Decision-maker needs assessment:
Assessment of decision-makers' needs and capacities, drivers and barriers for using scenarios, modelling and pathways analysis

Deliverable 1.2

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Summary

One of the aims of IMPRESSIONS is to provide empirically-grounded science that quantifies and explains the consequences of 'high-end scenarios' for society at large and in particular for decision-makers. To this end, Task 1.2 of WP1 conducts empirical research in the five IMPRESSIONS case studies and assesses actual decision-making processes and information needs. The main goals of this research are twofold. First, it seeks to improve understanding of how adaptation-related decision-making processes occur in reality and second, it intends to use the assembled knowledge to enhance the representation of adaptation processes (i.e. decisions and their outcomes) in the suite of models being developed and applied in IMPRESSIONS.

This document describes this empirical work for four of the five case studies; the interviews for the EU External case study will be undertaken later in the project to fit with the different aims and design of this case study which focuses on indirect effects. In total 72 interviews have been conducted from February to October 2015 by seven of IMPRESSIONS' researchers.

The interviews focused both on current decision-making processes and the information needs that are currently in place for making decisions relevant to climate change adaptation, and on how these may change in relation to high-end scenarios, so as to investigate the question: what is different about decision-making under high-end scenarios? An open interview process was chosen to allow for exploratory insights not anticipated by the researchers. Personal perspectives obtained through the interviews were recorded and transcribed, and the content was analysed inductively.

In order to facilitate cross-comparison across the case studies a common interview template was developed. The template built on a theoretical framing of decision-making processes – a 'Common Framework of Reference' (described in D1.1) – which facilitated an increased understanding of the structures of the decision contexts for the case studies. Since each case study had its own specific characteristics, the template, to a varying degree, was tailor-made to the specific needs of the different case studies.

The following conclusions can be drawn from this work:

- A general conclusion across all four case studies is that stakeholders perceive that their adaptation-related decision-making process will, in general, be *more affected by non-climate (socio-economic) factors than by climate factors*. This finding underlines the importance of studying climate change impacts in a socio-economic context; not only is the climate changing, society is also changing. Although this point is partly addressed by the scenario architecture of IMPRESSIONS, there is still a message here to climate scientists that they tend to over exaggerate the importance of climate change as the main driver for future vulnerabilities.
- A second conclusion across all case studies is that *uncertainty* related to climate change projections or climate impact modeling *is not in general perceived as a great problem in decision-making.* Uncertainty is often discussed at a technical level, but this tends to be less of a problem when the decision reaches the decision-making organisational bodies. This is somewhat surprising, especially given the time and energy the climate change research community spend on characterising and communicating uncertainties as exemplified by the latest (AR5) guidance note on consistent treatment of uncertainties as a common approach across all IPCC working groups. Part of the explanation seems to be a tendency amongst decision-makers to favour robust decision-making approaches, i.e. to strive for strategies that perform reasonable well over a wide range of future possible conditions.

- The use of climate projections (scenarios) and impacts modelling varies substantially between the four case studies. In some cases this is an integrated part of the decision-making process, while in other contexts this is the exception.
- The same can be said about high-end climate change, i.e. the awareness of these potential futures varies between the case studies. It is however unclear to what extent, and how, these types of scenarios actually influence decision-making in those cases where high-end scenarios are considered. Although the legal document of the COP21 in Paris does not specify any quantitative measures of mitigation efforts, it will be interesting to follow how stakeholders perceive the likelihood of high-end climate change after the agreement to keep global warming 'well below' the EU's previous target, i.e. 2°C above pre-industrial levels.
- An important conclusion regarding modelling is that stakeholders ask for *comprehensive and tailor-made modelling.* Modelling should leave a 'climate focused approach' and instead strive for a more comprehensive approach that is tailor-made to a specific decision-making process. This could mean (in the case where systematic tools are used) developing add-ons (plugins, extensions, …) to existing software tools rather than developing new stand-alone tools. In this way climate impacts modellers could become more decision-relevant. A hypothesis is that modelling activities today are good at being sector focused, but not so good at being decision-focused.
- The often very long time-horizons in climate change research and policy is a problem for stakeholders. Most policy processes include decision with consequence times much shorter than the time-horizons discussed by climate scientists. As an example, AR5 IPCC WG1 included a chapter on 'near-term climate change' and here the time-horizon is *30 years* (2016-2035 compared to 1986-2005). This could be compared to what is termed 'long consequence time' in the interview template which is more than 5 years. But looked upon differently, impacts of climate change could act as a catalyst for making societal decision-making *in general* (not only climate related) become more long-term.
- Regarding model-based indicators and quantifiable thresholds, there are already today many possibilities for better matching between decision-makers needs and modelling, especially at the EU level (and also linked to individual Member States). With closer cooperation between policy-makers and modellers this could be a promising way forward.

1. Introduction

Although there is a widespread agreement that the increase in global mean temperature should not trespass the 2°C threshold to avoid dangerous climate impacts, projections based on current emission trends point to much more substantial warming, with possible increases of 4°C or more unless there is radical action to cut emissions. Recently, the UNFCCC Conference of the Parties (COP) meeting in Paris in December 2015 agreed to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. However, the legal document does not specify any tools or mechansims to achieve this goal[1]. The latest estimates by the UN show that a 2.7-3°C increase in temperature is likely by the end of the 21st century based on current mitigation efforts, so these are highly insufficient to achieve the new goal.

The IMPRESSIONS project aims to provide empirically-grounded science that quantifies and explains the consequences of 'high-end scenarios' (HES) for society at large and in particular for decision-makers and develops innovative solutions to prevent them. Within the project, it has been acknowledged that present policies and conventional strategies may not be sufficient to cope with the social, economic and political threats posed by these HES and therefore transformative solutions need to be explored and analysed.

Work package 1 (WP1) on 'Innovative and effective decision-making under uncertainty' deals with the identification of the critical needs and capacities of European decision-makers for considering HES and their associated uncertainties in the development of adaptation policy and practice. One of the tasks in WP1, Task 1.2, is to conduct empirical research in the project's five case studies and assess actual decision-making processes and information needs. The main goals of this task are:

1. To improve understanding of how adaptation-related decision-making processes occur in reality;
2. To use the assembled knowledge to enhance the representation of adaptation processes (i.e. decisions and their outcomes) in the suite of models being developed and applied in IMPRESSIONS and to support other IMPRESSIONS WPs by providing the results obtained in the interviews conducted in the case studies.

WP1 identified and interviewed decision-makers within the four of the five case studies in order to empirically assess their decision-making processes and respective information needs.[2] Outcomes from the assessment are expected to inform WPs 2, 3, 4 and 5 and the case study coordinators so that research workplans can be fine-tuned to meet decision-makers' needs (in so far as is possible) and account for the capacities, drivers and barriers inherent in real-world decision-making.

Partners SEI and FFCUL are the authors of this report, with key contributions from partners leading the three local case studies who have conducted the interviews with the stakeholders and produced synthesis reports on them.

[1] http://climateactiontracker.org/news/257/Paris-Agreement-stage-set-to-ramp-up-climate-action.html

[2] The stakeholder engagement process for the EU External case study is different from the other case studies. The decision-making system (meaning the EU) is separate from the impacts and the scenario system (which includes Central Asia, Russia and China). This means that the involvement of the decision-makers from the EU is not foreseen until the third stakeholder workshop. Hence, it was decided to engage in interviews with EU decision-makers in relation to the third workshop.

2. Methods

2.1. General description of the case studies

A key component of the IMPRESSIONS project is a set of five integrated, multi-scale and multi-sectoral case studies: an EU External case study focusing on indirect impacts on the EU from the Central Asian region; an European case study, focusing on cross-sectoral impacts of several EU policies and Directives, and three local to regional case studies – Scottish, Iberian and Hungarian. In this report we present the results of the interviews carried out in four of the case studies. Due to the special structure of the EU External case study, the interview component of the case study has been postponed to year four of the project and, thus, excluded from this report (see footnote 2).

2.1.1 European case study

The European scale case study is quantifying cross-sectoral climate change impacts and vulnerability and developing adaptation and mitigation pathways for addressing them under high-end climate and socio-economic scenarios within the EU27. The sectors being analysed include agriculture, forestry, water, urban development, human health, coastal areas and biodiversity. The European scale study will provide the boundary conditions for the three regional/local studies.

2.1.2 Scottish case study

The regional scale case study for Scotland is exploring multi-sectoral interactions in a north-western European environment. The sectors being assessed include agriculture, forestry, water and tourism along with the multi-scale issue of supply chains for food and beverages.

2.1.3 Iberian case study

The regional case study for Iberia is exploring multi-sectoral interactions in a southern European environment and includes the water, agriculture, forestry and biodiversity sectors. It specifically focuses on the Tagus and the Guadiana river basins which are two of the five international river basins shared between Portugal and Spain and are among the European basins most likely to be affected by climate change.

2.1.4 Hungarian case study

The regional case study for Hungary is exploring multi-sectoral interactions in two municipalities in a central and eastern European environment. The sectors being studied include water, urban, agriculture and human health with the multi-scale issues of water management and local/regional food supply.

2.2. Research process

This section provides background information about the research process used to develop and run the interviews. The Description of work (DoW) refers to the use of intensive interviews with key decision-makers from the case studies in order to:

(i) Assess current decision-making processes, as well as so-called 'non-decisions' - referring to the power exerted by actors that restricts the space for decision-makers to consider the full range of options - and their treatment of uncertainty and long-term futures, including details of any known or perceived thresholds (e.g. physical or social/systemic thresholds);

(ii) Assess the capacities, barriers and drivers for using information describing possible futures, including scenarios;
(iii) Identify information needs, including (a) those that can be met within the IMPRESSIONS project, (b) those that the project will help to explain but not fully meet (e.g. via exploring the potential for tipping points and their consequences via scenario narratives, without necessarily defining when and how they will occur) and (c) needs that cannot be met through the project, but which are important to consider and be aware of in our analysis.

Thus, the interviews focused both on current decision-making processes and the information needs that are currently in place for making decisions relevant to climate change adaptation, and on how these may change in relation to HES, so to investigate the question: what is different about decision making under high-end climate change?

The dialogue approach within the four case studies was to be as active and open as possible. Based on consultations with other WP and case study leaders, the strategy for the interactions with the decision-makers consisted of an interview process aimed at 15-20 relevant decision-makers (identified as a subset of the WP6A stakeholder database for each case study) and led by case study leaders. It should be noted that the work of this task applied a relatively broad definition of decision-maker, including e.g. stakeholders not only taking decisions but also stakeholders supporting decision-making.

The open interview process was the chosen methodology to allow for exploratory insights not anticipated by the researchers. Personal perspectives obtained through the interviews were recorded and transcribed, and the content was analysed inductively. Most interviews were conducted personally although some were conducted by skype and by telephone for logistical reasons.

2.3. Selection of decision-makers

The methodology for stakeholder identification was designed to be as inclusive as possible to ensure the plurality of insights and backgrounds of stakeholders, thus limiting biases against certain views and improving the outcome legitimacy. It was therefore decided to carry out a highly methodological stakeholder mapping and identification process for each of the five case studies recognising those decision-makers that can enable or leverage change due to their position or function in organisations or society at large.

The approach applied to carry out this mapping follows the Prospex CQI-method that focuses on the identification of criteria (C) and quota (Q) for stakeholder identification before zooming in on the detection of individuals (I) (Gramberger et al. 2015). This method has been slightly adapted for the selection of the interviewees and followed six distinct steps: (1) definition of case study objectives for each of the five case studies; (2) discussion of stakeholder criteria matching the objectives; (3) agreement on criteria per case study and for the decision-maker survey; (4) construction of the stakeholder database; (5) completion of the database; and (6) check of stakeholder balance and discussion on relative importance of the criteria.

Following the first three of these steps in each of the five case studies resulted in eight main stakeholder categories, comprising a total of 50 stakeholder selection criteria. After completion of the other remaining three steps, the mapping resulted in the identification of 310 individuals in total spread over the five case studies. Only four of the criteria could not be fulfilled in one of the case studies, e.g. identifying individuals under the age of 30 in the Scottish case study. From these, a short-list of 15-25 ‘key decision-makers’ within each case study was selected for interview. For a

complete description of the stakeholder mapping methodology, please refer to the report by Gramberger and Zellmer (2014).

2.4. Interview templates

A general interview template was designed to assess climate adaptation-related options and strategies in four of the case studies. The rational for using one general template for all the case studies was to strive for comparability between them. However, while consulting with case study leaders, it became clear that each case study needed to adapt this template in order to accommodate its specificities; the number of questions and expected overall duration of the interview were also concerns that made it necessary to adjust the template. Thus, the interview templates differ across case studies, hence, making comparison a little more difficult compared to what it should otherwise have been. However, the overall structure and most of the content of the templates are the same, hence, being in line with the overarching philosophy behind the IMPRESSIONS case studies of 'controlled divergence'.

Annex A provides the information brief sent out to interviewees and Annexes B to F provide the interview templates for each of the case studies. The interview templates consisted of five parts and one appendix. They start with a section (A) consisting of basic questions concerning the decision-maker and the decision-making context. The core part of the template comprises three sections (B-D) corresponding to the four dimensions in the theoretical framework: decision-making objectives; decision support; decision-making; and outcomes (see D1.1, Capela Lourenço et al. (2015)). The last section (E) concludes the interview. The duration of the whole interview should be approximately 1-1.5 hours, with a total of 10-15 questions.

In each section there was an 'initial statement' which explained the framing and purpose of that section and a short list of questions. In some cases a varying number of 'supporting questions'/comments was provided as a suggestion of follow-up questions or prompts that could be used for stimulating the discussion, if needed. In some places in the template, specific instructions for the interviewer were provided.

The interview process started in February 2015 and ended in October 2015 (Figure 1). During this period, and with some support from WP1, the case study leaders of the regional case studies conducted between 12 and 25 interviews. Interviews for the European case study were conducted by the WP1 team. The results from the interviews from each case study were summarised by the interviewers in a short report and are synthesised in this report.

			2015											
CS	Contact Person	# interviewees	1	2	3	4	5	6	7	8	9	10	11	12
Hungary	Linda Horvath	12				Interviews			WS #1	Interviews			Report	Final Report
Iberia	Maria Cruz; Francesc Cots	25		Interviews				WS #1	Interviews				Report	
Scotland	Miriam Dunn	18				Interviews			Report					
European	Adis Dzebo; Tiago Lourenço	17									Interviews		Report	

Figure 1: Timeline of case study interviews.

3. Results of the interviews

The main results of the interviews for each case study are summarised in this section. A comparative analysis is provided in Section 4.

3.1 European case study

The essence of the WP1 work in the European case study is to highlight the implications of multi-sectoral policy responses to HES within several sectors, including agriculture, forestry, water and biodiversity, seeking clarification on:

- What are the key policy visions and goals in a set of relevant EU-wide sectors and how may these be affected under HES?
- How can these goals be captured by model-based indicators? Are the indicators that are currently available useful for policy support? Are these HES sensitive?
- Can quantifiable (model indicator) thresholds be defined for each policy goal? How would they change under HES? What level of HES change is considered 'acceptable' and how can this be captured by model indicators?
- Would the EU consider changing such goals because (in spite) of HES?
- What would the key responses be to maintain the set of goals/visions or to reach new goals/visions?
- Which sectors actually define (and quantify) critical thresholds and are they currently considering HES?
- Are systemic effects with relation to critical thresholds across multiple sectors managed? If so, how?

This analysis has been based on target interviews with selected EU-level decisions-makers. It has also included a mapping exercise (Annex G) where high-level visions/goals for a number of EU policies are linked to quantitative (and qualitative, when available) model-based indicators. This analysis considers the following EU policies: The Water Framework Directive, The Habitat Directive, The Common Agriculture Policy, The EU Forest Strategy, and The Floods Directive. The interviews were carried out by Tiago Capela Lourenço (FFCUL), Henrik Carlsen (SEI) and Adis Dzebo (SEI).

3.1.1. Interviewees profiles

For the European case study, 12 interviews were conducted with 17 stakeholders in total. In addition to the identification process described in Section 2.3, the EU Policy Day[3] organised by the IMPRESSIONS, HELIX and RISES-AM projects also provided an opportunity to meet with relevant stakeholders. Stakeholders were chosen from three EU institutions: The European Commission (EC), the European Parliament (EP) and the European Environmental Agency (EEA). From the EC, we interviewed stakeholders from DG Environment and DG Agriculture. From the EP, we interviewed stakeholders from the Scientific Foresight Service (STOA) at DG Parliamentary Research Services. At the EEA, we interviewed experts working in the relevant sectors.

[3] High-end Climate Change: Impacts and Vulnerabilities. *A Science-Policy Lunchtime Debate hosted by DG RTD and DG CLIMA,* 17 September 2015.

The role of the stakeholders in their various positions was mainly based around policy support and policy formulation. 88% of the stakeholders were included in these two categories. The third category that was mentioned was impact analysis (12%). Figure 2 summarises the main sectors covered by the interviewees.

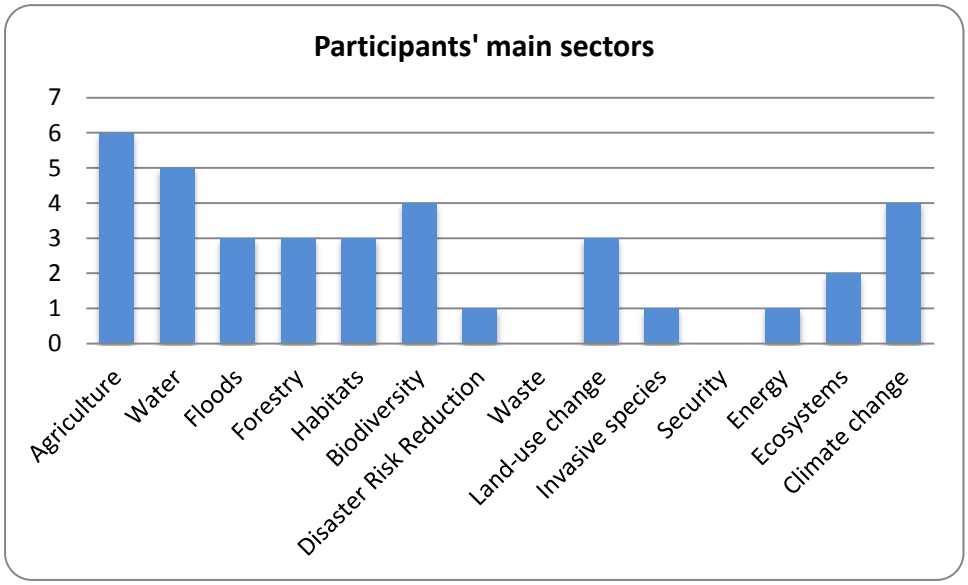

Figure 2: Main sectors across which stakeholders organisations operate.

3.1.2. Decision objectives

This section of the interview asked questions about the policy goals of the selected EU policy processes and eventual links with climate adaptation decision-making. The focus was on the problems, goals and preferences that motivate decision-makers, as well as the stakeholders affected by this process. The stakeholders were asked to highlight the principles currently guiding decision-making processes and eventual experiences involving climate change adaptation. The questions that were asked focused on: (1) key policy goals and visions; and (2) how the goals and visions were connected to climate change (adaptation and mitigation) challenges. Answers to the first question are summarised in Table 1.

Answers to the second question on the role of climate change revealed that several of the Directives were designed before climate change became a big issue. For example, the Habitats Directive in 1992 and Water Framework Directive in 2000. However, most of the Directives and polices analysed do to some extent include climate change considerations and the stakeholders that were interviewed do think about climate change in their decisions.

For example, climate change has been incorporated in the 2007-2013 period of the Common Agricultural Policy (CAP) and is also being considered in the new period 2014-2020. The two pillars[4] of CAP include adaptation and mitigation. The first pillar focuses on the greening of agriculture and the second pillar on Rural Development Programmes. This second pillar states that at least 30% of the budget of each Rural Development Programme must be reserved for voluntary measures that are beneficial for the environment and climate change. However, it was also noted that the overall policy goal of the sustainable management of resources conflicts with the short-term focus of the

[4] CAP comprises two 'pillars.' The first pillar supports farmers' incomes, while the second supports the development of rural areas.

CAP. Payments to farmers encourage certain actions that have a short-term focus and there are currently no financial tools to promote climate change-related action.

Table 1: Key policy goals and objectives.

Water Framework Directive (WFD)	Good ecological status
	Secure drinking water supply
	Good chemical status
	Protection of terrestrial & marine waters
Habitats directive (HD)	Restoration of natural habitat and wild species
	Protection for animal and plant species
	Special areas for conservation
Common Agricultural Policy (CAP)	Viable food production
	Sustainable management of natural resources
	Balanced territorial development
Forest Strategy (FS)	Sustainable supply of materials and energy
	Sustainable forest management
	Insure role of forests & forestry[5]
Floods Directive (FD)	Reduce adverse consequences for human health
	Reduce adverse consequences for environment
	Reduce adverse consequences for cultural heritage
	Reduce adverse consequences for economy
	Reduce adverse consequences for infrastructure

Interviewees stated that the Water Framework Directive does not mention climate change to a great extent. The Common Implementation Strategy of the Directive for Member States includes climate change at a very general level and most of the measures recommended are no regret measures. Many of the drafts of the second river basin management plans include information on climate change. For the Floods Directive, climate change is mentioned in the Directive but there is no obligation to report on it. The Floods Directive was partly introduced as a consequence of the Water Framework Directive not being very strong on climate change. It is expected that climate change will get a more prominent role in the Water Framework Directive in the future as new management plans are being developed and more data is gathered.

With regard to climate change, the Forest Strategy is the weakest of the policies analysed here as there is no explicit reference to climate change. At the EEA, it is part of the state-of-the-art work, but it is mainly included under land use and not as a stand-alone sector. Similarly, the Habitats Directive does not include any prominent discussions on climate change. Member States are currently not prioritising it and there are many pressures currently considered as more important such as agriculture intensification, agriculture abandonment, grazing, and canalisation of rivers and dams as drivers and pressures of biodiversity loss and degradation.

HES are considered in some policies, for example the CAP, which already notes a significant change in temperature between 1^{o}C and 2^{o}C. However, discussion around HES is more focused on the terms of not getting there rather than potential impacts.

[5] Role of forests and forestry in soil protection, erosion control, water regulation, improvement of air quality, carbon sequestration, mitigation of and adaptation to climate change effects, conservation of biodiversity and the restoration of damaged forests.

3.1.3. Decision support

This section of the interviews asked questions focusing on how policy goals are being supported – for example, through scientific and other activities, such as modelling, provision of data and policy advice. We also asked questions about what kind of climate and non-climate information is being used to inform decision-making within the context of the Policies and Directives.

With regards to modelling, most interviewees referred to the JRC as the key resource. Other institutions that were mentioned were the Institute for Environmental Studies (IES) for the Floods Directive and OECD for agriculture. Interviewees also pointed us towards the FP7/H2020 projects MODEXTREME and AGROFORWARD. It was notable that HES are rarely considered with regards to modelling indicators.

Most modelling was undertaken for the CAP. The CAPRI model was mentioned as well as some biophysical modelling through the JRC in Ispra and Seville (JRC-IPTS). A specific indicator that was mentioned was a farm/bird indicator. Work by the EEA on indicator preparation and updating also contributes to indicator support in DG Agri, for example, high nature value. However, complexity in representing environment-agriculture linkages is often considered to be too great for the widespread use of modelling.

For the Floods Directive, everything depends on Member State reporting. Some Member States use modelling, usually some form of hydrological and hydraulic modelling, whilst others rely on expert judgment. The use of modelling within countries is also very scattered. European future projections regarding the Floods Directive are almost always based on JRC data.

Regarding the Forestry Strategy, the EEA has a huge list of indicators, including growth and productivity, forest disturbances, forest fires, and phenology among others. Information is mainly gathered from Member States and from various EU projects. A lack of information sharing between JRC and EEA was noted in the interviews. In DG ENV there is an economic modelling unit currently running a study on resource efficient use of bioenergy.

For the Habitats Directive, there is a set of impact indicators, provided by the EEA, for the Biodiversity agenda. However, the general provisions in the Habitats Directive (and Birds Directive) are linked to ‘conserve what we have’ or ‘restore what has been lost’, and the use of modelling is not very relevant in this specific context. In the Habitats Directive, within the methodology to assess good conservation status, there are some parameters called ‘favourable reference values’. These provide information on how big a population of a certain species needs to be to be considered under good conservation status. A very political example of this can be found in Sweden in terms of the number of wolves deemed acceptable in the country. For such specific issues, modelling can be used, but this is rather limited.

Lastly, for the Water Framework Directive, several Member States use basin-level models. There is no need for indicators at the EU level as water basins vary greatly. Member States also vary in their use of modelling and expert judgment. There are no climate change related indicators for the Water Framework Directive. There are status and pressure indicators. These are produced at the water body level and aggregated to the river basin. All Member States use more or less the same indicators. These classify status based on biological elements such as fish fauna, micro invertebrates, etc., based on monitoring of 11km river stretches. This feeds into the ecological status which is compared to a reference level to calculate the deviation from the reference situation. This is then aggregated into one value going from good to bad.

This interview section also asked questions on whether quantifiable thresholds could be defined for the policy goals. None of the stakeholders could point towards any quantifications regarding thresholds or tipping points. There were some qualitative thresholds mentioned, such as for the Water Framework Directive, which has good ecological status as a policy objective. Everything below good ecological status was considered as under the threshold as there is a 'no deterioration objective'. For the Habitats Directive, there is a favorable reference value and favorable conservation status. However, these are not in general at the EU level. This was a very political debate. The Forest Strategy was seen as having too many conflicting goals (e.g. stopping deforestation and increasing bio-fuels) to be able to impose any thresholds.

Regarding information on future climate change used by stakeholders in their decision-making, the responses are summarised in Figure 3. It shows than the main source of climate change information comes from research as a first hand source and an indirect source through the IPCC and information from Member States.

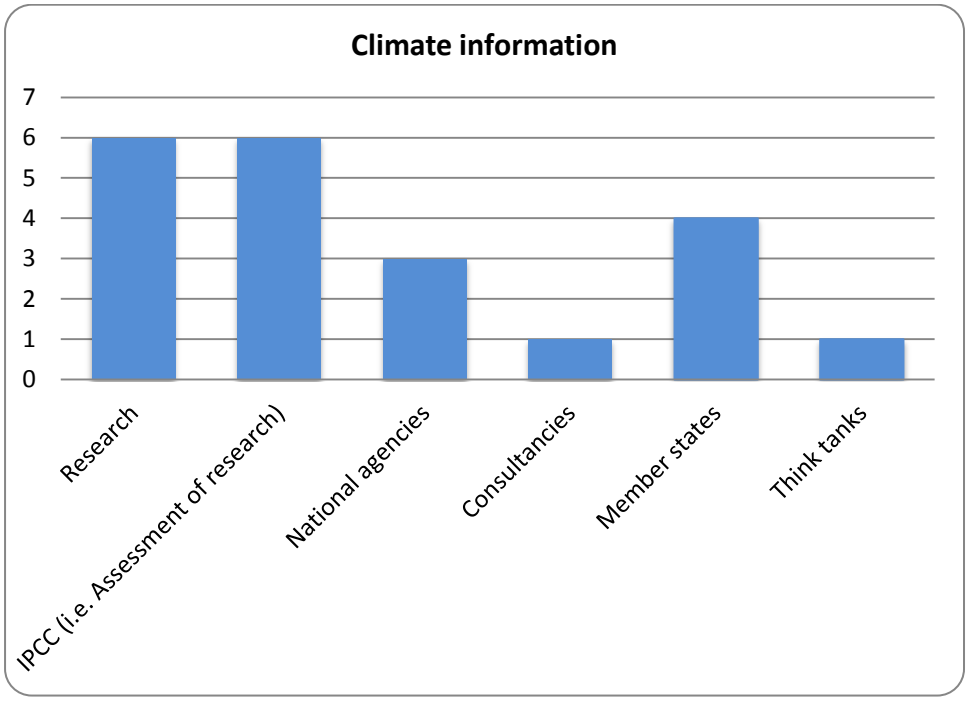

Figure 3: Climate change information used by stakeholders.

3.1.4. Decision outcomes

Adaptation-related decision-making is different from many other decision-making contexts because of the long-time scales involved, the pervasive impacts and resulting risks, and the 'deep' uncertainties attached to many of those risks. Moreover, the outcomes are difficult to assess and evaluate since it is necessary to wait until the consequences of each decision are visible and can be evaluated. This section of the interviews asked questions about assessment and prioritisation of climate adaptation challenges in policy-related decision-making processes. It asked: (i) about the implications for policy goals regarding the possibility that global warming might exceed 2°C; and (ii) cross-sectoral implications from other relevant policies and sectors.

Regarding the first question, all stakeholders argued that the policy goals and objectives were sufficient enough even in a HES world as they are very general. However, almost everyone noted

that while the policy goals are in place, the actions behind them and how they are operationalised need to be changed. Generally, when considering HES, actions on climate change must be implemented quicker.

For the second question on cross-sectoral impacts and issues, stakeholders were asked to name other sectors most relevant for their decision-making. Figure 4 shows the results. It indicates that energy, biodiversity, land use, ecosystem services, infrastructure and transportation were the other sectors that have the biggest impact on the policies analysed in this case study.

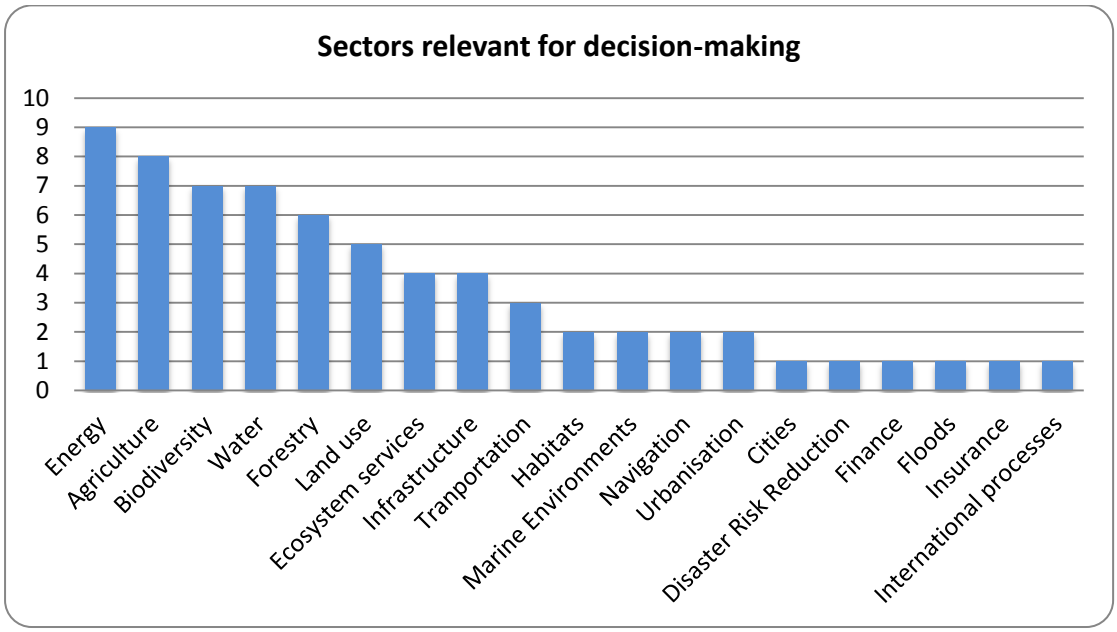

Figure 4: Cross-sectoral implications.

3.2. Scottish case study

The main theme of the Scottish case study is land resource management, including links to the global scale through food and beverage trade and its effects on land allocation. The research takes account of cross-sectoral interactions for agriculture, forestry, biodiversity, water and tourism. The case study involves the organisation Adaptation Scotland who coordinate a network of relevant private and public sector stakeholders with interests in climate change impacts and adaptation. This has allowed the development of a flexible research strategy which responds to stakeholder needs. The main outcome of the study will be new knowledge and evidence to support the implementation of the Scottish Adaptation Strategy, as well as capacity building for key decision-makers with respect to adaptive learning for coping with high-end futures. The interviews were carried out by Miriam Dunn (UEDIN).

3.2.1. Interviewees profiles

The case study involved decision-makers in Scotland in land resource management sectors. Scotland was chosen as a case study because it is at the frontier of adaptation planning, and has shown leadership in terms of integrating and financing adaptation. It was also chosen because of the (relatively) advanced knowledge of HES of climate change for this region – that is, there is a lot more agreement between climate models about the likely changes than is the case for many other regions. Although participants' organisations are all part of the land resource management sector

more broadly, many of the organisations operate across several different sub-sectors (Figure 5). Figures 5-8 show the profiles of the interviewed stakeholders.

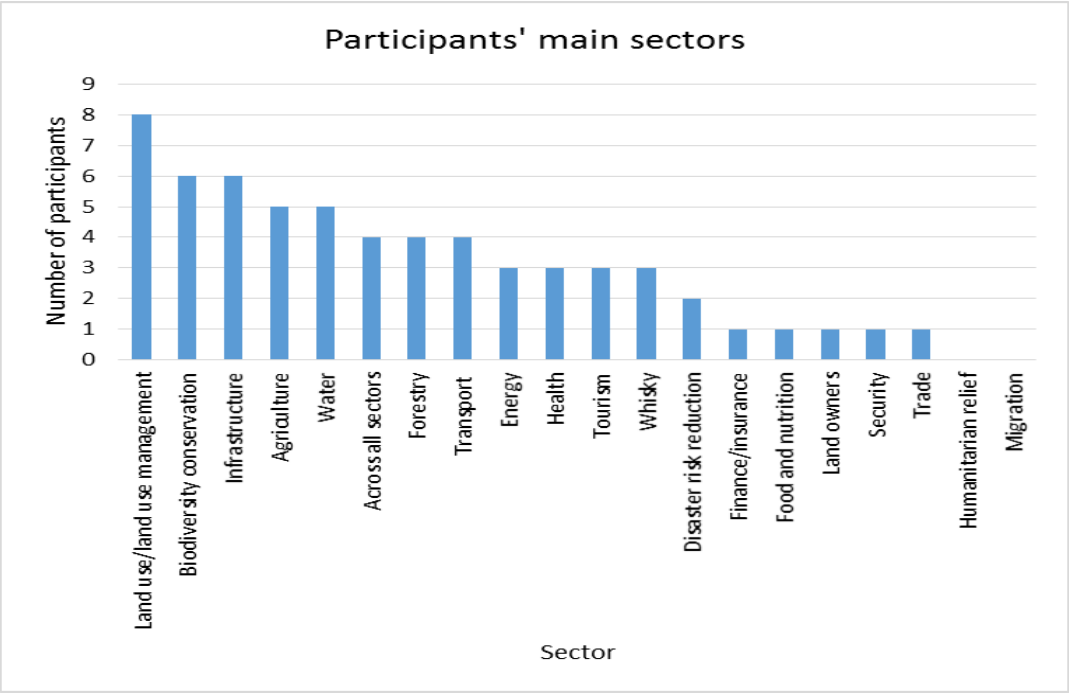

Figure 5: Main sectors across which stakeholders organisations operate.

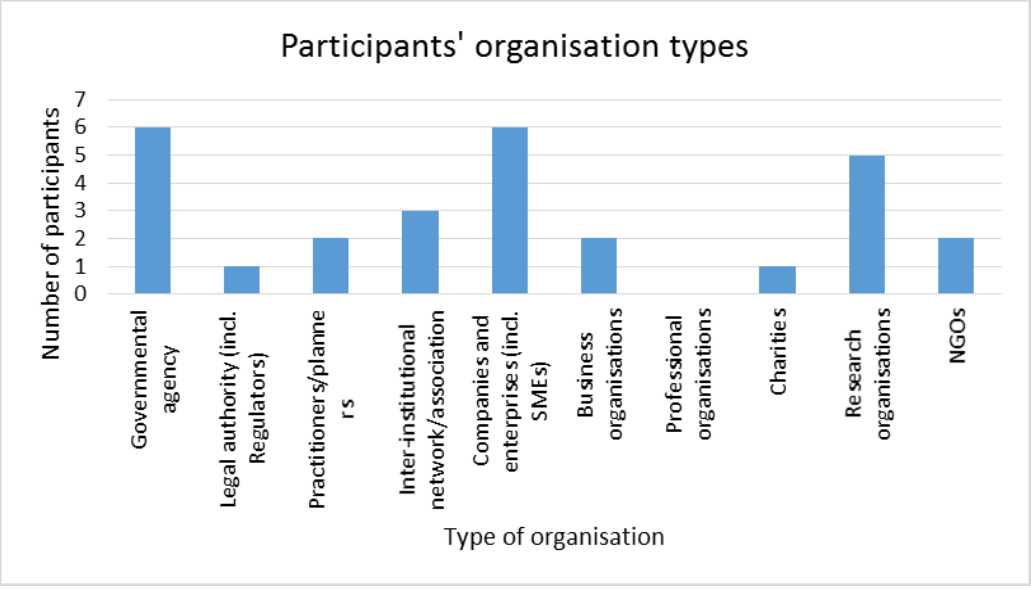

Figure 6: Main categories of organisations.

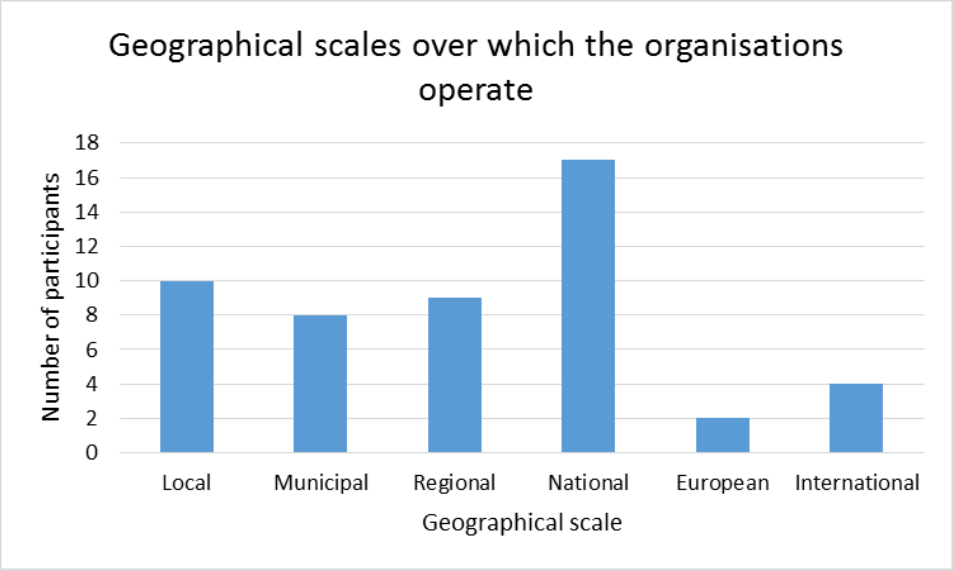

Figure 7: Geographical scale of operations.

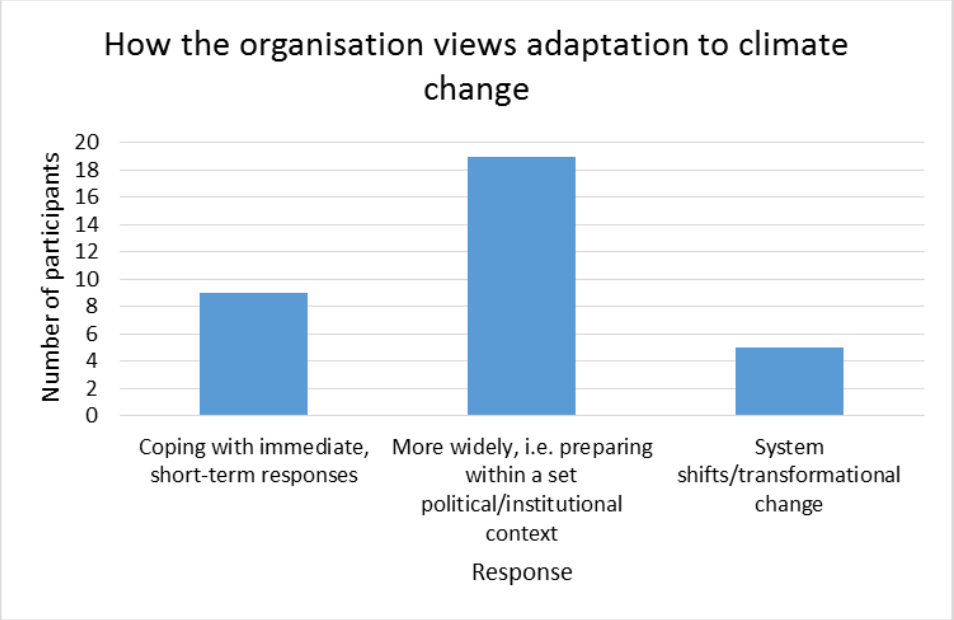

Figure 8: Organisational approaches to adaptation.

3.2.2. Decision objectives

This section focuses on the different types of adaptation-related decision-making processes uncovered by the interviews. Interviewees were asked to, if possible, cluster each process according to the WP1 Common Frame of Reference (CFR), that is, if they represent a normative, strategic or operational type of process. Approximately 50% of the stakeholders were making strategic decisions. The majority of the stakeholders interviewed are in a role of providing information or advising decision-makers rather than considering themselves as being decision-makers (Figure 9 explains all categories). The stakeholders also are overwhelmingly (95%) making decisions in a bottom-up (define/assess/evaluate objectives first) rather than top-down (define/assess/evaluate

scenarios first) manner. Finally, most of the stakeholders do not make very long-term adaptation decisions (Figure 10).

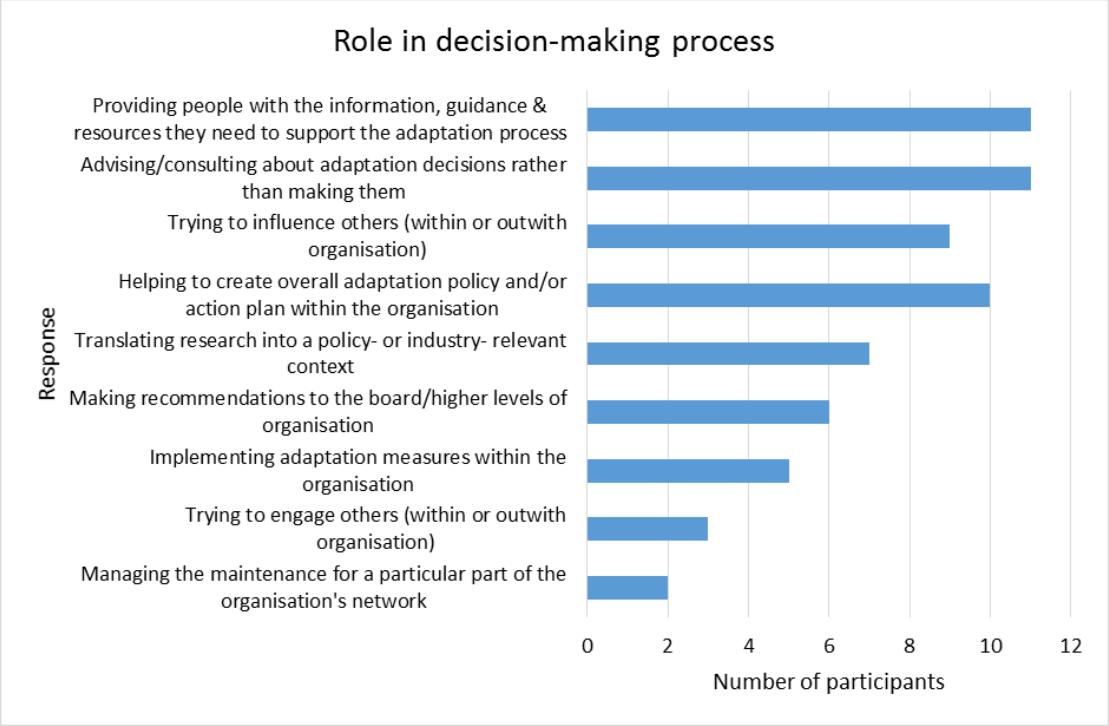

Figure 9: Interviewees' role in the decision-making process.

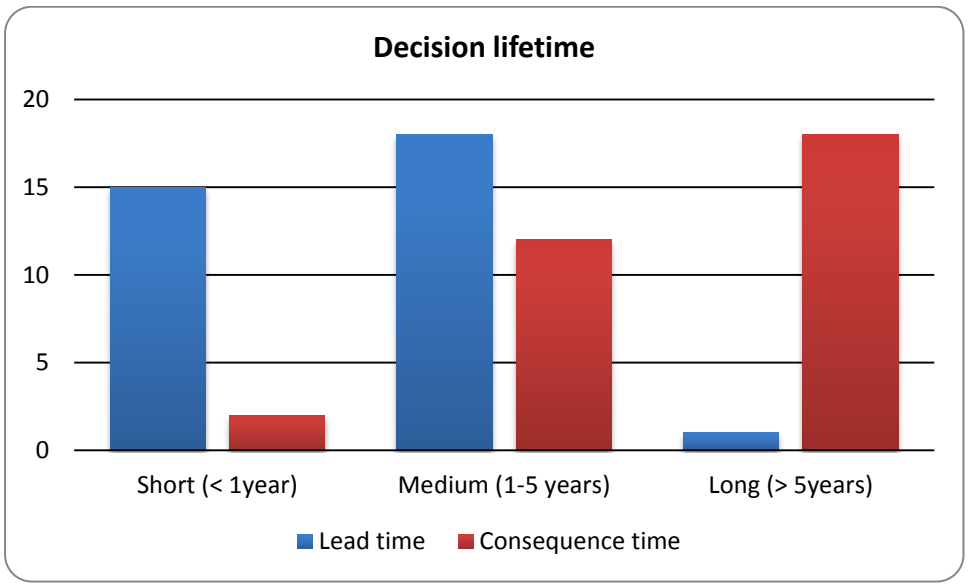

Figure 10: Time horizon of adaptation related decisions.

3.2.3. Decision support

This section of the interviews asked stakeholders to describe what are the key knowledge and information needs for the different types of adaptation-related decision-making processes. They were also asked to describe any use (or not) of models and provide suggestions for model improvement/requirements.

In terms of key methods and approaches to support decision-making, expert judgement, real options and risk minimisation were the three most commonly applied methods (Figure 11). Stakeholders also stated that they face a broad range of challenges in adapting to climate change. Importantly, the participants did not focus on information about climate change, but rather, the themes of the largest challenges were considered to be: political issues and the policy process; financial and economic issues; attitudes and capacity-building; and competing priorities (Figure 12). More explicitly, legislation and lack of authority, funding issues, changing established practice and competing priorities within the organisation were specifically noted.

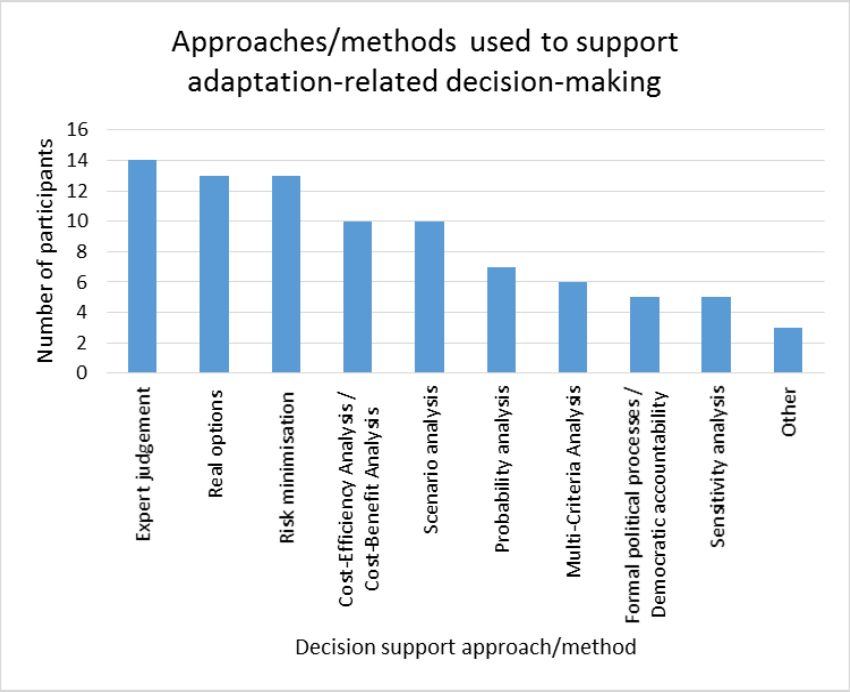

Figure 11: Adaptation-related decision-making methods.

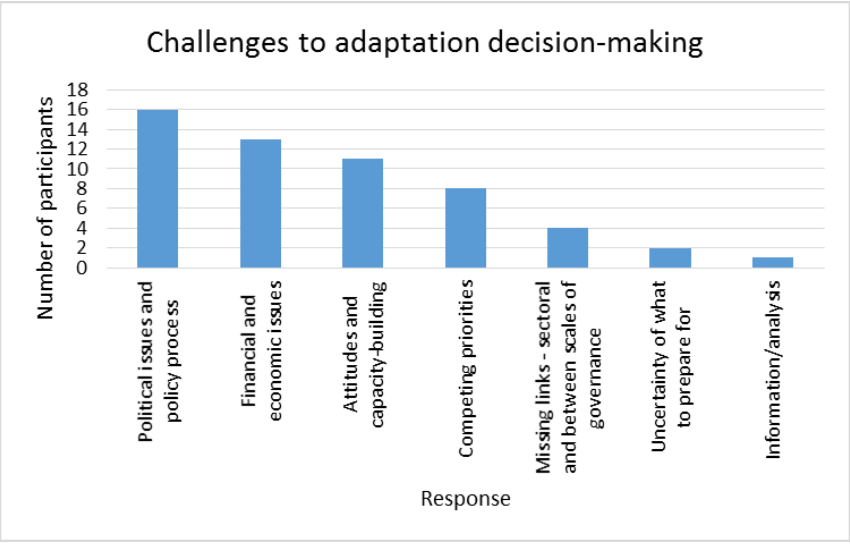

Figure 12: Perceived challenges to adaptation-related decision-making.

The types of information currently used by participants for decision-making are shown in Figure 13. All of the participants stated that they had used future climate change information in their decision-making (although to varying extents), while less than half of the participants stated that it had been successful in helping them make the decision. In terms of limitations of climate change information, key limitations centre on usability and issues of understanding (Figure 14).

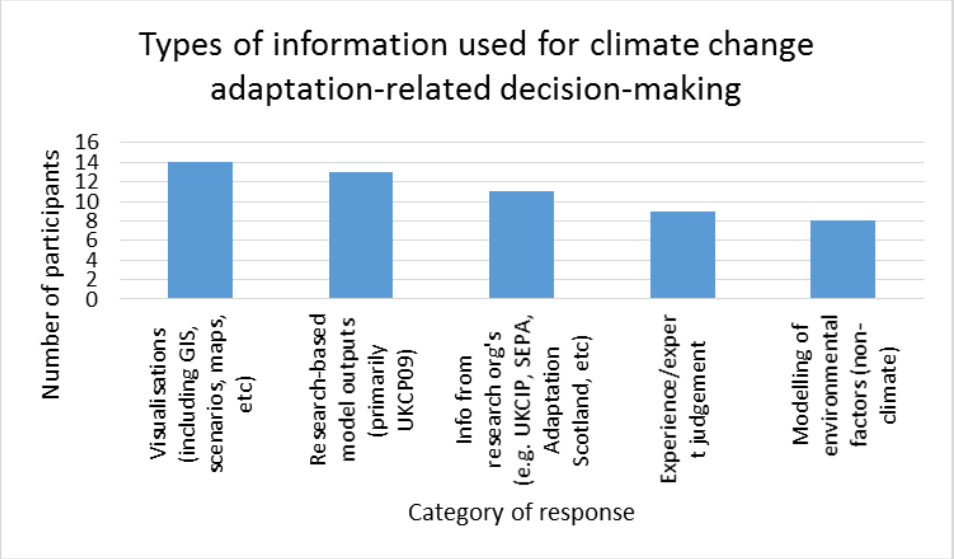

Figure 13: Types of climate change information used for decision-making.

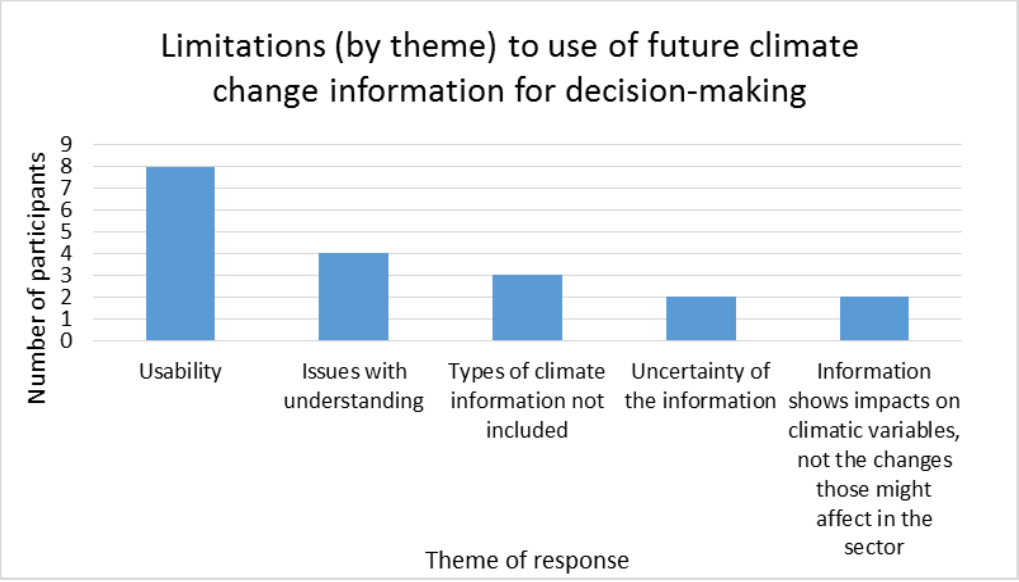

Figure 14: Limitations in climate change information.

In terms of HES, almost all stakeholders had previously received information on HES, but only half agreed that it had influenced their decision-making and only a few stated that their organisations considered HES. The information was most commonly received from Adaptation Scotland and UKCIP/UKCP09 (Figure 15).

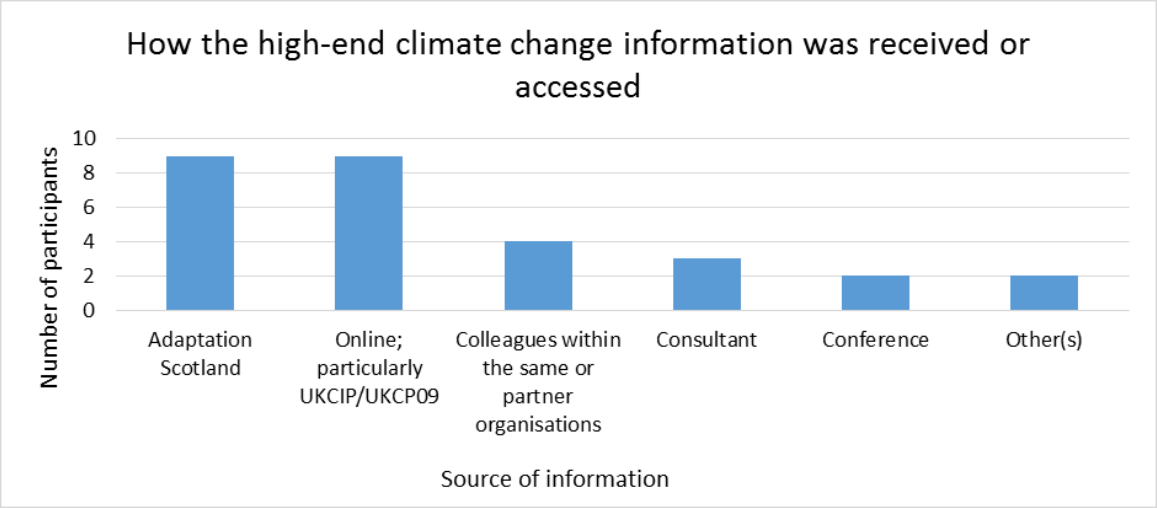

Figure 15: Sources of information on high-end scenarios.

The use of climate change models/model output was overwhelming and almost 100% of the interviewees noted that they use models. Those participants who were able to specify which model was used stated that it was climate model output from either the UKCIP website or UKCP09 directly. Some other (non-climate) models were also used by participants' organisations – e.g. tree growth models.

The majority of the interviewees stated that the temporal scales currently presented are useful enough for their decision-making. This is mostly because, although a lot of their decision-making is more near-term, when it comes to adapting to climate change, they are mostly considering general trends. Most participants stated that the spatial scale of the information needs to be tailored to the decision, keeping in mind the size of the organisation and its remit. This means that for many of the types of decisions that these participants are making, the existing spatial scales of the gridded future climate information were considered adequate, while for other more local-scale decisions, more local-scale information (e.g. at a local authority level) is desired. However this does not apply to the majority of decisions being made, and those who requested this level of detail also mentioned the inherent extra uncertainty when information is downscaled to this degree.

In terms of recommendation to the modellers, the interviewees specifically pointed to the need to ensure that the information is specific and appropriately tailored to the sector and/or decisions. There were also calls to consider portraying model outputs as visuals, i.e. less use of maps and more focus on visuals that allow people to picture themselves adapting. Lastly, there were also calls for a comprehensive decision-focused tool (not a climate-focused tool) that could support local scale mechanisms and integrate socio-economic changes including both direct and indirect impacts – focusing on society and the decision space rather than climate.

3.2.4. Decision outcomes

This section of the interviews asked the stakeholders to describe how each adaptation-related decision-making process is affected (or is perceived to be in the future) by: (i) uncertainty in climate and non-climate factors; (ii) high-end climate changes (>2°C); (iii) tipping points/critical limits; and (iv) the need for transformative actions.

Uncertainty is discussed within participants' organisations primarily in qualitative, descriptive terms (Figure 16). What is important is that uncertainty is not seen to be a significant barrier to taking action to adapt.

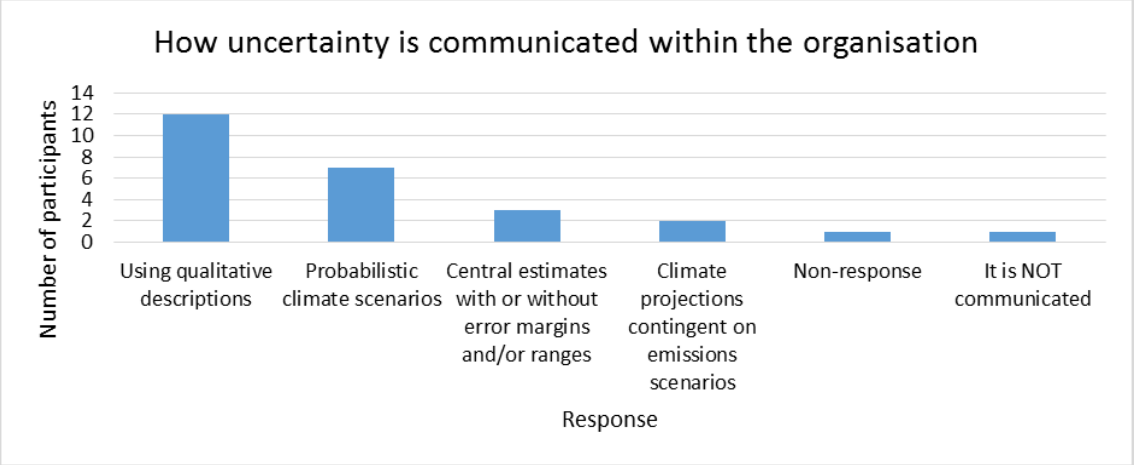

Figure 16: Communication of uncertainty.

Stakeholders all perceive that their adaptation-related decision-making process is/will be more greatly affected by non-climate (socio-economic) factors than by climate factors**.** The socio-economic factors considered the most important by each of the participants are shown in Table 2. The future changes to all of the socio-economic factors discussed are perceived to be highly uncertain because of how interrelated they all are.

Most participants stated that they cannot yet identify tipping points. Rather they only have an idea of the factors that will contribute to them. And lastly, in terms of incremental vs. transformative adaptation, only incremental adaptation actions are currently being pursued**.** However, some stakeholders are thinking of transformative changes that may be required in the not-too-distant future (e.g. moving a major road; building a new water treatment plant). However, most of the participants' organisations are waiting to see what happens first and are more willing to commit to smaller changes (e.g. over 5 year periods and that do not require large investment or the potential to incorrectly identify likely impacts and therefore commit to a course of action which turns out to be the incorrect one).

Table 2: Socio-economic factors important for adaptation-related decision-making.

Socio-economic sector	# of participants
Tourism	11
Health	10
Land-use change	10
Water resources	10
Governance regimes	9
Infrastructure	9
Invasive species	9
Technological developments	8
Communications	7
Food security	7
GDP growth	7

Socio-economic sector	# of participants
Agricultural productivity	6
Education and research	6
Environmental degradation	6
Income equality	6
Insurance	6
Population growth	6
Waste	6
Security	5
Trade	5
Transport and mobility	5
Air quality	4
GDP per capita	4
International organisations (EU, UN, WTO)	4
Migration	4
Private-public partnerships	4
Democratic decision-making	3
Gender equity	3
Transnational corporations	3
Access to sanitation	2
Business/finance	2
International relations	2
Corruption	1

3.3. Iberian case study

For the Iberian Case Study, 12 interviews were carried out in Portugal and 13 in Spain. The interview template for the Spanish Stakeholders was adapted to introduce concepts of institutional innovation, transformation and transitions taking into account the theoretical framework and the methodological approach taken by the Spanish case study partners (see Annex E). Thus, results for each country are presented separately. The interviews were carried out between December 2014 and October 2015; Portuguese stakeholders were interviewed by Tiago Capela Lourenço (FFCUL) and Maria João Cruz (FFCUL); Spanish stakeholders were interviewed by Francesc Cots (Sustainabilogy) and J. David Tàbara (Sustainabilogy).

3.3.1. Interviewees profiles – Portugal

The identification of stakeholders was developed in collaboration with a set of preliminary local contacts actively involved in a variety of climate change and water management cross-border cooperation programmes with the main goal of selecting a wide representation of institutional and sectoral interests in the region, as well as ensuring representation from different geographical scales (from national, to river basin to, local scales). This resulted in interviews that covered different economic sectors (Figure 17) and type of organisations (Figure 18).

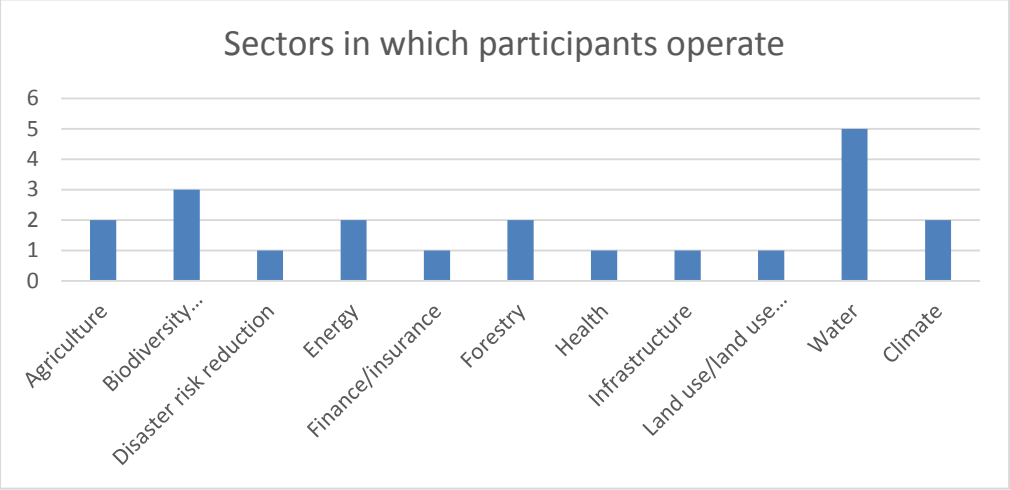

Figure 17: Main sectors across which participants' organisations operate.

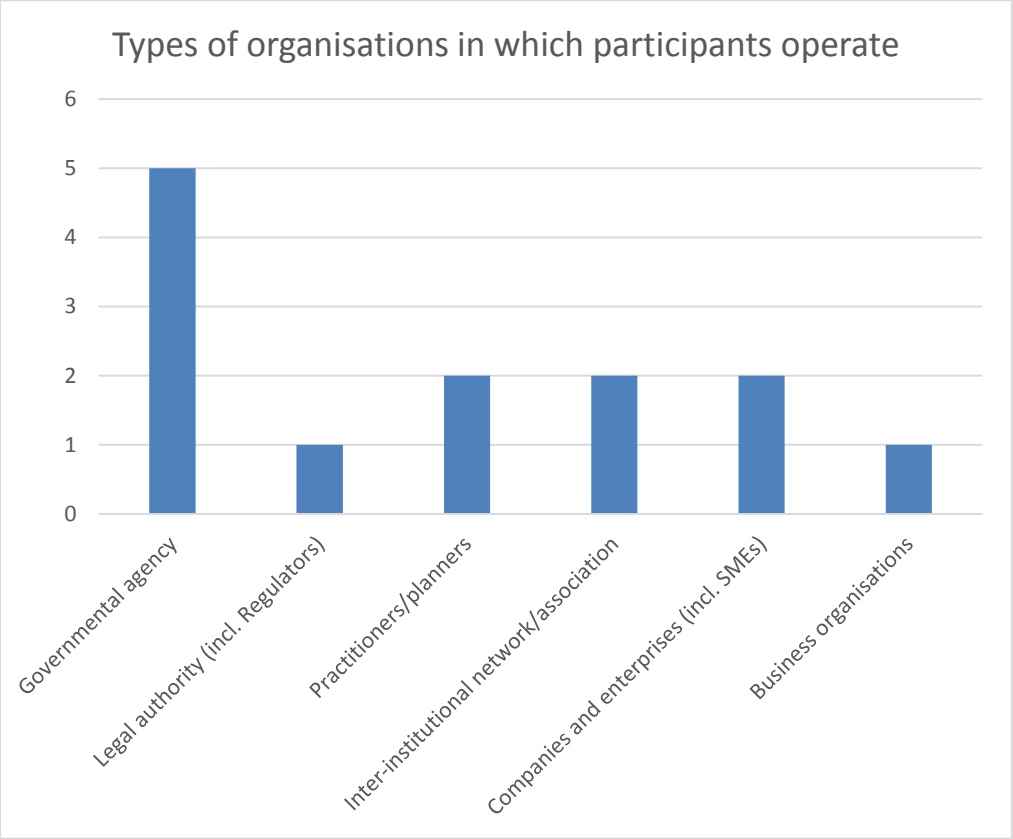

Figure 18: Types of organisations in which participants operate.

3.3.2. Decision objectives - Portugal

Adaptation to climate change is generally seen by decision-makers as an objective that needs to be integrated with other policy objectives.

Table 3 provides examples of adaptation-related decision-making processes reported by interviewees. As expected, the public institutions reported mainly on normative and strategic decision-making processes. The regulating organisations and private associations (e.g. association of

insurance companies) discussed not only their own decisions but also associated decision-making processes in general. Such processes were reported as being mainly strategic and operational in nature.

Table 3: Type of adaptation-related decisions in which the participants are involved.

Type of decisions	# of participants	Examples of adaptation-related decision processes
Normative	8	Preparing and supporting the implementation of specific policy and legislation, transposing EU policies (Nature Conservation Institute, Tagus River Basin Authority); Regulation of activities of water entities (Water Regulator Authority)
Strategic	9	Identifying (long-term) risks and opportunities to the company's business and assets and planning technological changes (e.g. replacing condensers at power plants with refrigeration towers that use less water although loose some water via evaporation) (Energy company); Discontinuing water uptake points (Agricultural association, Water utility)
Operational	10	Client management (Association of Insurers); Tariffs and prices (Agricultural association, Water utility, Association of Insurers); Decisions on how much water can be used by farmers based on availability information (Agricultural association)

Figure 19 shows the lifetime of the decision-making processes in which the participants are involved. Both lead and consequence time are quite variable. Public institutions are usually involved in decisions with a medium to long lead time and with long consequence times. Private enterprises and associations refer to shorter lead and consequence times, when talking about normative decisions. For example, the agricultural association reported that they mainly take operational decisions, such as limits for distributing water among farmers, within days or weeks; the association of Insurers referred to the fact that their insurance products can be short-term or medium-term (e.g. 1-2 years).

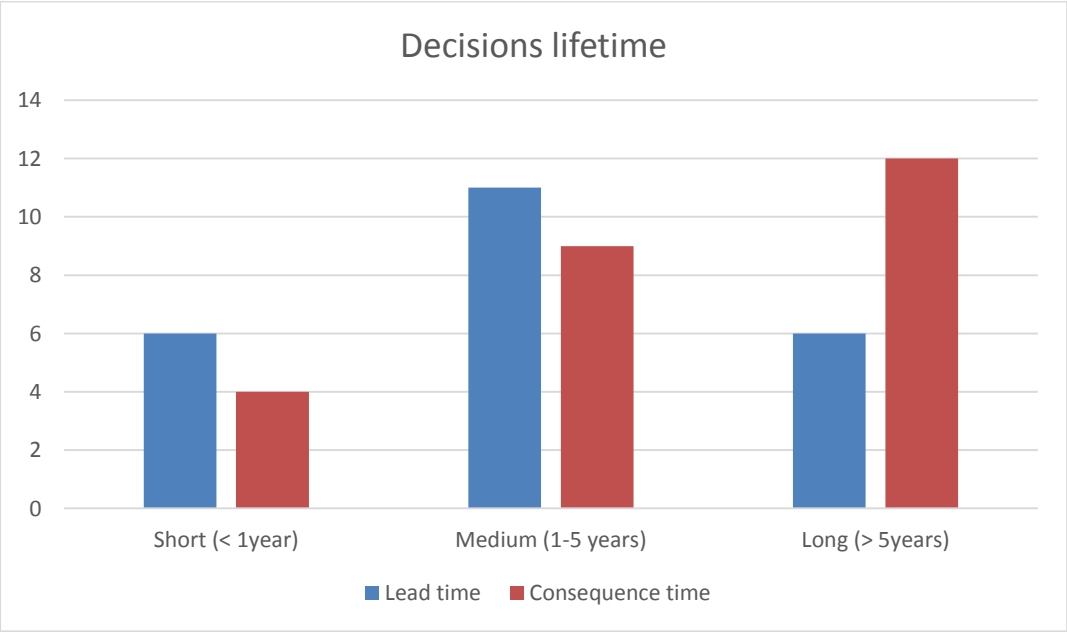

Figure 19: Lifetime of adaptation-related decisions in which the participants are involved.

On the other hand, most participants said that, when considering strategic decisions, consequence time may be extremely long (up to 50 years). For example, the Lisbon Municipal plan (PDM) has a consequence time of around 10 years; the Tagus River Basin Authority water plan measures are for the 2021-2027 time horizon; and the national desertification plan is created for a 20-year period. The water and electricity utilities reported longer consequence times as their actives usually last between 25 and 50 years.

3.3.3. Decision support systems – Portugal

This section of the interviews asked stakeholders to describe what are the key knowledge and information needs for the adaptation-related decision-making processes in which they are involved. They were also asked to describe any use (or not) of scenarios and models, as well as to provide details on the main limitations for using such information.

The use of future climate change information by interviewees is detailed in Figure 20. Most of the participants (58%) said that they do not use future climate change information in their decision-making in a systematic way nor impact models. However, there is usually some acknowledgment of climate change scenarios and their impacts when elaborating specific plans (e.g. Tagus water plan), but quantitative data is not used. The decision-makers that do not use climate change information acknowledge that it would be very useful to support their decision making processes. Representatives of companies that were interviewed stated that they have used both climate change scenarios and impact models. Within the public institutions interviewed, only one had used climate change scenarios in the elaboration of the National Adaptation Strategy. Most participants report the use of socio-economic trends, socio-economic projections or scenarios (Figure 20).

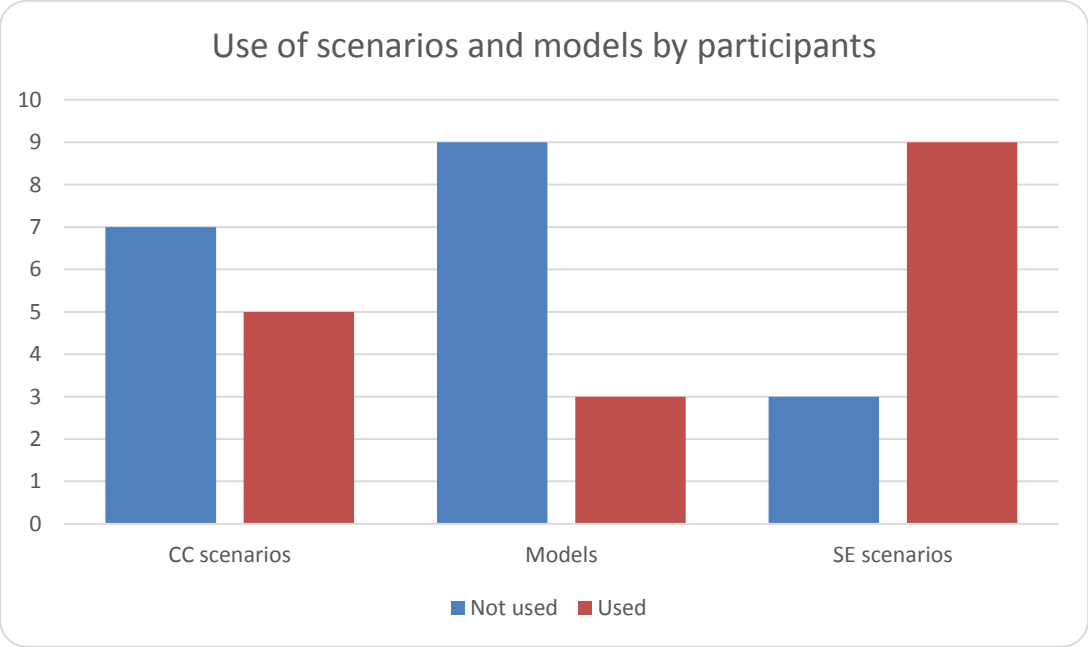

Figure 20: Use of climate change (CC) scenarios, impact models and socio-economic (SE) scenarios in the adaptation-related processes in which the participants are involved.

Table 4 presents the type of climate variables used and Figure 21 shows the most common sources of climate change information used, which are mainly products from national research projects and the IPCC reports. Table 5 presents the main socio-economic factors that are considered by participants in their decision-making.

Table 4: Participants' use of climate variables.

Climate variables	Temperature	3
	Precipitation	5
	Sea level rise	3
	River Discharge	3
	Water use	2
	Groundwater	1
	Lakes	2
Characteristics of climate variables	Changes in mean values	4
	Changes in extremes	7
	Variability of climate parameters	5

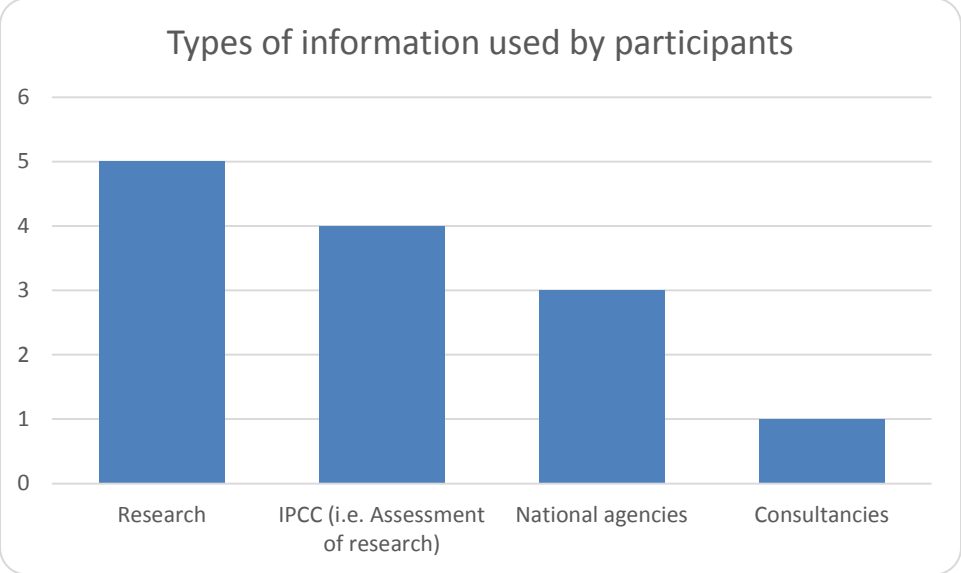

Figure 21: Sources of climate change information used by participants.

Table 5: Socio-economic factors considered important by participants in their decision-making.

Socio-economic factors	# of participants
Population growth	5
Energy	4
Infrastructure	3
Land-use change	3
Water resources	3
Agriculture	2
Energy prices	2
Environmental degradation	2
Health	2
Technological developments	2
Urban planning	2
Water use	2
Biofuel	1
Business/finance	1

Socio-economic factors	# of participants
GDP per capita	1
Income equality	1
Insurance	1
Invasive species	1
Migration	1
Security	1
Transport and mobility	1

Table 6 summarises the participants' perceived limitations when using future climate change information for decision-making. Most of the interviewees that do not use climate change information mention that the data they need is not available in a format that they can use (5 responses) or that they lack the knowledge or technological capacities to use such data (2 responses). Within those respondents that use climate change information, the fact that such information is not in an adequate format has also been refered to as the main limitation for it being used more broadly or effectively.

Table 6: Limitations presented by participants for using climate change information in their decision-making processes.

Theme of limitation	Perceived limitations to use of the future climate change information for decision-making	Participants not using CC information	Participants using CC information
Availability	Data is not available	1	
	Lack of projections on fire risk		1
	Not enough scenarios available		1
Usability	The information is not adequate – Projections wanted at shorter timescales	3	4
	The information is not adequate – Projections wanted at finer geographical scales (NUTS 2 or 3)	2	2
Understanding	Organisation lacks knowledge/ technological capacity to use this type of information	2	
Others	Not the role of the organisation	1	

Using climate change modelling to quantify impacts on indicators and thresholds related to the institutions policy objectives is something that is not usually done, as most institutions do not have the technical capacities for this. The water utility was the only institution that referred to having defined indicators and thresholds for water quantity and quality, having modelled how climate change would affect such indicators and thresholds, and having identified adaptation actions for implementation once some thresholds are reached. Other participants mentioned that they work with thresholds (e.g. from the Water Framework Directive) that will definitely be impacted by climate change but that they have no means of quantifying such impacts and thus refer to a "qualitative analysis" or "expert analysis" to judge if the adaptation measures that are planned will be sufficient to deal with potential impacts.

Regarding the question on how uncertainty is taken into account in the decision-making processes, most participants said that this is not considered to be an important issue. Since climate data and models are also not extensively used, most decision-makers look for robust measures that will lead to adaptation objectives regardless of the scenario. Thus, uncertainties are usually not explicitly

taken into account. Only two institutions using climate change scenarios and models, acknowledged that uncertainty is dealt with by using several scenarios.

Although five of the 12 participants have information about HES, no participants have used this information in their decision-making processes. The reasons for this are the lack of data for HES and the fact that the participants are mostly concerned with shorter time-scales (e.g. decisions with a consequence time below 10 years) where these HES are not very relevant.

3.3.4. Decision outcomes – Portugal

When asked about the potential implications of HES in the adaptation-related decision-making processes in which they are involved, several participants stated that they would not need to change the way they operate, but might need to start implementing adaptation options earlier (5 participants) or more effectively (3 participants) (Table 7). One participant refered to the eventual need to revise adaptation objectives. Only two participants mentioned implications that seem to imply some transformative thinking. Two participants stated that they are already doing what they can in terms of adaptation and therefore would not change their operations. The two participants that are coordinating the elaboration of the National Adaptation Strategy indicated that HES are not considered: "This is still far from being thought of in the present discussions. Tipping points and HES are still not considered. Sectors [involved in the National Adaptation Strategy] are focused on short-term issues and decision-making; scenarios for the end of the century to support current decisions may not be the most appropriate and are hard to cope with."

Table 7: Participants' views on the implications of HES in the decision-making processes in which they are involved.

Implications of HES	Number	Examples
Starting implementing options earlier	5	Nature Conservation Institute: "We would need to be more effective in implementing the measures faster. The planning is there, but the implementation phase is too long as they are not considered urgent."
Being more effective in the implementation of options	3	Tagus River Basin Authority: "We may need to be more serious about implementing some of the measures that have already been identifyed. Or we may need to consider more measures to reduce the impacts of droughts."
Designing new adaptation options	1	Insurers association: "We might need to change the risks we cover. Some areas may become good business oportunities for our sector; some risks may become too high to be covered."
Revise adaptation objectives	1	Tagus River Basin Authority: "We may need to change the objectives in our plans and directives considering that the reference conditions will also change, e.g. in the Water Framework Directive objectives."
Transformative thinking	1	Energy company: "Significant changes in technology use, decentralisation, recycling of water are all changes that may need to happen in HES. These are not necessarily 'transformative'".
No implications foreseen	2	Agricultural association: "Our association is already coping with extreme events, so, what we can do, we are already doing (e.g. saving water, increasing efficiency in distribution). Strategic thinking will need to change but we feel that there is little we can do as not much depends on us."
HES are not being considered, implications cannot yet be foreseen	2	Portuguese Environment Agency: "This is still far from being thought of in the present discussions. Tipping points and HES are still not considered."

Table 8: Participants' views on the need of transformative actions to deal with HES.

Is the need for transformative actions forseen?	Number	Examples/ quotes
Yes	1	Energy company: "Transformation (in objectives) going from utility (or energy solutions) to natural resource management."
No	11	Water utility: "No. The company is robust and can cope with severe climate change impacts. We would need to implement measures earlier, and probably more measures but not to use transformative options. Only disruptive or catastrophic events would "transform" the way we operate." Lisbon Municipality: "It will not be the decision-making process itself that will impede climate change adaptation but rather the level of spatial planning. So, we do not foresee changes in the way adaptation decisions are made and do not see the need for transformative actions."

The interviewed stakeholders that are involved in the existing Spanish Portuguese water governance mechanisms at the river basin level established under the framework of the Albufeira Convention believe that progress has been made in recent years, namely within the transboundary working groups. Those not directly involved in the process, are generally confident that the Portuguese institutional representatives are doing a good job representing national and regional interests: "The water regulator authority is not involved in the cross border agreement discussions. Some of the entities we work with are involved (e.g. Tagus River Basin Authority) and we trust that they are doing a good job."

However, several issues have been identified as limiting a more effective coordination. For example, the Portuguese Environment Agency refers to there being a " lack of information from the Spanish side on runoffs. We need to work on building a common base between the two countries, where we use the same data and scenarios. We do not know which scenarios they work with. All relevant sectors and stakeholders should be included in the discussions on transboundary water resources management."

Some concerns were also raised by agricultural associations - "We are concerned with the growing issues in water management in Spain (a lack of water in other areas is posing a threat to water availability in the Tagus). We are also concerned because Spain seems to be better informed about data/ trends and scenarios and are therefore more equiped to make negotiations" - and by the water regulator authority -"Our major concern is related with water quality - the agreement does not specify any minimum levels and this can pose a problem to us, so we would definitely benefit if there was more cooperation and information flow between the two countries."

3.3.5. Intervewees profiles - Spain

The identification of stakeholders was developed in collaboration with a set of preliminary local contacts actively involved in a variety of climate change and water management cross-border cooperation programmes with the main goal of selecting a wide representation of institutional and sectoral interests in the region, as well as ensuring representation from different geographical scales (of both Tagus and Guadiana river basins). This resulted in interviews that covered three economic sectors (**Figure 22**), local, regional and national administrative authorities, and transboundary institutions.

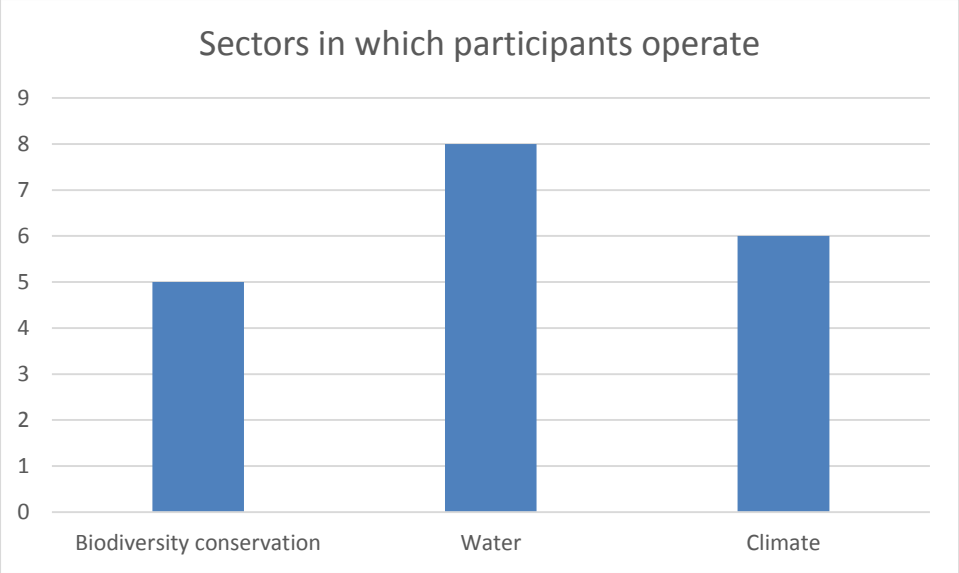

Figure 22: Main sectors across which participants' organisations operate.

3.3.6. Decision objectives - Spain

According to the information gathered from the interviews, a clear differentiation should be made between information and knowledge required for elaborating objectives for general policy programmes which specifically address climate change or land use planning, and those which are related to goals of other programmes or policies. Examples of the former are the Andalusia and Extremadura climate adaptation plans as well as the Tagus and Guadiana river basins hydrological plans. These programmes have been drafted using information from regionalised climate scenarios which were adapted from the previous IPCC assessment report (AR4). Therefore, the new RCP-based scenarios from AR5 have not influenced the setting of decision goals as they are in the process of being adapted and adopted to the new policy context.

Climate scenarios play a less relevant role in relation to other programmes and policies in which climate knowledge could have an impact, such as collaborative actions between cross-border organisations. In this case, the first step which is taken by the public authorities usually "has to do with the definition of adaptation objectives without previous analysis of climate models or similar tools", although the interviewees recognised that "it should not be this way". For instance, for the development of a cross-border strategy (Euroregion-Algarbe-Alentejo-Andalusia), "we did not take into account climate change scenarios since the main objective of the Strategy was to reach consensus and integrate existing regional policies in the three cross-border participating regions."

In relation to such programmes, there was also criticism about the role played by some of the financing agencies such as the European Regional Development Fund Managing Authorities, who have financed projects that have adopted adaptation objectives without first knowing the feasibility of achieving them in the long-term taking into account climate scenarios or other knowledge derived from climate-information tools. Some external consultants even pointed out that "scenarios are used by the politicians just to give an appearance they are doing the right thing, but they do not constitute an effective daily management decision tool".

In contrast, Hydrological Confederations officers working with the Tagus and Guadiana Hydrological Plans stated that "the adoption of adaptation objectives are based on assessments undertaken by CEDEX (Centro de Estudios y Experimentación de Obras Públicas) and the General Directorate of

Water of the Ministry of Environment, which take into account a regional interpretation of the IPCC reports to establish estimations of natural water contributions for the years 2027 and 2033." Finally, it should be noted that according to the draft of the Andalusian law on climate change, any plan or strategy adopted in Andalusia must consider climate scenarios, so there is at least a clear political will to mainstream the use of climate scenarios in decision-making processes in this region.

3.3.7. Decision support systems – Spain

In relation to the use of information instruments, some of the public actors interviewed have developed cost-benefit analysis but these are not directly related with potential responses to climate change. Another instrument that is often used is the constitution of Climate Change Observatories or Water Councils that integrate the participation of both experts and representatives of civil society (NGOs, irrigators, associations, trade unions, etc.), which is common in Extremadura and Andalusia (Climate Change Observatories) and in both the Tagus and Guadiana river basins (river basin water councils). In this regard, the genesis of the preparation of hydrological plans is similar in all Spanish basins. There is a Water Council for each river basin which includes participatants from NGOs, irrigators, competent authorities, users, etc. and a coordinating body which is only for competent authorities (i.e. public administrations).

On the other hand, there is a general perception that climate models need to be better adapted to local conditions. For instance, "even today these models are very general and in Spain there are many differences between basins and within each basin. For example, in the Tagus basin there are areas over 3000 metres and areas of just 300 metres that have very different climates. There are also localised rainfall variations and this causes precipitation estimations to have a high degree of uncertainty. We would be interested in having explanations more adapted to the local context".

The question of uncertainty was sometimes misunderstood by the interviewees, and some answered that they have certainty about the consequences of climate change. For instance, one respondent stated that "we do not have sufficient knowledge yet to exclude the realisation of certain investments due to existing climate uncertainty".

3.3.8. Decision outcomes - Spain

The interviewed stakeholders recognised that, despite its deficits, the existing Spanish-Portuguese water governance mechanisms at the river basin level established under the framework of the Albufeira Convention and promoted by the EU Water Framework Directive are functional. Progress is being made with regard to coordinating planning on both sides of the basin. Both countries are preparing written documents that establish joint commitments that each party has to incorporate in their respective Hydrological Plans. Both countries have agreed upon values of minimum water resources to provide weekly, monthly, etc. which must be respected except under exceptional conditions. There is also very effective cooperation with regard to the establishment of floods or extreme events forecasting and warning systems.

Furthermore, according to the interviewed stakeholders, Hydrographic Confederations are very unique organisations that have a high degree of representativeness in the institutional system and very well established competencies and powers. This includes the participation of environmental NGOs among others. However, there is a higher percentage of representation from public administrations (public enterprises, municipalities, etc.) which favours the adoption of agreements at the level of competent authorities. Nevertheless, there is also a general perception that the participation of central governmental authorities is too predominant and that participation of regional authorities, experts and environmental organisations should be enhanced and improved.

For example, “there are communication problems between nation states and regional entities. States seem to put obstacles to the participation of regional entities in water cross-border management bodies.”

Other actors believe that the cooperation mechanisms are correct, but criticise the goals and objectives pursued by the actors in charge of river basin management. For instance, the representative of an environmental organisation pointed out that “there are mechanisms that have been working for years and the mutual consultation in the development of water management plans is inevitable. However, what is needed is to change the objectives of these mechanisms so that water is not seen only as an economic resource but also takes into account the impacts on ecosystems as established in the Water Framework Directive. That is happening only in the realm of good intentions”.

On the other hand, cooperation at other levels such as climate change, nature protection and agriculture remains elusive. According to a Hydrographic Confederation official, “eventually water issues are interconnected with other topics such as nature protection, agriculture, etc which are mainly the responsibility of Spanish Autonomous Communities and Portuguese and Spanish central governments. It is quite difficult that information flows and decisions and commitments are taken in a coordinated fashion by all these organisations.” In this light, many actors have pointed out that in order to achieve real transformation “we should enhance joint cross-border planning between Spanish and Portuguese regions with regard to water management, biodiversity, climate change issues, etc”.

Also the interviewed stakeholders share the idea that the scope of the Euroregions AAA (Alentejo (PT)-Algarve(PT)-Andalucia(ES)) and EUROACE (Alentejo, Centre (PT) and the Extremaduran (ES)) would be appropriate to address such cooperation issues connected to water, but not falling under the scope of the Water Framework Directive. For example, “the Euroregion is the ideal institutional framework to promote initiatives and projects that fulfill those requirements. The secretariat of the Euroregion should play a stronger role in this regard as an impartial agency and the institutional and political capacities of the Euroregion should be enhanced”. However, some actors highlighted the lack of resources of these operational units in terms of capacity, time and the dedication needed to tackle the multiple difficulties associated with cross-border integration. Yet, since 2003 the number of environmentally related projects managed by the Euroregion AAA operational unit has grown exponentially and they have increased the number of specialised staff.

Some stakeholders also recognised the network facilitator role of the EUROACE operational unit, arguing that “EUROACE staff work is essential since they participate in all cross-border cooperation project meetings, boosting cross-border relationships, convening meetings, acting as an intermediary between public administrations and private actors when conflicts appear, etc”. According to several governmental officials “Cooperation between Spanish and Portuguese officials in the environmental area in the framework of the Euroregion EUROACE is very fluent. They cooperate in multiple European projects and have created long-term relationships based on trust.” This is supported by the relevance and impact of the cross-border cooperation projects implemented in this field, such as the creation of the Tagus International Park. There are also specific climate change cross-border cooperation projects, such as ALTERCEXA and PROMOENER. Consulted stakeholders value in a significant way the work done by this operational unit as key in promoting environmental cooperation in the area.

3.4. Hungarian case study

The Hungarian case study focuses on two local communities, Szekszárd and Veszprém, aiming to test the ability of existing overall and sectoral development strategies and adaptation plans to reduce vulnerability to climate change and increase resilience at the local level. Veszprém is a town with county rights[6] located about 100km south-west of Budapest in the Central-Transdanubian Region. Szekszárd is also a town with county rights located about 150km south of Budapest in the Southern-Transdanubian Region.

In terms of climate adaptation, the peculiarity of Szekszárd and Veszprém is that they are two out of the 27 settlements[7] that joined the Alliance of Climate Friendly Municipalities and thus committed to institutionalise climate change adaptation. Within the IMPRESSIONS project, the following priority issues of interest for vulnerability and adaptation research were indentified for Veszprém and Szekszárd: (i) sustainable water management and conservation of water resources, (i) sustainable food supplies and shorter supply chains, (iii) renewable energy, and (iv) health promotion.

The interview template was adapted for the Hungarian case study by reducing the overall emphasis on adaptation to enable the involvement of interviewees from a broad variety of backgrounds who did not necessarily have an explicit climate focus in their work. This allowed a number of adaptation related decisions, not labelled as such, to emerge during the discussions.

Some specific questions, such as the one on climate change information, were not directly asked, though answers could be concluded from the discussions. The question on socio-economic factors was simplified as interviewees could not relate to the original form; the interviewees were asked only to list those non-climatic factors that they considered the most important in terms of future climate change adaptation. All interviews concluded with a question on the interviewees' long-term vision for their region. In total 12 interviews were carried out by Linda Juhász-Horváth (CEU).

3.4.1. Interviewees profiles

The indentification of stakeholders for the interviews was carried out with the help of IMPRESSIONS sub-contracting project partners in Szekszárd and Veszprém. The aim was to interview both decision-makers of the local municipalities and key change agents from the business sector and civil society.

Figures 23 and 24 show the main sectors and type of organisations represented by the participants who were interviewed. Figure 25 shows that most participants operate at the local or municipal scale. It is important to note that in the two local governments, we interviewed mostly high level decision-makers, who, by nature of their position, often operate across sectors summed up under 'public administration'.

[6] There are 23 towns with county rights in Hungary.
[7] There are 3154 settlements in total in Hungary.

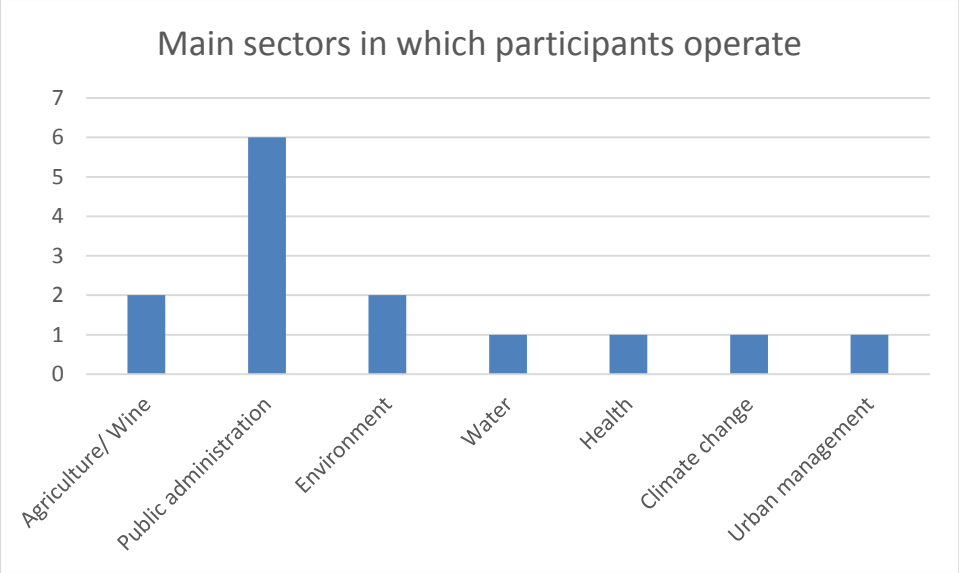

Figure 23: Main sectors in which participants operate.

Figure 24: Types of organisations in which participants operate.

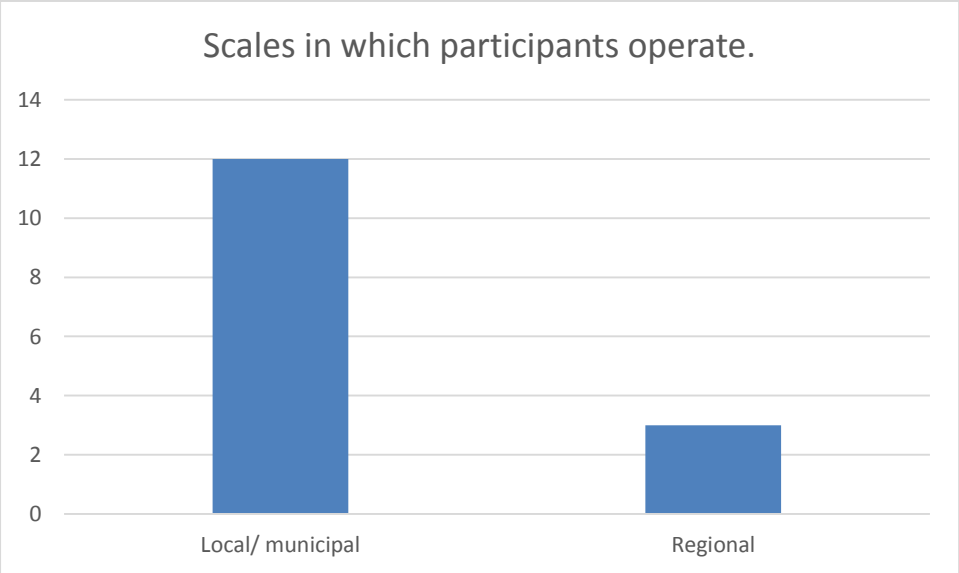

Figure 25: Scales at which participants operate.

3.4.2. Decision objectives

Most of the decision-makers interviewed reported operational and strategic roles within their organisations. Some higher level decision-makers, such as the Mayor or Deputy Mayor, are of course also involved in normative decisions. Representatives of local governments operate within the given administrative framework that defines the decision-making processes. At the municipal level, individual decision-making competence is limited. However, all participants reported a key role in preparing and coordinating decisions to be adopted by the general assembly or various technical committees. Table 9 shows the type of decisions in which interviewees are involved and some examples.

Table 9: Type of decisions in which participants are involved.

Type of decisions	# of participants	Examples
Normative	5	- Development of the Integrated Urban Development Strategy
Operational	12	- Controlling monitoring wells - Retrofitting public buildings - Installing LED lightings - Improving transport network
Strategic	11	- Switching to renewable energy sources - Building water reservoirs - Building drainage systems - Developing a climate strategy for the city

Given the local aspect of the case study and the multi-sectoral background of interviewees, the time horizon of decisions also varies widely. From simple administrative decisions to long-term strategic commitments, they cover the full range both in the public and private sectors (Figure 26). The development of a climate change adaptation strategy was given as an example of a decision with a long consequence time.

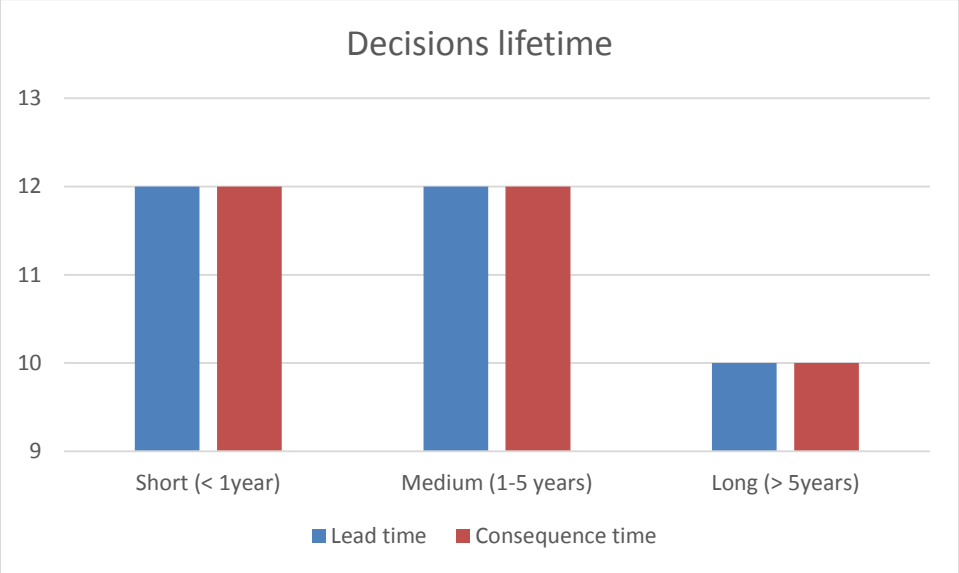

Figure 26: Lifetime of adaptation-related decisions in which participants are involved.

3.4.3. Decision support

While the civil society sector builds on bottom-up strategies and in the Hungarian context government agencies tend to favour a top-down approach, interviewees from local governments of both Szekszárd and Veszprém reported a strong reliance on stakeholders in their decision-making processes. Besides building on local experts, stakeholder involvement was identified as the second most important decision support tool by the majority of the participants.

In contrast, none of the interviewees reported the use of scenarios or models. The only modelling activity was mentioned by the CEO of Bakonykarszt Waterworks Ltd. who described the hydraulic model they use to determine water extraction or groundwater protection zones.

Global reports, such as the IPCC, are also rarely used by interviewees in their decision-making, who depend instead on the use of local expertise and knowledge. They also make use of some national analyses and reports, but rarely consult international sources for information, unless they are explicitly looking for good practices on a specific theme. The reasons for this may be limited capacity and lack of staff with adequate language skills, and the limited direct relevance of international documents at the local scale.

In terms of climate information, given the frequency and intensity of extreme weather events in both communities in the past years, decision-makers show a growing interest in some of the key related indicator trends, such as temperature, precipitation, water use, soil quality and erosion, air quality, wind or evaporation. In fact, the Head of the Economic and Financial Council of Szekszárd has been an amateur meteorologist for over 30 years who records daily climate data and uses his observations in his decision-making.

The question on socio-economic factors considered important in future climate adaptation-related decision-making generated significant interest. Some basic but very important factors came to light which resonate with the topics of the case study, but also show what factors will be key for adaptation (Table 10).

Table 10: Socio-economic factors considered important by participants in future climate adaptation-related decision-making.

Socio-economic factors	# of participants
Infrastructure	4
Agricultural productivity	3
Communication/Marketing	3
Land-use change	3
Transport and mobility	3
Business/finance	2
Environmental degradation	2
Health	2
Water resources	2
Democratic decision-making	1
Education and research	1
Food security	1
Governance regimes	1
Invasive species	1
Tourism	1
Waste	1

Socio-economic factors	# of participants
Other (not included in original template but mentioned by interviewees): - Population shrinkage - Awareness raising - Funding opportunities/Subsidies - Regulatory framework - Economic lobby - Lack of systems thinking - Unwise use of fossil fuels - Continuous desire for economic growth - Pesticide use - Political will - Consumption patterns - Technological discipline - Local wisdom and self-provisioning - Bureaucracy/public administration	

The regulatory and institutional framework was raised by the majority of participants as a current and potential future barrier to adaptation. Other key factors were mainstream economic policy, funding mechanisms, communication and education, and also abstract elements, such as local knowledge and systems thinking.

3.4.4. Decision outcomes

In terms of the outcomes, most participants have given examples of both incremental and transformative decisions (Table 11); the former triggering changes on the surface, while the latter generating changes at deeper systems levels. A major transformative step for both communities was joining the Alliance of Climate Friendly Municipalities in Hungary which triggered the institutionalisation of climate adaptation. Through their membership, both communities committed to developing a long-term climate strategy which became a reference point for all their development plans and policies.

Table 11: Examples of incremental and transformative adaptation-related decisions.

Decision outcomes	Examples
Incremental	- Building a special drainage system - Providing drinking water in public institutions during heat stress events - Development of a transport hub - Environmental rehabilitation of a river valley - Organisation of public consultations - Development of cycling road network - Infrastructural developments, such as solar, insulation, LED lightings - Organising a farmers' market, - Organising tree planting actions - Greening the urban environment - Organising composting and recycling programmes
Transformative	- Planting drought-resistant grapes - Land conversion from forest to viticulture - Reforming primary health care services - Banning GMOs - Building solar and wind farms - Developing a long-term climate strategy for the city - Switching to renewables - Joining the Alliance of Climate-Friendly Municipalities

Most of the interviewees reported that they monitor and evaluate the outcomes of their decisions, either through very strict processes prescribed by specific regulations (e.g. frequent monitoring of indicators and progress reporting), or more loosely if the nature of the project allows it (e.g. carrying out a survey or assessing the number of people who attended an event).

Besides monitoring efficiency, success or failure can also be a way to assess the outcomes of a decision. Almost unanimously, all interviewees said that they consider a decision successful when its result is functional, it is integrated in the urban system and people use and appreciate it.

4. Comparative analysis and conclusions

As discussed in Section 2 of this report, the aims and scope of the case studies is quite variable and therefore the interview template was adapted to accommodate the specifities and needs of each case study. Hence, there are significant divergences in terms of questions posed, types of interviewees and the institutions they represent, the sectors in which the participants operate, etc., which make generalisations across case studies challenging. Nonetheless, we believe that some general comparisons between the case studies can be informative and these are presented in this section.

Figure 27 shows the variety of sectors in which all the stakeholders operate. It shows that the sectors of biodiversity and ecosystems, agriculture, land use and water were the most common across all four case studies (Portugal and Spain reported separately).

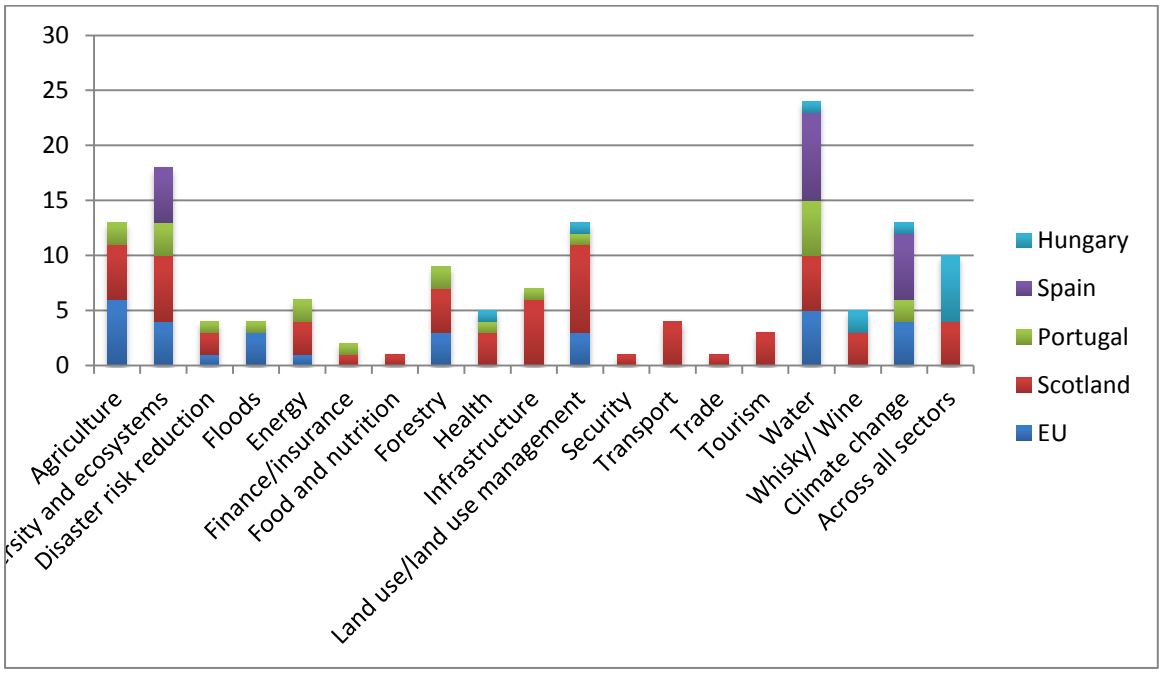

Figure 27: Sectors in which the stakeholders operate.

4.1. Decision objectives

The decision objectives for each case study are obviously highly case-specific. Hence, no cross-comparison is made.

4.2. Decision support

Use of climate change scenarios and models varied greatly between the case studies (Table 12). At one extreme, all Scottish case study participants reported using climate change scenarios and all but one use models (of the impacts of climate change). At the other extreme, only one of the Hungarian participants uses either scenarios or models. The only modelling activity that was mentioned was from a CEO of a local Waterworks company, who described the hydraulic model they use to determine water extraction or groundwater protection zones. What is notable in Hungary is that besides engaging local experts, stakeholder involvement was identified as the second most important decision support tool by the majority of the participants interviewed. For the European

case study, although model based information on climate change (especially on impacts) is not very prominent in EU level decision-making, there are already several model-based indicators that are being used for policy support and these should be checked by the modellers in IMPRESSIONS to ensure consistency. At the EU level, climate change was mentioned as an emerging problem, but one that is not ranked highest for any of the policies analysed. However, this is now starting to change.

Table 12. Use of climate change scenarios and models.

	Use of CC info or scenarios		Use of models	
	Yes	No	Yes	No
Europe	8	6	n.a.[8]	n.a.
Scotland	20	0	19	0
Portugal	5	7	3	9
Hungary	0	11	1	10

A lack of use of climate change information for decision-making was frequently related to the usability of the data that is currently available (Table 13). In particular, temporal and spatial scale issues were identified by many stakeholders both at the EU level and at the local level (Scottish and Iberian case studies). For Iberia, climate change information, in general, and quantitative model-based information, in particular, is not commonly applied directly in the decision-making process, although it is acknowledged as important and often discussed and assessed technically. The exceptions were the water and energy utilities and the insurance company. For Scotland, all of the participants said that they had used future climate change information in their decision-making (although to varying extents), while less than half of the participants stated that it had been successful in helping them make the decision. In the European case study, the lack of use of climate change information for EU level decision-making is related to a scale issue. Because policy implementation and monitoring is done at the Member State level, the EU mainly compiles and uses the Member State reporting obligations as sources of information.

Table 13: Use of climate change information.

	Types of issues/ limitations to the use of CC information				
	Availability	Usability & data format	Understanding	Uncertainty	Others
EU	2	2			
Scotland	3	11	4	2	1
Portugal	3	11	2		1
Hungary	-	-	-	-	-

In order to increase the usability of climate change information, several interviewees called for a comprehensive decision-focused tool, which not only includes a climate component, but that can also support local scale mechanisms and integrate socio-economic changes including both direct and indirect impacts. It was also noted that there is a need to ensure that the information is specific and appropriately tailored to the sector and/or decisions. Decision-makers that did not use climate change information acknowledged that better tools would be very useful to support their decision-making processes.

In terms of HES, there are considerable differences across the case studies (Table 14). In Scotland, almost all stakeholders had previously received information on HES, but only a few stated that their

[8] Question was framed differently in the EU case study.

organisations considered HES. For Europe, the discussion was mainly around not exceeding 2°C above pre-industrial levels. Information on future unacceptable changes due to climate change (HES or otherwise) is not readily available and usually not treated via model-based information. One reason for this is that EU policies are short-term, with several only having 6-year cycles before being revised. On the one hand, this does not give much space for long-term strategies. On the other hand, it provides the scope to include climate change considerations with relatively short notice. In Hungary, HES were not considered at all and in Iberia, HES have not usually been considered in the decision-making processes, since shorter time-scales still prevail (e.g. most deal with decisions with a consequence time below 10 years).

Table 14: Information on high-end scenarios.

	Received information on HES		Use of HES	
	Yes	No	Yes	No
EU	-	-	6	4
Scotland	19	0	5	12
Portugal	6	6	0	12
Hungary[9]	n.a.	n.a.	n.a.	n.a.

Finally, an interesting finding across all case studies was that uncertainty is not a very relevant factor regarding decision-making. While it was acknowledged in every case study, it was widely noted that it is not a reason for non-action. For example, for Europe and Iberia (PT), uncertainty in model outputs is not a very relevant factor for decision-making although its importance is acknowledged and often discussed at the technical level. The current approach in Portugal to adaptation seems to favour robustness and the precautionary principle thus reducing the need for very formal uncertainty-management approaches. The use of multiple scenarios is referred to by institutions using climate change (model) information directly in the decision-making process. Uncertainty in the sensitivity of indicators and cascading uncertainties from global to local scales was mentioned as areas that require further research.

4.3. Decision outcomes

One interesting finding across all case studies is that stakeholders all perceive that their adaptation-related decision-making process is or will be more greatly affected by non-climate (socio-economic) factors than by climate factors. Figure 28 shows the aggregated responses of the most important socio-economic factors relevant for their adaptation-related decision-making. It shows that water resources, land-use change, infrastructure, transport, health and energy are those with potentially the highest influence.

It should be underlined that these factors are in general contingent on the sectors under consideration for each of the case studies, but in all sectors studied here it still holds that stakeholders perceive non-climate factors as highly important for future vulnerabilities.

[9] No questions relating to HES were asked to Hungarian stakeholders

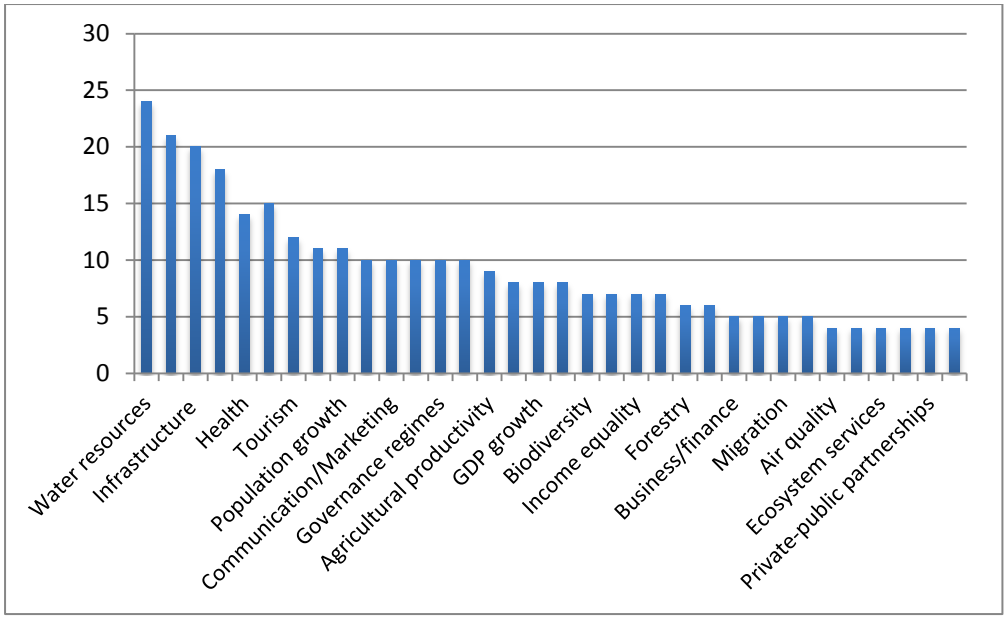

Figure 28: Socio-economic factors important for adaptation-related decision-making across the four case studies.

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Annex A – Information brief

Information brief

Assessment of current climate change adaptation-related decision-making

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Background

The aim of IMPRESSIONS is – in the context of climate change – to provide empirically-grounded science that quantifies and explains the consequences of 'high-end scenarios' for society at large and in particular for decision-makers.

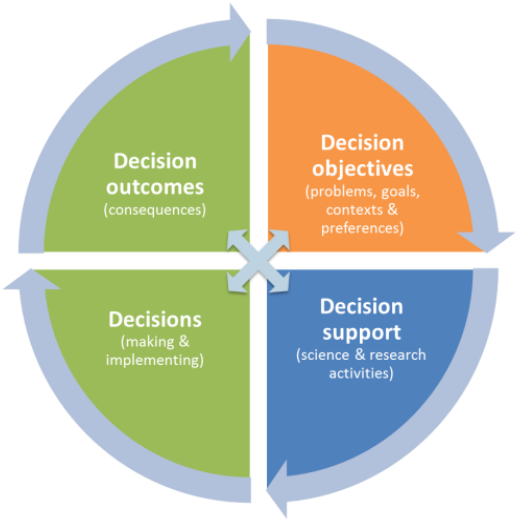
Work package 1 (WP1) entitled 'Innovative and effective decision-making under uncertainty' deals with the identification of the critical needs and capacities of European decision-makers for considering high-end scenarios and their associated uncertainties, in the development of adaptation policy and practice. One of the tasks in WP1, Task 1.2, will conduct empirical research in the five case studies and assess actual decision-making processes and information needs. The main goals of this task are twofold. On one hand it seeks *to improve the understanding of how adaptation-related decision-making processes occur in reality*, while on the other it intends to use assembled knowledge *to enhance the representation of adaptation processes (i.e. decisions and their outcomes) in the suite of models being developed and applied in IMPRESSIONS.*

This document describes this empirical work. Since the work in Task 1.2 is a joint effort between WP1 and the case study (CS) leaders (task leader: SEI, contributors: FFCUL, UEDIN, PROSPEX, JDTàbara, CEU, PLUS), this document aims to describe the work within task 1.2 that is to be done within each of the five case studies.

Analytical framework

In order to provide a generic baseline for the interviews, a Common Frame of Reference (CFR) will be applied (see Figure A1). For analytical purposes, when assessing the empirical findings from the interviews, the CFR will aim towards integration with the WP3 conceptual and modelling frameworks.

Figure A1: Common Framework of Reference (Source: Capela Lourenço *et al.* 2014).



This framework comprises a cycle of four inter-connected and complementary dimensions that we will use to structure and design an interview template:

Decision-Objectives: The entry point to a climate change adaptation-related decision-making process is often connected with the definition of its objectives and the context in which they exist, i.e. (i) normative; (II) strategic; and (iii) operative. This Decision-Objectives dimension relates to the adaptation problem, as well as to the goals, objectives, values and preferences of the decision-maker and those of the relevant stakeholders.

Decision-Support: The Decision-Support dimension refers to the set of science, research or other types of activities (like consultancy or policy advice) designed and carried out to support the decision-makers and the problems being considered. In the context of climate change, the relevant information needs can be divided into climate-related information (e.g. climate scenarios) and 'non-climate' information, which gathers other factors of relevance for adaptation-related decision-making. A key issue here is how uncertainty is treated and the use (or not) of models that could aid decision-making by quantitatively analysing possible impacts and adaptation strategies. Finally, Decision-Support can generally be approached from two ways. First, a top-down approach is based on the simulation of climate scenarios (downscaled or not to a regional level) that are fed into biophysical models to estimate potential impacts, which leads to a decision. Second, a bottom-up approach that identifies processes affecting vulnerability and adaptive capacity, normally independent of any specific future climate scenario, assesses a range of adaptation options and finally makes a decision based on the expected behaviour of those options against different climate projections.

Decision-Making and outcomes: Aspects of decision-making that distinguish climate change from most other contexts are the long-time scales involved, the pervasive impacts and resulting risks, and the 'deep' uncertainties attached to many of those risks. These uncertainties include not only future climate but also socio-economic change and potential changes in norms and values within and across generations. Adaptation-related decisions are usually made in relation to the original problem and objectives, after enough evidence or knowledge has been provided to support an informed action by a decision-maker. The outcomes of an adaptation decision are difficult to assess and evaluate since some time has to pass (shorter for climate variability and longer for climate change) until the consequences of the decision are visible and can be evaluated. The monitoring and evaluation (M&E) of adaptation decisions and options has gained recent attention, as more and more decisions need to integrate climate change adaptation aspects.

Annex B – European case study: Interview template

European Case Study - Interview Template

Common Agricultural Policy (CAP)[10]

There is a widespread agreement that the increase in global mean temperature by the end of the century should stay below 2°C to avoid severe impacts. However, projections based on current emission trends point to much more substantial warming, with possible increases of 4°C or more unless there is radical action to cut emissions.

The IMPRESSIONS project aims to advance understanding of the implications of high-end climate change scenarios (involving temperature increases above 2°C) while helping decision-makers apply such knowledge.

Basic information

Name and affiliation of interviewer:

Name, affiliation and title of interviewee:

Date and place of interview:

Additional information:

A. Characterisation of the decision-maker and the decision-making context

This first section is designed to provide background information about you and your organisation and the type of adaptation-related decisions that you face within the context of your organisation.

Q1. Can you tell me about your role and level of responsibilities in the decision-making processes of your organisation?

- What are the main sector(s) you and your organization operate in?
- What is your degree of influence in the decision-making processes?

B. Decision-making objectives

This section asks questions about the policy goals of the CAP process and eventual links with climate adaptation decision-making, within your organisation. I am interested in hearing about the problem, goals and preferences that motivate you as a decision-maker, as well as about the stakeholders affected by this process. In this section I want you to highlight the principles currently guiding decision-making processes and eventual experiences involving climate change adaptation.

[10] This is an example; for each of the policies/directives/strategies, this was changed accordingly.

Q2. What are the key policy visions and/or goals involved in the work you and your organisation typically make, support or advise in relation to the CAP?

- How would you describe them generically?
- What kind of information do you use to help you with these visions/goals?

Q3. Have these vision/goals been previously connected with climate change (adaptation or mitigation) challenges?

- How would you generically describe these connections?
- Have high-end scenarios (climate or non-climate) ever been considered and have they influenced your decision-making processes?
- If not, why not?

C. Decision support

In this section I will ask you questions about decision support. I want you to highlight how CAP related policy goals are being supported – for example, through scientific and other activities, such as provision of data, consultancy and policy advice. I would also like to know what kind of climate and non-climate information is being used to inform decision-making within the context of your organisation.

Q4. Have your CAP policy area goals been previously supported by model-based indicators?

- If so, can you provide examples of such indicators?
- Do you find the currently available indicators useful for policy support in this area?
- Would you consider these indicators to be sensitive under high-end scenarios?
- Could you please comment on how uncertainty regarding future climate change and socio-economic factors is taken into account in your policy development work?

Q5. Can quantifiable thresholds be defined for each of the key CAP policy goals?

- Do you think they would they change under high-end climate scenarios? If so, what would be the direction of change?
- Are there any levels of change in this indicators that are currently (or foreseen to be) considered as 'unacceptable'?
- Can those thresholds be captured with current model information?
- Do you have any recommendations to the modellers?

Q6. Have you used future climate change information in CAP related decision-making?

- Please comment on the most frequently used sources of climate information, monitoring and assessment tools, supporting decision-making processes in your organization (e.g. research, IPCC, national agencies, consultancies, other)?
- Did you find limitations in the climate change information?
- If you haven't used it, why not? What made you decide not to use it?

D. Decision-making and outcomes

Adaptation-related decision-making is different from most other decision-making contexts because of the long-time scales involved, the pervasive impacts and resulting risks, and the 'deep' uncertainties attached to many of those risks. Moreover, the outcomes are difficult to assess and evaluate since it is necessary to wait until the consequences of each decision are visible and can be

evaluated. This section asks questions about how you are assessing and prioritising climate adaptation challenges in CAP related decision-making processes.

Q7. Taking into account the possibility for global warming to exceed a 2°C threshold, what implications do you foresee in terms of the currently proposed CAP policy goals?

- Do you believe the EU would consider changing such goals because (in spite) of high-end scenarios?
- What would the key responses be to maintain the set of goals/visions or to reach new goals/visions?

Q8. What other EU policy sectors and respective policy goals would you consider as being critically relevant to the currently proposed CAP policy goals (and vice-versa)?

- Are you aware if those other EU policy sectors define (and quantify) critical climate-related thresholds in their policy goals?
- Are you aware if these other sectors are currently considering high-end scenarios?
- Can you point out which EU agencies are responsible for setting such goals and/or thresholds?
- Can you tell us a little more about if (and how) climate-related systemic effects across multiple EU sectors are being managed? Are you aware if such processes are considering high-end scenarios?

Wrap-up and next steps

Q9. Is there anything else you think is important which we have not yet touched upon?

Thank you so much for your time and your valuable contribution!

Annex C – Scottish case study: Interview template

Scottish case study - Interview Template

Basic information

Name and affiliation of interviewer:

Name, affiliation and title of interviewee:

Date and place of interview:

Additional information:

The interview consists of 4 sections. Before each section I will read you a sentence or two that describe the types of questions to be asked. Each section contains multiple questions about climate change adaptation decision-making. I may also ask some follow-up questions, depending on your responses. After the first 4 questions, I'll show you an information brief and ask you to read over it. Then we'll continue with the rest of the interview. Does that sound ok?

A. Characterisation of the decision-maker and the decision-making context

This first section is designed to provide background information about you and your organisation and the type of adaptation-related decisions that you face within the context of your organisation.

Q1. Can you tell me about your role and level of responsibilities in the decision-making processes of your organisation?

- What type of organisation are you working in?
- What are the main geographical scale(s) you operate across?
- What are the main sector(s) you operate in?
- How long have you been with your organization?
- What is your degree of influence in the decision-making processes?
- Are there any challenges you face in the decision-making processes?

B. Decision-making objectives

This next section asks questions about the objective of the decision-making within your organisation. I am interested in hearing about the adaptation problem, the goals, values and preferences that motivate you as a decision-maker within your organisation, as well as the stakeholders affected by this process. In this section I want you to highlight the principles currently guiding your climate change adaptation-related decision-making processes.

Q2. What are the main kinds of decisions that you and your organisation either make, support or advise?

- How would you describe them generically? (Normative/regulatory, operational, strategic)
- What kinds of information do you use to help you make these decisions?
- Who does the work? Is it through consultancy? Does the organisation do it internally? What is the process?

Q3. What is the typical lifetime of those decisions?

- Lead time
- Consequence time

Q4. How does your organisation view adaptation to climate change?

- E.g. as coping with immediate short-term responses? Do you view it more widely, e.g. as preparing for the future changes but within a set institutional/political context? Do you view it as transformational change, and recognise the need for system shifts?

****Now I would like to take a few minutes to discuss the brief with you.*

Q5. Have you made any adaptation-related decisions?

- Or decisions that unintentionally had adaptation consequences?
- If so, how did you go about it? What did you do to understand the decision? What kind of information did you use? etc.
- If not, can you imagine making one? What might it be?

C. Decision support

In this section I will ask you questions about decision support. I want you to highlight how your adaptation-related decisions are being supported – for example, through scientific and other activities, such as provision of data, consultancy and policy advice. I would also like to know what kind of climate and non-climate information is being used to inform decision-making within the context of your organisation.

Q6. Have you used future climate change information in your decision-making?

- If so, was it successful in helping you make the decision?
- At what level was the information? E.g. central estimate? High estimate? High emissions?
- Did you find limitations in the climate change information?
- If you haven't used it, why not?
- What made you decide not to use it? (E.g. Did you not find it relevant? Not understand it? Something else?)

Q7. Have you previously received any information about high-end climate change, such as that presented in the brief? If so, has it influenced your decision-making? If yes, how? If not, why not?

- How was this information received or accessed? Did that influence whether or not you used it?
- Is your organisation considering climate changes of more than 2 degrees C?
- Would that kind of change cause your organisation to surpass particular thresholds that are important to production or supply?
- How would your organisation cope with that level of change? What kinds of changes would your organisation be likely to make?
- What kinds of information would you need to make those changes?
- What informed the decision to consider or not to consider high-end changes?

Q8. What kind(s) of decision-support tools or approaches do you usually use to guide adaptation-related decisions? From where do you source/receive these tools/approaches?

E.g.
Risk minimisation
Cost-Efficiency Analysis / Cost-Benefit Analysis
Multi-Criteria Analysis
Real options
Formal political processes / Democratic accountability
Sensitivity analysis
Scenario analysis
Expert judgement
Probability analysis
Other

- When working with adaptation-related decisions, do you normally need to have the climate change information upfront (e.g. scenarios, maps) or do you start by identifying your adaptation objectives?
    - Top-down or science first
    - Bottom-up or systems first

Q9. Are models used by you or your organisation for decision making?

- Do they include climate factors?
- Have you used them to consider future climate? If not, could they be used as such?
- If using them, what influenced deciding to use them?
- If not using them, why not?
- Do you use them to support adaptation-related decision-making processes? If not, why not? If yes, see next question.

Q10. (If yes to Q9) Can you tell me more about your experience with using modelling in support of your adaptation-related decisions?

- Ease of use?
- Do the models analyse the right things for your organisation?
- Do the models present information/data at the right spatial and temporal scales for your decision-making?
- Is the accuracy of the modelling sufficient for the needs of your organisation?
- Do you have any recommendations to modellers?

Make sure to encourage the interviewee to provide any forms of complementing documentation related to modelling or model outputs.

Q11. Are you familiar with climate change uncertainty?

- How is uncertainty regarding future climate change communicated within your organisation?
    - Via different emissions scenarios (i.e. climate projections contingent on emissions scenarios)
    - Probabilistic climate scenarios
    - Central estimates with/without error margins and/or ranges.

Q12. What do you think about uncertainty of socio-economic factors?

- What kinds of socio-economic factors and their future development do you consider the most important in your climate adaptation-related decision-making?
    - How important or unimportant and how certain or uncertain do you consider these factors to be within your organisation's work?
        - For those factors, what information sources do you use most frequently?
- How does your organisation deal with uncertainty?
- Do socio-economic factors influence your organisation's decisions about adapting to climate change?

Q13. What do you consider is your organisation's current level of capacity to adapt to high-end climate change?

- If good, what measures are in place to support adapting?
- If not good, what would improve your organisation's capacity to adapt to high-end climate change?
    - Support activities?
    - Information?
    - Other?

D. Decision-making and outcomes

Climate change decision-making is different from most other decision-making contexts because of the long time scales involved, the pervasive impacts and resulting risks, and the 'deep' uncertainties attached to many of those risks. Moreover, the outcomes of an adaptation decision are difficult to assess and evaluate since it is necessary to wait until the consequences of the decision are visible and can be evaluated. This section asks questions about how you are assessing, prioritising and making adaptation-related decisions.

Q14. So your organisation considers timeframes of XXXX (insert from Q3). Do you consider longer timeframes?

- Have you considered the impacts of high-end climate change over these timeframes? Why or why not?
- Are they a part of your risk management strategies? Why or why not?
- What have you considered doing to adapt?
- Would you need information other than what you already have? If so, what?
- From where or whom would you want to receive this information?
- In what form?
- Over what areas and during which timescales?
- Do you plan for a particular temperature threshold? If so, what is the threshold? And what aspect of the organisation or product does it impact on?
- What kinds of decision-support tools or approaches did you use to help develop these strategies?

Q15. At what point do you think that your current strategies would no longer be enough?

- Would you have to do things differently?
- If so, can you think of ways that you might be able to make changes and adapt?
- What if incremental changes aren't enough? Do you think you might need to make transformative decisions? Are you considering this?
- Do you have an idea (could you give me an example or some examples) of what these transformative decisions might involve (and do you have strategies concerning them)?

- Are you waiting for particular information or for particular impact(s) to occur to make these decisions?

E. Wrapping-up and next steps

Q16. Is there anything else you think is important which we have not yet touched upon?

This interview will be assessed and analysed together with other interviews. The synthesis will contribute to the development of the IMPRESSIONS project in two ways. First, your input will contribute to scenario development in the light of High-End climate change projections. Second, it will bring valuable input of decision-makers' information needs to the different models that are being developed in the project.

Thank you so much for your time and your valuable contribution!

Annex D - Iberian case study: Interview template for Portugal

Iberian case study - Interview Template (Portugal)

Although there is a widespread agreement that the increase in global mean temperature should be below 2°C to avoid severe impacts, projections based on current emission trends point to much more substantial warming, with possible increases of 4°C or more unless there is radical action to cut emissions.

The IMPRESSIONS project aims to advance understanding of the implications of high-end climate change (involving temperature increases above 2°C) while helping decision-makers apply such knowledge.

Basic information

Name and affiliation of interviewer:

Name, affiliation and title of interviewee:

Date and place of interview:

Additional information:

A. Characterisation of the decision-maker and the decision-making context

This first section is designed to provide background information about you and your organisation and the type of adaptation-related decisions that you face within the context of your organisation.

Q1. Can you tell me about your role and level of responsibilities in the decision-making processes of your organisation?

- What type of organisation are you working in?
- What are the main geographical scale(s) you operate across?
- What are the main sector(s) you operate in?
- How long have you been with your organization?
- What is your degree of influence in the decision-making processes?

B. Decision-making objectives

This section asks questions about the objective of the adaptation-related decision-making within your organisation. I am interested in hearing about the adaptation problem, the goals, values and preferences that motivate you as a decision-maker within your organisation, as well as the stakeholders affected by this process. In this section I want you to highlight the principles currently guiding your climate change adaptation-related decision-making processes.

Q2. What are the main kinds of adaptation-related decisions that you and your organisation typically make, support or advise?

- How would you describe them generically? (normative/regulatory, strategic operational);
- What kinds of information do you use to help you make these decisions?
- Who does the work? Is it through consultancy? Does the organisation do it internally? What is the process?

Q3. What is the typical lifetime of those decisions?

- Lead time
- Consequence time

C. Decision support

In this section I will ask you questions about decision support. I want you to highlight how your adaptation-related decisions are being supported – for example, through scientific and other activities, such as provision of data, consultancy and policy advice. I would also like to know what kind of climate and non-climate information is being used to inform decision-making within the context of your organisation.

Q4. Have you used future climate change information in your decision-making?

- If so, was it successful in helping you make the decision?
- Please comment on the most frequently used sources of information, monitoring and assessment tools to support climate decision-making processes in your organization (e.g. research, IPCC, national agencies, consultancies, other)?
- At what level was the information (e.g. means, trends, extremes, estimates; high/low emissions, climate variables, etc)?
- Did you find limitations in the climate change information?
- If you haven't used it, why not? What made you decide not to use it?

Q5. What kinds of (non-climate) socio-economic factors do you consider important in your climate adaptation-related decision-making?

Q6. Could you please comment on how uncertainty regarding future climate change and socio-economic factors is taken into account and communicated within your organisation?

- Via different emissions scenarios (i.e. climate projections contingent on emissions scenarios)?
- Probabilistic climate scenarios?
- Central estimates, error margins and/or ranges?
- What kinds of socio-economic factors and their future development do you consider important in your climate adaptation-related decision-making?
- For those factors, what information sources do you use most frequently? How does your organisation deal with it?
- Do they influence your organisation's decisions about adapting to climate change?

Q7. Are models used by your organisation?

- Do they include climate factors?
- Have you used them to consider future climate? If not, could they be used as such?
- Do the models analyse the right things?
- Do you use them to support adaptation-related decision-making processes?

- Do the models present information/data at the right spatial and temporal scales for your decision-making?
- If using them, what influenced deciding to use them?
- If not using them, why not?
- Do you have any recommendations to the modellers?

Q8. Have you previously received any information about high-end climate change (>2°C)? If so, has it influenced your adaptation-related decision-making processes, and how? If not, why not?

D. Decision-making and outcomes

Adaptation-related decision-making is different from most other decision-making contexts because of the long-time scales involved, the pervasive impacts and resulting risks, and the 'deep' uncertainties attached to many of those risks. Moreover, the outcomes of an adaptation decision are difficult to assess and evaluate since it is necessary to wait until the consequences of the decision are visible and can be evaluated. This section asks questions about how you are assessing, prioritising and making adaptation-related decisions.

Q9. Taking into account the possibility for global warming to exceed a 2°C threshold, what implications/options do you foresee in terms of the adaptation-related decision-making processes in your organisation?

- Would you have to do things differently? At what point do you think that your current strategies would no longer be enough?
- If so, can you think of ways that you might be able to make changes and adapt?
- What if incremental changes aren't enough? Do you think you might need to make transformative decisions? Are you considering this?
- Do you have an idea (could you give me an example or some examples) of what these transformative decisions might involve (and do you have strategies concerning them)?
- Are you waiting for particular information or for particular impact(s) to occur to make these decisions?

Q10. In particular, please comment on the current and potential developments for cross-border cooperation regarding water management and integrated climate policies in the Tagus/Guadiana river basins.

Wrap-up and next steps

Q11. Is there anything else you think is important which we have not yet touched upon?

Thank you very much for your time and your valuable contribution!

Annex E - Iberian case study: Interview Template for Spain

Iberian case study - Interview Template (Spain)

Basic information

Name and affiliation of interviewer:
Name, affiliation and title of interviewee:
Date and place of interview:
Additional information:

Context

The Iberian Peninsula river basins are among the European basins most likely to be affected by climate change, and especially in a plausible situation of High End Scenarios (HES). The Tagus and the Guadiana river basins are two of the five international river basins shared between Portugal and Spain and this poses distinct challenges for social-ecological systems coordination. Water scarcity is likely to be aggravated by the traditional focus on irrigation - the main source of water demand in both sides of the river basin- as well as by growing urban water demand and large-scale water transfers.

Climate change is expected to greatly increase water-resource management challenges in the drier South of the Iberian Peninsula, so significant institutional and agents transformations are needed to cope with the impending warming future. Sectors such as agriculture, forestry, energy and nature conservation may become more vulnerable to activities carried out upstream the river basin. There is an increasing need for holistic, integrated, multi-scale and trans-boundary solutions, which require improved coordination between different political, legal and institutional settings and actions.

Our ambition is to study the conditions and processes that enable relevant agents - including policy makers, trans-boundary institutions and local organisations- to develop and implement integrated solutions, and to build transformative capacities aligned with sustainable pathways to cope with HES in the Tagus and Guadiana river basins. To do so, we take a dual perspective. On the one hand, we use and ***integrated solution-based comparative approach*** *of the two river basins by studying the state of implementation and how to improve the resilience of the European Water Framework Directive in a situation of HES. Constraints and opportunities posed by mainstreaming climate change in Integrated River Basin Management (IRBM) are being analysed. On the other hand, we will also look at a series of nested examples of integrated solutions at local level, mainly Ecosystem-Based Adaptation (EBA) which will also take into account other integrated and innovative options and practices dealing with adaptation, mitigation and sustainable development (e.g. at farm level). The overall goal is to explore the conditions, options and leverage points for enhancing overall system and agents' resilience in situations of HES.*

A. Characterisation of the decision-making context and processes

This first section is designed to provide background information about you and your organisation and the adaptation-related decision-making processes that you face within the context of your organisation. I am interested in hearing about the types of adaptation-related decisions and the problems, goals and preferences that motivate you as a decision-maker within your organisation, as well as the stakeholders affected by these processes.

Q1. Please provide a general description of your organisation's role in climate change policy decision-making and governance. Please describe the kinds of particular adaptation-related decision-making processes you are involved within our organisation (Q3)

B. Decision-making objectives and support (including assessment of tools and methods)

In this section I want you to highlight the principles currently guiding your climate change adaptation-related decision-making processes. I would also like you to highlight how your adaptation-related decision-making processes are being supported and to understand what kind of climate and non-climate information is being used to inform them.

Q2. When working with adaptation-related decisions what is usually the first step you take? Do you normally start with the climate change information (e.g. scenarios, maps, projections) or do you start by identifying your adaptation objectives (e.g. what I want to adapt and why; what is the scale and lifetime of the decisions)?

Q3. Please comment on the most frequently used sources of information, monitoring and assessment tools to support climate decision-making processes in your organisation (e.g. IPPC reports, down-scaled scenarios, models, cost-benefit analysis, stakeholder consultations). What kinds of (non-climate) socio-economic factors do you consider important in your climate adaptation-related decision-making?

Q4. Could you please tell us what is mostly needed to improve the existing information and assessment tools used to support climate adaptation-related decision making in your organisation?

Q5. Could you please comment on how uncertainty in climate change assessment of risks and opportunities is taken into account/communicated in your organisation's climate change decision-making processes?

C. Institutional innovation and cross-border transformative cooperation in the face of HES

Although there is a widespread agreement that the increase in global temperature should be below 2°C to avoid severe impacts, projections based on current emission trends point to much more substantial warming, with possible increases of 4°C or more unless there is radical action to cut emissions. The IMPRESSIONS project aims to advance understanding of the implications of high-end climate change, involving temperature increases above 2°C, and to help decision-makers apply such knowledge within integrated adaptation and mitigation strategies.

Q6. Taking into account the possibility for global warming to exceed a 2°C threshold, what implications/options do you foresee in terms of transforming institutional arrangements and decision-making practices in your organisation?

- In particular, please comment on the current and potential developments for cross-border cooperation regarding water management and integrated climate policies in the Tagus/Guadiana river basins.

- *[If not mentioned, comment on the Euroregions EUROACE (Alentejo Centro and Extremadura) and AAA (Andalusia, Alentejo, Algarve) and development /possible transformation actions, etc]*

Q7. Which particular policy instruments, mechanisms and resources would be necessary to transform current cooperation arrangements between Portugal and Spain so as to secure long-term sustainable development of these river basins even in the face of a High-End Scenarios?

- Please name some possible transformative actions regarding cross-border cooperation in the Tagus/Guadiana river basins.

- *[Introduce the concept first if necessary by distinguishing between transformative and incremental]*

Q8. Please discuss how engagement and communication with key actors at different levels of governance (both state and non-state one) could be improved to as to support institutional transformation and improve resilience to high-end scenarios.

Wrap-up and next steps

Q9. Is there anything else you think is important which we have not yet touched upon?

Thank you very much for your time and your valuable contribution!

Annex F – Hungarian case study: Interview template

Hungarian case study - Interview Template

Basic information

Name and affiliation of interviewer:

Name, affiliation and title of interviewee:

Date and place of interview:

Additional information:

A. Characterisation of the decision-maker and the decision-making context

Q1. Can you tell me about your role and level of responsibilities in the decision-making process of your organisation?

- What type of organisation are you working in?
- What are the main geographical scale(s) you operate in?
- What are the main sector(s) you operate in?
- For how long have you been with your organization?
- What is your degree of influence in the decision-making process?

B. Decision-making objectives

Q2. How would you generically describe the main type of decisions you make, support or advise?

- Normative/regulatory
- Operational
- Strategic

Q3. What is typically the lifetime of those decisions?

- Lead time
- Consequence time

Q4. What is usually the first step you take in your decision making process?

- Top-down or science first
- Bottom-up or systems first

Q5. How do you think environmental awareness of the wider public and decision makers evolved in the past decades?

C. Decision support

Q6. What kind of information about possible future climate change do you consider most important in your decision-making process?

- Climate change variables
- Characteristics of climate change variables [e.g. means, trends, extremes]
- What are your most frequently used sources of climate change information (i.e. research, IPCC, national agencies, consultancies, other)?

Q7. How is future climate change communicated within your organisation?

- Via different emissions scenarios (i.e. climate projections contingent on emissions scenarios)
- Probabilistic climate scenarios
- Central estimates with/without error margins and/or ranges.

Q8. Which socio-economic factors do you consider important in future climate adaptation-related decision-making?

Q9. What are the main decision-support approaches/methods you use to guide decisions?

Q10. Are models or model outputs used to support your adaptation-related decision-making processes? If not, why? If yes please specify?

D. Decision-making and outcomes

Q11. Does your organisation have methods for monitoring, evaluating and reassessing decision outcomes? If not, why?

- How do they function?
- Do you sometimes postpone or change a decision in order to wait for more information?

Q12. In your decision-making context, what constitutes a successful adaptation-related decision? Why?

E. Wrapping-up and next steps

Q13. What is your long-term vision for your city/region?

Q14. Is there anything else you think is important which we have not touched upon yet?

Thank you very much for your time and your valuable contribution!

Annex G – Mapping of EU policy goals and modelling indicators for the European case study

	WFD				Habitat (HD)			CAP			Forest (FS)			Floods (FD)				
	Good ecological status	Secure drinking water sup.	Reduce haz. subst. emissions	Protection of terr. & marine waters	Restoration of nat. habit. & wild species	Protection for anim. & plant spec.	Special areas for conservation	Viable food production	Management of nat. resources	Balanced territorial develop.	Satisfy demand for raw materials	Sustainable forest management	Insure role of forests & forestry [1]	Reduce adverse conseq. for human health	Reduce adverse conseq. for environment	Reduce adverse conseq. for cultural heritage	Reduce adverse conseq. for economy	Reduce adverse conseq. for infrastructure
Biodiversity index				x	x	x	x		x			x	x		x			
Land use diversity				(x)	x	x	x		x		x	x	x		x	x		
Food prod. per capita								x										
Total cropped area									x	x					x	x		
Area in risk of flooding									x	x			x	x	x	x	x	x
People flooded in 1/100 y event												x	x	x				
Pesticide usage	x		x						x			x	x	x	x			
Fertiliser usage	x		x						x				x	x	x			
Total water use	x	x		x														
Falkenmark index		x						x		(x)								
Water exploitation index	x	x						x	x								x	
Irrigation usage	x							x							x		x	x
Unmanaged land					x	x				x								
Int/extensively farmed land					x	x	x	x	x	x		x			x		x	
Areas of habitats				(x)	x	x	x		x			x	x		x		x	
Species specific change in habitat suitability					x	x			x	x			x					
Potential wood yield											x	x					x	
Forest area				x	x	x	x				x	x	x		x			
Potential net primary production				x			x			x	x	x					x	
Potential carbon stock									x			x	x		x		x	
Agricultural yields								x	x	x								
Ecosystems services				x	x	x	x	x	x	x			x		(x)	x		
Natura 2000 areas					x	x	x											
Can we simulate actions for this objective in IAP?	?	?	yes	±	yes	yes	yes	yes	yes	yes	?	yes (?)	?	?	?	?	?	?