions

The literature proposes different indicators in order to help policy makers and stakeholders to select indicators that deliver useful information. Indicators are categorized on the basis of the different types of information they can provide. The monitoring of climate adaptation should be supported with both process based and outcome based indicators. Process based indicators could monitor the process of implementing climate adaptation, building adaptive capacity and mainstreaming (Table 2.3). Outcome based indicators could measure climate exposure, climate sensitivity, climate impacts and the effect or impacts of climate adaptation itself (Table 2.4). It is not necessary to cover all indicator categories in the monitoring program. Instead, indicators should be selected that provide the most relevant information. In the beginning of the adaptation process, the process may be more relevant, while later on, the adaptation impact will become more important.

Table 2.3: the framework of indicator categories for process based adaptation indicators (between brackets the unit of measurement, in this case – because these are qualitative indicators)

Type	Description	Examples
Planned adaptation	Indicates the phase of the adaptation policy or process; formulating objectives, formulating policies, taking measures, etc.. • formulation of adaptation policies • delivery of adaptation measures	[-] → is adaptation recognized in spatial planning projects?
Adaptive capacity	Indicates the adaptive capacity provided by institutions. Indicators can focus on the following aspects: • Variety • Learning capacity • Room for autonomous change • Leadership • Resources • Fair governance	[-] → are multiple stakeholders involved in the decision making process?
Mainstreaming	Indicates the level of mainstreaming. Indicators can focus on the following aspects; • Inclusion	[-] → what are the climate objectives within the Water Framework Directive?

	• Consistency • Weighting • Reporting • Resources	

Table 2.4: the framework of indicator categories for outcome based adaptation indicators (between brackets the unit of measurement)

Type	**description**	**Examples**
Climate exposure indicators	Indicates climate change and climate exposure • changes in exposure to extreme events (probability and magnitude) • changes in average weather	[1/T] → probability of a 10 mm/h rain event [°C] → average temperature in The Hague in July [m^3/s] → Lowest annual discharge of the Rhine
Climate sensitivity indicators	Indicates the influence of non-climatic drivers on climate sensitivity	[number of buildings] → number of buildings built within floodplains
Climate impact indicators	Indicates the effect of climate change on the environment or social-economic system	[Euro] → expected annual damage by floods [casualties] → number of heat related deaths
Adaptation impact indicators	The climate impact on the social, economic and ecological system The impact of adaptation action on the social, economic and ecological system	[Euro] → prevented annual flood damage as a result of higher levees [casualties] → number of avoided heat related deaths as a result of action plans

2.5 Proposed monitoring and evaluation procedures

In general, to produce credible and legitimate monitoring and evaluation results, there have to be clear monitoring procedures by policy makers and stakeholders. Monitoring procedures are detailed study plans that explain how data are to be collected, managed, analysed, and reported. Clear monitoring procedures are important because they 1) provide a key component of quality assurance for monitoring programs to ensure that data meet predefined standards such as a known level of confidence, 2) are necessary for the program to be credible so that reports stand up to external review, 3) are necessary to detect changes over time, and 4) are necessary to allow comparisons of data among places and agencies (Oakley et al., 2003).

2.5.1 Adaptive monitoring

Learning is always an important goal of monitoring and evaluation. For climate change adaptation, as a relatively new field of policy associated with a fair amount of uncertainty, learning is even more important. The perspective of how societies frame adaptation is likely to change over time. Adaptive management was already introduced in the first chapter as a flexible and learning approach. Monitoring plays an essential role within adaptive management. It promotes learning and thus the ability of decision makers to respond to social and ecological change (Cundill and Fabricius, 2009). In this context, not only adaptation policies and projects should take a learning approach,

monitoring should be adaptive as well. Several reports on monitoring climate adaptation recognize this and state that adaptation monitoring programs need to be flexible in order to adapt to new insights about adaptation.

We propose to use the concept of adaptive monitoring as developed by Lindenmayer and Likens (2009). Adaptive monitoring is defined as a monitoring program in which the development of conceptual models, formulation of questions, experimental design, data collection, data analysis and data interpretation are linked into interactive steps. This means that adaptive monitoring is a double loop learning process. At the end of every evaluation the monitoring program is questioned in order to improve the system. An adaptive monitoring program can evolve in response to new questions, information, situations or conditions but this must not distort or breach the integrity of the data record (Lindenmayer and Likens, 2009).

2.5.2 Adaptation perspectives

Adaptation takes place by different actors and can be reactive or anticipatory, individual or collective, private and public, planned or autonomous (Adger et al., 2005). Monitoring objectives will differ between stakeholders and scales, for example, the European Commission might be interested to compare adaptation strategies across Europe while individual Member States might be more interested in the efficiency of specific adaptation measures.

Stakeholders will frame climate related problems and solutions differently. *Frames* are the organizing principles of perception that shape in a "hidden" and taken-for-granted way how people develop a particular conceptualisation of an issue (De Boer et al., 2009). Involved groups have different perceptions and views about information needs and they will respond differently to the monitoring results. The behaviour of these groups is guided by the tasks, opinions, rules and language of their own organisation (Timmerman et al., 2010 after Koppenjan and Klein, 2004).

The stakeholders of adaptation must be involved in the monitoring and evaluation process, preferably already while the monitoring program is developed. (Swart et al., 2009). The system of interest should be discussed with stakeholders. This process can also bring focus to adaptation policies, projects and measures. Due to the different views among stakeholders, it is important that there is some agreement on the focus, aims and goals of adaptation and that stakeholders agree on the indicators (van Minnen et al., forthcoming). This process includes discussions between those that are developing and those that are using adaptation indicators to achieve consistency and complementarity, and to minimise differences in opinion on the monitoring system (van Minnen et al., forthcoming).

2.5.3 Conclusions

It is important to describe the monitoring and evaluation procedures in a detailed and precise manner. Monitoring procedures are a key component of quality assurance for monitoring programs and consist of three elements:

- Data and reporting: a detailed description of data collection, data management, data analysis and data reporting.
- Requirements for a data infrastructure: how to store spatial data and time series?
- Adaptive monitoring: how to cope with and adjust to new scientific insights and information needs?

3 European monitoring initiatives

In this chapter the framework of chapter 2 is used to assess monitoring programs at the national scale. This is meant as an iterative step: both to learn about and compare these programs, and to reflect on the usefulness of the framework.

At the national scale most European countries adopted or are designing a national adaptation strategy (NAS). However, not many countries have supported the NAS with ex durante or ex post monitoring. An analysis on the basis of European Climate Adaptation Platform in April 2012 showed that only 4 countries are working on a monitoring program or already have such a program in place; UK, Germany, Finland and Spain. Only Finland, Spain and the UK have monitored the NAS. Germany has launched a report on indicators to monitor and evaluate the German Adaptation Strategy. According to Bauer et al (2012), in Denmark yearly reports on adaptation are published; not in English however. The monitoring program used by Spain has not been published in English either. The language barrier made it impossible to assess these programs. We will discuss the programs developed by the UK, Finland and Germany.

Table 3.1 European nations with or without a National Adaptation Strategy and with or without a monitoring and evaluation program

Country	Strategy	Monitoring	Country	Strategy	Monitoring
Austria	No	No	**Lichtenstein**	No	No
Belgium	Yes	No	**Lithuania**	No	No
Bulgaria	No	No	**Luxemburg**	No	No
Cyprus	No	No	**Malta**	No	No
Czech republic	No	No	**Netherlands**	Yes	No
Denmark	Yes	Yes	**Norway**	No	No
Estonia	No	No	**Poland**	No	No
Finland	Yes	Yes	**Portugal**	Yes	No
France	Yes	No	**Romania**	No	No
Germany	Yes	Developing	**Slovakia**	No	No
Greece	No	No	**Slovenia**	No	No
Hungary	Yes	No	**Spain**	Yes	Yes
Iceland	No	No	**Sweden**	Yes	?
Ireland	No	No	**Swiss**	Yes	No
Italy	No	No	**UK**	Yes	Yes
Latvia	No	No			

3.1 Finland

Finland was the first country worldwide to adopt a National Adaptation Strategy (Ministry of agriculture and forestry of Finland, 2005). The strategy was coordinated by the Ministry of Agriculture and Forestry. Other organisations involved are the Ministry of Transport and Communication, the Ministry of Trade and Industry, the Ministry of Health and Social Affairs, the Ministry of Environment, the Ministry of Foreign affairs, the Finnish Meteorological institute and the Finnish Environmental Institute. The strategy describes the impacts of climate change in the following 15 sectors: agriculture and food production, forestry, fisheries, reindeer husbandry, game management, water resources,

biodiversity, industry, energy, traffic, land use and communities, building, health, tourism and recreation, and insurance. The strategy describes the present sensitivity to climate change and outlines actions and measures to improve adaptive capacity and to adapt to future climate change. The strategy aims at reducing the negative consequences and taking advantage of the opportunities associated with climate change. The Adaptation Strategy includes a proposal on starting a research programme (Ministry of agriculture and forestry of Finland, 2005). An evaluation of the implementation of the Adaptation Strategy took place in 2008 (Ministry of Trade and Industry, 2005). As frontrunners Finland already published the progress of their NAS in 2009.

3.1.1 Institutional body responsible for monitoring

The evaluation of the National Adaptation Strategy of Finland is published by the Ministry of agriculture and forestry of Finland (Ministry of agriculture and forestry of Finland, 2009). The evaluation itself was steered by a Coordination group for Adaptation to Climate Change. The Coordination group consists of representatives of Ministries, research institutes, research funding agencies and regional actors. The Coordination Group is steered by the Ministry of Agriculture and Forestry and will utilize the results of the evaluation in its future work on promoting adaptation measures (Ministry of agriculture and forestry of Finland, 2009). The Adaptation Strategy forms and integrated part of the National Energy and Climate Strategy. According to this strategy another review of the NAS takes place in the period 2011 – 2013.

The Coordination Group as an institution is not independent. Firstly it is steered by the Ministry of Agriculture and Forestry that was responsible for the NAS itself and secondly the Coordination Group was also appointed to support the implementation of Finland's Adaptation Strategy. The Coordination Group members may not have been involved directly in the development of the adaptation strategy. For the next evaluation the Coordination group will become more involved in adaptation policy, because until 2013 it will also work on promotion of adaptation measures.

Stakeholders are involved because they participate in the Coordination group. The involvement of different stakeholders in the Coordination group commits most stakeholders groups to the monitoring results.

The document describing the evaluation of the implementation of Finland's adaptation strategy (Ministry of agriculture and forestry of Finland, 2009) gives some insight in the resources made available to monitor climate adaptation. The human resources are made available by setting up the Coordination group and its 32 members. The document does not give information on the financial resources. It is unclear if the Coordination Group has a permanent or a temporary status.

3.1.2 System of interest

The system of interest is described as the adaptation context and includes the information needs. The adaptation context is built around a conceptual framework of adaptation planning that is derived directly from the NAS itself (Ministry of agriculture and forestry of Finland, 2005). The framework recognizes three levels; 1) climate change, social economic development and changes in the natural system, 2) climate impacts and adaptive capacity and 3) decision making. The framework structures the problem of climate change and the solutions. The framework pays attention to changes in the climate system, climate impacts and adaptation action (see also Figure 3.1).

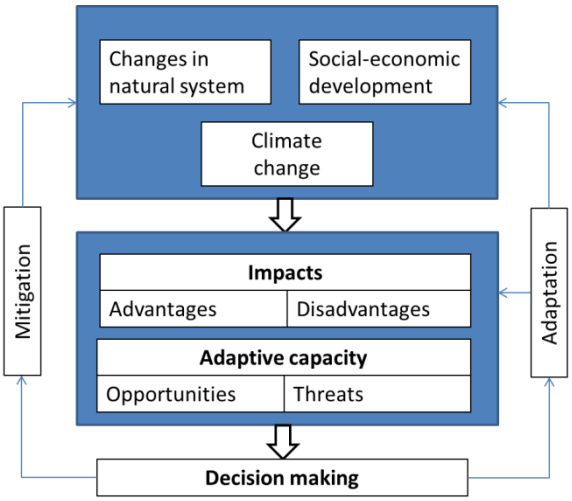


Figure 3.1 Conceptual framework for Finland's National Strategy for Adaptation to Climate Change (Ministry of Agriculture and forestry of Finland, 2005)

The NAS gives an in depth description of climate change for Finland. It describes changes in atmospheric temperature, water temperature, ice conditions, precipitation, snow cover, ground frost, windiness and solar radiation. The climate projections are based on different studies with different assumptions. Most studies report on the basis of a single scenario. As an exception atmospheric temperature and precipitation are projected with the 4 FINSKEN scenarios. The FINSKEN scenarios are backed by a multitude of climate models and a wide range of greenhouse gas and particle emission scenarios for the future. FINSKEN scenarios are downscaled from AOGCM simulations (Carter et al, 2000). The NAS also gives social economic projections on the basis of WM scenarios. Three scenarios are used; Basic scenario, Regressive Finland and Alternative Finland.

New insights in the climate system are described in the document "Evaluation of the implementation of Finland's National Strategy for Adaptation to Climate Change 2009". Information about recently observed global temperatures and precipitation in Helsinki are described and the report gives an update about the latest climate scenarios and their predictions.

The impacts are described for the following sectors; use of natural resources (agriculture, forestry, fisheries, reindeer husbandry, game management, water resources), biodiversity, industry, energy, transport and communication, land use and communities, constructions and buildings, health, tourism and recreational use of nature and insurance operations. The description of the impact starts with a description of the current situation. The second part describes how projected climate changes impacts the current situation and if these impacts bring advantages or disadvantages. It is indicated where it is unclear if a climate impact is an advantage or a disadvantage. The strategy also describes the effect of climate change in other parts of the world on Finland.

After defining the advantages and disadvantages adaptation measures are identified. The strategy identifies the following priorities for increasing the adaptive capacity: (i) mainstreaming climate change impacts and adaptation into sectoral policies, (ii) addressing long-term investments, (iii) coping with extreme weather events, (iv) improving observation systems, (v) strengthening the research and development base, and (vi) international cooperation (Ministry of agriculture and forestry, 2005b). The

Adaptation strategy identifies measures for each sector and the measures are categorised as followed:

- Responsibility: public or private
- Anticipatory or reactive
- Timing: immediate (2005-2010), short term (2010-2030) and long term (2030-2080)

It is interesting that *Finland's strategy for adapting to climate change* (Ministry for agriculture and forestry, 2005a) does not mention mainstreaming. However as mentioned above mainstreaming is mentioned as a priority by the summary *Finland's National Adaptation* Strategy (Ministry for agriculture and forestry, 2005b). According to the latter document mainstreaming comprises a detailed assessment of the impacts of climate change that should be incorporated into the regular planning, implementation and monitoring processes of the different sectors, in order to improve their preparedness to climate change.

The appropriate spatial scale of the strategy differs between climate impacts and adaptation measures. The main spatial scale of the NAS is the national level, although more spatial detail is needed in some cases. Smaller spatial scales are described for example in the northern part of Finland and in sixty-five regions in Finland where flooding could cause significant damage.

This shows that the adaptation context covers the aspects that we proposed in the framework for a system of interest.

3.1.3 Indicators

In this report we analyse the Finnish evaluation of the implementation of the Adaptation Strategy that took place in 2008. The main objective of this evaluation was to find out what progress has been made in different sectors since the NAS came out in 2005. The progress measurement in adaptation consisted of four parts; 1) the adaptation measures taken, 2) current adaptation research, 3) cooperation between sectors on adaptation and 4) recognition of the need for adaptation. These aspects together provided a comprehensive view of where Finland stands in the process of implementation. It also means that no outcome based indicators were included in the evaluation.

A preliminary indicator of the level of adaptation was developed for the assessment. This indicator shows the levels of adaptation to climate change on a scale of 1 to 5. The indicator provides indicative information on the level of adaptation, because in most cases it is impossible to define the level of adaptation in an unambiguous way. The indicator combines the four aspects of the `measurement mentioned above. These aspects can be linked to the types of process indicators mentioned in the indicator building block of our framework:

- Measuring adaptation action is linked with adaptation action indicators
- Measuring progress in research is linked to the learning aspect of measuring adaptive capacity. Learning from past experiences and improved scientific knowledge are important institutional patterns for adaptive capacity(Gupta et a., 2010).
- Measuring recognition of the adaptation problem is linked to the variety aspect of measuring adaptive capacity. Variety indicates how many room there is for

multiple frames of reference, opinions and problem definitions. It also shows the involvement of different actors at different policy levels (Gupta et al., 2010)

- Measuring cooperation between sectors is linked to the inclusion aspect of measuring mainstreaming. Inclusion indicates to what extent climate change policy objectives and climate change adaptation have been covered (Mickwitz et al, 2009).

Table 3.2 Indicator for the Level of adaptation (Ministry of agriculture, 2009)

Level of adaptation	Characteristics
Step 1	• Need for adaptation recognized among a group of pioneers in the sector • Little research done on the impacts of or adaptation to climate change • Some adaptation measures identified but not yet implemented
Step 2	• Need for adaptation measures recognized to some extent in the sector(some decision makers) • Impacts of climate change known indicatively (qualitative information), taking account of the uncertainty involved in climate scenarios • Adaptation measures identified and plans made for their implementation, some of them launched
Step 3	• Need for adaptation measures quite well recognized (majority of decision makers) in the sector • Impacts of climate change quite well known (quantitative information), taking account of the uncertainty involved in climate scenarios • Adaptation measures identified and their implementation launched • Cross-sectoral cooperation on adaptation measures started
Step 4	• Need for adaptation measures widely recognized and accepted in the sector • Adaptation incorporated into regular decision-making processes • Impacts of climate change well known, within the limits of the uncertainty involved in climate scenarios • Implementation of adaptation measures widely launched and their benefits assessed at least to some extent • Cross-sectoral adaptation measures an established practice
Step 5	• Adaptation measures under the Adaptation Strategy or recognized otherwise implemented in the sector

3.1.4 Procedures

The evaluation was executed by members of the Coordination group for adaptation to climate change. The precise protocols are not clear from the evaluation report (Ministry of Agriculture and Forestry, 2009). The document states that the members of the Group were responsible for ensuring that the survey of the measures in their own sector was sufficiently comprehensive. The requested information had to be produced either by themselves or with assistance from other experts. In practice experts from different organisations responded to the survey. Representatives from funding organisations compiled information on adaptation research in different sectors financed by the Climate Adaptation Research Program ISTO, the Finnish Funding Agency for Technology and Innovation Tekes, the Academy of Finland, various UE programs and to some extent private foundations. The final report was circulated among those involved in the process for comments. The report was discussed in meetings of the Coordination group and approved in 2009.

3.1.5 Conclusions

As frontrunners the Finnish monitoring program started to assess the progress made in implementing the NAS. Finland follows the framework described by Harley et al. (2008) by focusing on process based indicators only and adding outcome based indicators to the monitoring program by 2013. It is interesting to see that Finland's NAS and monitoring program are built on a broad and systematic approach, backed up with science. Finland's NAS provides a good description of their system of interest. The field of Climate Adaptation is simplified into a conceptual model. All sectors involved in adaptation are described within this model. The monitoring objectives are described well. It is interesting to see that the combined indicator of the level of adaptation covers different aspects of the adaptation process. It covers information on the process of implementing adaptation, on building capacity and on mainstreaming. The monitoring program does not provide information on outcomes, but in 2013 Finland will focus on both outcome-based and process-based indicators.

There also are some weak aspects. The system of interest doesn't include the vulnerabilities to climate change. Instead, Finland chose to focus on climate impact and their advantages and disadvantages for the different sectors. The procedures for data collection and reporting are unclear. The Finnish monitoring organization can also be described more clearly. The dependency or independent Coordination Group is not established and it is not clear how long this body will be in place. Although the coordination Group is equipped with human resources, the financial resources are unclear.

The conclusions of the monitoring program of Finland are summarized in table 3.3

Table 3.3 The results of applying Finland monitoring strategy to the framework

Institutional body	Institutional body	Coordination group for Adaptation to Climate Change
	Dependency	Not independent - steered by the ministry of Agriculture and Forestry and involved in implementation
	Resources	Supported with resources
	Stakeholder involvement	Several stakeholders are member of the Coordination group and therefore committed to the results
System of Interest - Adaptation context	Climate system	In depth analysis based on downscaled scenarios for Finland in different research programs with different scenario assumptions
	Climate impact	In depth sectoral analyses. Sectors cover natural and social economic systems
	Vulnerabilities	No, impacts are described in terms of advantages and disadvantages
	Time scales	Clearly delineated scales: "immediate " (2005-2010), short term (2010-2030) and long term (2030-2080)
	Spatial scales	Unclearly delineated scales: mostly at national level but in some sectors more detailed (regional scale)
	Mainstreaming	Is seen as an important way to implement climate adaptation policies and measures. Mainstreaming means that climate change impacts should be incorporated into the regular planning, implementation and monitoring processes of the different sectors
	Adaptation action	Yes, identified for each sector and categorised along responsibility, anticipatory or reactive and timing
	Information needs	Defined, what progress has been made in adaptation for different sectors since the adoption of the NAS? The progress is measured on the following elements: • Recognition of the need for adaptation • Adaptation measures launched • Adaptation research

		• Cooperation between sectors
Indicators	Planned adaptation	A part of the indicator "level of adaptation" indicates progress in adaptation measures taken
	Adaptive capacity	No explicit measurement of adaptive capacity, the indicator "level of adaptation" indicates part of the adaptive capacity by the criteria variety and learning.
	Mainstreaming	A part of the indicator "level of adaptation" indicates the level of mainstreaming by the criterion inclusion
	Outcome	No outcome based indicators used
Procedures	Data collection and reporting	Coordination group collected data by assessing adaptation measures themselves or with assistance from other experts. Representatives of funding agencies assessed the research efforts. It is not clear how conclusions were made about the cooperation between sectors and the recognition of the need of adaptation.
	Process	Not clear
	Adaptive monitoring	Not mentioned

3.2 The United Kingdom

The Climate Act legally bound the United Kingdom (UK) to tackle the dangers of climate change by both mitigation and adaptation. The UK adopted the Climate Act in 2008 (Department of Energy and Climate Change, 2009). The Act creates a framework for domestic action on adapting to the impacts of climate change. The objective of adaptation policy is to put a framework in place that commits the Government to assess and address climate impacts so that the UK is better able to respond to the unavoidable impacts of climate change. In addition, the Act intends to strengthen the UK's international leadership to tackle climate change.

The Act requires the Government to take two adaptation actions; 1) publishing a UK climate risk report every 5 years and 2) publishing an Adaptation Programme mainly covering England. The Adaptation Programme should be based on the principles of sustainable development. The UK government installed a requirement to regularly assess all the impacts of climate change in a programmatic and holistic approach. In order to allow flexibility in the long term, the Act doesn't specify policy interventions. The Secretary of State is appointed to establish the programme. The act also creates a number of powers for the government, for example to ask for adaptation reports from local public authorities and statutory agencies.

The Adaptation Sub-Committee (ASC) has been installed under the UK's Climate Act. The Climate Act states that the ASC must advise the government on the progress of its adaptation work. Since 2010 the ASC delivers a yearly report on the progress on climate adaptation (ASC, 2010)(ASC, 2011)(ASC, 2012).

The UK Climate Change Risk Assessment 2012 Evidence Report (CCRA) (Department of Environment, Food and Rural Affairs, 2012) meets the requirement by the Climate Act of a UK risk assessment every 5 years. This assessment provides a risk evaluation in 11 sectors: agriculture, biodiversity & ecosystem services, built environment, business, industry & services, energy, forestry, floods & coastal erosion, health, marine & fisheries, transport and water.

3.2.1 Institutional body responsible for monitoring

The UK Government shows leadership by a strong legally binding obligation to take action on adaptation. The UK government is also legally bound by the Climate Act to

provide human and financial resources for monitoring of climate adaptation. The Adaptation Sub-Committee (ASC) has been installed and most members have a scientific background. The ASC does not seem to have members who represent stakeholders in the field of climate adaptation. The Climate Act provides the ASC annually with financial resources. The financial resources are divided in several categories; Sub-secretariat, Sub-Committee, research and running costs.

Summarizing: the ASC is an independent institutional body to monitor the UK Government Programme on Adaptation. It is legally provided with the needed resources. The body has a strong scientific character but there is no involvement of stakeholders in the ASC.

3.2.2 System of interest

The ASC delivers a yearly report on the progress of climate adaptation in which a process of learning can be discerned. We describe the subsequent frameworks used by the ASC to assess the preparedness of the UK for climate change as conceptions of the system of interest.

Framework development

The ASC first introduced an outcome based indicator framework called the adaptation preparedness ladder in 2010 (ASC, 2010). The adaptation preparedness ladder is a framework to measure, evaluate and monitor how well the UK is preparing for climate change. The ASC's Adaptation Ladder consists of three elements; 1) the desired adaptation outcome, 2) the ladder of key activities in delivering adaptation outcomes and 3) policy to enable delivery (both by encouragement and by removing barriers).

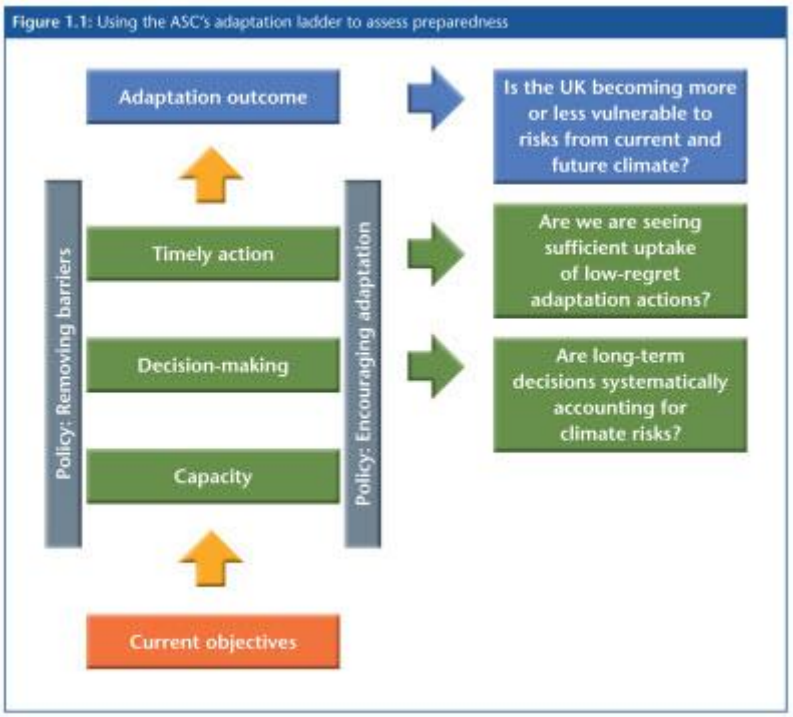


Figure 3.2 The ASC's Adaptation ladder (http://www.theccc.org.uk/adaptation/action-to-adapt)

Adaptation outcome was already a part of the first framework of 2010. To plan efficient adaptation measures decision makers needed to understand how objectives were likely to be affected by climate change and with which adaptation measures the objectives could be achieved. According to the ASC adaptation outcomes had to be monitored and evaluated to assess if adaptation action met the desired goals. However, in 2010 the adaptation preparedness ladder did not give enough insight how this outcome based monitoring should be executed. A reason could be that the adaptation ladder itself does not provide a structured way to assess the adaptation context.

The second report of the ASC (ASC, 2011) recognizes the difficulties related to outcome based monitoring. According to the ASC, adaptation is context-specific, has no prescribed target, and has to be flexible and keep options open in order to deal with uncertainty. Recognising these problems the ASC and AEA created an adapted framework to develop an initial set of indicators consisting of climate impacts, drivers and action (AEA, 2011). Today's climate impacts are assessed and form a baseline against future changes in climate impacts and vulnerabilities. The ASC assessed how key climatic and non-climatic drivers influenced vulnerability. Some drivers are 'controllable' (open to adaptation intervention) and some are 'contextual' (little or no scope for adaptation). Adaptation actions aim to reduce the climate impact by reducing the influence of controllable non-climate drivers on vulnerability.

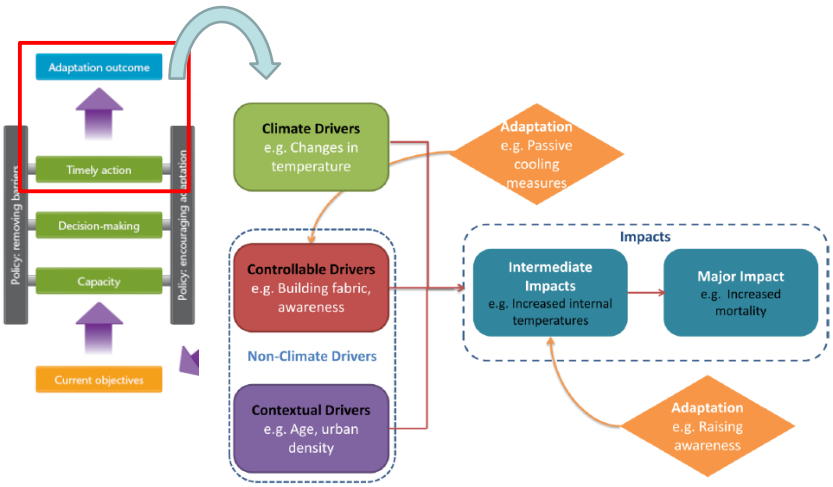


Figure 3: ASC adaptation ladder and the link with outcome based indicators (source ASC, 2011)

The third ASC progress report (2012) uses the five-yearly Climate Change Risk Assessment (CCRA) as a starting point of the adaptation assessment toolkit. The CCRA describes the problem of climate adaptation in terms of climate risks, adaptation action outcome and the combined effect of climate change risks for society and the effect of climate adaptation on this risk. The CCRA (2012) provides information on the most significant climate impacts, drivers and vulnerabilities. The methodology of the CCRA is described in detail and published on the Defra website (Defra, 2012b). The ASC reviewed the method of the CCRA. The CCRA consists of four main components:

1. **Identification and characterisation of the impacts of climate change**; the identification is done by a literature review, stakeholder involvement and technical reviews. Stakeholder workshops where held in order to get also insight in cross sectoral and indirect impacts. The result is a long list covering 700 identified climate impacts, the Tier 1 list.

2. **Assess vulnerability**; this assessment involves a high level snapshot on policy objectives that could be affected, a high level assessment on social vulnerability and a high level assessment on the adaptive capacity of sectors. The assessment of adaptive capacity is based on the PACT framework (Defra, 2012 after Ballack, Blake and Longsdale, 2011)
3. **Identify the main risks**; the high level risks where identified by stakeholder groups based on the social, economic and environmental magnitude of impacts, the likelihood of the impact and the urgency of taking action. Magnitude, likelihood and urgency are weighted equally. Also the social, economic or environmental impacts are weighted equally. This resulted into a short list of main risks, the Tier 2 list
4. **Assess current and future risks**; The risks of the Tier 2 list are assessed to project current and future climate risks. The assessment is based on response functions, also referred to as risk metrics, that describe a relationship between climatic trends and their consequences. The response functions are based on historic data, modelling and expert judgement. UKCP09 Projections of future climate where used to assess future risks for 2020, 2050 and 2080. The risk assessment does not take social changes or adaptation action into account, except population growth. All changes given by the UKCP09 projection are relative to the baseline period 1961-1990. UKCP09 projections cannot provide sufficient information on weather extremes. The UKCP09 model instrument can downscale climate projections on a river basin or an administrative region scale. Finally the risks are expressed in monetary terms.

The third ASC progress report (2012) introduces a new framework that is clearly influenced by risk management thinking. This framework called the Adaptation Assessment Toolkit has two main components:

1. An indicator framework that monitors changes in climate risks; this involves the monitoring of the risks factors (weather events, exposure and vulnerability), adaptation actions and the remaining impact (realized risks) for society.
2. Decision making analysis; this involves analysing decision-making to assess if climate adaptation is sufficient to both adopt low-regret measures at the short term and set the stage for long term decisions.

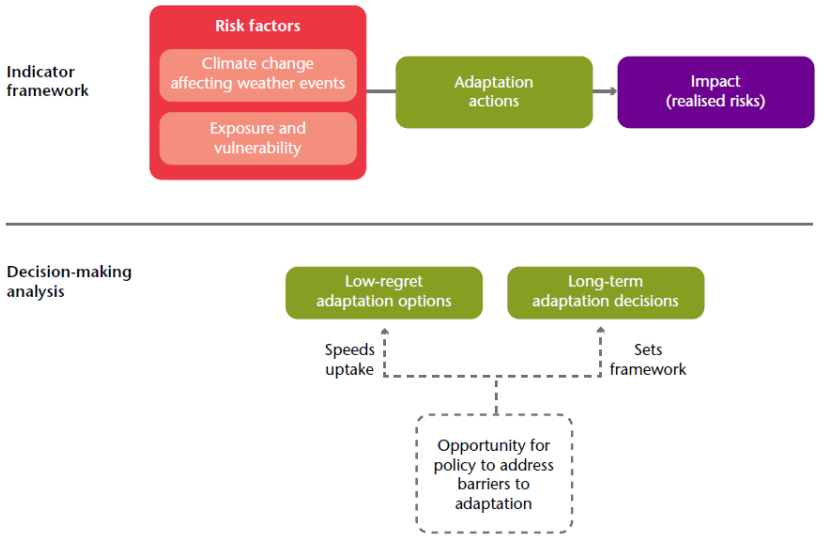


Figure 3.4 The adaptation assessment toolkit (source: ASC, 2012)

Policy process

Next to a growing interest in the adaptation outcome, a more and more focused interest in the policy process is developed by the ASC over time. The adaptation ladder of 2010 'is' the policy process that adapts in three steps, from capacity building, to decision making and then to timely action, supported by a longitudinal policy of removing barriers end encouraging adaptation action by private stakeholders.

1. Building adaptive capacity ensures that governments and stakeholders will have the knowledge and skills to take sensible decisions to implement adaptation action. The ASC report (2010) mentions the following aspects of adaptive capacity:

- gathering scientific knowledge, monitoring climate change impacts and assessing action in order to learn,
- building partnerships to develop adaptation action,
- train and inform staff and individuals and build leadership.

2. The second level, decision-making, defines how structured decision-making in the adaptation context should take place. Structured decision-making in the adaptation context should include; identifying and setting outcomes, explicitly incorporating climate impacts and their uncertainties into key decisions, and taking tangible action to reduce vulnerability.

3. The third level, timely action, measures if tangible action is taken or not. Timely action is the result of the decision-making process and consists of actions to reduce current climate vulnerability, provide co-benefits or built in robustness to a range of climate projections. Timely action might build in flexibility for future adaptation, which implies that timely action can be taken immediate or later.

The element describing if 'policies enable delivery of adaptation action' assesses to what extent governments support organisations to move up the ladder to achieve adaptation outcomes. In general the government can support adaptation by removing barriers and by encouraging adaptation. Removing barriers consists of behavioural barriers, market failures, institutional and regulatory barriers, and financial constraints. Policy instruments to encourage adaptation are direct regulation, market based measures, research and monitoring programmes, information provision and public engagement. The adaptation preparedness ladder does not describe how barriers are identified.

The adaptation assessment toolkit builds on previous analyses with the adaptation preparedness ladder and experience in other countries of measuring progress. It analyses the decision making process. This assessment is now limited to the question if climate adaptation is sufficient to address climate risks now and in the future. The sub-committee focuses on the uptake of no regret measures and decisions that take the long lasting or systematic consequences of climate change into account, including uncertainties and trade-offs between different objectives.

3.2.3 Indicators

The ASC reports provide the reason behind the evaluations: the UK wants to assess the progress and outcome of climate adaptation to show adaptation action is taken and to justify adaptation action expenses. In 2011 the ASC also aims to use the adaptation preparedness ladder framework in a more quantitative way. It identifies both process and

outcome-based indicators to assess the progress of adaptation in the fields of land use planning, managing water resources and the design and renovation of residential buildings. The third ASC report (2012) introduces a new framework. Of this report we mainly look into the indicators used for flood management in both frameworks. Flood management is a part of land use planning. The CCRA (2012) recognizes flood management and water resource management as priority fields. As a result indicators for climate adaptation in the field of flood management are defined for both frameworks.

Adaptation preparedness ladder - 2011

According to the ASC (2011) it is important to take early action in land use planning because it can directly increase resilience. Also action or inaction can lock in future generations into development pathways with increased vulnerability to climate change which can lead to high costs. In the field of land use planning the ASC focuses on dealing with the following climate issues; floods, coastal erosion and the urban heat island effect. The assessment is based on the sample of five local authorities. The sample locations are representative for the trends in vulnerability and adaptation action in the UK. For floods and coastal erosion outcome-based indicators aim to provide information on trends in vulnerability. The ASC used the Ordnance Survey Mastermap data for assessing land use change between 2001 and 2010. Flood risks zones identified by the Environmental Agency (2009) were used. Coastal zones vulnerable to erosion were identified from the relevant Shoreline Management Plans (Flamborough Head to Gibraltar Point and North Solent). For an overview of indicators in 2011 see table 3.4. Not all indicators were covered by available data sets.

The process-based indicators aimed to provide information on adaptation action taken and on how local authorities account for climate risks in their decision making. The sub-committee used a representative sample of application documents, committee reports, decision reports and relevant assessments to assess adaptation process. New model projections were not included in the assessment.

A conclusion of the ASC was that, given the multi-faceted nature of climate change, it is not desirable to develop indicators for every possible impact or risk. The ASC identified available indicators and data sets that could be used to track these trends (ASC, 2011). The ASC states that the establishment of a coherent and credible indicator set is an iterative process. The process of selecting a subset of impacts and drivers is the most important and significant decision in selecting adaptation indicators. At the moment there is limited knowledge on how to prioritize the most significant climate consequences.

Table 3.4 Land use indicators used by the ASC in 2011 (adaptation preparedness ladder) for assessing adaptation progress (source ASC, 2011)

Indicator type		**Indicator**	**Data source**
Process-based	Adaptation action indicator	Catchment/neighbourhood-level measures taken	ASC sample of application and Environmental Agency documents
	Adaptation action indicator	Property-level measures taken	ASC sample of application
	Adaptive capacity indicator	Are short-term and longer-term effects properly weighted in decision making	ASC sample of application
	Climate impact indicator	Insurance claims weather related causes	Association of British Insurers
	Climate impact indicator	Number of houses flooded	Not available

Outcome-based	Climate sensitivity indicator	Number of buildings constructed in areas prone to flood risk – not accounted for flood defences (2001 – 2010)	OS Mastermap – ASC sample Environment Agency – Fluvial & Coastal Flood Risk Zones and Areas Susceptible to Surface Water Flood Risk
	Climate sensitivity indicator	Number of buildings at locations of low, moderate and significant likelihood of river and coastal floods–accounted for flood defences (2001 – 2010)	OS Mastermap – ASC sample Environment Agency – National Flood Risk Assessment (NaFRA)
	Climate sensitivity indicator	Proportion of new dwellings built in areas of high flood risk (1989 – 2009)	Department of Communities and Local Government – Land Use Change Statistics
	Climate sensitivity indicator	Change in land covered by buildings in areas at risk from coastal erosion	OS Mastermap – ASC sample

ASC assessment toolkit (2012)

In 2012 the ASC used the ASC assessment toolkit to evaluate preparedness for the impacts of climate change in the UK. The impacts of floods and water scarcity emerged as most important climate risks from the CCRA. The assessment on floods starts to summarise the current scale of flood impacts in the UK. Secondly it summarises future flood and erosion risks based on CCRA. The CCRA concludes that the property at risk and the annual damage costs of coastal and river floods are expected to double to quadruple by 2080. Others estimated that flood damages from surface run-off is expected to increase between 60 to 220 per cent by 2050.

The process based indicators focus on the actions taken. Indicators of action could be categorised by different action types such as flood defences, measures at property-level, urban water management and emergency planning and response management. The potential barriers to adaptation to flooding are discussed. Also some aspects of adaptive capacity are measured. The ASC assesses how organisations and governments weight short-term and longer-term effects in decision making. Outcome indicators cover actual damages, the location and design of property, social vulnerabilities and the actual measures taken over the period 2001 to 2010. Damage indicators show actual changes in flood exposure in terms of annual insurance losses from flooding. Vulnerability indicators aim at both the susceptibility of property and society. The susceptibility of property is described in terms of the amount of property in floodplains, property at risk from surface water floods or at risk from coastal erosion. Also the rate of development in these vulnerable zones is measured. The susceptibility of society is described in terms of vulnerable population at risk, the number of care homes and schools located at places with a significant flood risk and the number of households of deprived communities in areas with significant flood risk. Significant flood risk is defined as a greater than 1 in 75 chance of a flood in any given year. For an overview of indicators used in 2012 see table 3.5.

Table 3.5 Flooding and coastal erosion indicators used by the ASC in 2012 (adaptation preparedness ladder) for assessing adaptation progress (source ASC, 2012)

Indicator type		**Indicator**	**Data source**
	Adaptation action indicator	Design of new development (proportion of Environmental Agency objectives to planned applications on flood risk grounds that are over-ruled by local authority)	Environmental Agency
	Adaptation action	Provision of flood defences (Effective	Environmental Agency

Process-based	indicator	spend in flood risk management activity from public and private sources (capital and revenue))	
	Adaptation action indicator	Number of existing properties at flood risk retrofitting property-level measures	Defra
	Adaptation action indicator	Management of service water in built up areas (proportion of new development with sustainable drainage systems)	Defra
	Adaptation action indicator	Provision of early warning systems (uptake of flood warnings by properties in the floodplain)	Environmental Agency
Outcome-based	Climate sensitivity indicator	Number of property in river flood plain, coastal flood plain, at risk for surface water flooding (1 in 200 year event) and areas at risk from coastal erosion (2001 – 2011)	Environmental Agency OS Mastermap
	Climate sensitivity indicator	Rate of development in river flood plain, coastal flood plain, at risk for surface water flooding (1 in 200 year event) and areas at risk from coastal erosion (2001 – 2011)	Environmental Agency OS Mastermap
	Climate sensitivity indicator	Proportion of flood plain development in areas with significant, moderate or low risk of coastal/river flooding	Environmental Agency OS Mastermap
	Climate sensitivity indicator	Area of impermeable surfaces in urban areas	OS Mastermap
	Climate sensitivity indicator	Number of households within highest 20% of ranked deprived communities in areas of significant flood risks (accounting for flood defences)	Office for National Statistics Environmental Agency
	Climate sensitivity indicator	Number of care homes in areas of significant flood risks (accounting for flood defences)	Care quality commission Environmental Agency
	Climate sensitivity indicator	Number of schools in areas of significant flood risks (accounting for flood defences)	Department for education Environmental Agency
	Climate sensitivity indicator	Area of impermeable surfaces in urban areas	OS Mastermap
	Climate impact indicator	Annual insured losses from flooding	Association of British Insurers
	Climate impact indicator	Annual number of deaths by caused flooding	CCRA
	Climate impact indicator	Annual number of injuries caused by flooding	CCRA
	Climate impact indicator	Annual number of mental illness caused by flooding	CCRA
	Adaptation outcome indicator	Provision of flood defences (number of households at reduced risk due to construction of flood defences)	Environmental Agency

Summary of indicators approach

The total indicator set used in the UK covers a wide spectrum of different indicator types covering environmental and societal sensitivity to climate change impacts. This includes a number of process indicators, but the ASC doesn't take into account the progress in mainstreaming. As frontrunners the UK started with the measurement of the outcome of adaptation. The ASC identified several adaptation outcome indicators, for example the number of households at reduced risk due to construction of flood defences. As we can see in table 3.5 the ASC covers all types of outcome indicators in the field of flood management if we include the expected climate changes by the CCRA.

It is interesting to see how indicators are chosen. They are closely related to available data sets and sometimes datasets were combined to reveal relevant information.

3.2.4 Procedures

As we mentioned before the UK adopted the Climate Act in 2008. The Act explicitly pays attention to monitoring and evaluating of adaptation. The CCRA has to meet the requirement of a UK risk assessment every 5 years. The methodology to assess the risks of 11 sectors is described in detail (Defra, 2012b). The methods and procedures of the CCRA are clear and well defined.

To advise the government on the progress of its adaptation efforts the Adaptation Sub-Committee (ASC) has been specifically installed under the UK's Climate Act. The ASC must advise about;

- The adequacy of the adaptation programme to address the risks;
- The contribution of the adaptation programme to sustainable development;
- Progress on the implementation of the adaptation programme;
- Directions issued to authorities on adaptation.

The assessment of adaptation progress is executed by the ASC. The role of the ASC as set by the Climate act is to provide independent information on;

- The preparation of the UK risk assessment, in particular its methodology and conclusions;
- The implementation of the Governments Adaptation Programme, indicating areas where the Government is doing well and areas where the Government is falling short on delivering changes;
- Any relevant topic suggested by Government and the Devoted Administrations.

Since 2010 the ASC delivers a yearly report on the progress on climate adaptation (ASC, 2010; ASC, 2011; ASC, 2012). The ASC provides the UK government with a yearly assessment on the UK's preparedness for climate change. This frequency is not required by law. The monitoring procedure and data collection are well described in the ASC reports. The ASC does not explicitly mention the adaptive character of the monitoring program. However, as will have become clear from the previous paragraphs, the ASC method is under development and is more elaborated every year. This shows that the ASC is flexible and adaptive.

3.2.5 Conclusions

At the moment, the UK has the best developed monitoring program for climate adaptation in place. This is the result of the strong leadership the UK wants to take on climate change policy and is reflected in a legally binding Climate Act on climate adaptation and mitigation. As a result the UK installed the ASC to monitor the progress of UK's preparedness to climate change. The ASC is independent and has a predominantly scientific character. It organizes no stakeholder involvement. It is provided with finances by law. As a result UK's monitoring programme focuses on providing information for classic policy evaluations with more emphasis on accountability than on learning.

The different reports form an elaborate foundation to describe the adaptation context. Especially the CCRA and the progress reports of the ASC provide this information. However, the model the ASC uses to describe climatic changes, exposure, sensitivity, impacts, vulnerability and adaptation action is not described in one report. It is advisable to describe the overall systematic approach used in the fourth assessment report. This would bring all information and frameworks used by the ASC together.

The indicators used provide a wide spectrum of information on climate change adaptation. All types of outcome-based indicators are represented. The process-based indicators mainly aim to measure the adaptation process and action taken. Some aspects of adaptive capacity are included, such as how institutions involve climate change in their decision-making and an inventory of barriers to climate adaptation. Mainstreaming is not taken into account.

The adaptation preparedness ladder and the ASC assessment toolkit are useful frameworks identifying process-based indicators. However, they are not suitable to define the complete adaptation context in a systematic way. The CCRA fills this space and provides a sound foundation for describing the adaptation context. It assesses and projects the current and future UK climate with data and standardized downscaled climate models (UKCP09). It has a structured way to project climate impacts and vulnerabilities on the basis of scientific knowledge. The temporal and spatial scales of the projections are well defined. Temporal scales are related to the time horizons of 2020, 2050 and 2080 and the spatial scales are defined on river basin or administrative region level. The mainstreaming context is partly covered by assessing the sectoral impacts including the impacts for sectoral policy objectives. The impact assessment also pays attention to the cross-sectoral and indirect impacts. The ASC assessment toolkit uses the outcome of the CCRA to define adaptation action.

The protocols are described clearly, including the sources used. The ASC does not explicitly recognise the need for an adaptive approach to climate adaptation monitoring. However the ASC acts in the process of developing a monitoring program in a flexible and adaptive manner.

The conclusions of the monitoring program of the UK are summarized in table 3.6

Table 3.6 The results of applying UK's monitoring strategy to the framework

Institutional body	Institutional body	Adaptation Sub-Committee
	Dependency	According to the Climate Act must the Adaptation Sub-Committee independent information on preparation of risk assessments and the implementation of the Governments Adaptation Programme.
	Resources	The Government shows strong leadership in the field of climate adaptation and is legally bound to provide human (Adaptation sub-committee and financial resources.
	Stakeholder involvement	No stakeholder involvement in the Adaptation sub-committee
System of Interest - Adaptation context	Climate system	In depth analyses with standard downscaled scenarios (UKCP09) for almost all projections
	Climate impact	Rough analysis of all impacts in order to find the most important impacts followed by an in depth analyses for most important impacts based on model projection (UKCP09) and response relations. Impacts are described with social, economic and environmental indicators
	Vulnerabilities	Includes a basic assessment to assess the vulnerability of sectoral policies, social groups and adaptive capacity.
	Time scales	Clearly delineated scales: (2020), (2050) and (2080)
	Spatial scales	Clearly delineated scales: on the level of river basins or on the level of regional administration
	Mainstreaming	Not mentioned in the CCRA and the 2011 and 2012 progress reports of ASC. Mainstreaming does not play an important role in the 2010 progress report of the ASC
	Adaptation action	Adaptation actions aims to reduce the climate impact itself, enhance adaptive capacity or reduce the influence of non-climate drivers on climate vulnerability.
	Information needs	Strong emphasis on classic evaluation needs. Justification of the adaptation programme, adequacy of the action taken and to show the progress made
Indicators	Adaptation action	The UK defined important adaptation measures and assessed how

		often measures are in place
	Adaptive capacity	The UK focuses on learning capacity by measuring how organisations and governments weight short-term and longer-term effects properly in decision making. The inventory of barriers toward adaptation actions can cover all aspects of adaptive capacity
	Mainstreaming	None
	Exposure indicators	In the CCRA, both current climate and climate projections
	Sensitivity indicators	The sensitivity indicators focus on two aspects; 1) the amount of property in areas at risk and the rate of development in these areas at risk 2) the amount vulnerable functions in areas with significant flood risk. The indicator measuring the amount of sealed soil in urban areas measures is the only indicator measuring the sensitivity of the environment
	Impact indicators	These indicators measure the actual impacts of flood in insured losses, deaths, injuries and mental illnesses
	Adaptation outcome	The number of households at reduced risk due to construction of flood defences
Protocols	Data collection and reporting	The collection of data and the reporting of data is done in a structured matter. The sources of data is referred to and the monitoring method is well described
	Process	The UK is legally bound to a risk assessment every 5 years. The assessment on the effectiveness of adaptation done on a yearly basis. However this is not obliged by law
	Adaptive monitoring	Not explicitly mentioned, but they develop the assessment framework in a flexible and adaptive manner

3.3 Germany

The German Adaptation Strategy (DAS) was adopted in 2008 by the Federal government (German Federal Cabinet, 2008). The strategy aims at a contribution of the Federal Government to climate adaptation and provides guidance for other stakeholders and governments of the Bundesländer (Federal states). The aim of the DAS is to reduce vulnerability, maintain or increase adaptability and to take advantages of opportunities as a result of climate change. As was mentioned before, the Umweltbundesambt (UBA) recognizes 13 action fields (Human health, Building sector, Water regime, water management, coastal and marine protection, Soil, Biodiversity, Agriculture, Woodland and forestry, Fishery, Energy industry, Financial services industry, Transport and transport infrastructure, Trade and industry, Tourism industry), and 2 cross-sectoral fields for climate adaptation (Spatial planning and Population protection). The DAS introduces a framework for adapting to climate change that consists of the following steps: 1) to provide a step by step assessment for the risks of climate change, 2) to state the potential requirements for action, 3) to define adaptation goals and measures and 4) to implement climate adaptation in a process (Umweltbundesambt, 2010).

In order to facilitate a precautionary approach to sustainable planning and action in the private, scientific, business and public sectors there is a need to:

- Improve the knowledge base with a view to better define and communicate opportunities and risks, and to identify options for action,
- Create transparency and participation by means of a broadly based process of communication and dialogue, and support various stakeholders, for example by providing decision support and information on which to base decisions,
- Support public awareness raising and information through widespread public relations work,
- Develop strategies for dealing with uncertainty factors. (DAS, 2008)

According to the DAS monitoring of climate impacts is important because of the long term climate impact. Monitoring can document and demonstrate climate change impacts with concrete data. Climate impact monitoring can be used to review progress in adaptation measures. The UBA (2010) starts with general requirements to be met by an indicator system. Firstly, the indicator system must be adaptive and kept up to date. New scientific, technical and political insights emerging from a lively debate must be allowed to adjust the indicator system. Also the indicator system should take into account both measured data and data projected by models or scenario studies. In this way the indicator system can help to validate model and scenario studies. Secondly, it should provide a clear prioritisation of the themes to be covered by the system. Thirdly, the UBA states that the indicator system should be based largely on existing data. Finally the indicators used should be accepted by stakeholders and other experts. Besides general requirements the UBA recognizes also the governmental requirements at European, National and Federal level. At European level the main requirements are set by the White Paper on Adapting to Climate Change (EC 2009). At national level the indicator system must provide insight in the process of implementing the DAS and recording the success and failure of measures taken. At Federal level the indicator system must facilitate statements on the actions taken in order to adapt.

To implement the strategy with concrete action the DAS was followed up with "Adaptation Action Plan of the German Adaptation Strategy" (APA) (Bundesregierung, 2011). The APA first describes the objectives and principles of the Adaptation Action Plan and then explains the four pillars of the action plan:

1. Research and communication: expanding the knowledge base on future climate and adaptation options, working on public awareness and assisting local governments;
2. Institutional reform: integrating adaptation requirements into laws, technical regulations and economic instruments;
3. Direct adaptation actions by the Federal government: adaptation of federally owned buildings and infrastructure such as waterways, railways, roads and forests.
4. International dimensions: international cooperation and linking up to EU policy.

Monitoring is again recognized as an important aspect of climate adaptation policy in the APA. The APA announces an initial evaluation report for the evaluation of the DAS and the Action Plan 'in the next electoral term', and further reports are to follow at regular intervals (Bundesregierung, 2011)

Although Germany has not yet set up a monitoring and evaluation program it has started to develop an indicator set. The report by UBA with an initial indicator set was released in 2010. A follow-up with a final indicator set is expected in 2013.

3.3.1 Institutional body responsible for monitoring

The APA (2011) states that the Federal Government and the Länder are responsible for the monitoring of climate impacts. Monitoring climate impacts should be built on the broad expertise at Länder level with existing monitoring in place. According to the APA monitoring programs already in place should become more effective or must be adjusted to meet the information needs of climate adaptation. As a result the existing institutional bodies for monitoring in each action field will become responsible for their part of the monitoring of climate impacts.

The impacts of climate change on biodiversity should, for example, be monitored throughout Germany. The monitoring of climate impacts is closely connected to the existing monitoring programme on the status of biodiversity as a result of pollution (BMU, Länder, BMELV, BMG, BMVBS). This existing monitoring programme could be expanded with climate impact monitoring. The monitoring of climate impacts on biodiversity should be set up in coordination with BMU/BmF and Länder within the existing monitoring programme between 2011 and 2016.

As this example shows, existing monitoring programmes already have their organizational structures. They are already provided with resources and there are arrangements on their independency and how stakeholders are involved. From the policy documents it was not possible to find information regarding the structure of those existing monitoring programmes in the different action fields. Extra monitoring would mostly mean more resources to the same institutes. The DAS and APA do not give insight if existing monitoring programmes will be provided with additional resources to monitoring climate impacts.

3.3.2 System of interest

The DAS Indicator system is intended to gather information around the objectives and the implemented or recommended measures identified by the German Adaptation Policy. The UBA (2010) does not describe the system of interest explicitly, but the DAS and the APA cover the different aspects of the system of interest. The DAS states that the targeted adaptation process calls for a systematic approach and a common base of methods, knowledge and data on the impacts of climate change. Monitoring of observed climate impacts should play an important role. According to the APA the knowledge base of climate impact modelling should be deepened.

The DAS Indicator System uses the DPSIR indicator framework to identify possible indicators. Driving forces, pressures and state mainly deal with climate mitigation. As a result UBA states that adaptation indicators should have a strong focus on impact indicators or response indicators. UBA aims to have a balanced set of Impact and Response indicators for each field of adaptation: 13 action fields (Human health, Building sector, Water regime, water management, coastal and marine protection, Soil, Biodiversity, Agriculture, Woodland and forestry, Fishery, Energy industry, Financial services industry, Transport and transport infrastructure, Trade and industry, Tourism industry), and 2 cross-sectoral fields (Spatial planning and Population protection). Adaptation action, described by response indicators, must be linked to the climate impacts and aim to control impacts in these action fields.

It is not possible to deal with uncertainty of climate projections using a single model with a single scenario. This is recognized by the DAS. To get insight in the uncertainty of future climate projections different global and regional models are necessary. The German climate projections are executed with the four regional climate models. Germany uses the models REMO, CLM, WETTREG and STAR. Each model has been run under different emission scenarios (A1B, A2 and B1) and under different boundary conditions. The results are described in the DAS. Future climate projections can be used to project impacts in the social-economic domain and the environment. The results of the climate projections can be used as input to generate ranges of climate impacts with climate impact models. In 2011 a large number of impact studies have been executed to investigate the climate impacts in the action fields. The APA mentions research on the climate impacts of waterways and navigation, the economics of adaptation, managing

climate change in regions for the future (KLIMZUG), and the impact on human health, agriculture and biodiversity. Not all action fields are covered yet with climate impact projections.

The DAS puts emphasis on the costs and benefits of adaptation. Three types of costs and benefits are distinguished: 1) the costs and benefits of climate change without adaptation, 2) the costs and benefits of alternative adaptation methods and 3) the costs of residual damages. In other words, the DAS proposes to create a baseline (without adaptation) of climate change impacts. The costs and benefits and the residual damages of different adaptation measures can be compared to the baseline and to each other. However, currently the DAS describes climate impacts not in quantitative but in qualitative terms for all 15 sectors.

The spatial scale of the indicator system is at national level (Bundesländer). The national scale can be too coarse for the level of detail required in some cases. Requirements in terms of natural space, economic and social conditions vary within Germany. Also some problems, such as sea level rise, are restricted to certain areas. According to UBA the National Indicator System should also cover regionally important indicators, because they can provide contact points between monitoring programs at federal and national level. The spatial scale is also reflected in the scientific literature that identifies the climate impacts and adaptation actions.

Time scales are not explicitly defined. The monitoring program requires a description of observed data in the past and present and projected data based on scenario studies. UBA states that the indicator system should provide answers on the following aspects;

- Historic developments; this includes actual changes in the climate and the observed impacts of these changes. The observed climatic changes can be split into changes in frequency and intensity of extreme events and in changes in average weather. The impact of the observed changes in climate can be both on the human or the natural system.
- Current risks and opportunities. The UBA gives some examples like: which settlements and which infrastructures appear to be at risk from flooding with increasing frequency and severity? And which regions stand to benefit from predicted increases in temperature for their summer tourism?
- Tangible future climate impacts; this includes the prediction of damages on the basis of scientific findings and available scenarios.

Although mainstreaming itself is not mentioned in the DAS, it becomes clear that adaptation should be implemented by sustainable planning and action in the private, scientific, business and public sectors. The APA is more clear about the role of mainstreaming. According to the APA adaptation should be implemented by taking into consideration climate impacts and adaptation options in plans and decisions, so that sectoral targets for resource use and conservation could be reached under a changing climate. The DAS promotes an integrated approach for adaptation and is embedded in the Federal sustainability policy. Sustainable development could form the basis for an integrated approach. Integrated approaches can optimize the interaction between sectoral and cross-sectoral adaptation measures and facilitate trade-offs. As a result the DAS also aims at an integrated cross-sectoral approach to the development of indicator systems. The indicator system should be pursued in close cooperation between

departments at federal, Länder and local level and should be built on existing indicator systems at federal, Länder and local level, e.g. in the field of sustainability.

3.3.3 Indicators

The DAS mostly focuses on the monitoring of climate impacts and the monitoring of adaptation measures. According to the DAS the monitoring objectives are to document and demonstrate climate change impacts with concrete data. Climate impact monitoring can also be used for progress review of adaptation measures. The DAS summarizes for each action field possible adaptation options.

The APA proposes to assess the effectiveness of adaptation action. According to the APA establishing climate adaptation monitoring is important to supply the policy process with essential and robust data on climate related changes in social and economic systems. Monitoring should also provide a sound basis to interpret the data and evaluate the consequences of climate change and adaptation measures.

A first outline for an indicator system is described by UBA in 2010. The DAS Indicator System is intended to gather information around the objectives of the DAS and information of the process of implementing recommended measures identified by the German Adaptation Policy. The DAS Indicator System structures indicators within the DPSIR indicator framework.

The state of the climate is measured by the German Wetter Service. UBA (2010) states that the selection of adaptation indicators should have a strong focus on impact indicators or response indicators. After these notions UBA (2010) surprisingly identifies three different categories of indicators:

- Indicators at Impact and Response level following the DPSIR indicator framework;
- Indicators assessing sensitivities and vulnerabilities;
- Indicators describing processes.

Impact indicators describe the impact of different climatic changes on the different action fields. The climate impacts are manifold and the cause effect relations are complex. The response by adaptation measures is perceived suitable if they reduce the sensitivity of natural and human systems to actual and projected impacts of climate change. Adaptation measures can be pro-active, reactive, private, public, autonomous and planned. UBA aims to find at least one impact and one response indicator for all action fields.

The number of possible indicators to include in the indicator system is enormous. UBA has started to developed a system to select suitable indicators. The selection of indicators is done in the following way. The first step is to collect the climate impacts for each Adaptation Action Field. This is done with a literature assessment resulting in a long list of climate impacts and possible solutions for all Adaptation Action Fields mentioned in the DAS. In some Adaptation Action Fields the long list is extended with impacts and measures mentioned by experts (bilateral or in small groups). The impacts and measures on the long list are allocated as ‘sub items’. The sub items contain information on the basis of observed or modelled data or on qualitative assessments. At response level all sub items respond to implemented or proposed measures mentioned by literature research. The long list of sub items has not been subject to any form of selection. This means that the sub items also have impacts included that are controversial among experts. The second step is to order the sub items into sub themes and finally into

indicator fields. This results in an indicator field that represents one or more sub themes and sub items.

According to the UBA (2010) the final Indicator System should have the following requirements:

- Every Action Field should be represented by one key indicator in the indicator set, both at impact and response level;
- Every Indicator Field should be characterized by a core indicator that represents the indicator field in a comprehensive way.

Selecting key and core indicators is not only a technical decision but also a political one. The selection of key indicators that represent a DAS Adaptation Action Field has been done on the basis of the following criteria;

1. Relevance of the indicator to the Adaptation Action Field
    a. Is the indicator field addressed by the DAS?
    b. Is the indicator field regularly addressed in literature pertaining to Germany or Central Europe?
    c. Are there indicators established for this indicator field?
2. Status of the Data
    a. Is the data collected regularly?
    b. Are there contact points with proven research projects that have been carried out methodically?
3. Cause effect relations with respect to climatic changes
    a. Is the cause effect relation known and can it be attributed to climate change?
4. Comprehensibility
    a. Is it possible and simple to communicate about climate adaptation on the basis of the indicator?
5. Spatial dimension
    a. Is the issue not only regionally important?
6. Approach
    a. Are there various approach options open?

The UBA used two different methods to select key indicators out of core indicators. The first one is a points system. For every criterion a fixed amount of points could be divided over the categories 1) fulfilled, 2) fulfilled in part and 3) not fulfilled. The total points given to the different categories can be counted. Indicator fields recommended for further consideration are those that have at least 7 of all points available in the category fulfilled and at the same time at least 18 points in the category partly fulfilled. The second method is grading the indicator fields by experts. The indicator fields were evaluated with an awarding system. Each indicator field could be awarded with the category very important, important or less important. Prioritisation was achieved by counting the total points of each indicator field.

The allocation system made it possible to select a manageable number of indicator fields. During the process of making the indicator system operational it is likely that this system will be further adjusted.

Example: indicators selected for flood management

Various indicators are mentioned by Umweltbundesambt in 2010. We summarize the indicators that are mentioned in the field of flood management.

Table 3.7 Flooding and coastal erosion indicators proposed by Umweltbundesambt in 2010

Indicator field	Impact/ response	Description	Prioritized
Groundwater table	Impact	Changes in ground water table	Yes
Coefficient of run-off	Impact	1) Changes in the mean coefficient of run-off and seasonal run-off distribution 2) Clustering of an increase in extreme run-off events 3) Accelerated glacier shrinking with impacts on water management downstream	Yes
Sea level and sea currents	Impact	1) Sea level rise 2) Changes in current conditions and in tide dynamics	Yes
Protection systems for coasts and related infrastructure	Impact	1) Overloading drainage systems in low-lying marshy areas 2) Increased loads on/failure of coastal protection systems 3) Damage to/destruction of coastal settlements and infrastructure	Yes
Communicating to inhabitants regarding risks and hazards	Response	1) Education 2) Develop early warning systems and information services	No
Adverting danger, ensuring emergency supplies	Response		No
Adapting Water Management Infrastructure	Response	1) Improving technical protection from flooding 2) Water retention technology and treatment from precipitation 3) Safeguarding and extending water infrastructure for water management, including drinking water supply, and drainage	No
Adapting water- and land use management in catchment areas	Response	1) Designation and conservation of priority areas 2) Conservation and creation of retention areas	No
Protection of property	Response	Safeguarding the infrastructure and buildings from water damage	No
Adapting water management monitoring	Response	1) Adapting the monitoring of groundwater and surface water 2) Extending the monitoring of coastal protection	No
Extending research	Response	Various	No
Market development	Response	Develop insurance market	No

The German "impact" indicators represent different types of outcome indicators. Most indicators focus on the climate exposure, for example the indicator 'changes in ground water tables' or 'sea level rise'. Others focus on the impact of climate change, for example, the damage to or destruction of coastal settlements and infrastructure. There is no emphasis on indicators that show changes in sensitivity towards floods, like development of property and infrastructure in flood plains. This is also the case in other indicator fields. The "impact" indicators can be used as adaptation impact indicators, for example the avoided increase in flood damages. However, they are not in place yet.

The response indicators focus on possible adaptation measures. There is no emphasis on the adaptation process. Some measures aim at improving the adaptive capacity of citizens of institutions, for example communicating flood risks and improving the scientific knowledge base. However, the indicators do not measure adaptive capacity aspects like available variety, room for autonomous change, resources, leadership and

fair governance. There are no indicators present to monitor mainstreaming. The monitoring of mainstreaming might be important in this case, because Germany wants to implement climate adaptation through the adaptation action fields.

3.3.4 Procedures

Contrary to Finland and the UK, Germany has not yet executed an ex ante evaluation. The absence of an implemented monitoring program explains the absence of a monitoring protocol. It is evident that Germany will need such a monitoring procedure in the near future.

It is likely that UBA will give attention to the adaptive character of the indicator system, since a general requirement for the indicator system is flexibility.

3.3.5 Conclusions

Germany has adopted a National Adaptation Strategy and an action plan to implement the strategy. The monitoring of adaptation is an important aspect of the action plan. However, a monitoring program is not in place yet.

The monitoring of climate change adaptation will be built on existing monitoring programmes and available data sets in the different action fields. This is an advantage, because the monitoring infrastructure is already in place. On the other hand it is unclear if and to what extent existing monitoring programmes should be adapted to provide sufficient adaptation monitoring. The DAS and the APA do not give insight if additional monitoring resources are available for adaptation monitoring. Existing environmental monitoring programmes may not be compatible with a learning approach.

The DPSIR indicator system is used as a model to describe climate adaptation. Germany focuses on the climate system, climate impacts and adaptation measures. Climate adaptation policy builds on a strong scientific analysis of current and future climate and an extensive review of scientific literature on impacts. However, little thought is given to social drivers affecting sensitivity. The APA recognizes this problem and states that a method for a vulnerability assessment needs to be developed for Germany. The Indicator System provides a baseline of climate impacts without adaptation action. This provides a good foundation to measure the outcome of adaptation action.

The Indicator System has a clearly defined the spatial scale. The Indicator System should provide information at federal and national level. Some important local climate impacts, like sea level rise, can be included. This provides linkages to local adaptation policies. The UBA (2010) is not specific on the time horizon. According to the UBA the Indicator System should cover the following general time aspects; historic development, current state and future protections.

An extensive literature review led to an extensive list of possible adaptation measures. These measures are linked to climate impacts, but the knowledge of cause-effect relations in the field of climate change is weak. The list of adaptation measures forms a good starting point for measuring the progress and impact of implementing these measures and learn about cause effect relations. However, the list could be expanded with measures aiming to decrease sensitivity.

The information needs are described in general terms. It is advisable to define the information needs more specifically for each adaptation action field.

A strong point of the German Indicator System is that the pragmatic approach leads to a list of existing indicators. UBA uses both modelled and measured data to monitor climate adaptation. This leads to a long term database providing information on historic developments and projections for the future. We could say that the types of indicators used have a strong focus on measuring climate exposure, climate impact and taking adaptation action.

Although Germany wants to implement climate adaptation through mainstreaming, no attention is given to monitoring the progress and success of mainstreaming. This could be an interesting addition to the monitoring program.

There is no insight in monitoring protocols.

Table 3.8 The results of applying Germany's monitoring strategy to the framework

Institutional body	Institutional body	DAS uses existing institutional bodies for monitoring in every action field to monitor climate change impacts and adaptation
	Dependency	Unknown
	Resources	Equipped with resources, however no indication of extra resources to cover the monitoring of adaptation
	Stakeholder involvement	Unknown
System of Interest - Adaptation context	Climate system	Strong analyses of the climate system. Future climate is projected with different downscaled climate models and for different scenarios to project a ranges of climate changes and impacts
	Climate impact	In some adaptation action fields strong analyses of climate impacts. Climate change ranges (see climate system) are used as input for climate impact modelling (waterways, navigation, economics of adaptation, managing climate change in regions for the future, the impact on human health, agriculture and biodiversity). In other action fields analyses are qualitative.
	Vulnerabilities	Not explicitly defined, under the APA a method for a vulnerability assessment for Germany will be developed
	Time scales	Not explicitly defined
	Spatial scales	National scale with regional additions
	Mainstreaming	Important aspect of climate adaptation. Mainstreaming takes place in the action fields and through sustainable development
	Adaptation action	All possible measures are identified for each action field. The base line provides a basis to measure or project the effect of the measures
	Information needs	Demonstrate, document and interpret climate changes and climate impacts. Also monitoring for progressive review of adaptation measures
Indicators	Adaptation action	Emphasis is on adaptation action, not on the process of adaptation policies
	Adaptive capacity	Some measures proposed by Umweltbundesambt aim at increasing the learning capacity. However there is no aim to measure adaptive capacity
	Mainstreaming	There are no indicators proposed by Umweltbundesambt to measure the level or success of mainstreaming
	Exposure indicators	The proposed indicators are mostly exposure indicators
	Sensitivity indicators	There are almost no sensitivity indicators proposed
	Impact indicators	Impact indicators are in place
	Adaptation outcome	Adaptation outcome indicators are not in place yet
Protocols	Data collection and reporting	Unknown
	Process	Unknown
	Adaptive monitoring	Adaptability of the monitoring system is a general requirement

4 Proposed framework for monitoring of adaptation

In chapter 3 we assessed three national monitoring programmes to test the framework introduced in chapter 2 and to learn how the framework can be improved. In chapter 4 we will draw conclusions on the different building blocks and discuss how they can be improved. We also give recommendations for future research.

4.1 Requirements for an institutional body responsible for monitoring

The monitoring programs of the UK and Finland have an institutional body in place that is responsible for the monitoring. How these bodies are installed and provided with resources varies over the programmes. The UK is legally bound to monitor climate impacts and adaptation and so the Adaptation Sub-Committee is installed and provided with resources by law. The Coordination group of Finland is installed on the basis of the national adaptation programme by the Ministry of Agriculture and Forestry. It is not clear whether the Finnish Coordination Group has a permanent status or how it is provided with finances. Germany has only started with preparations for monitoring with the production of an indicator system and there is no body in place yet. They intend to use existing sectoral and environmental monitoring programmes (and bodies). It is not clear if additional resources are needed and granted to insert adaptation monitoring in these sectoral programmes.

There is not a fixed answer to the question how the monitoring body should be institutionalized. Legal binding provides a strong foundation for monitoring and it is more likely that monitoring will take place on a regular basis for a long period of time. An aspect to take into consideration in case of a legal obligation that it is more likely monitoring leads to a classic accountability approach instead of a learning approach.

The German approach makes use of existing monitoring bodies. Existing monitoring programmes are already operative and provided with resources. It may be appealing that there is no need to set up a new monitoring structure. However, this approach seems less flexible and there might be competition between the monitoring of climate change adaptation and other environmental aspects.

The ASC has an independent status and the Finnish Coordination Group has not. Independency may lead to a better accountability approach, while dependency may work better for learning and mainstreaming. However, at this point we lack the information to draw any final conclusions on this aspect.

It is important that the collected data is accepted by stakeholders. We see different strategies between the assessed countries to involve stakeholders. In Finland stakeholders are directly involved in the Coordination Group. In the UK the ASC has a strong scientific foundation and stakeholder participation is organized by the ASC. In Germany the Indicator System is developed in dialogue with stakeholders.

After this assessment we conclude that setting up a monitoring institution requires the following aspects:

1. A decision on how a monitoring body should be institutionalized.
2. A decision on how the body is structurally equipped with resources.
3. A decision on how independent a monitoring body should be.

4. A process to make sure that the body provides credible and legitimate information according to the stakeholders.

4.2 Method for defining system of interest

Defining the system of interest is an important step to narrow down the monitoring of climate change adaptation to its essence and to decide on the information needs. In all monitoring programmes the various aspects of the system of interest are described. Surprisingly in none of the cases the information on the adaptation context and monitoring objectives could be found in one single document. We recommend to define explicitly the different components of the system of interest and describe them in a combined report. It is also important to discuss this description with the stakeholders.

The model based structure used by the different countries to describe climate adaptation varies widely. Finland and the UK each developed their own model based on typical adaptation concepts like climate exposure, sensitivity, impacts, vulnerabilities and adaptation action. Germany used the DPSIR concept to describe climate adaptation schematically.

The information on the current state of the climate and how it will change has a strong scientific basis in all countries. All climate programmes are supported with downscaled models and available projections for different scenario's. Information on climate sensitivity and impacts is more fragmented. Often there is only quantitative data available for some sectors and some scenario's. The use of qualitative data on climate sensitivity and impacts can still form a good basis to define useful indicators.

In Germany and Finland there is little emphasis on the social aspects of climate change adaptation. The UK is an exception. The ASC incorporated social drivers in the monitoring programme.

Mainstreaming plays an important role in the German and the Finnish Adaptation Strategy. However, mainstreaming does not play an important role in their systems of interest. Both Finland and Germany show a strongly sectoral approach for designing monitoring programmes.

The monitoring programmes of Finland, the UK and Germany provide general information on the adaptation actions taken and on the justification and effectiveness of these measures. There is little emphasis on learning.

After this assessment we conclude that the framework provided a good structure to compare the different monitoring approaches in England, Germany and Finland. We do not need to change the building block of the system of interest.

4.3 Method for selection of indicators

The three monitoring programs analysed have several process-based indicators in place. These indicators focus on measuring the progress of adaptation action. Typically the formulation of policy and the taking of measures form the basis of indicators. There is little emphasis on measuring adaptive capacity however. Measuring the effectiveness and level of mainstreaming is not in place either, although Finland and Germany see mainstreaming as an important instrument for implementation.

The first monitoring strategy of Finland analyses only the adaptation process. The UK and Germany also incorporate outcome-based indicators in their monitoring programmes. The

UK used all types of outcome-based indicators in their monitoring programmes, while Germany has a strong emphasis on exposure, climate impact and adaptation impact indicators. The UK also provides clear insight in the data sets used. Both monitoring programs struggle to identify adaptation impact indicators. Unclear cause-effect relations are the reasons for that struggle. Both Germany and the UK propose a base line scenario to project climate impacts without adaptation. This base line scenario can be used to measure the effect of adaptation action. This is a useful addition for the building block selecting indicators.

The German report uses both measured and projected indicators in the Indicator System. According to UBA it is important to use both types of indicators because adaptation options are intended for the long term. This is an interesting approach and it should be given consideration when implementing a monitoring program. Another lesson we can learn from the German approach is the focus on existing monitoring programmes and data sets. Using existing data sets and monitoring programmes is pragmatic and the costs are expected to be lower than the costs for setting up new programmes. It also ensures availability of datasets over longer timeframes.

From the assessment we conclude that selecting indicators is not an easy task. Especially the outcome indicators will probably require some years of further development. We also conclude that the building block for selecting indicators should be extended with the following aspects:

1. A decision if existing databases should be used;
2. A decision about the use of projected data incorporated in indicators.

4.4 Monitoring and evaluation procedures

The procedures of the monitoring program of Finland are not clearly described. The ASC provides clear insights in the procedures of the CCRA and also provides clear insights in the data sets used in the ASC reports. In Germany an operational monitoring program has not been developed yet.

Although the UK doesn't mention adaptive monitoring, the subsequent ASC reports show a flexible and adaptive working method in practice. The German report states that adaptability is a general requirement for the Indicator System. However such a structured method for adaptive monitoring has not been described.

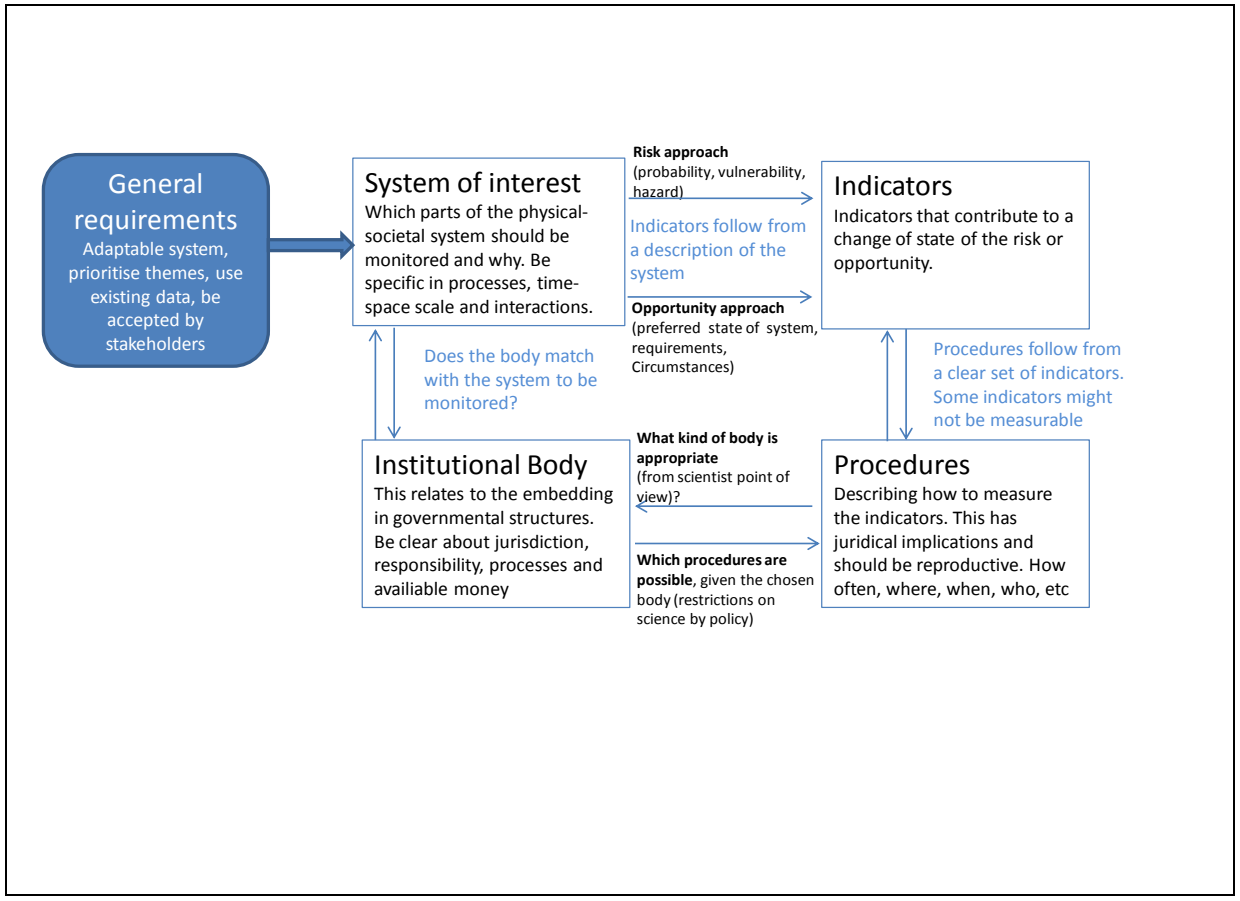
After this assessment we conclude that the procedures are the least developed building block in the present monitoring initiatives. We did not discover a need to change the building block of the procedures.

4.5 Additional requirements

The German report explicitly describes the general requirements of the Indicator System. The Indicator system should be adaptable and kept up to date, give a clear prioritisation of the covered themes, based on existing data and the accepted by stakeholders. Defining general guidelines of a monitoring programme is in our opinion an important step for setting up a monitoring programme. Therefore we will add this step as a fifth building block to our framework. The adjusted framework consists of the following 5 building blocks:

1. General requirements
2. Requirements for an institutional body responsible for monitoring

3. Method for defining the system of interest
4. Method for selection of indicators
5. Monitoring and evaluation procedures



5 Conclusions

Our study has led to a climate adaptation monitoring framework that provides a useful structure for the analysis of adaptation monitoring and evaluation programmes. The framework provided a structure to compare the different monitoring approaches in England, Germany and Finland. The study has indicated that there is no need to change the building blocks of the system of interest.

Our analysis has raised the potential of this framework for setting up such a monitoring programme, but this should be further tested.

Our study has also indicated that the following aspects of monitoring and evaluation of climate adaptation can still be considered as weak and require additional research:

- The effect of dependence/independence of the monitoring body on the learning effect of monitoring.
- How can stakeholders contribute to and learn from a monitoring and evaluation program?
- How can adaptation indicators be (i) contextualized; for example, by involving climate drivers; (ii) selected from the multitude of possibilities.
- Which outcome indicators / data have a long term value, even when policy goals will shift substantially?
- How can the impact of adaptation measures be separated from other influences on the outcome?
- The creation of indicators for mainstreaming with other policies.
- The creation of indicators for adaptive capacity.
- The pro's and con's of using existing data in adaptation monitoring.
- Clear procedures for an adaptive monitoring and evaluation system.
- How to design a monitoring program that is open to double loop learning?

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