BASE BOTTOM-UP CLIMATE ADAPTATION STRATEGIES FOR EUROPE

Title: D6.1 Protocol for data formats needed for up-scaling and modelling

Summary: This document provides a framework and consecutive protocol for consolidating data from the case studies in a format that delivers compatibility and quality to meet the requirements for up-scaling and modelling costs and benefits at European scale. The deliverable has close relations with WP3 (modelling tools) and WP4 (case study analysis framework). The protocol addresses the need for common definitions, methods and assumptions to be applied throughout the project and it provides for a data request to the case studies and procedures to hand over data (who provides the data, who receives the data, what deadlines are applied, etc.). Such a common grid is a pre-requisite for being able to upscale information to a European sectorial and policy level. A procedure is proposed in which case studies as a start are provided with draft categories of generic adaptation tipping points, measures and an evaluation protocol. This is followed by training for the case study owners and testing of the proposed methods in the case studies their selves. Based on the experience gained the protocol will be finalized before month 18 to steer final data delivery of cases studies to the integration work package 6. Because of this circular approach and also because the framework for up-scaling (D6.2) is still under development we have separated this deliverable into 6.1a, being the 'test protocol' and 6.1b being the final scheme for data delivery (scheduled for M18). This is 6.1a

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SEVENTH FRAMEWORK PROGRAMME

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Contents

1 Introduction

1.1 Introduction WP6

The aim of WP6 is to provide WP7 with a good quantitative (but also qualitative where needed) basis of expected adaptation including longer term options and its costs and benefits across Europe.

Work package 6 has to integrate results of case studies with modelling within the BASE project. The models, developed in WP3 are applied on a national to European scale in WP6 to perform an economic assessment of: i) the cost and benefits of adaptation in separate sectors, health, agriculture, flood risks and ecosystems and ii) across sectors the economy wide effects and the trade-offs between adaptation and mitigation (task 6.3).

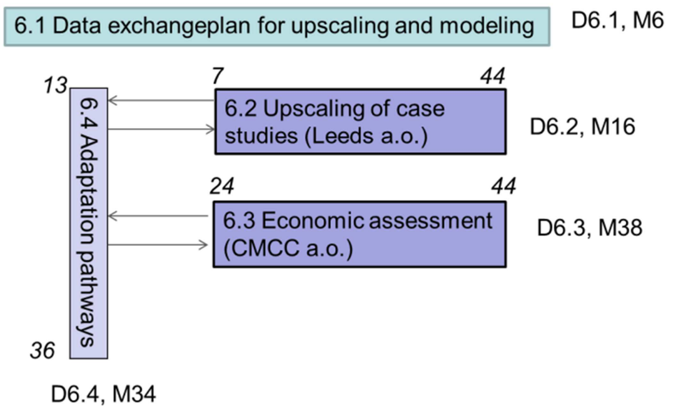


Figure 1 Tasks and deliverables of WP6

Main input for the assessment are generic adaptation pathways derived from (upscaled, D6.2) information from the case studies (on costs and benefits of adaptation strategies). In addition WP6 will develop storylines using a stakeholder panel to enrich the pathways of sectorial adaptation in Europe (D6.4).

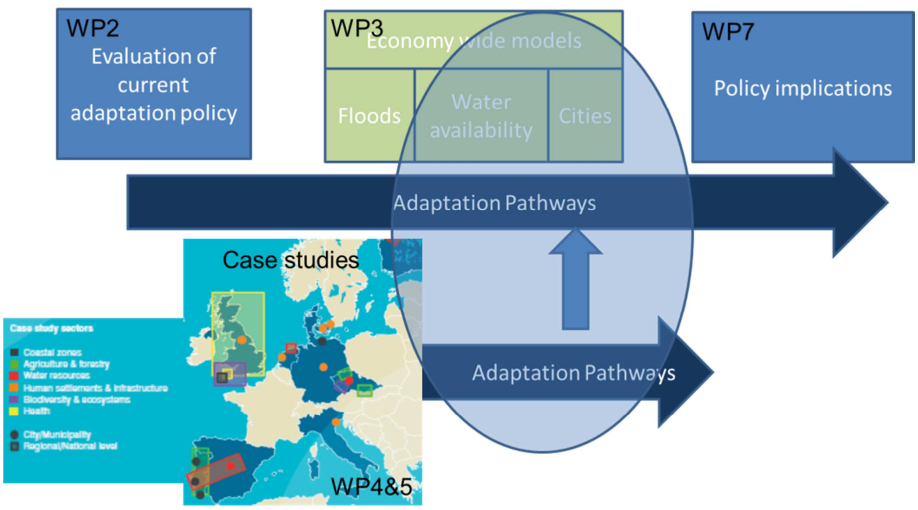


Figure 2 Role of WP6 within BASE is to integrate the top-down modelling with bottom-up results (pathways and its costs and benefits) from case studies.

Together WP3 and WP6 are the economic core that should support the central aim of BASE to assess the effectiveness and full costs and benefits of adaptation strategies to be undertaken at local, regional, and national scales using innovative approaches (mainly by integrating bottom-up knowledge/assessment and top-down dynamics/processes) with particular attention on sectors of high social and economic importance. With this economic assessment task BASE is a follow up to projects as CLIMATE-COST (see also 2.1) and CLIMSAVE. In using the methodology of scenarios, storylines, tipping points and pathways BASE is further developing on projects such as SCENES and MEDIATION.

1.2 Aim and outline of this deliverable

From the description of work (DoW):

Task 6.1 will be conducted at the beginning of the project to ensure that data available from the case studies can be applied for full economic costs and benefits and that the data availability is well planned. The main activity is to develop a protocol for consolidating data from the case studies in a format that delivers compatibility and quality to meet the requirements for the modelling of the full economic costs and benefits at European scale. This activity will be a joint activity with WP3 (modelling tools) and WP4 (case study analysis framework). The protocol will address the contents of data (e.g. units, spatial and temporal characteristics) and procedures to hand over data (who provides the data, who receives the data, what deadlines are applied, etc.).

In general deliverable 6.1 will organize data and information flow between work packages in order to enable WP6 to execute its integrating task. There are strong links with Deliverable 3.1 (climate data and model catalogue) in WP3 and 4.1 (case study analysis framework) in WP4:

D3.1 describes the scenarios and forthcoming data delivery to the case studies plus the models used in BASE, how they intercommunicate, what sort of data they need and for what purpose they will be used and further developed. In D6.1 procedures should be outlined how pathways developed in WP6 should feed into the frameworks of the models that are used in 3.1 and how, what and how many variables provided by case studies these models may use, in upscaling bottom up information across Europe and economy wide.

D4.1 provides guidelines for executing the case studies, centred on questions posed in thematically similarly case clusters and around three methodological lines: evaluation of costs and benefits, policy analysis and the use of participatory processes. D4.1 has been developed partly on the basis of input of questions posed to the case studies by WP3 and WP6. D6.1 has to concretize this into a planning of data flows between WP4 and WP6. This will be in two ways: building representative adaptation pathways reflecting single policy options and adaptation pathways explored in the case studies and upscale information on the impacts of various scenarios and on the costs and benefits of these policy options and pathways.

A basic prerequisite for integration of information from different work packages is the use of similar basic assumptions and methodology across the project. In this respect we speak about a ‘common grid’ for BASE. Such a common grid is essential for being able to upscale information to a European level. Since this common grid is a shared development of WP3, WP4 and WP6 there will be considerable overlap in the deliverables.

This document is organized on above mentioned main elements. In chapter 2 the common grid is outlined. In chapter 3 the upscaling of pathways from case studies to EU level and associated data flow will be outlined. In addition the data and information flow for the modeling will be the second central subject in this chapter. Finally chapter 4 will present a summary of requested data, formats, delivery procedure and planning.

2 A common grid for BASE

2.1 Introduction

The BASE project needs to come up with improved estimates of full cost and benefits of adaptation to climate change upscaled and integrated nto sectors at EU-level. This upscaling and integration is the main challenge of WP6.

There have been many studies done before to estimate the costs of adaptation against climate change. Climate Cost has made a review of the studies done to identify gaps and potential needs in the climate adaptation cost estimate research area. Below a summary of the main observations derived from the 7th FWP Climate Cost Study (Hunt and Watkiss, 2012).

• Availability of information: There is limited coverage of impacts and adaptation costs across sectors (majority of studies have been done for the coastal zone and flooding), and of adaptation strategies (often only hard engineering solutions are considered and no behavioural changes). Cost estimates are incomplete and there is an uneven distribution of available information over countries (the most comprehensive national adaptation cost assessments have been done in the Netherlands, Sweden and the UK).

• Comparability: Adaptation cost assessments vary heavily in methodology and approaches; the use of different metrics, time periods, assumptions with regards to changing socio-economic conditions and with regard to a proper reference strategy: often at a local level the current backlog of investment needs and normal investment replacement cycles are included in adaptation costs and the marginal additional costs for climate change are rarely split from those induced by socio-economic change. These differences make it challenging to compare various assessment studies and to draw generalized conclusions.

• Scalability: Assessments either deliver aggregated representation of impacts and adaptation based on integrated assessment models that provide insufficient detail for national or sub-national adaptation planning or sector specific results neglecting economy wide effects. Insufficient model resolution and availability of ground data make it difficult to validate and calibrate assessment models.

It is the challenge of BASE to improve upon the shortcomings noticed from previous studies

2.2 Requirements for a common grid

The BASE-project follows a 2-way approach as is explained in 1.1. On the one hand there are various modelling approaches contributing to an economy wide assessment of costs and benefits of adaptation, developed in WP3 and in the end applied to European level adaptation pathways in WP6. On the other hand there are case studies at different levels (ranging from very local to national), retrospective and/or prospective and participatory or non-participatory. In WP6 both models and case studies have to contribute to the questions:

- What are the impacts to different sectors of climate change
- What are options to adapt or more specifically cope with, abate, avoid and/or benefit from these impacts?
- What are associated costs, damages, direct and possibly indirect benefits (people, planet, profit)?
- What is the associated uncertainty?

In order to answer these questions comprehensively at EU level we need a common approach on:

- Definitions on scenarios, strategies, pathways, storylines, and a consistent use of it throughout the project
- A common upscaling method for case studies linking data and models at different levels either sectorial or economy wide.
- Clear choices on the use of climate and socio-economic scenarios from IPCC. What range and timeframes to consider.
- An economic evaluation protocol including a baseline or reference strategies for comparative assessment among case studies.

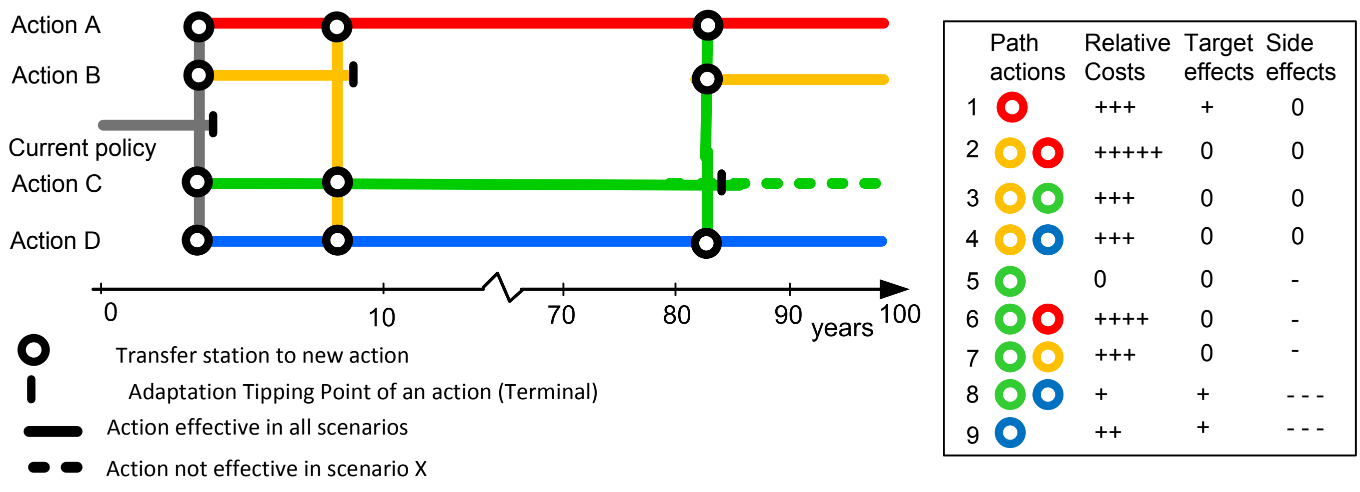
To achieve a common approach within task 6.1 a number of activities have been employed. A first draft of a joint deliverable 3.1 and 6.1 has been prepared at an early stage containing questions for the case studies. Both the modelling workshop in Venice and case study workshops in Hamburg and Cascais have been attended to stress the need of a common framework and to provide guidance on what to incorporate in the common case study analysis framework (D4.1). Within D3.1 a common approach for using scenarios has been proposed and in D4.1 an economic assessment protocol has been proposed.

2.3 Definitions within the context of BASE

Within the BASE project there are some essential concepts and wording used that need to be understood similarly across the people involved in the project. Here we provide some practical definitions.

One central approach within BASE is to define adaptation strategies by means of adaptation pathways (Haasnoot et al. 2012, 2013).

An *adaptation pathway* consists of a sequence of adaptation actions to achieve targets under changing climate and socio-economic conditions. Usually these pathways are used in the context of policy planning, i.e. ***planned adaptation***. Actions may also involve stimulation and enhancement of ***autonomous adaptation*** the response of individual stakeholders to external changes and (sectorial) policy. Adaptation pathways may be considered as part of an adaptation ***plan*** in which coping with uncertainty is considered important. Central to the adaptation pathways concept are ***adaptation tipping points*** (Kwadijk et al., 2010), which are the conditions under which an action no longer meets the clearly a-priori specified objectives. After reaching a tipping point, additional actions are needed to reach the defined objectives. As a result, a pathway emerges. An ***adaptation pathways map*** presents an overview of relevant pathways and policy options after an adaptation tipping point. A scorecard can present the costs, the extent to which policy goals are achieved, and potential side effects of the pathways. In combination with signposts, that can be monitored to indicate whether implementation of actions is needed, decision makers can make an informed decision about short term actions, while keeping options open to adapt, if necessary.



Adaptation Pathways Map **Scorecard pathways**

Figure 3 Graphical depiction of an adaptation pathways map (Haasnoot et al, 2013). In the map, starting from the current situation, objectives begin to be missed after four years: an adaptation tipping point is reached. Following the grey lines of the current policy, one can see that there are four options. Actions A and D should be able to achieve the objectives for the next 100 years in all climate scenarios. If Action B is chosen after the first four years, a tipping point is reached within about five years; a shift to one of the other three actions will then be needed to achieve the targets (follow the orange lines to a transfer station). If Action C is chosen after the first four years, a shift to Action A, B, or D will be needed in the case of Scenario X as in this scenario the performance of this actions was unacceptable after approximately 85 years (follow the solid green lines). In all other scenarios, the objectives will be achieved for the next 100 years (the dashed green line).

Other definitions used within BASE include:

Scenarios: are coherent descriptions of alternative hypothetical futures that reflect different perspectives on past, present and future developments, which can serve as a basis for action (Van Notten, 2005). For BASE scenarios are climate change and socio-economic projections describing a range of plausible external contexts for the system considered in the case studies and model exercises. These scenarios are only very indirectly influenced by adaptation within the considered system and sectors and are thus policy-free. Scenarios are used within Base as a means to evaluate impacts of climate and socio-economic changes and the performance of adaptation actions and pathways, and as a context for developing story lines. The choices for using scenarios have been further elaborated in deliverable 3.1.

Storyline: a narrative of a plausible future including climate change, socio-economic developments and adaptation pathways. These storylines tell the combined logical story of external developments and sectorial responses.

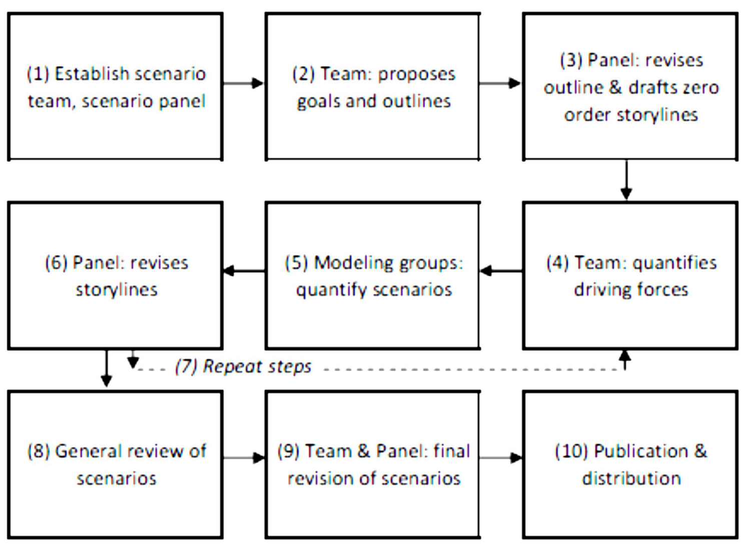


Figure 4 Overview of SAS (Story And Simulation) approach to scenario development as applied in the SCENES project (Duel and Meijer, 2011).

The Storyline And Simulation (SAS) approach (Alcamo, 2001) has been adopted in the SCENES project to develop pan-European water scenarios. The SAS approach accounts for all steps considered essential to develop scenarios at a single scale (see Figure 4). Important steps include the establishment of a scenario panel and scenario team (1-2); construction of storylines (3) that are quantified and revised (4-6). BASE in turn will adopt this approach. BASE storylines will be made using a stakeholder panel. The scenarios, adaptation pathways and modeling results will be the most important input to these storylines.

Upscaling: We define upscaling as an activity in which information on a lower spatial scale is translated into information at a higher spatial scale. This information on a lower spatial scale is scattered sparsely in space and often highly context specific. A certain representativity for a broader context or larger area of similar characteristics is required for scalability. In the context of BASE, and more specifically WP6, the information to be upscaled is gathered from the case studies and consists of adaptation pathways and its characteristics, costs of impacts and adaptation, and adaptation benefits. As an example; the benefits of a certain flood risk reduction action, studied in detail at the local scale for a specific catchment, can be translated by using the models developed and applied in BASE, to the European scale, for catchments where a similar measure is supposed to be relevant.

BASE sectors: The BASE project has the aim to consider adaptation in sectors of major economic importance. These sectors are defined in a very practical manner to group research questions and activities. For the case studies six clusters are defined distinguishing between 'human settlements and infrastructure', 'agriculture and forestry', 'coastal zones', 'human health', 'water resources management', 'biodiversity and ecosystems'. In addition there is the need to comply with impacts of climate change and sea level rise, like heat waves, pests, droughts and floods and cross-sectorial economic effects. These impacts are partly covered by the models that are developed under WP3 (with models for water availability, agriculture and riverine floods). Within WP4 and WP5 cross referencing tables have been developed to link impacts to major sectors in cases. A simplified version derived from this is depicted in Table 1.

	Impact from		
Case cluster	*Sea level rise*	*Precipitation/Evaporation*	*Temperature*
Human settlements and infrastructure	coastal flooding coastal erosion	flooding from extreme rainfall riverine flooding soil erosion other extreme events (storm, snow)	extreme temperatures
Coastal zones	coastal flooding coastal erosion		
Biodiversity and ecosystems	Salinization	water scarcity / droughts	Temperature shifts
Human health	Flooding	Flooding	Extreme temperatures Vector and food borne diseases
Water management	Flooding	Flooding, water scarcity / droughts	
Agriculture and		Droughts	Temperature shifts

Forestry			

Table 1 Case clusters and impacts

Within BASE economic evaluation of costs and benefits of climate change adaptation for sectors is one of the central aims. The terminology on cost types sometimes differs in the literature and among different communities (see e.g. Parker et al., 1987; Smith and Ward, 1998; Heinz Center, 2000; Wilhite, 2000; Thieken et al. 2010, Meyer et al. 2013). For BASE it is important to work with a set of definitions that apply for the broad set of sectors, case studies and models involved.

Baseline: In order to be able to ultimately assess costs and benefits of climate adaption it is necessary to have a common baseline strategy next to adaptation strategies for economic assessment. There are basically two main ways to choose a reference strategy: i) Starting from a reference year there is ***no further adaptation***. This will result into a large need for adaptation. ii) Policy and management is continuing business as usual (***BUA***). For example regular flood- and drought risk management is carried through. This may imply increasing costs to cope with climate change. In terms of pathways there is however no change of strategy. In addition to above mentioned strategies, that refer to planned adaptation there is the always autonomous adaptation of individual stakeholders, which also involve societal costs. In BASE we choose to use the BUA strategy as baseline strategy against which cost and benefits are assessed. For autonomous adaptation additional assumptions have to be made.

Costs: All negative effects of an adaptation option compared to a baseline option, which is usually the “business-as-usual”-option. The most important cost components are

- Investment costs to implement a certain adaptation measure. Transaction costs, i.e. costs associated with the design and implementation of measures are part of it.
- Running costs, operation and maintenance costs
- But also negative side-effects, possible negative effects in another sector, such as negative environmental and social effects of the measures. I.e. building a dike reduces flood risk but could also have negative impacts on floodplain ecosystems or on the spatial quality of a city front.

Benefits: All positive effects of an adaptation option compared to a baseline option, which is usually the “business-as-usual”-option. The most important benefit components are:

- Avoided damages (at buildings, yields, insured persons, environment, treatment costs in health care)
- Positive side benefits (possibly for other BASE sectors) such as change of recreational function, tourism change of potential for development, change of biodiversity and ecosystem services , change of values of goods or land

If possible, costs and benefits should be expressed in monetary terms as annual average damage avoided (reduced risk due to the adaptation measures). However, intangible effects, such as social and environmental impacts, are not easily measurable in monetary terms. Methods exist to include them in a CBA, which try to monetise effects by means of valuation approaches such as contingent valuation, choice modelling, hedonic pricing, travel cost approach or replacement cost approach. Most often however they can be included in non-monetary terms in a multi criteria analysis.

Direct damage: Assessments of the climate extreme impacts (e.g. flooding) have focused on the initial impact on people and assets. These initial estimates, so-called 'direct damage', are useful both in understanding the immediate implications of damage, and in marshalling the pools of capital and supplies required for re-building after an event.

Indirect damage: Since different economies (at different regional scale) as well as societies are coupled, any damage occurred in the impacted region (e.g. transport disruption, utilities out-of-function) can be propagated throughout the regional, national, and international supply chains due to. The cost of damage beyond the impacted region can be referred as 'indirect damage'.

Economy wide effects: These are different from indirect damages even though often confused. They refer to the final economic effects (either costs or gains) expressed in terms of GDP or of monetized welfare that materialize once all the market adjustments in the economy took place. Economy wide effects thus include the feedback that the macro-economic context exert at the micro (single market) level.

Mainstreaming: it is that process according to which climate change, climate change impacts, risks and policies (strategies/measures) aiming at addressing them are included in (latu sensu) development planning. Mainstreaming climate change adaptation can therefore ensure that development programs and policies are not at odds with climate risks both now and in the future.

2.4 Development of adaptation pathways

Adaptation pathways can be developed in different ways. The development of adaptation pathways is part of a stepwise policy analysis for supporting decision making under uncertainty. A summary is given in Box 1. Evaluation of pathways is part of such a policy analysis. An approach for economic evaluation is described in D4.1.

The construction of adaptation pathways is basically an iterative process. There are different ways to construct the pathways. We describe here two approaches that can be used within BASE.

1. A pathways map is drawn manually based on expert judgement and/or model results, using the individual actions, and the condition and moment that their tipping point occurs, as building blocks. A new action is activated once the previous no longer meets threshold values of acceptable performance and thus reaches its tipping point. All possible routes are explored with all available actions. However, some actions may exclude other, and some sequences of actions may be nonsensical.

To construct the pathways, the actions are grouped into two categories. For example, flood mitigation actions and damage mitigation actions. Actions with long sell-by dates are shown on the top or bottom of the map, while actions with short sell-by dates are shown close to the current plan. The next step is to add the sell-by dates and all the possible transfers to other actions that would extend the sell-by date. Sometimes actions affect each other. If the sell-by date for an action will increase considerably, this is shown by an additional line in the same color. Next, illogical actions are eliminated (background color in contrast to bright colored logical actions). The steps in this procedure are illustrated in Figure 6.

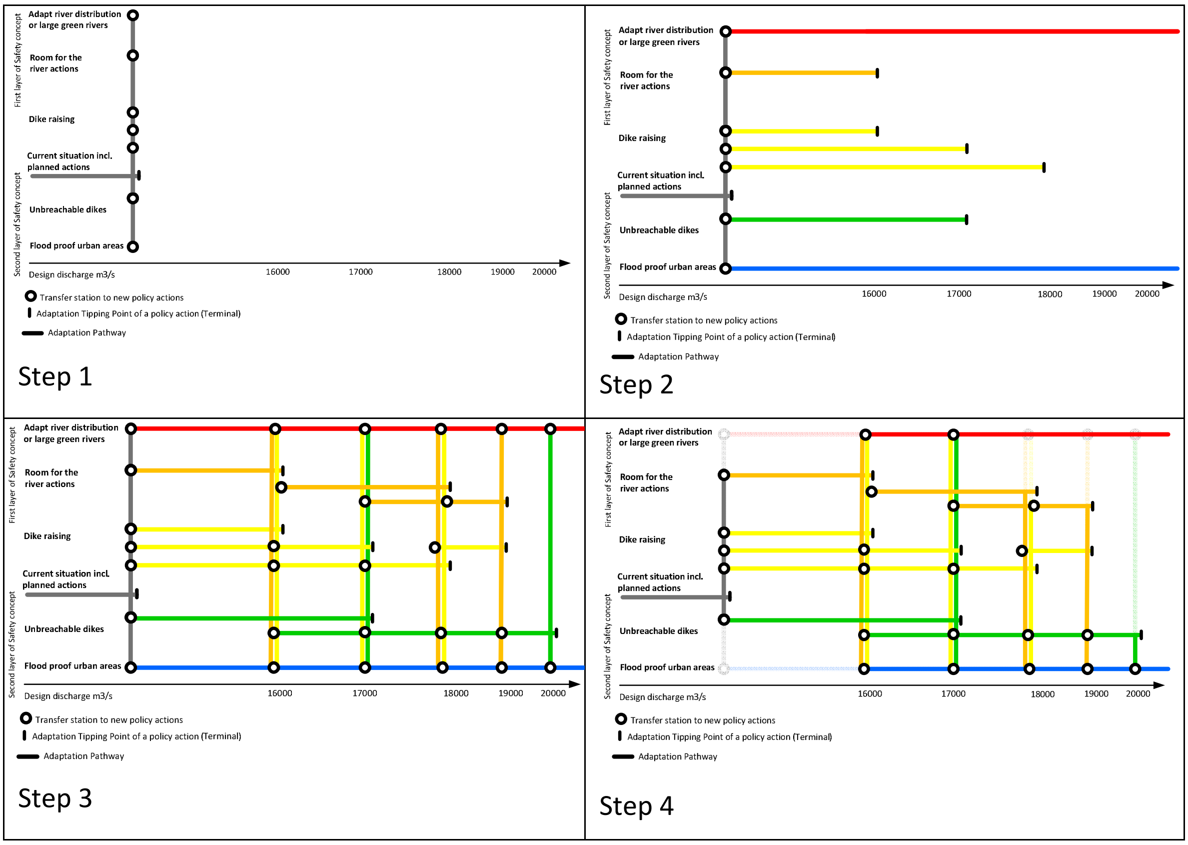


Figure @. A procedure for drawing an adaptation pathways map.

2. A second approach is to construct pathways from a set of storylines that are developed together with stakeholders. Based on the storylines the main routes to adaptation under different plausible futures can be summarized into a pathways map. It is also possible to combine this with the above mentioned approach, for example by drawing the paths developed by stakeholders into the map with all the promising pathways. This way preferred pathways may be indicated. It may also become clear if stakeholders potentially experience tunnel-visioning and forget some of the options they have and may want to keep open.

A third approach is to develop pathways automatically for example with genetic algoritms and robust optimization (Kwakkel et al., under review) or with policy models (Wijermans et al., in prep).

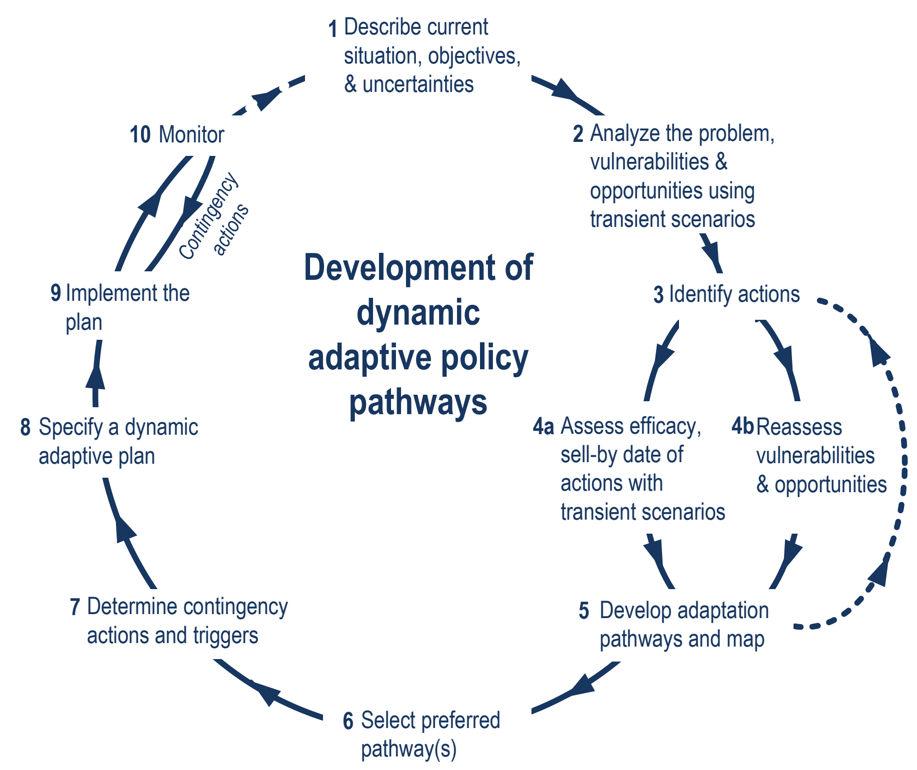
Key elements for applying the adaptation pathways approach in the BASE project are:

- ✓ The use of critical thresholds, also called **adaptation tipping points** (ATP): how much climate change can we cope with before current management and policies (per sector) will perform unacceptably? In this way climate impacts are linked to (sectorial) policy goals. Adaptation tipping points help to identify for how long a policy action will perform acceptably, and thus when investments should be made. To assess under which conditions a tipping point of a policy action occurs, policy goals are needed. These policy goals determine whether a policy action performs acceptably or not. Reaching ATPs might have physical, ecological, technical, economic, societal, or political causes (Kwadijk et al. 2010). An example of a physical boundary is the possible shift of aquatic habitats in case of sea level rise, limited by natural dunes or artificial barriers such as dikes. Economic ATPs may occur if the investments needed to adapt are larger than the economic benefits. Society may change its values and standards, resulting in different policy goals, which may cause an ATP or may shift the timing of an ATP (Offermans et al., 2012). Political processes can make it unlikely to carry out a decision in time. The timing of the adaptation tipping point for a given action is referred to as its **'sell-by date'** and is scenario dependent.

- ✓ Consider a wide portfolio of actions for adaptation to reach policy goals after an adaptation tipping point. Distinguish at least between short term policy actions that might be planned for implementation and long term policy options that can be taken in the future if necessary. This means working with multiple time horizons, for example: 2015, 2030, 2050, and 2100.
- ✓ Consider more than one climate and economic **scenario** (at least 2, describing a low-end and high-end) to make clear the uncertainty involved from external developments (using the low end scenario will require a lower adaptation effort than the high end) and give some indication of the robustness and flexibility of different adaptation options across the bandwidth of plausible futures described within the scenarios.

Box 1. Stepwise policy analysis; Dynamic Adaptive Policy Pathways (DAPP)

The steps in the DAPP approach are presented in the Figure below. First, the system and targets are described. This is followed by a problem analysis in the current and future situation. The problem analysis should not only identify adverse impacts but also opportunities. To address the vulnerabilities and opportunities, policy actions are defined. A rich set of actions is assembled by considering different types of actions. In an iterative approach, promising actions are selected and their sell-by date is assessed under a wide variety of plausible futures. Promising actions are building blocks for the construction of pathways. Pathways are evaluated and improved. Based on the resulting improved pathways, an adaptive plan is constructed. The plan describes which robust and flexible actions should be taken now to anticipate change, while keeping options open to adapt against low costs, if necessary. Signposts and triggers are used to monitor whether actions should be implemented earlier or later, or whether reassessment of the plan is needed. A more detailed description of the steps in the DAPP approach, including an example on water management, is given by Haasnoot et al., 2013.



Steps in the Dynamic Adaptive Policy Pathways approach.

3 Approach to arrive at full economic costs and benefits at EU scale

3.1 General upscaling plan

As **Error! Reference source not found.** shows there are two levels where adaptation pathways are defined and costs and benefits are generated: at a case study level (either at local, sub-national or national level) and at EU level using European scale models that are developed within work package 3. To arrive at pathways at EU scale that find a solid base in the case studies both these levels have to be connected. This is what the upscaling plan is about. The exact methods and tools to do the upscaling will be further developed under task 6.2.

As stated in 2.3 the information to be upscaled from the case studies are roughly the adaptation pathways itself, its characteristics, costs and benefits. To ensure comparability this information has to relate to a common grid as described in 2.2. Here we will outline what data has to be exchanged between the work packages and what arrangements are needed.

In general we have to connect the bottom-up and top down approach in the project for:

1. The adaptation pathways – consisting of policy actions and their adaptation tipping points. These need to be sorted and summarised into smartly chosen timeframes and categories reflecting BASE sectors, climate impact and generic pathways. At case study level the pathways describe specific actions at EU level

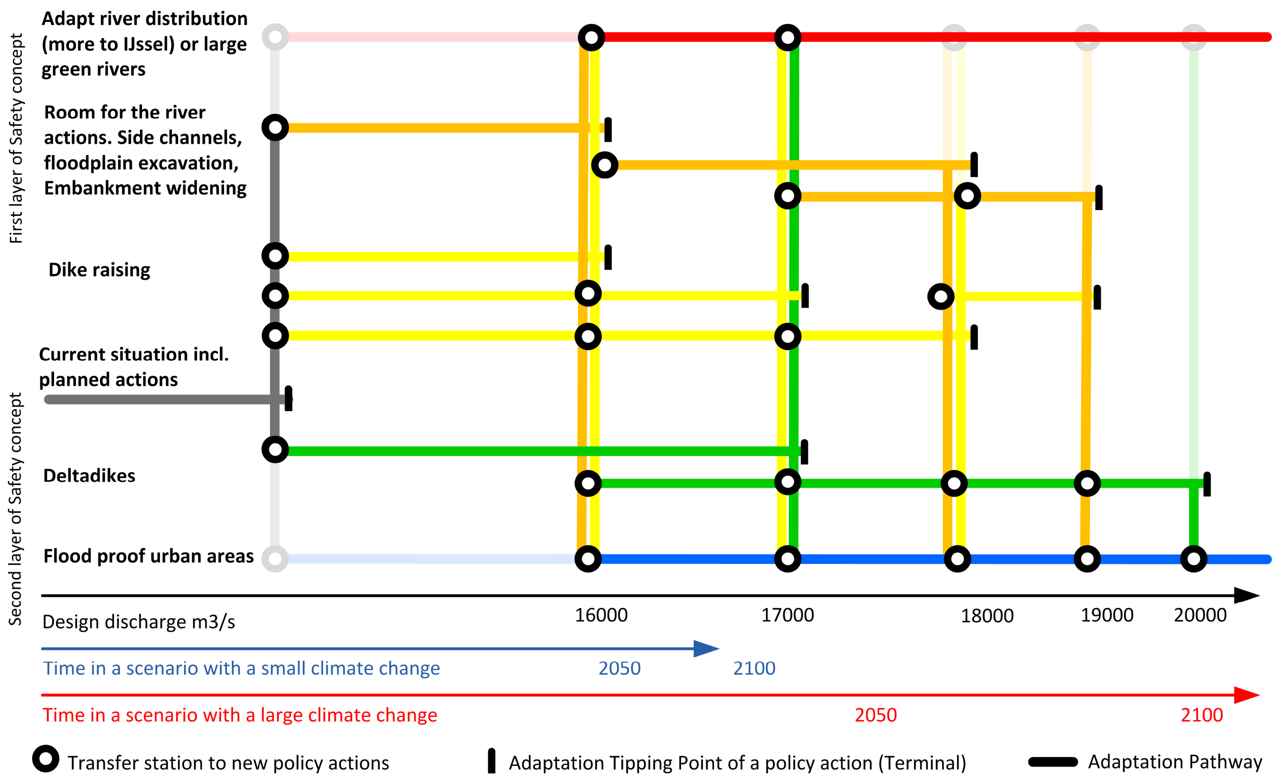
pathways consist of generic actions, also reflecting major policy choices (see also text box example). These EU level pathways should also be used to drive the EU level models within task 6.3.

2. The performance of adaptation pathways for different BASE sectors in order to arrive at estimates of full economic costs and benefits at EU scale. The EU level models are the most important tool to evaluate this performance. These models have to calibrated and improved using ground data from local to national case studies. Direct upscaling of case study results without interference of modelling is expected to have only limited additional value, but nevertheless will be explored.

Upscaling of pathways is further treated in section 3.2, upscaling of the performance of pathways is treated in 3.3. Both lead to a data request for the case studies. A summary of this request is given in 3.4.

Box 2. Example of specific and generic actions from Delta program Rivers.

Specific actions for flood risk mitigation at specific locations are translated to more generic categories of flood risk mitigation actions for a whole river system in the example graph below.



Generic actions for flood risk mitigation that can be distilled from this example and other adaptation programs in the Netherlands are: Increasing levees, construct storage reservoirs, build flood barriers, creating more "Room for the river", Adaptive or waterproof building. The generic actions in this example serve as a package of specific actions at specific locations with specific performances resulting into different sell by dates and different moments to switch to other actions.

3.2 Upscaling of adaptation pathways

3.2.1 Procedure

Throughout work package 6 in task 6.4 adaptation pathways at a high aggregated level are developed. These pathways ('EU-pathways') and their ultimate assessment are the major outcome of WP6 and policy implication analysed in WP7 will be based on it. EU-pathways need to fulfil the following requirements:

- They should reflect the major policy questions on adaptation across countries in the EU and the major strategic choices on adaptation within the BASE sectors.
- They should reflect what are principal adaptation strategies in various bottom up cases across Europe
- It should be possible to relate the actions defined within the pathways with major (political and private) actors involved in the BASE sectors
- They should be able to give a short and long term perspective on adaptation depending on how fast climate change will progress

As described in 2.3 the pathways consist of few central elements. A portfolio of actions for adaptations, their timing and sell by date depending on climate development and critical tresholds and an possibilities for switching between strategies. It is the aim of BASE WP6 to describe the pathways and its elements as complete as possible also at EU-level since we want to make use of the potential advantages of the method: providing policy options from different perspectives, give an indication of the timing of necessary investments and of robustness and flexibility of policy choices under different future scenarios.

Studies up till now (Reeder and Tarrant 2009, Kwadijk et al. 2010, Haasnoot et al. 2012, 2013) have only considered adaptation tipping points and pathways on a local level. The major challenge is to translate these local contextual knowledge into more generic tipping points and pathways (with for instance a more diffuse timing of impacts) at a higher scale and policy level. For this reason we need to define categories of regions with similar climatological characteristics, categories of generic adaptation tipping points, categories of generic adaptation pathways

We propose a two-way approach consistent with the bottom-up and top-down character of the project consisting of 5 steps:

1. Start with draft definitions of categories for: generic measures (Table 2), generic criteria for adaptation tipping points (Table 3) at the same time providing examples how measures at local level relate to different generic pathways.
2. Provide the case studies with a protocol to deliver information and data within these categories (Table 6) and give training and guidance to the case study on interpreting or if possible executing their case study using the concept of adaptation tipping points and pathways.
3. As the case studies are progressing, collect feedback on the use of the format and adjust the categories and formats into a final version which will be used for final data collection at the end of the case studies. (manifested in D5.5).
4. In parallel research existing literature for more information on adaptation strategies across Europe. Deliverable 2.2 may be of help here since it is supposed to provide analyses of national level adaptation strategies.
5. Assemble per sector pathways (under task 6.4)

Deliverable 6.1a is guiding the case studies as a start providing the main categories and a protocol (step 1 and 2). Because task 6.2, the development of an upscaling framework, is still work in progress and training and testing within the cases is used for feedback, the protocol will be updated at a later stages (Deliverable 6.1b, formal deadline month 18).

Characteristic	Generic measure	Example measure
Non-structural *(applicable to all impacts and sectors)*	Awareness raising	Campaigns, stakeholder meetings, education
	Disaster response management	Evacuation plans, early warning systems, water rationing schemes,
	Economic incentives	Subsidies, taxes, shares, water pricing, nature farming, building codes
	Risk transfer tools	Insurance, catastrophe bonds
	Monitoring and management	Information and communication systems, screening, forest management, permits for (ground)water use,
	Land use planning	Risk zoning, nature conservation areas, connecting nature areas, crop rotation
Structural *Floods, Human Settlements and infrastructure, coastal protection*	Improving flood defences (engineering)	Dikes, dams, barriers, flood walls, artificial reefs
	Improving flood defences (building with nature)	Coastal sand nourishment, wetlands,
	Giving Space to rivers	Widening, deepening, side channels, green rivers, removing obstacles
	Improving drainage	Increasing capacity, decoupling, permeable pavement, WADI's
	Improving water retention (peak flows)	Upstream basins, emergency retention areas
	Flood proof building and design	Wet- and dry proof building, save shelters, floating houses
Structural *Water resources management / agriculture /droughts*	Water conservation	Basins, aquifer storage and recovery
	Water saving measures	Drop irrigation, House hold water saving measures
	Ground water management	Water level control,
	Water technology	Recycling of water, desaliniation
Structural *Health / Human settlements and infrastructure*	Measures to minimise exposure to diseases	Vector control (vector habitat destruction, bed nets and repellents). Food sanitation and hygiene (refrigeration, chlorination of drinking water, etc). Water and sanitation systems. Planning of city parks and controlled burning of vegetation.
	Heat proof building and design	Green roofs, water in the city, wind lanes. Thermal buildings insulation, use of fans coolers and air conditioning. Green spaces, trees in streets and open places, increased ventilation between buildings.
	Flood and heat resilient infrastructure	Engineering solutions such as flood protection structures (e.g. dams, dykes, walls and raised banks, pump stations), river channelization, bridges. Reforestation, soil protection, restoration of riparian zones. Flood-resistant buildings.

Table 2 Draft generic measures to refer to within BASE (partly based on ClimateAdapt)

Sector	CC Impact	Generic tipping point
Health	Increase vector borne diseases	Vector habitat establishment (transmission window for relative humidity and temperature conducive to malaria).
	Increase heat stress	Increased intensity and frequency of heat island effects beyond acceptable limits.
Water resources management	Increase in droughts	Water demands cannot be met by supply (risk bases approach)
Water resources management	Increase in droughts Increase in salinization	Water prices too high
		Too frequent closure of freshwater intakes
		Too high use of groundwater
	Increase in low flows	Economic risk for shipping too high
Flood risk management	Increase in peak river flows	Protection standards can no longer be met financially, as flood risk and required investments in protection are becoming too high (e.g. relative to GDP)
Flood risk management **Coastal zones**	Increase in peak river flows Sea level rise	Retention capacity is insufficient
		Economic risk and risk on casualties too high
		Coastal erosion is progressing too fast
Coastal zones **Human settlements and infrastructure**	Sea level rise Peak rainfall events	Costs for drainage become too high
		Public acceptance of current management fails
		Too frequent failure of infrastructure
Agriculture and forestry	Change of seasons	Dying trees
	Droughts	Crops cannot be grown anymore
Biodiversity and ecosytems	Droughts	Key species disappear

Table 3 Draft generic criteria to derive tipping points per BASE sector.

3.2.2 Requirements for the case studies

Usable data from the case studies in developing 'EU-pathways' should be provided to relate measures and options explored in case to categories distinguished in table 3 and to describe the elements of adaptation pathways for the 2 climate scenarios and 2 SSP's. It is recognized that not all case studies may be able to provide all desired data to full extent. Cases that are retrospective may not be able to deliver all desired information on different pathways as a single investment approach has been used, using less and different climate scenarios. Also, cases that apply a more qualitative approach may not be able to deliver all information on costing, at least not in monetary terms.

With the help of this document for structuring data requests and supported by training on how to derive adaptation pathways it should be possible to obtain at least enough information to sustain a bottom up approach. Each case study is requested to describe the scope of the case properly in terms of sectors, impacts, current and proposed or newly implemented strategy to cope with climate and climate change. The following list of questions should guide case studies to provide the right information to WP6 to assemble adaptation pathways.

- Describe what climate and socio economic scenarios were used for assessing impacts and exploring strategies. Indicate:
    - If BASE scenarios were used, both high and low end for climate and socio-economic changes (in principal this should be the same for all prospective case studies).
    - If not, what alternative has been used? How do they relate to scenarios of BASE?
    - What are the main drivers for change used from these scenarios?
- Describe what are the main impacts considered in relation to the drivers for change (refer otherwise expand on Table 1). Does the case study have a single or multi impact focus? What are the variables looked at?
- What sectors are affected (refer to the sectors as described in Table 1) and are considered within the case?
- What is the current strategy to cope with climate variability? What is or are the objectives of this strategy?
- Can adaptation tipping points, critical levels for adaptation, be defined for this current strategy?
- When (roughly) will there be impacts due to climate change, following a lower climate projection (supposedly of RCP4.5) , current strategies be insufficient? And when if the higher projection (RCP8.5) is followed?
- What are the adaptation measures considered, proposed, selected or implemented within the case for the short term? Which for the long term? Please refer or expand on the generic measures mentioned in Table 2.
- What is their rough sell by date for each scenario considered?
- Is flexibility or keeping options open part of the strategy?
- What measures do include or exclude others because of low or high regret of switching between them.
- Can windows of opportunity be distinguished in time? Where do these opportunities stem from? (One may think of other investments needed, other policies to be implemented of which adaptation may co-benefit).
- Can case pathways for different sectors and the rough timing of actions be assembled based on previous information?

When placing things in a temporal context in answering the above questions, reference should be made to the following time periods: short term 2015-2030, mid-term 2030-2050, and long term 2050 to 2100.

In addition each case study should give indications about the representativeness of the case: for what similar regions, cities within Europe with similar impacts would it be applicable?

3.3 Upscaling of economic data

3.3.1 General approach

Ultimately one of the main central questions of BASE is what the full costs and benefits are of adaptation in Europe. Underlying questions are:

- What part of major sectorial costs (investments and damages) can be attributed to adaptation? This refers to the issue of mainstreaming adaptation into sectorial investment agendas
- What is the optimal mix between investing in mitigation and adaptation? Research in this field is still limited and conducted with highly aggregated and poorly calibrated top-down models (see e.g. Agrawala et al 2011, Bosello et al. 2010, 2013 de Bruin et al. 2009)
- What are the economic advantages of one sort of strategy over the other in terms of:
  - *Direct Economic Performance* – often this refers to direct costs and effects (like avoided damage) of strategies (cost effectiveness)
  - *Wider Economic Performance* – referring to cross-sectorial effects and economy wide effects. Benefits of adaptation can extend beyond the risk impact regions throughout the economic production and consumption supply chain. The avoided damage (both direct and indirect damage) prevented by the adaptation measures and strategies can be seen as the benefit of the adaptation. For example flooding in one location can impact the whole economy. Neglecting these knock-on costs (i.e. the true footprint of the flood) means we might be ignoring the economic benefits and beneficiaries of flood risk management interventions. In 2007, for example, floods cost the UK economy about £3.2 bn directly, but the wider effect might actually add another 50% to 250% to that.
  - *Sustainability* To include benefits that cannot directly be quantified in economic terms
  - *Robustness/flexibility* – referring to dealing with uncertainties. A strategy may perform well under one scenario (for instance RCP4.5) but poor under the other (for instance RCP8.5). The adaptation pathway method allows us to include multiple possible future measures in a strategy. Specific assessment methods similar to real option analysis can be used to value the flexibility with respect to future outcomes. Otherwise robustness can be assessed using Monte Carlo methods.

The setup of BASE allows us to research these questions both from a bottom up and top down perspective.

There are three sources of information that will be included in the analyses:

1. The BASE models,
2. Literature on local to national climate assessments,
3. BASE case studies

As indicated in Figure 5 within BASE there are a number of models able to support the investigation on the abovementioned questions. There is a series of EU-wide sectorial models that are able to do spatially explicit calculations on impacts and damages depending on different socio-economic and climate scenarios. These models can address the question of performance and, albeit within a sectorial context, of robustness or flexibility of strategies.

The two economy wide models within BASE can translate climate change impacts and adaptation strategies from the sectorial perspective to the economy as a whole and in this way be able to support economic questions on sustainability.

We know up front that the models can at best be very supportive to the economic analysis in work package 6 (task 6.3) . The major shortcomings are that not all sectors are fully covered, not all effects can be quantified and that there is a lack of ground based validation.

Therefore within BASE the combination of all three sources of information mentioned above needs to be maximally used. In the upscaling protocol (D6.2) this will be elaborated further. Within deliverable 6.1 however we need to make sure that the models and the case studies within BASE take into account that methods and assumptions on costs and benefits of adaptation are exchangeable.

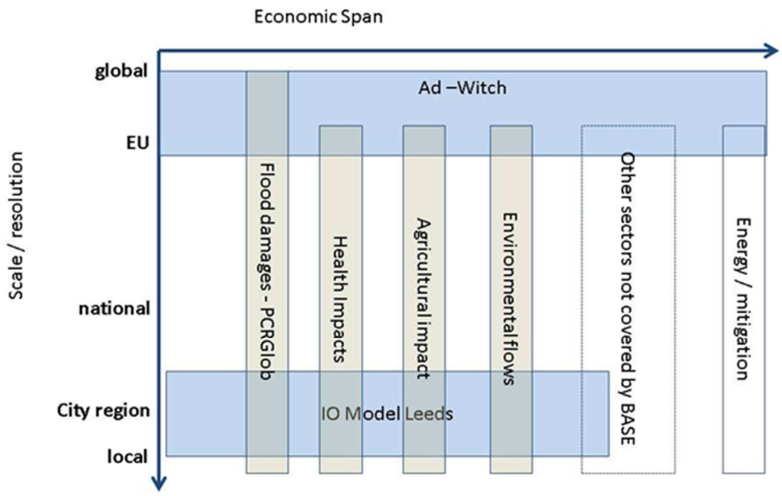


Figure 5 Models within BASE (colored rectangles) and their relation to each other and scales (from D3.1)

The interaction between models and case studies can be threefold:

- A particular sectorial model is applied and further developed and calibrated within one or more case studies. This is especially the case for the spatially explicit models. The case study in this sense is also an experimental facility to test certain model hypotheses. For example the question of the effectiveness of strengthening the adaptive capacity of farmers in a certain region could be investigated using the agricultural model within the Tagus case study. Insights and improvements gained from this case in the model will also sustain better estimates for other similar regions covered by the model.
- The case studies are providing input for the models without using the model directly for the purpose of the case. This information can be derived from literature or by smaller scale model analysis at case study level. For example, information on flood protection standards, damage figures from past hazards for the Elbe, Ebro and other basins are applied to calibrate the EU level flood risk model. Or for the health sector: national damage curves for heat stress impacts and adaptation strategies will be refined based on case study output and these in turn will feed into the damage curve for Ad-Witch is adjusted and applied for EU wide assessment.
- Indirectly the pathways that will be assembled using the procedure outlined under 3.2 will be implemented as measures in the models under task 6.3

The interactions between the different models and the interaction between case studies and models are described in D3.1 (see example Table 4). In this deliverable per model the directly supportive case studies and the variables on which to interact with the top down Ad-Witch model are explicitly mentioned. Also in 3.1 an uncertainty analysis using the models is proposed. Although the uncertainty analysis will be also part of work package 6, the forthcoming data requirements for the cases are part of D3.1. The case studies will provide some data on the uncertainty associated with impacts and adaptation measures which will feed into the way in which uncertainty affects the assessment of different adaptation pathways in the top down analysis.

Country	Case name	Team	Zone	Impact	Data and information from hydro model to case	Data and information from case to hydro model
Germany	Jena	UFZ	River basin/city	Flooding	Flood inundation maps; monetary losses; people affected	Flood extent maps for different return periods; information on potential flood impacts (monetised)
Finland	Kalajoki river	SYKE	River basin	Flooding	Flood inundation maps; monetary losses; people affected	Flood extent maps for different return periods; information on potential flood impacts (monetised)
Spain, Portugal	Tagus river	UPM	River basin	Water scarcity	Flow timeseries (including low flow)	To be defined
Czech Republic	Prague	CVGZ	City	Flooding	Flood inundation maps; monetary losses; people affected	To be defined
Spain	To be defined	BC3	River basin	Flooding	Flood inundation maps; monetary losses; people affected	To be defined
Vietnam	Mekong	Deltares	River basin	Flooding	Flood inundation maps; monetary losses; people affected	To be defined

Table 4 Example, data request from the flood risk model to the case studies

It is currently not clear to what extent direct output on costs and benefits figures from case studies might contribute to upscaling on EU level. This is highly dependent on the representativeness of individual cases for larger or other regions with similar impacts in Europe. Contextual case study results will help to shed light on the variation in economic outcomes across different contexts and some of their key determinants. The case studies cannot form a "sample" in the conventional sense, they provide complementary results to modelling ones and the two together enable us to say more than one would on the basis of just one or the other information base. In addition to direct information from the cases, a literature review of available economic climate assessments from local to national level across Europe will be undertaken. Cases will be asked to come up with good suggestions.

3.3.2 Data and information requirements for upscaling of economic data:

Similar to the data and information requirement put forward in 3.2.2 to upscale pathways we list similar questions here needed to properly upscale associated costs and benefits. In deliverable 4.1 the case study analysis framework a chapter has been dedicated to the economic evaluation protocol for the case studies (see Figure 6) .

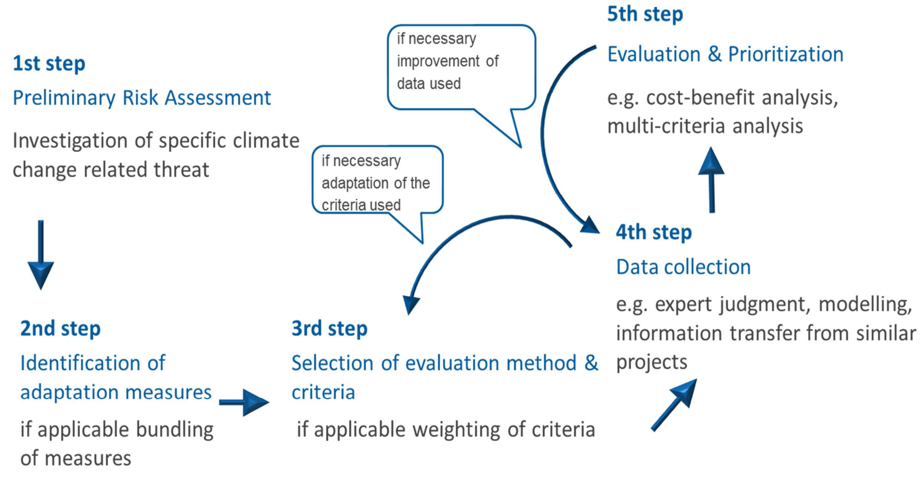


Figure 6 Economic evaluation protocol for the case studies (from D4.1)

For each step there is a set of questions defined to help case studies do the economic evaluation (Table 5).

Key questions	Auxiliary questions
Step 1 Preliminary risk assessment	
What is the climate change related problem/risk you would like to mitigate by adaptation?	Which problems already exist, what is/are the current risk/s?
	Which assets and sectors are at risk?
	Which adaptation or protection measures are already in place?
	How do these risks presumably change due to climate and socio-economic change?
Step 2 Identification of adaptation measures and adaptation pathways	
What are the alternative adaptation measures?	What are the primary and secondary objectives of adaptation?
	What are potential measures to meet these objectives?
	What is your baseline option (the “business-as-usual”-option)?
	Are there complementary measures? Is it appropriate to bundle these measures?
What are alternative adaptation pathways?	What is the “sell-by”-date of the measures or bundles of measures? I.e. when will they – under conditions of climate change – not be able any more to meet the defined objectives?
	What would be alternative measures or bundles of measures at these “tipping points”?

Step 3a Selection of evaluation criteria	
Which evaluation criteria should be used?	What are the relevant positive and negative aspects of the measures (costs and benefits) to be considered in the evaluation process (economic, ecological and social effects)?
	What is the appropriate unit to measure each of these criteria? Is the performance of the adaptation options measured in qualitative, monetary or other quantitative terms?
Step 3b Selection of evaluation method(s)	
What is the appropriate evaluation method?	Is it possible to express all relevant cost and benefit criteria in monetary terms? (→ cost-benefit analysis)
	Is it possible to express the positive effect (objective) by a single non-monetary indicator? (→ cost-effectiveness analysis)
	Are there several relevant criteria which cannot or cannot easily be expressed in monetary terms? (→ multi-criteria analysis)
Step 3c Weighting of evaluation criteria (applicable only to multicriteria analysis)	
What are the preferences of stakeholders regarding the different evaluation criteria?	Are there different stakeholder groups with different preferences regarding the evaluation criteria?
	Which weight do stakeholders and/or decision makers attach to a substantial change in the performance of the adaptation options regarding each evaluation criterion? (→ Swing-Weight method)
Step 4 Data collection	
What are the costs of the alternative adaptation options? What are the benefits of the alternative adaptation options?	For each cost and benefit criteria selected in step 3a: What potential data sources, including damage & impact assessment methods or existing CBA studies on adaptation measures?
	If no relevant data sources are available and modelling cannot be undertaken: Which experts can estimate proxies for assessing the performance of measures regarding the respective criterion?
What is the evaluation time frame	What is the lifespan of the measure with the longest lifetime?
Which discount rate should be applied?	Which discount rate is recommended by national guidelines for climate change adaptation measures (or public investments)? (In addition, for testing sensitivity of results against different discount rates also a low and high discount rate should be applied (1% and 5%))
How to deal with data uncertainty?	Can uncertainties related to the performance of the measures regarding certain evaluation criteria be described by a range (min-max), a triangular distribution (min, most likely, max) or any other kind of probability distribution?
Step 5 Evaluation and prioritization	
What is the ranking order of alternative adaptation options (measures, bundles of measures or pathways)?	For cost-benefit analysis: What is the net-present value (discounted benefits – discounted costs) of the alternative options? What is the benefit-cost ratio?
	For cost effectiveness analysis: Which alternative option achieves a defined objective at lowest costs? What is the cost-effectiveness ratio?
	For multi-criteria analysis: Which adaptation option performs best? (e.g. for PROMETHEE approach: which option has the highest net flow?)
	What are the uncertainties associated with the performance of the different options? Is there and, if so, to what extent uncertainty in the ranking of options? Is it possible to determine which option most likely performs best or is it necessary to gather

	further information to reduce uncertainty (go back to step 4)?

Table 5 Economic evaluation protocol from D4.1

This protocol ensures that the case studies follow a similar approach. For drawing overall conclusions about costs and benefits at the end of the case studies task 5.5 and 6.2/6.3 cross comparison and integration of results of the case studies should be made over similar **areas**, **sectors** and **impacts (and scenarios)** on:

- the **BUA baseline** strategy:
  - o what measures are included, what is the timing of these measures
  - o what ambition level is supposed to be sustained (for example maintaining current risk levels or current protection levels or more general is the yearly effort or certain standard the base).
  - o What are associated costs:
    - ▪ investments,
    - ▪ running costs and
    - ▪ negative side effects
  - o and benefits
    - ▪ direct: avoided damage,
    - ▪ indirect: positive side effects, some city cases also economy wide effects).
- The **adaptation** pathways – For one or more adaptation strategy the same questions should be repeated. Additional questions are:
  - o is the current backlog of investments included in or excluded from the adaptation measures ?
  - o Does it include only planned adaptation or also autonomous non-planned adaptation

In addition each case study should clearly state what methodology CBA (full costs and benefits analysis), CEA (cost effectiveness), or MCA (multi criteria analysis) and discount rate has been used. Depending on the applied methodology more or less quantified results can be obtained.

As for the case studies the models are expected to follow the same lines as much as possible on scenarios, baseline strategy, economic evaluation parameters etc. The most critical issue for the models probably will be what general adaptation measures can be modelled in a realistic way and does this match with requirements from the case studies and expectations from the sectors. Therefore it is essential to indicate clearly in advance when starting the modelling activities what sort of strategies can be supported by the EU-scale modelling and what cannot. BASE model development is part of BASE WP3 sub-tasks 3.2. and 3.3. The associated deliverables are expected for months 15 and 18. By that time the issue of which adaptation form can be considered by different models will be clarified.

3.4 Overview of data request

In Table 6 the combined data requirements of 3.2 an 3.3 is given. As stated before this deliverable is a living document that will be adjusted during the course of the project as case study researchers are being trained and are going to use this protocol. The most important missing element is that at this stage of the project there is not clear what case studies will be really able to provide the requested information. That's why the last column is still empty for questions 6-18. During the planned training workshop (November 2013) for the cases it will be further inventoried to what extent the different cases will be able to supply the requested information.

Question to the case study	Format requirement	Providing Cases
1. Describe general characteristics of case	primary sector, geographic location, prospective, retrospective.	All
2. Describe what climate and socio economic scenarios were used for assessing impacts and exploring strategies.	All prospective cases mention RCP, SSP. Retrospective cases describe scenarios used and what RCP/SSP they resemble most. Describe which variables (drivers for change) are considered.	All
3. Describe what are the main impacts considered in relation to the drivers for change.	Refer to, otherwise expand on Table 1	All
4. What sectors are affected and are considered within the case?	Refer to the sectors as described in Table 1	All
5. What is the current strategy to cope with climate variability? What is or are the objectives of this strategy?	Refer to the measures described in Table 2	All
6. Can adaptation tipping points, critical levels for adaptation, be defined for this current strategy?	Refer to otherwise expand on Table 3	
7. When (roughly) will these critical levels be reached due to climate change or socio-economic change	Give appropriate period (2015-2030,2030-2050, after 2050) for each considered combination of climate and socio-economic scenario	
8. What are the adaptation measures considered, proposed, selected or implemented within the case for the short term? Which for the long term?	Please refer to or expand on the generic measures mentioned in Table 2.	
9. What is their rough sell by date for each scenario considered?	For the timing refer to the periods 2015-2030,2030-2050, after 2050	
10. Is flexibility or keeping options open part of the strategy?	*Narrative*	
11. What measures do include or exclude others because of low or high regret of switching between them.	Please provide a *narrative* for each measure considered within the case	
12. Can windows of opportunity be distinguished in time? Where do these opportunities stem from? (One may think of other investments needed, other policies to be implemented of which adaptation may co-benefit).	Please provide a *narrative* for each opportunity considered within the case and relate them to the time periods 2015-2030,2030-2050, after 2050	
13. Can case pathways for different sectors and the rough timing of actions be assembled based on previous information?	Based upon questions 6-13 what are the main pathways.	
Upscaling of economic data		
14. Which method and major assumptions have been used	Refer to CEA, CBA or MCA, discounting rate	
15. Describe Baseline: Business as usual	- what measures are included (refer to question 5) - what is the objective (this should coincide with ATP, question 6) - What are associated costs: investments, running costs and negative side effects (in euro, or MCA scores) for each scenario. - and benefits. direct: avoided damage. indirect: positive side effects for each scenario.	

16. Describe alternate Adaptation pathways	Provide similar variables as under 15. In addition	
17. is current backlog of investments included or excluded in the adaptation measures? 18. Does it include only planned adaptation or also autonomous non-planned adaptation	Yes/No please give an estimate for what share (%) Please indicate qualitatively if autonomous adaptation is not included what societal cost and benefits are associated with it	
Other questions		
19. Please provide any reference to studies that may provide data with respect to the above questions	References, datasets, contacts	All

Table 6 Summary of all case study questions.

4 Planning, tasks, responsibilities

Table 7 shows the main activities and associated dates on delivering data and information to WP6 in order to be able to perform the promised tasks in time.

Required action	Attributed to task	Has to deliver to (tasks WP6 only)	By when	By whom (lead)
Scenarios on Climate and socio-economics	3.1	6.3, 6.4	Month 13-24	CMCC
Economic evaluation protocol, baseline	4.1	6.2, 6.3	Month 13	UniLeeds
Overview of current strategies and policies at EU level	*2.1*	*6.4*	*Month 13*	*SYKE*
Training of case studies in describing adaptation pathways and economic evaluation	4.2	6.2, 6.3 (in this case training of cases is key to successful data delivery)	November 26,27,28	Deltares, UFZ
Overview of measures that can be modelled at EU level	3.2, 3.3	6.4, 6.3	Month 15-18	CMCC, UPM
Adaptation pathways at EU level for modelling and upscaling	6.4	6.2, 6.3	Month 24	Deltares
Input from casestudies on pathways, costs and benefits (table 6)	5.5	6.2, 6.3, 6.4	Month 13-24	FFCUL

Table 7 Planning of actions to support deliverables of WP6 (in italics actions that are not required by the DOW).

Within work package 6 a series of research papers will be developed amongst others on upscaling methodology, on the application of with case studies validated EU scale models for sketching generic adaptation pathways and on the analysis of the main economic questions.

5 Conclusions

As an integrating work package, WP6 will have to have a firm contribution to the central BASE aims:

Assess the effectiveness and full costs and benefits of adaptation strategies to be undertaken at **local, regional, and national scales** using innovative approaches (mainly by **integrating bottom-up knowledge/assessment and top-down dynamics/processes**) with particular attention on **sectors** of high social and economic importance. *(WP 3; 6) and*

Improve current, develop new and **integrate methods and tools** to assess climate impacts, vulnerability, risks and adaptation policies to **stock take and enrich past and current EU research project outputs**. *(WP2; 3; 6; 7).*

The protocol outlined in this document together with the closely linked deliverables 3.1 and 4.1 will at least enhance (by common scenarios, definitions, approaches and assumptions) that data which are exchanged over different scales and between models and case studies will be comparable. In this way there will be less practical issues prohibiting the integration of bottom-up and top down approaches in cases and modeling. Part of the upscaling via the BASE models has been discussed in this report. However still enough of the 'innovative assessment approaches' needs to be developed in forthcoming deliverables within WP3 and 6.

By combining large scale modeling, economic assessment and the concept of adaptation pathways, a central challenge in this deliverable, the BASE project will be able also to make new methodological improvements compared to previous projects. In this respect BASE will seek opportunities for cross-fertilization with sister projects as TOPDad (on modeling), RISES and IMPRESSIONS (on developing adaptation pathways).

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