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EUPORIAS

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EUPORIAS

European Provision Of Regional Impact Assessment on a

Seasonal-to-decadal timescale

Deliverable D12.*2*

Climate services providers and users' needs

Workshop report

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Acknowledgements

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Executive summary

The aim of this workshop was to elicit knowledge and experiences of users' needs of seasonal to decadal (S2D) climate predictions from European climate service providers. The workshop was attended by 26 climate service providers and purveyors from across Europe representing 11 countries and two European organisations and numerous sectors including water, energy, tourism and health.

All workshop participants produced a short paper that summarised their own experiences of working at the interface between the provision of S2D predictions and users. These insightful papers were used to shape the workshop sessions and its interactive sessions: 1) Learning from other European projects; 2) Exploring the universe of S2D users; 3) Understanding barriers and limitations to the use of S2D; 4) Lessons from abroad; 5) Interactions between users and producers of S2D; and 6) Understanding the chain of S2D provision. These sessions were used to elicit knowledge and experiences from participants.

A range of other ongoing European projects and initiatives are relevant to the EUPORIAS project. Although the majority tend to focus on long-term climate projections, their interaction with the users of climate information can provide important insights.

From the workshop we found that in Europe the users of S2D climate information are mainly related to the energy, insurance and transport sectors. The majority of these organisations use predictions with lead times of a month up to a season and users in the energy sector were identified particularly for seasonal forecasts. The majority of organisations/users identified use this type of climate information to improve the management of their activities, products and outputs with a view to improve efficiency and, for those in the private sector, increase profitability. In terms of how these users were using this information in their organisations these ranged from using forecasts as additional information to climatology to those using this information in operational/dynamical models to support decision-making. Annual and decadal climate information is much less used across European sectors/countries.
The main barriers and limitations to the use of S2D identified by participants revolved around issues of skill and predictability; capacity, relevance, and usability; accessibility and communication; and changing existing practices.

Substantial knowledge and experiences in using seasonal forecasts can be learned from other regions of the world (e.g. USA, Brazil, and Australia). Such experiences have highlighted some of the existing barriers and limitations to the use of this type of forecasts and which should be considered in the European context.

The interactions between climate services providers and users amongst participants varied. Those providing climate services (e.g. National Meteorological and Hydrological Services - NMHSs) tended to have some kind of relationship with users

although these tended to be more interactive and iterative in some cases (e.g. MeteoSwiss, KNMI) than in others (IPMA).

Participants identified chains of provision of S2D climate information, but almost all of these chains focused on the seasonal or sub-seasonal timescale. The chains consistently started with data provided by ECMWF to NMHSs (e.g. AEMET, Météo-France, IPMA, Meteo Romania, Met Norway) and in some cases directly to certain organisations (e.g. EDF, ENEA). The NMHSs tend to act as purveyors by performing post-processing of information which they translate to generic products (and in many cases freely available) and/or products tailored to users' needs (which tend to be a paid service). Again, the main users identified by participants included those in the energy sector; Government agencies and national institutes, and sectors such as the insurance sector, the media, general public, forestry, and road maintenance.

Project objectives

With this deliverable, the project has contributed to the achievement of the following objectives (DOW, Section B1.1):

No.	Objective	Yes	No
1	Develop and deliver reliable and trusted impact prediction systems for a number of carefully selected case studies. These will provide working examples of end to end climate-to-impacts-decision making services operation on S2D timescales.		x
2	Assess and document key knowledge gaps and vulnerabilities of important sectors (e.g., water, energy, health, transport, agriculture, tourism), along with the needs of specific users within these sectors, through close collaboration with project stakeholders.	x	
3	Develop a set of standard tools tailored to the needs of stakeholders for calibrating, downscaling, and modelling sector-specific impacts on S2D timescales.		x
4	Develop techniques to map the meteorological variables from the prediction systems provided by the WMO GPCs (two of which (Met Office and MeteoFrance) are partners in the project) into variables which are directly relevant to the needs of specific stakeholders.		x

5	Develop a knowledge-sharing protocol necessary to promote the use of these technologies. This will include making uncertain information fit into the decision support systems used by stakeholders to take decisions on the S2D horizon. This objective will place Europe at the forefront of the implementation of the GFCS, through the GFCS's ambitions to develop climate services research, a climate services information system and a user interface platform.		x
6	Assess and document the current marketability of climate services in Europe and demonstrate how climate services on S2D time horizons can be made useful to end users.		x

Background, aim, and structure of the workshop

In recent years seasonal climate predictions have been evolving in Europe although the skill and predictability of such predictions still differs significantly between areas. Decadal predictions are an emergent area of research although a number of challenges remain with regard to the development of the science underpinning this type of climate information.

Given the current status of the use of seasonal climate predictions there are very few examples of the actual use of this type of predictions to decision-making processes across Europe. In other parts of the world the use of seasonal forecasts is more advanced although its use has been questioned at times due to issues surrounding its credibility, saliency, and legitimacy.

Currently, very little is known about the use of Seasonal to Decadal (S2D) climate predictions in Europe (Dessai and Bruno Soares, 2013). As a result, the experience and knowledge of those working at the interface between the climate science (the 'producers' of climate information) and the users can help us understand some of the existing users' needs with regard to S2D climate information. Given the on-going interaction between climate services providers and users, this workshop aimed to elicit and share what climate service provides and purveyors know about S2D users' needs across European sectors and society.

The workshop included various types of sessions (oral presentations, interactive sessions, plenary session) (Figure 1). Ahead of the workshop, participants were asked to prepare a paper summarising their experiences and knowledge with regard to the interface between climate services providers of S2D climate predictions and the users of such information. Participants were asked to prepare this paper by responding to questions around the demand for S2D climate information, identifying the users (and potential users) of this type of information, and describe the

interactions between users and producers in their countries/sectors and who should be providing this type of climate information (see Appendix 4 for more on summary papers by participants).

The workshop was shaped and structured around core issues which were identified based on previous work (see Dessai and Bruno Soares, 2013) and the summary papers prepared by participants. For example, the existence of other European projects relevant to the EUPORIAS project due to their interaction with users of climate information led to session 1 which presented three different European projects and initiatives from which we could learn with regard to users and their needs and expectations. The recognition of a whole universe of users (and potential users) of S2D climate information in Europe compelled us to explore in more depth in session 2 who these users are and why they were using this type of information. Common barriers and limitations to the use of S2D climate predictions were also identified leading to a closer examination of these barriers potential solutions to overcome those barriers (session 3). In other parts of the world, the use and application of seasonal forecasts have a longer history than in Europe and, as a result, we can also learn from those experiences including the many factors influencing (or preventing) the uptake of this type of climate information (session 4). A range of different types of interactions between users and producers of S2D climate information across European countries/sectors were identified in the summary papers and session 5 aimed to capture and examine more closely those interactions. Another core issue we wanted to explore at the workshop was the existence of different chains of S2D climate information provision across Europe in order to map these against the producers, the purveyors, and the users of S2D predictions (session 6). Session 7 aimed at capturing the main ideas and lessons learned from the workshop.

This report is structured around the various workshop sessions (Figure 1 below). It starts with an introduction to the workshop and the EUPORIAS project. The report then follows the order of the workshop's sessions each covering a particular core issue as described above. Many of the sessions included presentations[1] by participants looking at the issues discussed in that session and then an interactive session involving all participants.

[1] The majority of presentations by participants are available at www.euporias.eu.

Introduction to the workshop, EUPORIAS' project, and S2D climate predictions Suraje Dessai, University of Leeds	
Session 1 Learning from other European projects	**"JPI Climate - research for climate service development"** Janette Besseminder and Teresa Zölch, JPI Climate
	"The FP7 project ECLISE: Enabling Climate Information Services for Europe, and its experiences with users" Roeland van Oss, KNMI
	"The FP7 project CLIM-RUN: determining users' needs" Clare Goodess, University of East Anglia
Session 2 Exploring the universe of S2D users	**"Decadal predictions in planning of electrical grid"** Rasmus Benestad, Norway Met Office
	"S2D products and their use" Christoph Spirig, MeteoSwiss
	Exploring the universe of S2D users Interactive session
Session 3 Understanding barriers and limitations to the use of S2D	**"ENEA as Climate Information provider: our Experience with the Energy Sector"** Matteo de Felice, ENEA
	"Bridging the gap between providers of S2D predictions and potential users: Tourism as a case study" Adeline Cauchy, TEC
	Exploring the barriers and limitations to the use of S2D Interactive session
Session 4 Lessons from abroad	**"A historical perspective on the use and need of seasonal climate forecasts"** Mike Harrison, Climate-Insight
	"The use of seasonal climate forecasts: lessons from outside Europe" Maria Carmen Lemos, University of Michigan *(Via Skype)*
	What lessons are most relevant to Europe? Plenary session
	Wrap-up session
Session 5 Interactions between users and producers of S2D	**"Interactions between Meteo-France and its users"** Jean-Pierre Ceron, Météo-France
	"Interactions with users of S2D information - the Met Office experience" Anca Brookshaw, Met Office
	Exploring the interactions between users and producers of S2D Interactive session
Session 6 Understanding the chain of S2D provision	**"Provision of climate information to ECMWF users"** Laura Ferranti, ECMWF
	"Supply of S2D information to users: is there an ideal scheme?" Laurent Dubus, EDF
	Understanding the chain of S2D provision Interactive session
Session 7 **What have we learned about S2D use in Europe?** Plenary session	

Figure 1 – Workshop sessions.

Session 1 looks at three examples of other European projects from which lessons can be learned. Session 2 then focussed on exploring in more depth the universe of S2D users across European sectors. Section 3 aimed to understand the existing barriers and limitations to the use of S2D climate predictions in Europe. Section 4

included a couple of presentations from examples of the use of S2D beyond Europe and lessons to be learned. The final session of day 1 was a wrap-up session which included short presentations from participants on issues relevant to the workshop and the EUPORIAS project in general. Day 2 of the workshop started with session 5 which focused on understanding the existing relationships between the climate services providers and the users. In session 6 the chains of S2D provision were examined. The final session was a plenary session looking at some of the lessons learned at the workshop and next steps for this work package.

Workshop report

The workshop started with a welcome greeting by the head of Climate Services at KNMI Mr. Arnout Feijt. An introduction to the workshop was then presented by Professor Suraje Dessai from the University of Leeds. In his presentation, Professor Dessai explained the EUPORIAS project whose goal is to deliver reliable predictions of impacts of future climate conditions on S2D scale. This project looks into a range of sectors including health, water, energy, agriculture, tourism, and forestry. The workshop was prepared under EUPORIAS' work package (WP) 12 which focuses on the assessment of users' needs with regard to seasonal to decadal (S2D) climate information. This WP will use a number of methods to reach its objective, including interviews and surveys with end users and potential end users. The main findings from the literature review with regard to the current use of S2D in Europe included: seasonal predictions are still evolving in Europe whilst decadal predictions are still an emergent research area; there are not many examples of active use in European context, though other parts of the world are more advanced; there are key issues with regard to credibility, salience; legitimacy; structural/institutional barriers to the use of this type of climate information (particularly seasonal forecasts).

Professor Dessai presented the terminology and timescales involved in the EUPORIAS project with regard to S2D by proposing a taxonomy of climate information as a function of prediction lead time (Figure 2). In the context of EUPORIAS "the primary forecast timescale for the project is one season to one year ahead, with a secondary focus on the more scientifically challenging two to 10 year timescale" (Hewitt et al., 2013, p.106).

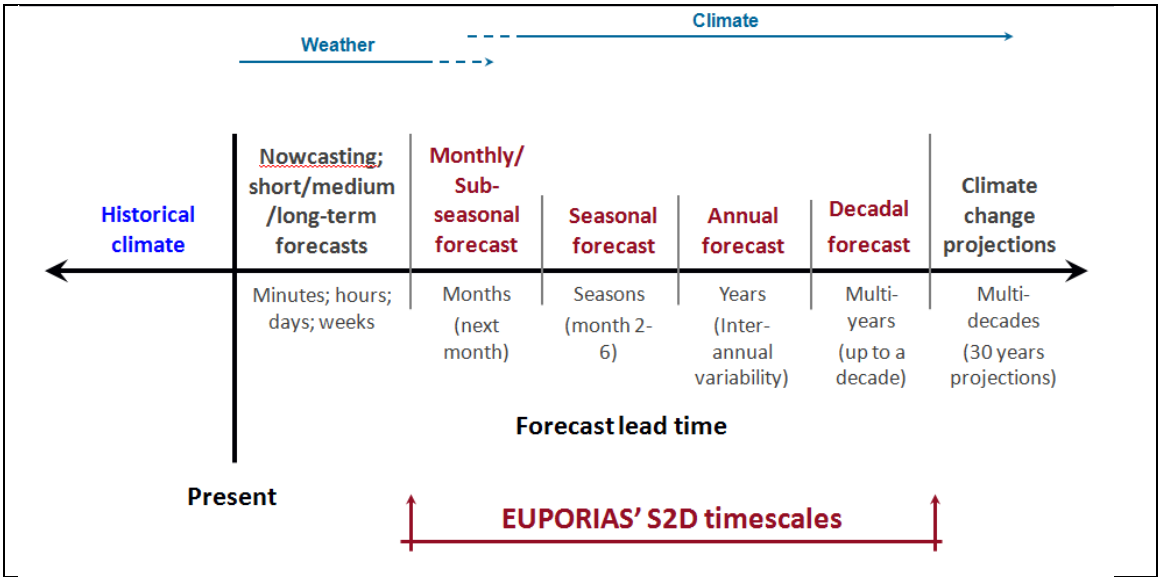

Figure 2 – Proposed taxonomy of climate information as a function of prediction lead time.

This taxonomy generated a very interesting discussion and some of the timescales and categories presented were questioned by participants, such as:

- Some participants thought that Nowcasting should be split from short/medium forecasts as these should not be considered together;
- The term forecast is not normally used for weather data;
- Inter-annual variability (i.e. under the category of annual forecast) includes seasonal variability as well;
- Need to clarify as to whether the definitions of S2D timescales regard lead time (how long off) or timespan (how long for);
- 'Long term' is an ambiguous phrase (i.e. could refer to yearly/decadal predictions or climatological projections 30+ years);
- The word 'predictions' can be misleading by giving a 'false' sense of certainty in terms of what is being provided to users.

Session 1 - Learning from other European Projects

The first session of the workshop consisted of a few presentations by other European projects and initiatives that also relate to climate services provision. These included: JPI Climate, the ECLISE Project, and the CLIM-RUN project. Brief overviews of the presentations made on these projects are described below.

1.1. "JPI Climate – research for climate services development"

Janette Bessembinder, KNMI and Teresa Zölch, Germany Climate Service Center

JPI Climate (www.jpi-climate.eu) is a European initiative concerning the coordination of climate research funding encompassing various modules (Figure 3).

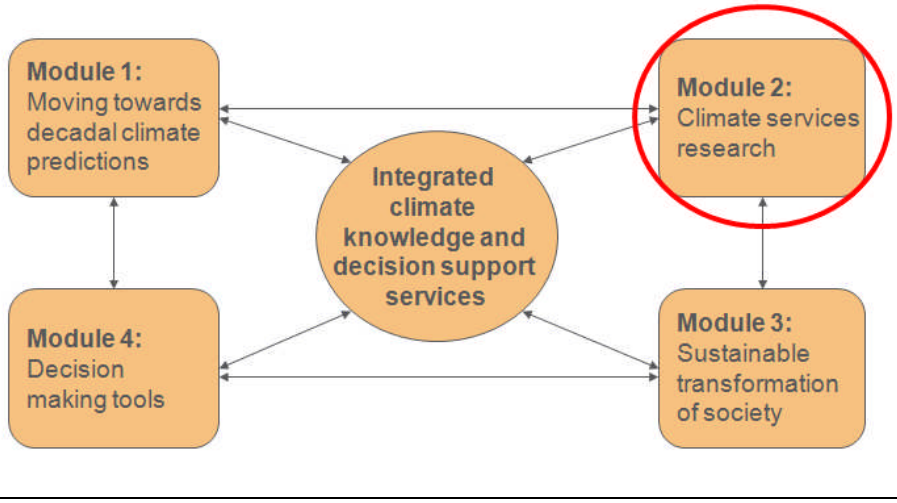

Figure 3 – JPI Climate modules

(From Bessembinder and Zölch, 2013).

JPI Climate Module 2 focuses on research for climate services development in order to ensure: quality assurance of climate services provided, effectiveness of service provided, and standards. This module encompasses two fast-tracks activities (FTA):

- FTA 2.1 – Mapping users' requirements;
- FTA 2.2 – Mapping climate services providers.

FTA 2.1. Aims to improve the transfer of data, information and knowledge about climate and climate change to society and within Europe. Better dissemination requires proper knowledge on users' needs, which set the scope for the relevance of the data/information/knowledge.

This FTA mainly involves understanding what is available; understanding users' needs; and improved interface. To achieve this, a number of activities are being pursued including: preparation of an inventory of user requirements (what do users need to know; user perceptions of risk); collection of guidance documents; analysis of existing uses; and recommendations for future research.

FTA 2.2 focuses on mapping climate services providers within Europe. A number of definitions can be used to identify specific roles within climate services including:

- *Climate service* - User driven development and provision of knowledge for understanding climate, climate change and its impacts, as well as guidance in its use to researchers and decision makers in policy and business;

- *Climate service provider* - Produces its own climate data and adds value for users;
- *Climate service purveyor* - Uses climate data available from other providers and adds value for users (i.e. translates raw data provided by providers for specific purposes).

The main aim of this FTA is to review current capabilities for providing climate services; lay ground for mid- to long term interdisciplinary research on governance; and production of guidance documents. Among other activities this FTA will conduct an initial pilot study for Germany where a questionnaire will try to identify how and why climate services are being provided as well as develop a portfolio of climate services providers (e.g. categories of climate services providers, nature and scope of such provision, gaps in knowledge).

The so called National Dialogues are workshops that intend to bring users and producers together (and therefore linking the two FTA). These workshops aim to facilitate networking, exchange expertise and experiences with climate services, and develop indicators for climate services quality standards. Underpinning these workshops is the overarching goal of developing a certifcation tool for climate services and safeguarding the use of valuable climate data for climate services.

Questions/comments on the presentation

- Little information exists on what is required at the S2D timescale.
- Two types of user identified in the Netherlands:
  - Operational users (shorter timeframe: want forecasts for next day to a year in future;
  - Strategic users (longer timeframe: 5 -10 years; concerned with variability; used for planning – e.g. water companies).
- Need to understand time horizons of users.

1.2. "The FP7 project ECLISE: Enabling climate information services for Europe, and its experience with users"

Roeland van Oss, KNMI

The ECLISE project (www.eclise-project.eu) aims to take the first step towards the realization of a European Climate Service. ECLISE provides local climate services for several climate-vulnerable regions in Europe, organized at a sectorial level: cities, water resources, coastal defense and energy production. A number of both northern and southern European countries are involved in this consortium.

CSC Germany will conceptualise the way in which this European network can be developed. The project will involve users (through work package 1 – WP1) which will specify their needs and evaluate the service at the end (i.e. user evaluations). The

project (WP 2) will use existing models and simulations (ENSEMBLES); decadal CMIP5 runs; Regional CORDEX runs; and non-hydrostatics runs (2-4km spatial resolution).

There are 26 case studies across four broad themes: coast, cities, water, and energy.

- WP 3 focuses on coasts:
  - Coast database (CoastDat)
  - Flood risks NL
  - Coastal protection NW Europe
  - Atlantic storm tracks

- WP 4 looks into urban issues:
  - Baia Mare - floods, heat
  - Oslo - waste water
  - Greek cities - floods, heat
  - Sicilian cities – floods
  - English cities – storm
  - Rotterdam - floods, drought
  - Stockholm - floods, water

- WP5 focus on regional water issues:
  - Baragan Plain – drought
  - Vrancea - floods, landslides
  - Lombardia - water availability
  - Crete – floods
  - English cities – floods
  - Sweden - water quality
  - Somes basin - water availability

- WP6 covers energy production issues:
  - Hydro power
    - Ume river dams
    - Alpine & Apennine dams
    - Somes river dams
  - Wind power
    - Norway
    - North Sweden
  - Solar power
    - Sicily
    - Crete
    - Future energy demand

WP7 focuses on developing the overarching concept for pan-European Climate Services by studying existing climate services; developing case studies: water & energy; and by preparing synthesis and recommendations.

Users' information needs identified include:

- Precipitation changes – both extremes and average;
- Temperature changes – mostly to be used as input for models;
- Wind and Storms;
- Solar Radiation;
- Output of impact models (mainly hydrological).

For 15 out of 19 case studies changes in precipitation is the most important information needed such as change in precipitation extremes and input variables for hydrological models (i.e. to estimate water availability and flood risks). Precipitation model data is (most) uncertain.

Users tend to need other data beyond climatic data (e.g. land use, sociological data) and there is a need for observations (statistics). The majority of users are aware of uncertainties in the data although it is often unclear how they will deal with that uncertainty or they simply don't know how to deal with it. Some want to know "what the odds are" (thus look to past frequencies).

<u>Questions/comments on the presentation</u>

- How do users deal with reliability issues
  - Users not aware of biases (this is a persistent issue)
- Importance of validating models across different climate services producers
- How do users' concerns impact upon modellers
  - More sophisticated models desired (to predict above listed events)
  - Issue of user interest versus actual usability
  - Different types of users: more advanced users to whom you can send data and others who prefer to talk about it in terms of 'stories'; Suggest that presenting data as narratives facilitates use amongst "less sophisticated" users.
- What timescale do users want?
  - Most users would like to have more on decadal data (10 to 20 years) for infrastructure development with regard to potential flooding and heatwaves.

1.3. "The FP7 project CLIM-RUN: determining users' needs"

Clare Goodess, University of East Anglia

The CLIM-RUN project (www.climrun.eu) aims to develop a protocol for the provision of adequate climate information at regional to local scale that is relevant and useable by different sectors of society (policymakers, cities, industry).
The project is based in the Mediterranean region and uses bottom-up case studies involving end-users in the areas of tourism, energy, wildfires, and also an integrated case study (cross-sectoral). Users' needs are assessed through an on-going iterative consultation and collaboration with stakeholders which involves four main stages:

- Stage setting (first workshops completed between May-November 2011);
- Mapping of issues (through perception and data needs' questionnaires - completed);
- Iterative consolidation/collaboration (second stakeholder workshop – April-May 2013);
- Synthesis and recommendations (final workshop and end of project – February 2014).

In the integrated case study in Venice for example, stakeholders were selected based on a ranking system developed by social scientists based on their: Importance; influence; effects; relevance; and attitudes.

Through collaboration with stakeholders (through questionnaires, stakeholders' interviews, and local workshops) it was possible to determine the 'who' and the 'what' including:

- Who are the climate services stakeholders?
  - Why is climate variability and change relevant to them?
  - How do climate issues fit within their decision making mechanisms and their perception of risk?
- What do they need/want from climate services?
  - Specific data
  - Analysis tools
  - Guidance and training

Emphasis was made to understand what end-users want or need with regard to different timeframes (i.e. seasonal, decadal, climate projections). It was also felt by the researchers that there is a need for clarity in definitions (personal comment: what is meant versus what is understood with respect to language/terminology is a matter that needs further investigation – amongst both specialists and non-specialists).

The main findings from this collaboration have shown that the majority of respondents were using observed data and climate change projections (few were using seasonal climate information). In addition to temperature and precipitation data

and derived indices/extremes the need for other climate information was also identified including:

- Wind data (speed, direction, consistency), snow, humidity, and cloud;
- Radiation (especially DNI for solar energy);
- Sea bathing water temperature, SLR, storm surge, wave height;
- Local winds (Bora, Scirocco) and dust storms;
- Tourism comfort indices and Fire Weather Index.

In general, stakeholders seemed more interested in next 20-30 years (50 years at most) timescales i.e., seasonal/decadal rather than 'climate' timescales (though little current use). To meet stakeholders' needs there was a 'translation process' by the CLIM-RUN Climate Expert Team (CET). It diagnosed and categorised users' needs in order to:

- State what is already available and possible to obtain (or could become possible in the future);
- State what information is easy and difficult to provide (0 not possible to provide; 1 already available; 2 easy to provide; 3 able to provide, but with a lot of work).

The production of first examples of products and outputs as well as defining new modelling tools needed is now under way through iterative discussions with stakeholders.

Some issues have been raised throughout this on-going collaboration including:

- Perception questionnaires:
  - Flexibility versus consistency (deployment of different versions);
  - Too technical for some stakeholders;
  - Did not provide all of the details CET would have liked.

- Issues for information provision:
  - Narratives and examples may be useful;
  - Problem that users may "tick everything" if asked;
  - The extent to which needs rely on timeframe (different variables/resolutions for S2D and climate change?); Don't forget observations (current/recent past);
  - Reliability of forecasts;
  - Explaining the difference between forecasts, predictions and projections.

<u>Questions/comments on the presentation</u>

What precisely does reliability mean in this context? Problem of definition.

Session 2 - Exploring the Universe of S2D users

This session focused on the universe of S2D climate prediction users across European sectors. The first part of this session consisted of a couple of presentations by Rasmus Benestad from the Norwegian Met Office and Chirstoph Spirig from the Swiss Met Office. Brief overviews of the presentations made on these projects are described below.

The second part of session 2 consisted of an interactive session where participants were asked to share their knowledge and experience regarding the users and potential users of this type of climate information in Europe. The methods used and main findings from this interactive session are described below.

2.1. "Decadal predictions in planning the electric grid"

Rasmus Benestad, Norway Met Office

Types of information requested tend to be technical reports and dialogues. Near future data (1995-2025; 2010-2040) is provided using CMIP3 with 90% confidence intervals. Some indication of quality is provided by evaluating the ranges using binomial distribution and values outside 5-95% confidence intervals. Empirical-statistical downscaling is achieved by evaluating against observations year-to-year variations and past trends.

This has led to new work in 2011 (e.g. report on updated temperature and precipitation scenarios for Norwegian climate regions) with new models and information, and attempting to deal with different questions such as cold spells (which are important for energy consumption). Production and consumption of energy: dry autumn followed by cold winter regional assessment - less likely problem in the future due to more precipitation and higher temperatures (Benestad, 2013)

2.2. "S2D products and their use – current situation and outlook"

Chirstoph Spirig Andreas Fischer, Irina Mahlstein, and Mark Liniger, MeteoSwiss

MeteoSwiss currently provides monthly forecasts (tercile forecasts for weeks 1-4) and seasonal forecasts (terciles and climagrams[2] of 3 monthly means for months 1-7) for selected locations and maps worldwide.

Main users of this information are the general public (who mostly access monthly forecasts online; terciles not understandable). Commercial customers include insurance (monthly and seasonal forecasts – terciles and climagrams – worldwide) and energy companies (monthly and seasonal forecasts mainly terciles – worldwide).

[2] A Climagram is a climatic diagram.

This information is used for operational tasks mainly for trading (energy) and weather derivatives. Users tend to couple forecasts to their own application models and these forecasts tend to be used worldwide (not only Switzerland). Recent trends include contracts (such as for weather derivatives) over a given time period (and not necessarily over complete months) and customized averaging periods are also common. Monthly means and loss of information can also lead to cumulative indices based on daily data.

Ideas for improving the visualization and presentation of forecasts including for the visualizing of seamless predictions and services include: time axis, climagrams, and different granularity for different time ranges (such ideas are already pursued by KNMI). Other ideas were also briefly presented (see e.g. Figure 4 below).

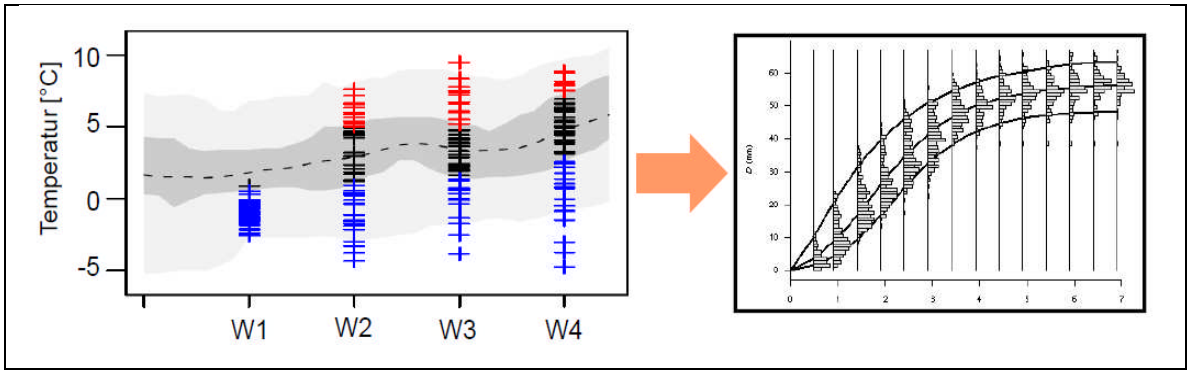

Figure 4 – Other ideas for visualization of forecasts

(From Spirig et al., 2013).

For example, the left diagram on Figure 4 shows weekly temperature probabilistic forecasts (for weeks 1 to 4) for different members corresponding to upper, medium, and lower terciles whilst the image on the right side is an alternative way of visualizing the same information.

2.3. Interactive session

This first interactive session of the workshop aimed to explore the current universe of users (and potential users) of S2D across European sectors.

Participants were divided into mixed groups of 5/6 people each including representatives from national meteorological institutes and other climate services providers (e.g. boundary organisations) and academics (see list of participants in Annex 1).

Participants were asked to identify users (or potential users) of S2D in Europe and write them down on post-its (providing as much detail as possible on each user). A

matrix was then provided showing different categories of users and different prediction lead time (Table 1 below).

Table 1 – Categories of S2D users and prediction lead time used in session 2.

		Using S2D at operational/ strategic level	Moderate use of S2D	Aware of S2D and potential user	Unaware of S2D but potential user	Unaware of S2D and no potential use
Prediction lead time	Monthly/sub-seasonal					
	Seasonal forecast					
	Annual forecast					
	Decadal forecast					
	Don't know					

Participants were then asked to place each of the post-its where users had been identified in the matrix accordingly (Figure 5).

Figure 5 – Example of one of the matrices completed by participants.

Each group then discussed their findings in their matrix and reported to the whole group on those findings.

2.4. Main findings from interactive session

The table below lists the comments by participants regarding users and the use (or potential use) of S2D information for a particular prediction lead time. Some of the users identified lay between different categories of lead time and in those cases sub-categories were created to capture that (e.g. seasonal/annual forecast). Similarly, some users were identified as being between two different categories of S2D use and sub-categories were also created for that effect (e.g. using S2D at operational and/or moderate use of S2D).

As illustrated in the table below, many of those users already using this type of information (i.e. using S2D at operational/strategic level, or using it moderately) were identified by the name of the user (i.e. the organisation using S2D) such as Electricité de France (EDF), Metnext, GDF Suez, EDP, REN, DVwater, AXA, Schipol airport, and ProRail. These users are mainly related to the energy, insurance, or transport sectors. The majority of these users use lead time predictions of a month up to a season and operational users in the energy sector were identified particularly for seasonal forecasts.

Other clusters of users (and potential users) were also identified for a range of sectors including:

- Agriculture and health (food security from a health perspective) including crop forecasts;
- Tourism;
- Urban planning;
- Water management, flood and wildfire;
- Financial services;
- Wind energy for planning;
- Emergency response
- Mining;
- Nuclear power;
- Forestry.

Although still an emergent area the potential use of decadal forecasts were identified for a range of sectors including: energy, insurance, water management, planning, mining, agriculture, and infrastructure.

Table 2 – Users of S2D climate information identified in session 2.

Using S2D at operational/strategic level	
Monthly/sub-seasonal	• EDF energy
Monthly/sub-seasonal/seasonal forecast	• Metnext / Climpact – energy; supply chain • DVWater • Energy companies and energy producers (e.g. EDF) • TV broadcasters for general public • National hydrological and water management institute • Water administration (Apele Romane)
Seasonal forecast	• Insurances – weather derivatives • AXA – insurance company (Lead time 1 month; range 3 months) • Institutional – Drought Committee (Lead Time 1 month; range 3 months and 1 month)
Seasonal/annual forecast	• Financial sector (banks, insurances) • Schiphol airport (uses wind conditions, fog, precipitation)
Decadal forecasts	• Energy (EDF) • Re-insurances

Using S2D at operational/strategic level and/or Moderate use of S2D	
Monthly/sub-seasonal	• Municipal health authorities
Seasonal/annual	• Agriculture (potential use) to estimate production EU/traders
Decadal forecast	• Investments/financial • Power suppliers – hydroelectric production
At various prediction lead time (sub-seasonal, seasonal, annual)	• Energy generation utilities; E.ON RWE EnBw plus smaller regional utilities

Moderate use of S2D	
Monthly/sub-seasonal	• Financial application WSI (purveyor) • French Ministry of tourism • EDP – energy distribution • GDF Suez – energy • EDF/GDF – energy company (cf. Laurent) monthly/seasona • Powernext – NYSE – Euronext – Finance • RTE/ERDF – energy, transport, distribution, grid management • Agricultural application JRC ISPRA
Seasonal forecast	• Forestry – wildfire and pest control • Federal ministries of agriculture • Retail/food buyers • Media
Seasonal/annual forecast	• Water utility companies – waste water; water resources – infrastructure; operational investment; planning • Supply chains; food; clothes; supermarkets
Annual forecast	• EDF/GDF Suez/RTE – energy • ProRail (railway NL) use M/S forecast on winter conditions

Decadal forecast	• REN - Energy production • Investors that are buying land/water internationally • River Basin Agency (2027) • Water resource – River Basin Agency (decadal) • Urban planning (flooding, heat) • Government planning • Mining companies

Moderate use/aware of S2D and potential use	
Monthly/sub-seasonal	• Public health institutes • Civil protection agencies
Seasonal forecast	• Airport and port operations • Agriculture – Farmers union use precipitation (droughts) • National Farming Union • Water management (e.g. government agencies, private companies) • Contingency planners (e.g. UK government)
Seasonal/ annual forecasts	• National and regional ministries of health • Disease control; protection agency (animal and human)
Decadal forecast	• Centres for disease control • Urban/peri-urban planning and wildfire policy

Aware of S2D and potential use	
Monthly/sub-seasonal	• Tour operators and incoming agencies • DG Forest (Min. Env) • Spanish River Basin Agency (e.g. Chebro) • Local water operator (e.g. Aguas de Barcelona)
Monthly/sub-seasonal/seasonal forecast	• Veolia? Water management • DG Forest (Min. Env) • Agriculture/farmers • Transport and road maintenance
Seasonal forecast	• Transmission grid manager TERNA (TSO) • Renewable energy (e.g. Croatia seasonal hydrological predictions for production) • ADP – Portuguese water supply company • River Basin Agency • Water operator • River transport (in Winter) (range season) • Agriculture (UK) especially in face of current/recent increases in variability as it affects access to land, yield, and quality of harvest) • Agriculture – ARVALIS (LT 1 month to 3 months; range 3 to 6 months)
Seasonal/annual forecast	• Farmers as land use and wildlife managers • Building and institutions operations managers (those responsible for operation and maintenance) • Agriculture – crop forecasts • Hydropower (e.g. snowpack, winter temperature, autumn precipitation) • Water management and water availability • Large retail organisations • Financial industry

Annual forecast	• Military – land owners/operators/operations • Wildlife/habitat managers and related agencies • Tourism – private building investors/managers (hotels); Village du Soleil • DG Water (Min. Env) • EDF/RTE energy • River basin agency • Insurance
Decadal forecast	• KFW – development bank • CCS – Insurance • Financial institutions (predictability within coming years of all kinds of different sectors) • Agriculture sector – port wine region • Agriculture – ARVALIS • Water and energy regulators • DG Water (Min. Env) • TurEspana (Tourism) • Energy • EDF/RTE energy • Wind energy company (for financing new energy wind peeks) • Nuclear plant (Cernavoda/Cernavoota?) • Small hydropower managers – Romania, interested in climate change • Civil protection and risk of extremes • Infrastructure investments retrofitting to planning
Don't know	• Fisheries management internationally • EDF – hydro power

Aware of S2D and potential use/ Unaware of S2D but potential use	
Monthly/sub-seasonal forecast	• General public • Agriculture • Road maintenance
Seasonal forecast	• Professional of tourism (outdoor activities) Savoie Mont Blanc Tourism • Park managers and related agencies (local and national parks and conservation)

Unaware of S2D but potential use	
Monthly/sub-seasonal /seasonal forecast	• Tourism – regional tourism agencies; tourism offices (Rhone – Alps; Mont Blanc Savoie Tourism; MITRA) • Emergency/contingency planning
Seasonal forecast	• Agriculture sector – ASAJA • Agriculture and farmers (e.g. how wet are the fields, restriction with ploughing) • Irrigation groups/community • Forestry (e.g. reforestation, logging, timber transport) • Water resources – river basin agency (potential - 2 involved in EUPORIAS) • Tourism • Renewable energy demand – medium islands (e.g. Cyprus); related to tourism

	• Mediterranean tourism from regional to national bodies/operators – conditions in tourism area but also beyond
Seasonal/annual	• Local authorities' planners; emergency planners and management (RS) • Transport - Ministerio de Fomento • Transport – ALVAC • Agriculture organisations (national, regional, local) • ASAJA – agriculture
Annual forecast	• Agriculture sector – ASAJA • Water management/drinking water
Annual/decadal forecast	• GDF/SUEZ – energy • Finance/energy
Decadal	• Agriculture (farmers interested in prediction of variability). • Forestry
Don't know	• City (Toulouse) • Flower and gardening

Unaware and no potential	
Decadal	• Procurement from design of aircraft and ships by military and commercial organisations

Participants were also asked to explain 'why' and 'how' these users were using S2D climate information particularly those already using this type of information. The majority of organisations/users identified use this type of climate information to improve the management of their activities, products, and outputs with a view to improve efficiency and, for those in the private sector, increase profitability. In terms of how these users were using S2D in their organisations these ranged from using forecasts as additional information to climatology to those using this information in operational/dynamical models to support decision-making.

Table 3 – 'Why' and 'How' users are using S2D climate information.

Sectors	Sub-sector/ Organisation	Why	How
Insurance & bank investment	Bank investment	Improve investments (return on); profits; minimising losses; to inform product development	Economic models (one of the drivers); risk models; strategic planning
	Insurance	Risk assessment (e.g. storms, agricultural production) for premium calculation	Basis – climatology; forecasts as additional information
	AXA	Their business to manage climate risk	They have climate department (capabilities)
Energy	In general	Improve products and results; security reasons; increase profits; planning; provide evidence required to support – statutory obligation; stakeholders requests; Demand	Operational/dynamical models (use as a driver); strategic planning; Support to decision-making (not

Table 3 – 'Why' and 'How' users are using S2D climate information.

Sectors	Sub-sector/ Organisation	Why	How
		(forecasts energy prices)	included in models)
	Power producers	Decide whether to tap the dams and sell off electricity in autumn or save for winter; anticipate supply and demand – strain on the grid; energy demand and energy supply (renewable energy)	Probabilistic Input to internal models
	Hydropower production	Demand forecasts; grid management; support for decision-making	
		Hydropower forecast	Temperature and precipitation (ECMWF +analogues) Hydrological model – river flow
	Hydropower + reservoir/dams operators	Snowpack estimation for spring flood forecast (reservoir refill)	
	Wind energy	More certainty about profitability and investment	
Water resources management	River Basin Agency	Planning	Spanish regulation giving % of resources restriction
	Basin/city water management authorities	Support emergency decisions; water restrictions; predict drought – advice on water restriction decision	
	DG Water	Support decision process (e.g. drought)	When implement emergency measures
	Dutch water management	Regulate groundwater level – less risk of flooding; freshwater – improve water supply over whole summer season	
	Water management authority APEE Romane	Water management for hydro-power management	Add the prediction to diagnose of present state to identify the options for water management on monthly and seasonal scales
	National Hydrological and Water Management Institute (Romania)	To make hydrological prediction	They use the S2D input in their statistical models
Tourism	In general	Communication/awareness; operations; medium-term planning/small scale investment; diversification; profitability; less	Strategic planning; risk/opportunity assessment; marketing; providing

Table 3 – 'Why' and 'How' users are using S2D climate information.

Sectors	Sub-sector/ Organisation	Why	How
		uncertainty.	advice to 'operators' regarding public
Agriculture	In general	Indentify which crops and areas (suitable)/ type; type of agriculture; business viability/minimise loss; trade; less uncertainty about production	Crop models/economic models; hydrological/irrigation models; pest model; decision-support model
Health	European Centre for Disease Prevention and Control (ECDC)		Modelling changing vector distribution (e.g. ticks - TBE, mosquitoes - malaria, tse-tse fly)
	Public health and civil protection	Developing extreme weather action plans; Preparing response	
	Municipal health authority	Public health/staff/resource planning; public health protection; developing public health capacity (e.g. Paris use in implementing heat-health action plan)	
	Ministries of health	Developing extreme weather action plans; National climate change and health strategy development – via UNFCCC reporting	
Media	In general (e.g. TV)	to capture general public interest for higher ratings; Headlines like "The summer will be fantastic"	they just take the communications from Met services; Any hint of high temperature
Urban planning	In general	Flood prevention (long-term); reducing urban heat island effect during heat waves (e.g. developing green spaces – skopje)	
Other	Public transport authorities	Infrastructure/capacity investment	
	NMHS	Apply downscaling and do some calibration	
	UK Environment Agency	water management; environmental protection; planning especially in drought	
	WSI	(dynamical and statistical) downscale	
	International development	Preparation for 'disaster mitigation	

Session 3 – Understanding the barriers and limitations to the use of S2D

This session aimed at understanding the current barriers and limitations to the use of S2D forecasts in Europe and also exploring potential solutions to overcome those barriers. The session started with a couple of presentations from ENEA and TEC on their experiences with users and some of the issues and problems identified with regard to the use of this type of climate information. An interactive session was then performed where these barriers and solutions were brainstormed and discussed amongst the participants.

3.1. "ENEA as a climate information provider: our experience with the energy sector"

Matteo De Felice, ENEA

Problems of definitions and terminology used in this area include: PCA or EOF[3]; anomalies; seasonal versus medium term forecasting; and weather versus climate.

TERNA is an Italian grid operator which seeks to predict peak demand in summer and photovoltaic production estimation. It uses past demand time-series information and there is an urgent need of information to describe the present and predict the future.

A range of problems persist however, namely lack of knowledge and the tendency to use traditional methods (inertia) by TERNA as well as the lack of accuracy of seasonal forecasts in Italy.

Providing information and the need to consider different trade-offs in the data supplied with regard to uncertainty and comprehensiveness of data - Completeness versus comprehension (i.e. that complex 'complete' information may not be usefully understood) (Figure 6).

[3] PCA stands for Principal Component Analysis and EOF stands for Empirical Orthogonal Function.

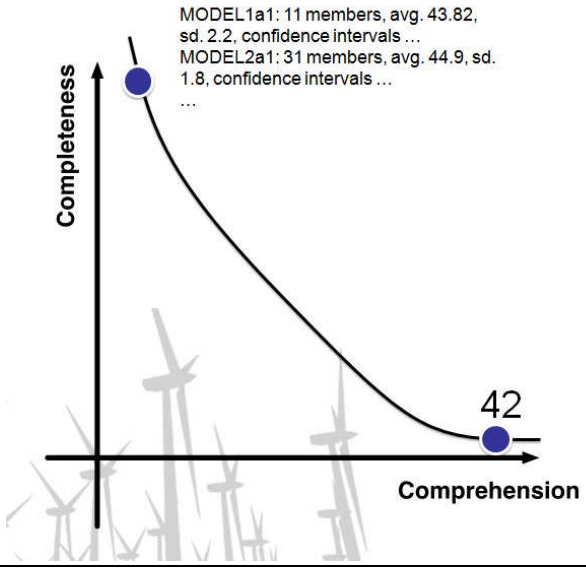

Figure 6 – Completeness versus comprehension of information (From De Felice, 2013).

Examples of common users' statements:

- "We need data on this location"
- "I don't know if this data is reliable"
- "Why do we have multiple climate change scenarios"

Questions/comments on the presentation

- With regard to the problem of communication between scientists and users: When does "stripped down" information become misinformation?
- Marked differences between doing science versus communicating science.

3.2. "Bridging the gap between providers of S2D predictions and potential users: Tourism as a case study"

Adeline Cauchy, TEC

Tourism sector is an area where forecasts/predictions can be of use across time horizons (i.e. monthly, seasonal and longer term). Potential needs and users of S2D predictions (largely based on TEC's experiences from the CLIM-RUN project) include:

- Seasonal forecast :
  - Seasonal temperature (destination level/home market) ;
  - Seaside tourism – indicators of bathing seasons ;
  - Moutain tourism – indicators for summer seasons .

- Seasonal to long-term indices (3 months to decadal) :

- Tourism comfort indexes ;
- Various climate data requirements from 5 to 20 years (spring conditions, sea level rise, extremes events).

There is also the need for decadal forecasts as these can be used by tourism actors to inform investment, site location, facility design, etc.

Potential benefits for using S2D forecasts from a stakeholder perspective (e.g. Mitra tourism) include:

- Communication and awareness of the destination (anticipation) ;
- Operational management (anticipation and adaptive) ;
  - Response strategies (e.g. encouraging indoor activities, organizing ephemeral events) ;
- Medium term planning (5 years) ;
  - Reorganisation of services on offer, diversification of activities, creating new brand ;
- Long term planning (5-20 years)
  - Infrastructure adaptation/development.

The users (or potential users) of S2D forecasts in the tourism sector range from:

- Institutional organisations at different scales : Ministry of tourism ; Professional agencies in the destination; Regional tourism agencies ; tourism offices.
- Privates actors : Tour operators ; incoming agencies ; professionals of tourism (e.g. outdoor activities) ; private investors (e.g. hotels).

Current problems and barriers in using S2D include:

- Low awareness in the sector (most do not know what's available);
- Short term vision and greater focus on economic benefits;
- No relationship between potential end-users and providers/purveyors;
- Lack of training in using climate information;
- Complexity of the products and interpretation (too "scientific");
- Lack of communication (graphs/maps);
- Issues with regard to reliability of the information (uncertainty/low skill) and accuracy of the products (too large scale; not enough parameters).

3.3. Interactive session

The interactive session aimed to explore and understand the existing barriers to the use of S2D climate information. Participants were asked to work in the same groups as those from the previous session. Each group was asked to brainstorm the main barriers to the use of S2D in Europe, write them down using post-its, and discuss these barriers in order to cluster them. The same was asked of each group but regarding solutions to overcome those barriers. Each group reported back the main findings from their table at the end of the session.

3.4. Main findings from interactive session

3.4.1. Barriers and limitations to the use of S2D

The main barriers and limitations to the use of S2D identified by participants revolved around issues of skill and predictability; capacity, relevance, and usability; accessibility and communication; changing existing practices; other barriers. These are described below.

- Skill and predictability

The issues around skill and predictability included unknown skill and poor/low predictability over Europe and/or lack of skill. For example, road maintenance in Spain does not make use of S2D due to poor skill whilst in Scandinavia, poor skill in seasonal prediction (which was tried, tested, and did not work) led to poor reputation of this type of information. There are also doubts regarding the usefulness of predictions of low skill although predictability is subject to windows of opportunity[4] and "sufficient skill" depends on application. The lack of deterministic skill, the marginal value of this type of forecasts, and the need to understand better the value of probabilities forecasts were also recognized as barriers to the use of S2D. The need to understand the difference between perceived and real accuracy of products was also identified by participants. Decadal predictions were regarded as unchartered territory.

[4] The term "windows of opportunity" refers to the fact that at times influences/factors which confer predictability will be stronger/clearer or act in concert, rather than in opposition. In such situations, signals (probability of an anomalous outcome) in the forecast are likely to be stronger. In addition, confidence in predictions would be greater than the average skill information may suggest. Such situations could be considered as a "window of opportunity" for using the predictions in decision making. These "windows of opportunity" however will vary depending on the phenomenon, thresholds, and decisions involved.

- Capacity, relevance, and usability

Limited resources and capacity by both users and producers were also identified by participants as a barrier to the use of S2D. These limitations included not only the lack of motivation to invest more money/time but also limited capacity to provide to users what is required, and limited capacity to ingest information.

The need to understand what users' need, how they use information, and what is relevant to their decision-making was also considered very important to increase the use of S2D. These included issues such as the adequacy of available information and requested information (temporal/spatial resolution); the need to understand and focus on reliable variables that are relevant to users (i.e. not just indices) and tailoring of information; the ability to exploit and demonstrate the benefits of S2D; and understand the asymmetry of risk (cool/hot summer; cold/warm winter).

- Accessibility and communication

Issues around accessibility and communication were also identified by participants including the difficulties in accessing data and information; lack of awareness by the users on what is already available; lack of interface (i.e. boundary organizsations) and/or a lack of awareness about who are the purveyors (i.e. don't know who to ask – need for advertising). Lack of tools to exploit the forecast information as well as the complexity of the products which tend to be too scientific and not user-friendly were also recognised as barriers.

Another important barrier was the communication around S2D. This included issues related to the language and terminology used between users and producers including scientific language and the format used to report scientific findings which are inaccessible to most people (e.g. "monthly – seasonal: too complicated to understand what S2D information really means"); how uncertainty is communicated e.g. how to explain the probability to non-expert and clear information on the limitations and assumptions made. A lack/limited support to users such as guidance, case-studies, and peer-products was also identified as a barrier to the use of S2D.

- Changing existing practices

Another barrier identified related to existing practices and the reluctance in changing existing working protocols. This reluctance is mainly related to the (perceived) risk in changing existing practices and protocols and also conservative approaches by both users (in their management practices) and producers (which for many S2D tends to be regarded an academic challenge). For example, the insurance and re-insurance sectors do not use S2D due to reluctance in breaking with existing practices. Another example is the lack of regulation in the Netherlands with regard to the use of climate information to plan for the future (e.g. housing sector and infrastructure).

- Other barriers

Other barriers and limitations identified by participants included the lack of knowledge by users regarding S2D and climate science in general. For example, poor knowledge of climate science advancements, red tape in the process of requesting and paying for climate predictions services were both recognized as a barrier for nuclear plants. Another example, but for farmers included poor knowledge of climate science advancements; poor knowledge of decision systems; costs for a large number of small farms. Another barrier related to the cost for obtaining this information (e.g. “won’t be used by public or academic sector unless it is free”).

The lack of scientific community to publish work and the lack of recognition of that work as scientific outputs were also identified as barriers. Other barriers included the complexity of climate-related impacts and forecasting climate impacts not perceived as a priority and perceptions of vulnerability.

3.4.2. Solutions to overcome barriers and limitations

The solutions identified by participants included those referring to interface, training, and communication; skills and predictability; and other solutions.

- Interface, training, and communication

The need to demonstrate the benefits, advertise success stories (e.g. case study pilots), and report on value added was identified by many participants as one of the most important solutions to overcome some of the main barriers to the use of S2D.

The need for new/improved interface(s) between users and producers was recognized including the idea of creating a climate service partnership or alliance in Europe (i.e. shared proposal, publications and establishing academic credibility) as well as a joined programme on S2D predictions and development of services (such as ECOMS project and JPI Climate). Other suggestions included the need for co-production and co-generation of services, products, and support to improve interactions (user-producer) and increase relevance (e.g. co-working on real case-study examples) and the use of professional organisations and groups for delivering solutions.

Education and training for both users and providers including more regular engagement and dialogue between these groups and using simpler language to communicate (e.g. scientist in plain talk, presentation and writing skills).

Developing better data portals (e.g. KNMI explorer) for sharing and disseminating information; promote events (e.g. conferences on real case studies examples,

showcases); share guidance and case studies/peer products as well as clear information on limitations and assumptions; and good illustrations, factsheets, and graphical presentations.

Other solutions included the need for advertising (i.e. purveyors need to be proactive – information "pushers") and the need to present the results in convenient and known format to end-users.

- Skill/predictability

Solutions on skill and predictability included improving the models to improve skill; invest in R&D to increase the number of people working in S2D models; use pilot case studies; and simplify the accessibility of data (technical, cost, policy). Moving from temperature/precipitation only forecasts to indices (e.g. cumulative, water balance) and devise predictions for relevant variables. Discussing the scientific and physical processes behind lack of skill and explaining why there is low skill (as it is different from usefulness) were also recognized as a solution.

- Other solutions

Other solutions included the need for public financing, and User Interface Platform (GFCS).

The feedback session from the group reiterated some of the issues with regard to the barriers and limitations identified by participants including:

- It is important to break existing practices. Many industries 'move as a pack' and none are keen to make the first move towards a new accepted standard as they see a risk to doing things in a different way.
- Retailers have exposure to large geographic areas and S2D variables are not right for them.
- The accuracy of different pieces of the overall puzzle is important for users e.g hydrology models can be more accurate than their input data.
- Cumulative indices important.
- Case studies of success would be useful.
- No published recognition of the middle space between science and users – increase the visibility of this through an industry journal? Elsevier has a new open-access journal entitled, *Climate Risk Management*, which may fill this gap: http://www.journals.elsevier.com/climate-risk-management/
- Opinion that consultancies can go out and produce anything from S2D predictions. This can lead to:
    - Users becoming disillusioned and forming an opinion that S2D is useless;
    - National Met Services often have to 'clear up the mess' since the user does not go back to the original provider but to the 'authoritative source'.

Session 4 - Lessons from abroad

The aim of this session was to share some of the experiences from those dealing with and using this type of climate information in other parts of the world where the development and use of S2D has a longer history than in Europe.

4.1. "A historical perspective on the use and need of seasonal climate forecasts"

Mike Harrison, Climate Insight

- A single model plot isn't the same as a climate service.
- A prediction service is different to a climate service; EUPORIAS project should look at the delivery of predictions services rather than climate services provision.
- Defines the output of a climate service as 'actionable climate knowledge' NOT forecasts.
- Searching for systems would be better than searching for forecasts.

Some lessons from Agricultural Production Systems Research Unit (APSRU; Queensland) – actionable climate knowledge – from analysis to synthesis – Experiences from 20 years of applied climate risk research in Australia (Meinke et al., 2006).

- First key lesson:
    - Climate knowledge needs to deliver true societal benefits;
    - Need to expand systems boundaries and fully explore the scientific and socio-economic tensions and interactions – the system is bigger than most of us thought;
    - Include socio-economic dimensions but without abandoning science foundations;
    - Need to achieve true integration of disciplinary knowledge; existing institutional arrangements often act as a disincentive to true integration; many examples of strong leadership BUT this is often institutional benefit rather than societal benefit.
- Second key lesson:
    - Real resourcing; the capacity to think and act beyond disciplinary boundaries is rare; Strong leadership is required.

Troccoli et al. (2008) provide examples of factors influencing decisions in the context of water management (Table 4).

Table 4 – Examples of language and perceptual barriers to achieve maximum communication and optimal decision making

(From Harrison and Williams, 2008).

Factor	Scientist's perspective	Water manager's perspective
Identifying a critical issue	Based on a broad understanding of the nature of water management	Based on experience of a particular system
Time frame	Variable	Immediate (operations) Long-term (infrastructure)
Spatial resolution	Defined by data availability or funding	Defined by institutional boundaries or authorities
Goals	Prediction Explanation Understanding of natural system	Optimisation of multiple conditions and minimisation of risk
Basis for decisions	Generalising multiple facts and observations Use of scientific procedures and methods Availability of research funding Disciplinary perspective	Tradition Procedure Professional judgement Training Economics Politics Job risks
Expectation	Understanding Prediction On-going improvement Statistical significance of results Innovations in method/theory	Accuracy of information Appropriate methodology Save money and time Protect the public Project jobs, agendas or institutions
Product characteristics	Complex Scientifically defensible	As simple as possible without losing accuracy Importance of context
Frame	Physical (atmospheric, hydrologic, etc.) conditions as drivers Dependent on scientific discipline	Safety and well-being Profit Consistency with institutional culture, policy, etc.
Nature of use	Conceptual	Applied

- Continues to be undue reliance on scores without recognition of the limited information that such scores can communities;
- Work by Simon Mason – produced verification scores from users' perspectives;
- Verification through WMO standardised verification system for long range forecasts and also verification scores from user perspective?
- Progressively recognized are the outstanding issues of delivering services; service delivery must include the decision process and delivery of information relevant to this decision;

- Benefit/value is not achieved through forecast quality alone, it is also the delivery of information to the user community;
- Effective and appropriate communication are the most significant factors of all – it is in regards to communication that the most significant advances may be made in the next few years; Effective and appropriate communication is the most fundamental part of this process yet all funding goes into the models;
- Seamless forecast system – great achievement but does not improve the skill; what we require is a seamless decision-making process.

- Suggested lessons for EUPORIAS include:
  - View the objective as a provision of services to supply information to decision processes and not as delivery forecasts;
  - Society exercise in which communications is central;
  - Engage the user throughout to ensure all aspects of the services and needs;
  - Consider giving leadership to the user not the scientist;
  - Eliminate provider institutional considerations (user at the top).

WMO ran Climate and Information Prediction Systems (CLIPS) project in 2000. Need to organise pilot studies to demonstrate the value of seasonal forecasts - similar to EUPORIAS. Asked why we have not moved on from this question, what are the issues to be addressed?

4.2. "The use of seasonal climate forecasts: lessons from outside Europe"

Maria Carmen Lemos, University of Michigan (via Skype)

The case of Brazil was reported in the literature as a successful one although that was not exactly the case on the ground. In 1991/1992 Brazil suffered less from drought through the use of seasonal forecasts. Lemos' work involved working in similar issues in other contexts to help understand what it could be done towards increasing the usability of seasonal forecasts.

There is a lot to learn from the USA and South America with regard to seasonal forecasts. Table 4 shows a summary of what can be found in the literature both from developed and developing countries. Some of her work looked at barriers and opportunities versus the 'fit' of data, interplay, and interaction and a lot of the positive case studies in the literature occur when there is a strong interaction between users and producers (Table 5).

Table 5 – Summary of opportunities and barriers that affect usability of seasonal forecasts (From Lemos et al. 2012).

	Barriers identified in the literature	**Opportunities identified in the literature**
Fit	Not accurate and reliable Not credible Not salient Not timely Not useful; not usable Excessive uncertainty	Accurate and reliable Credible Salient Timely Useful; usable
Interplay	Professional background Previous negative experience Value routine, established practices, local knowledge Low or no perceived risk Difficulty incorporating information Insufficient technical capacity (for example lack of models) Culture of risk aversion Insufficient human or financial capacity Legal or similar Lack of discretion	Previous positive experience Threat of public outcry; public pressure Perception of climate vulnerability Sufficient human or technical capacity More flexible decision framework Technocratic insulation Water scarcity In-house expertise Triggering event/crisis (drought, El Niño and so on) Organisational incentives Value research; information seeking
Interaction	Not legitimate One-way communication Infrequent interaction End-user relationship	Legitimate Two-way communication Iterative Trust Long-term relationship Co-production

The fit of data is a very important factor although this fit is also ‘moveable’ namely through the interaction between users and producers and an understanding of what can be achieved. This fit of data also influences and moves data from usefulness to usability (there is an important distinction between useful and useable) (Lemos and Rood, 2010).

Rather than downscaling the models to fit the users’ decision-making processes the users will fit their decision-making processes to existing and available data. For

example, paleoclimate data has been shown to be useful for drought planners/ water managers in getting information for one particular decision.

Wrap-up session from day 1

The majority of this wrap-up session was used by participants to present specific issues not covered in the workshop sessions but relevant to EUPORIAS. The three topics covered included: the initial findings of the survey developed for the SPECS project; a brief introduction to the 'South East Europe Climate Outlook Forum (SEECOF)'; and the SPECS-EUPORIAS data portal developed by the University of Cantabria. These are described below.

- **Initial results from SPECS' survey**

  Geert Jan van Oldenborgh, KNMI

As part of the SPECS[5] project a survey has been launched to assess which climate events that occurred in the recent past are most interesting to stakeholders. Up to now they have received 30 responses mainly from SPECS and people with a scientific background. From the events presented in the survey those most mentioned by stakeholders included seasonal events related to temperature (extremes hot/cold temperatures) whilst the most mentioned decadal events encompassed the warm summers in Europe 2002-2012 and cold winters in 1960s.

- **Introducing the South East Europe Climate Outlook Forum (SEECOF)**

  Anca Brookshaw, Met Office and Jean-Pierre Ceron, Météo-France

Anca described the main aspects regarding these Climate Outlooks Forums. These outlooks started to be developed due to the lack of capability in Africa to access this information and the main aim was to gather users and producers (Met Offices).

The South East Europe Climate Outlook Forum[6] (SEECOF) is a consensus process for achieving an outlook where users are involved and the outcome is typically a forecast for the next season. In the SEECOF there are more interactions and capacity across users and producers than in other parts of the world. However, the opportunity to get together and discuss issues downstream diminishes as users tend to get a little less involved.

[5] SPECS stands for Seasonal-to-decadal climate Prediction for the improvement of European Climate Services. For more go to: http://www.specs-fp7.eu/SPECS/Home.html.
[6] For more on this go to: http://www.seevccc.rs/?p=22

Jean-Pierre Ceron described an example of the use of this type of outlooks in Africa focusing on coffee production. The interaction with the users of the information occur by presenting a first consensus forecast (using all sources of information) and the impacts in different domains are discussed with respect to that consensus forecast. Another outlook in Africa is the forecast for Malaria which is owned by its users and considered as success case.

- **SPECS-EUPORIAS data portal**

  Maria Dolores Frias, University of Cantabria

The Santander Meteorology Group at the University of Cantabria developed a data portal for SPECS-EUPORIAS projects where users can access data. There are two links where more information on this data portal can be found (see below).

The link to the portal is:
http://www.meteo.unican.es/tds5/catalogs/system4/System4Datasets.html
The link to the wiki is:
https://www.meteo.unican.es/trac/meteo/wiki/SpecsEuporias

Session 5 - Interactions between users and producers of S2D

This session aimed to depict the interactions and relationships that exist between the users and producers of S2D (and other types of climate information). Similarly to previous sessions, this session started with a couple of presentations from European National Meteorological Institutes - Météo-France and Met Office – and an interactive session with participants afterwards. These are described below.

5.1. “Interactions between Météo-France and its users”

Jean-Pierre Ceron, Météo-France

The “Conseil Supérieur de la Météorologie” (CSM) is a users’ consultation body at the national level. The CMS was re-organised in 1991 and its mission is to:

- Evaluate the services provided by Météo-France to its users;
- Formulation of recommendations for different users (on behalf of the different organisations and users);
- Monitoring/following of provision;
- Suggests resources to meet user needs;
- Proposals for new products/projects.

The CMS is composed by users from both the public and private sector including:

- Members nominated by the Ministry in charge of Meteorology;

- Representatives of relevant ministries (23);
- Representatives of organisations involved in Meteorology and Climate (18);
- Specific experts with respect of their responsibilities or competencies (42);

There are also 11 Thematic Commissions in various domains[7] which are chaired by a representative of the relevant domains (elected for 2 years); representatives of organisations, users, experts from the corresponding domain(s); one expert from Météo-France (focal point - correspondent); one staff from Météo-France (secretary); and invited additional experts when relevant.

There are regular meetings including the Commission meetings (bi-annual meetings) where latest scientific and technical developments are discussed at Météo-France as well as discussion about potential areas for deployment/use, specific users' requests and preparation of the 'wish list' for next year.

Examples of the Commission meeting agendas:

- Agriculture:
  - The DRIAS web portal : Regional scenarios;
  - Spring frost days forecast in the Champagne vineyard;
  - The new "normal references"; Impact on agrometeorological parameters.
- Hydrology:
  - Hourly radar quantitative precipitation estimate reanalysis;
  - Infra Hourly radar quantitative precipitation estimate;
  - Snow measurements.
- Civil protection:
  - Forest Fire indexes for Reunion Island;
  - Snow sensor in plain areas;
  - Coastal vigilance implementation: results and prospects.

Other regular meetings include the plenary session (yearly) which includes:

- Thematic / technical conference (prior to the Plenary session);
- Commissions' reports;
- Action follow-up and answers from Météo-France;
- Commissions' wishes for the next year and prospects from Météo-France.

[7] The 11 Commissions are: Agriculture; Aviation; Commercial Aviation; Education and Training; Environment and Energy; Hydrology; Navy; Health and Biometeorology; Civil Protection; Tourism and Information; and Land Transports and Engineering.

The CSM is an interesting example for a sustainable interaction and dialogue between users and producers. This dialogue (the CMS) is part of Météo-France organisation and work (e.g. through regular meetings) and is also under the umbrella of the Ministry in charge of Meteorology.

The CSM gives a privileged customer focus at the national level (in addition to individual and regional/local actions and focuses) by providing a global view of needs and demands (via representatives) and possible co-ordination between the various demands.

The CSM help to sustain the proximity with users and meet their requirements and avoid not using existing knowledge (from meteorology and climate) which can be helpful to users.

The CSM is at the starting point of numerous actions at Météo-France e.g. agriculture and climate change, fog, hydrometeorology vigilance, heat and cold waves, observation and snow forecast, air pollution, and data rescue.

Questions/comments on the presentation

- What is the tenure of members?
  - President active for two-years;
  - Changing members.
- How do commissions manage user expectations regarding scientific capability?
  - Presentations from experts make users aware of what is possible (or close to possible with respect to near-future).

5.2. "Interactions with users of S2D information - the UK Met Office experience"

Anca Brookshaw, UK Met Office

Provides three examples of interactions between the Met Office and users:

- Example 1: User driven;
- Example 2: Unclear;
- Example 3: Science driven.

Example 1: River Volta authority in Burkina Faso

- Precipitation to predict water needs;
- Skill in this area;
- User driven: River Volta authority collaboration with the Met Office;
- User already had models;
- Collaborative;
- Served to enhance existing model.

Example 2: Prediction of West Africa monsoon onset

- Result of producer/user interaction;
- CSRP development;
- Strong user interest;
- Prediction of monsoon onset: result of close producer-user interaction;
- New science needed;
- Determined refinements in presentation format (experiment with different formats).

Example 3: Seasonable prediction for UK government

- Seasonal predictions for UK government (Cabinet office) 'producer-driven' product;
- Variety of users and uses;
- Some needs not achievable with current science;
- Generic product as a starting point;
- Continual interaction between producers and users essential;
- Information must be useful when combined with existing shorter term forecasts;
- Potential for skill is regional;
- No 'one-size fits all' solution;
- Need for "good quality" products;
- Need for user-relevant variables.

Skill in the UK is quite varied. However, even if skill is not great there is an opportunity to work with users and develop the variables they need by using windows of opportunity.

Overall comments:

- No one-size-fits-all solution;
- User-provider interaction can deliver additional benefits;
- No substitute for 'good quality' forecasts – continuing need for improvement in forecasting systems;
- Personal view: biggest hope for a quick gain is in forecasting user-relevant variables.

Questions/comments on the presentation

- Having low skill does not mean that the information cannot be used.
- "No useful contribution (skill) can still be useful." (i.e. indicate no change in needs).

- Mention that contribution takes place in “windows of opportunity” (i.e. signal versus no clear signal).

5.3. Interactive session

Participants were asked to gather in groups of 3 and share their experiences as a climate service provider or user interacting with a user/climate service provider. Participants were asked to perform ‘Active listening’ which consists of:

- Person 1 – Speak for 5 minute about his/her experiences;
- Person 2 – Actively listen to what is being said;
- Person 3 – Records in writing what is being said.

The roles then rotated between participants. The main findings from this session are described below.

5.4. Main findings from interactive session

The range of experiences from participants as climate services providers and/or users of climate information varied considerably given the nature of the organisations represented at the workshop. The majority of the climate services providers (e.g. NMHSs, ECMWF) have some kind of contact with the users of climate information although the users tend to change depending on the climate services provider. For example, whilst the main users of ECMWF products are the NMHSs; the NMHSs tend to deal with users in their own countries. In some cases, the relationship with users is already well established and there is regular contact between the NMHSs and users (e.g. KNMI, MeteoSwiss) whilst in others the contact tend to be ad-hoc (e.g. IPMA). In some cases (e.g. AEMET) recent efforts have been made to improve the relationship between the NMHS and some of the ‘bigger’ users.

As mentioned previously, the main users of seasonal forecasts in Europe are those in the energy and insurance sectors (e.g. MeteoSwiss, UK Met Office, EDF, ENEA).

The potential for using S2D climate information was also reiterated by participants across a range of sectors such as agriculture, tourism, health, planning, emergency services, etc (e.g. UKCIP, University of Cantabria, WHO).

Some of the participants did not have any contact with users (e.g. University of Cantabria).

Appendix 2 includes the text recorded by participants during this interactive session.

Session 6 - Understanding the chain of S2D provision

This session aimed to explore in more depth the chain of S2D provision across Europe and how this type of information travels from the providers to the end-users. A couple of presentations by the ECMWF and EDF provided some interesting aspects with regard to chains of provision and the relationship between the various parts involved. Following that, there was an interactive sessions where participants were asked to discuss and explore some of these chains. These are described in the sections below.

6.1. "Provision of climate information to ECMWF users"

Laura Ferranti, ECMWF

- Observations and monitoring are very important.
- ECMWF provides seasonal forecasts which are up to 7 months ahead.
- ERA interim and ERA clim are now free and graphical products provided with a week's delay.
- ECMWF provides skill measures – reliability?
- Accessibility to forecasts – re-analysis available online.
- ECMWF are primarily a provider of data which can then be used to add value by NMHSs or consultants.
- Seasonal user interactions generally through national met services.
- Users of ECMWF include:
    - NMHS for 34 estate and co-operative members. NMHS provide the most feedback; also have the best capacity to get data in house. They look after end users and provide tailored solutions. Includes UKMO, MeteoFrance and MeteoSwiss.
    - Few commercial users which include insurance and management companies (who tend to buy all products – weather too). Financial services take the product and combine with other statistical and dynamical predictions. Little feedback or dialogue with ECMWF.

Although not in the climate context, ECMWF and its members are confronted with a similar question: should we allocate some resources to develop new products to satisfy better the user needs?

We should focus entirely on improving the forecast and leave the "provision of the forecast" to NMHS. ECMWF tries to satisfy the needs of all their users (NMHS) but they don't interact with end-users; instead there is collaboration with NMHS to improve their capability and the development of their products.

Smaller countries do not have the same infrastructure – more difficult to reach end users. Annual user meetings and intensive training required.

Users tend to use seasonal forecasts and combine them with other statistical and dynamical predictions.

6.2. "Supply of S2D information to users: is there an ideal scheme?"

Laurent Dubus, EDF

Energy is (now generally) a competitive sector where issues of competitiveness, confidentiality and cost are all present. The management of a power system is very complex with many complex and interrelated processes in energy industry. Forecasts are required (e.g. for renewable resources and hydropower production) however it is very difficult to make forecasts due to the complexity of the system (Figure 7).

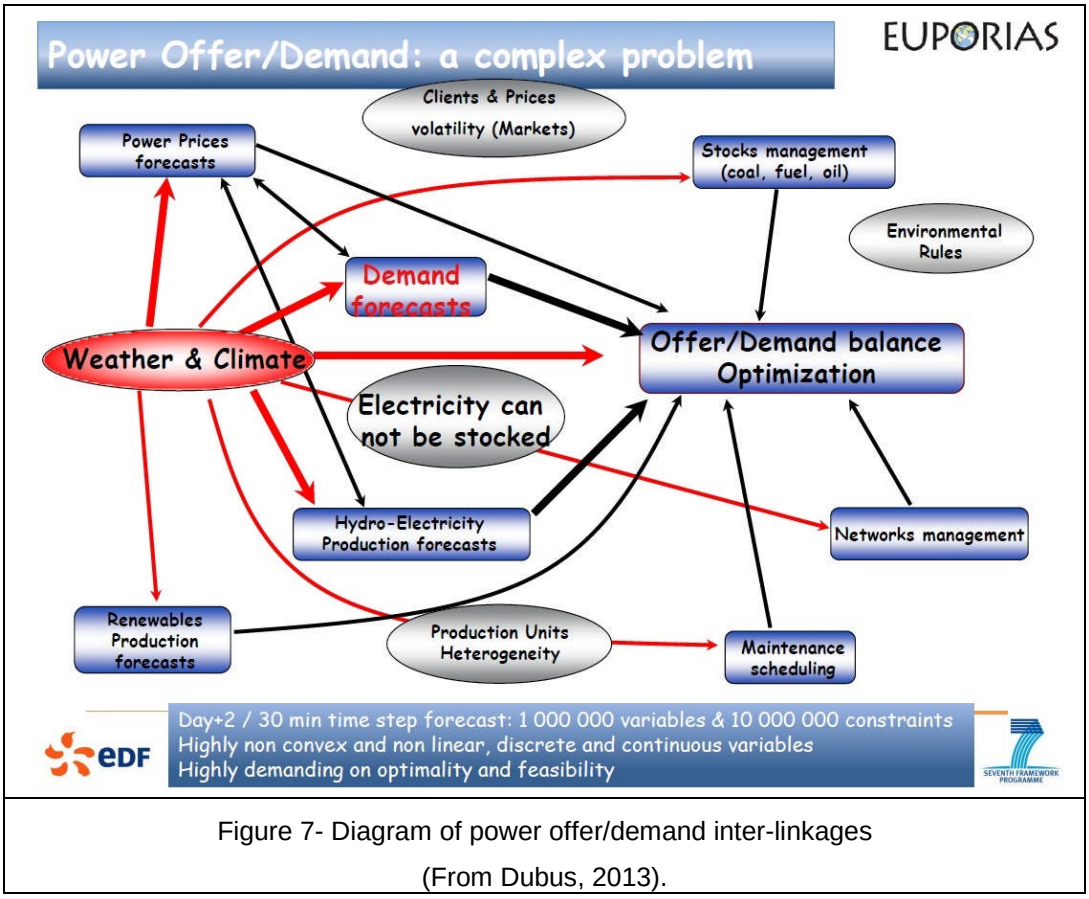

Figure 7- Diagram of power offer/demand inter-linkages (From Dubus, 2013).

Weather and climate information needed is very complex and requires skills in meteorology/climatology.

In addition, Power systems operators/managers/decision makers have (in general) little time to dedicate to weather/climate science training and, as such, it is important to have an interface between the forecasts and the decision-making (i.e. scientists/providers and the end-users).

This interface should include: Providers (e.g. Met Office, ECMWF), purveyor (private companies), in-house options (e.g. EDF has an operational team to do this).

However a range of problems can hinder this interface including:

- At the provider level (e.g. Met Offices) – problems of resources (human, funding); lack of knowledge regarding end-user (e.g. energy processes/business); confidentiality issues.
- At the purveyor level (e.g. private companies) – Can develop tailored products for each customer but there might be some confidentiality issues from the users' side due to competitiveness; cost of producing such products.
- At the end-user level (e.g. in-house) – availability of resources (human, funding); expertise in the applications at stake and no confidentiality issues.
- In terms of products and provision/use of information:
    - Provider: Raw data; forecasts; generic products; guidance;
    - Purveyor: Tailored products for generic/specific applications (when no confidentiality issues);
    - End-users: Tailored products when there are confidentiality/strategic issues/ complex applications/requirements.

The Supply of S2D information to users: is there an ideal scheme? This will ultimately depend on a number of issues namely the type of information delivered, confidentiality issues, and to whom it is provided (e.g. size of company, level of expertise in weather/climate, etc).

In any case, a close and early on-going collaboration is essential, including:

- Importance of knowing people personally;
- Importance of establishing a common language (e.g. in the energy sector «medium-term» deals with 1-3 years forecasts!);
- Set-up formal teams and meet regularly;
- Importance of training in both directions: weather – user;
- Development of product/service should be user-driven.

<u>Questions/comments on the presentation</u>

- Do we need a boundary organisation for Europe?

6.3. Interactive session

This interactive session aimed at exploring some of the chains of S2D provision across Europe. Participants gathered in groups and each participant was asked to, using the post-its provided, describe a particular chain of S2D provision. Then, working as a group participants were asked to discuss the different chains and try to merge them by finding commonalities across the chains and potential linkages between them. Finally, based on the chain developed participants were asked to discuss which products should be publicly and freely available and which should have a commercial value. The main findings from this interactive session are described below and the various chains of provision of S2D climate predictions identified by participants can be found in Appendix 3.

6.4. Main findings from interactive session

ECMWF consistently emerged at the beginning of chains. As described in Laura Ferranti's presentation (see section 6.1.) this organisation provides climate information (e.g. raw data which is freely available) to its European NMHSs members including AEMET, Met Norway, Météo-France, IPMA, Meteo Romania but also directly to other organisations such as Electricité De France, VG (media company), ENEA, national research centres, Skogforsk (Swedish forest research institute). These organisations tend to act as purveyors and perform the post-processing of this data before passing it on to users (on some occasions the end-user resides in the same organisation). This 'translation' process by purveyors include post-processing of data (Forecast post-processing by NMHSs which tend to be generic and freely available and/or for specific customer needs which tend to be paid for; and training users).

In some cases, the NMHS are the main providers of climate information such as the case of Meteo Norway which provides statistical forecasts to CBF which is an energy consultant who then 'translates' this information to energy traders. Another example, in the health sector, includes the case of DWD which provides climate information to Academic Institutions and/or public health institutions (e.g. University of Helsinki) who then 'translates' this information to the Ministry of Health in Kyrgyztan and Uzbekistan.

The main users identified by participants included those in the energy sector (e.g. EDF; Stat Kraft – Hydro-power company in Norway; Endesa - renewable energy company in Portugal; Electrica - Hydro-power provider in Romania); Government agencies and national institutes (e..g Ministry of Health in Uzbekistan; National Hydrological and Water Management Institute in Romania; Administration Apele Romane; Portuguese Civil Protection Service), and sectors such as the insurance sector, the media, general public, forest companies, road maintenance, etc.

An interesting linkage identified by participants was one involving the National Centre for Environmental Prediction (NCEP) based in the USA and ECMWF which, in some cases, work together to provide climate information for the Europe region.

This information tends to be freely available from NCEP/ECMWF but is normally a paid service when 'translated' to users by the purveyors. The two examples provided by participants included the Weather Services International acting as a purveyor of information to the financial sector in Europe; and WCS (based in the USA) providing information to EDF R&D (i.e. seasonal forecasts for temperature and precipitation for the Eurozone).

During the feedback session to the whole group, participants reiterated some of the issues and limitations to the providers such as the NMHS which included limitations to their resources, lack of knowledge of the business processes and users' needs, and how existing confidentiality issues in some organisations can hinder the development of useful products. The majority of participants agreed that NMHSs should be the main providers of 'raw data', generic products, forecasts, and guidance to users. NMHSs were identified as both climate information providers and purveyors.

A range of comments were also provided with regard to the issue of which products should be freely available as a public service and which should be paid for. In general, the majority of participants agreed that generic 'raw data' from climate information providers (NMHSs, ECMWF) should be freely available (as many are funded by the taxpayer) whilst products requiring tailoring should be paid for. However, some participants suggested that some commercial companies are profiting from this freely available data and therefore, maybe which products are free should be re-considered. Hence, the need to define what we mean by public and free data was raised by some as this will ultimately depend on who is using the information. Similarly, what we mean by 'raw data' was also questioned as this term may mean different information/products.

In some countries (e.g. The Netherlands) existing regulations dictate which climate information and products are free and publicly available. In addition, issues around quality control and the potential profit from certain products also influence what is freely available (e.g. users used to have to pay to access observation data from KNMI as the Government thought that there was a potential profit to be made there).

Another point raised, related to the need for adequate guidance on how to use the data as caution is required when using climate information.

User oriented products were regarded as very important and productive and requiring a close relationship and building of trust and a common language (e.g. relationship between Météo-France and EDF). Other examples and potential initiatives to enhance the relationship between users and producers was given including Journals that might accept papers in this context (e.g. AMS Weather Climate and Society, considers both science and social science; Elsevier Climate Risk Management new journal); and conferences such as the ICEM conference which aims to promote further relationships between energy and climate sectors.

Other comments by participants included the need for the weather and climate communities learn what is at stake and the process that users are going through (e.g. potential to provide training for end users on forecasts?). The idea that skill is a complete barrier to the use of S2D can be overcome if we understand better what the user needs from existing skill (i.e. existing skill may be suffice to the user) depending on the variables they need (what, when, how?).

Session 7 - What have we learned about S2D use in Europe?

The closing session was led by Professor Suraje Dessai who summarised some of the main aspects and issues brought to light during the workshop and directions for future work with regard to EUPORIAS' work package 12. These included:

- What aspects of S2D are of interest to users (or potential users);
- How do users evaluate the information with which they are provided;
- Lack of peer reviewed literature.

Future work for this work package:

- Stakeholder interviews;
- Key sector survey;
- Workshops with S2D climate predictions (includes SPECS and others);
- Surveys;
    - Indentifying barriers and enablers - how can barriers be overcome?

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Appendix 1 – List of workshop participants

Organisation	Participant	Country
Agencia Estatal de Meteorología	Ernesto Rodríguez-Camino	Spain
CETaqua	Laurent Pouget	Spain
Climate-Insight	Mike Harrison	UK
European Centre for Medium-Range Weather Forecasts	Laura Ferranti	Europe
Electricité de France	Laurent Dubus	France
Italian National agency for new technologies, Energy and sustainable economic development	Matteo De Felice	Italy
Climate Service Center	Teresa Zölch	Germany
Instituto Português do Mar e da Atmosfera	Mariana Bernardino	Portugal
The Royal Netherlands Meteorological Institute	Janette Bessembinder	Netherlands
The Royal Netherlands Meteorological Institute	Roeland van Oss	Netherlands
The Royal Netherlands Meteorological Institute	Wilco Hazeleger	Netherlands
The Royal Netherlands Meteorological Institute	Geert Jan van Oldenborgh	Netherlands
UK Met Office	Anca Brookshaw	UK
Meteo Norway	Rasmus Benestad	Norway
Metéo-France	Jean-Pierre Ceron	France
Meteo-Romania	Roxana Bojariu	Romania
MeteoSwiss	Christoph Spirig	Switzerland
Predictia	Daniel San Martín	Spain
Predictia	Max Tuni	Spain
Swedish Meteorological and Hydrological Institute	Lars Bärring	Sweden
Tourisme Transports Territoires Environnement Conseil	Adeline Cauchy	France
University of Cantabria	Maria Dolores Frias	Spain
University of Cantabria	Maria Eugenia Magarino	Spain
University of East Anglia	Clare Goodess	UK
United Kingdom Climate Impacts Programme	Roger Street	UK
University of Leeds	Andrea Taylor	UK
University of Leeds	Suraje Dessai	UK
University of Leeds	Marta Bruno Soares	UK
University of Leeds	Ruth Lawford-Rolfe	UK
World Health Organisation	James Creswick	Europe

Appendix 2 – Interactions between users and producers of S2D identified in session 5

The text below describes the conversations that occurred between the participants during interactive session 5.

- ECMWF – Monthly forecast users tend to be national meteorological services which normally ask specific questions on graphic products or help extracting the forecast signal for their region. Interactions with end-users are very limited as commercial users are mainly interested in the data but not interested in providing feedback.

- IPMA (Portuguese Met Office) – The Director is occasionally contacted by private sector users regarding products although many users don't know what they want and, as a result, an interactive discussion is needed to elucidate needs. There are seasonal forecasts for civil protection regarding forest fires (to help prepare).

- AEMET (Spanish Met Office) – Has provided climate services/products for many years although the list of available products was initially compiled without users. Recently a discussion with users ("large" customers) has started and in some cases has led to co-operation and joint ventures. Example with insurance companies where there was funding from insurers but also strong restrictions due to the need for a very specific service (3-4 years project). Another example with energy companies although in the case of wind energy it unclear what their exact needs are. AEMET has introduced new formats in all operational products. So far, seasonal forecasts move on a qualitative basis (between already established relationships).

- Romanian Met Office – Use ECMWF model and work with users. Previous bad experience particularly during the winter of 2010 where mild season estimation has led to a loss of credibility when the media and politicians blamed the meteorologists for the death of people in the north of the country after a cold winter. Users were the general public and information disseminated from the media. Following from that, the dissemination to the media has stopped but media now accuses them of keeping such information secret.

- MeteoSwiss – The use of S2D is limited to insurance and energy sectors. The interactions are two-fold: 1st contact from MeteoSwiss to insurance companies and then collaboration via research projects (funding) and specific results plus refinements to those outputs. More precise forecasts require time and space

resolution. Currently there are 7 commercial contracts with the insurance and energy sectors.

- UK Met Office - 2 or 3 insurance users focusing on tropical storms hitting the USA. There are combined assets with an interest in big cities. Decadal variability of storms. Prediction of number of storms. They stopped the collaboration and started using climatology again.

- SMHI (Swedish Met Office) – They have little experience with seasonal forecasts. Some experience from hydropower energy which tend to be interested in snowpack but have their own model. Tabloids: seasonal forecasts especially in summer season (for recreation). No skill (according to SMHI) but someone is providing this kind of information (however it has no skill according to SMHI's evaluation) now monthly outlooks by SMHI bought by tabloids. Agriculture potentially interested in seasonal forecasts and the forestry sector interested but reluctant (is there any skill?).

- KNMI (Royal Netherlands Meteorological Institute) – there is the need for long-term information (e.g. to inform the decision to buy salt for next winter). Coastal protection would also benefit from seasonal climate information to help prepare when there are long periods of rainfall, high tides and storm surges. Weighting the advantage of early frost that may be correct of more correct forecast with days warning. There is a relative penalty for false alarm or a wrong prediction (did not act because of false alarm last time). In terms of long-term climate information (i.e. decadal – 1/5/10 years) there is a need to do something but this costs money. KNMI does not have a system like Météo-France but have regular contact with users (e.g. Ad-hoc meeting with specific users). They also have the monthly outlooks - Low skill in general but for some seasons there is skill and this is available online (not a pushed service). Commercial weather providers do provide seasonal predictions and we do meet with them to exchange ideas and developments. There are many small companies that do translation of weather forecasts.

- Météo-France – Seasonal forecast application in Africa (3 countries). Problem to manage water resources in dry season (electricity, agriculture). How are users using the information? By downscaling seasonal forecasts; Better predictability of river flow; provide more relevant information; software to manage the dump. Sometimes climate information is taken into account although there are other factors (e.g. political).

- Meteo Norway - Provide climate information. Energy sector: statistical forecast (persistence) and teleconection. Start with simple climatology and add incremental information.

- Climate Service Center (Germany) - Short experience working at JPI climate. S2D focus for energy as well as agriculture, forestry, water, insurance (heavy rain). However, science is not yet fully developed as it is a new institute/provider. “Climate services” is not a concept in circulation in Germany.

- UKCIP (UK Climate Impacts Programme) – Only works with users. There is a lot of interest in seasonal forecast (e.g. agriculture). Seasonal 1-3 years. Emergency planning and multiple emergencies. Fire risk moving/sharing equipment. Tourism – ski potential (e.g. Scotland alternative activities). Forestry - longer term (e.g. where to spray, access to land). UK level also European – need to share resources across the board.

- World Health Organisation - From the perspective of the user side in the health sector: information on heat waves is very important. Interrelation with users is sporadic and driven by the subjective perception of general public. In the health sector there is a great potential to use S2D but now only long term projections are used or shorter term for heat wave prediction. What could be provided, what could be useful, and how the users could access the information. The language of transferring knowledge is needed.

- Electricité de France - End-user and diversity. Work at national scale and also islands. Multifaceted work and develop project with Météo-France. There are however commercial constraints. Ongoing collaboration with the other electric companies. Long way to user-driven production of information.

- ENEA (Italian National agency for new technologies, Energy and sustainable economic development) - The grid manager predicts next summer e.g. for seasonal - 3 months in advance – information avoid critical movements in grid in summer (hotter, more AC) no promises, assess potential, explain nature of climate information exchange of information (statistical ↔ climate) have to publish national demand, also regional demand - recognise the problem/produce correlation maps. Main driver is a temperature heat index (rel. humidity not easy to predict). Expand on national level. Dialogue for how power system is working. Still on-going.

- Predictia (Spain) – Users not using S2D predictions but they have experience in weather forecasts. They need information for maintenance of the roads in winter.
  Predictia (the provider) is able to provide downscaled weather prediction (1 week ahead) but in the future they will provide forecast up to a season ahead.

Predictia also provides a portal where tests are done for seasonal forecasts although no much skill yet.

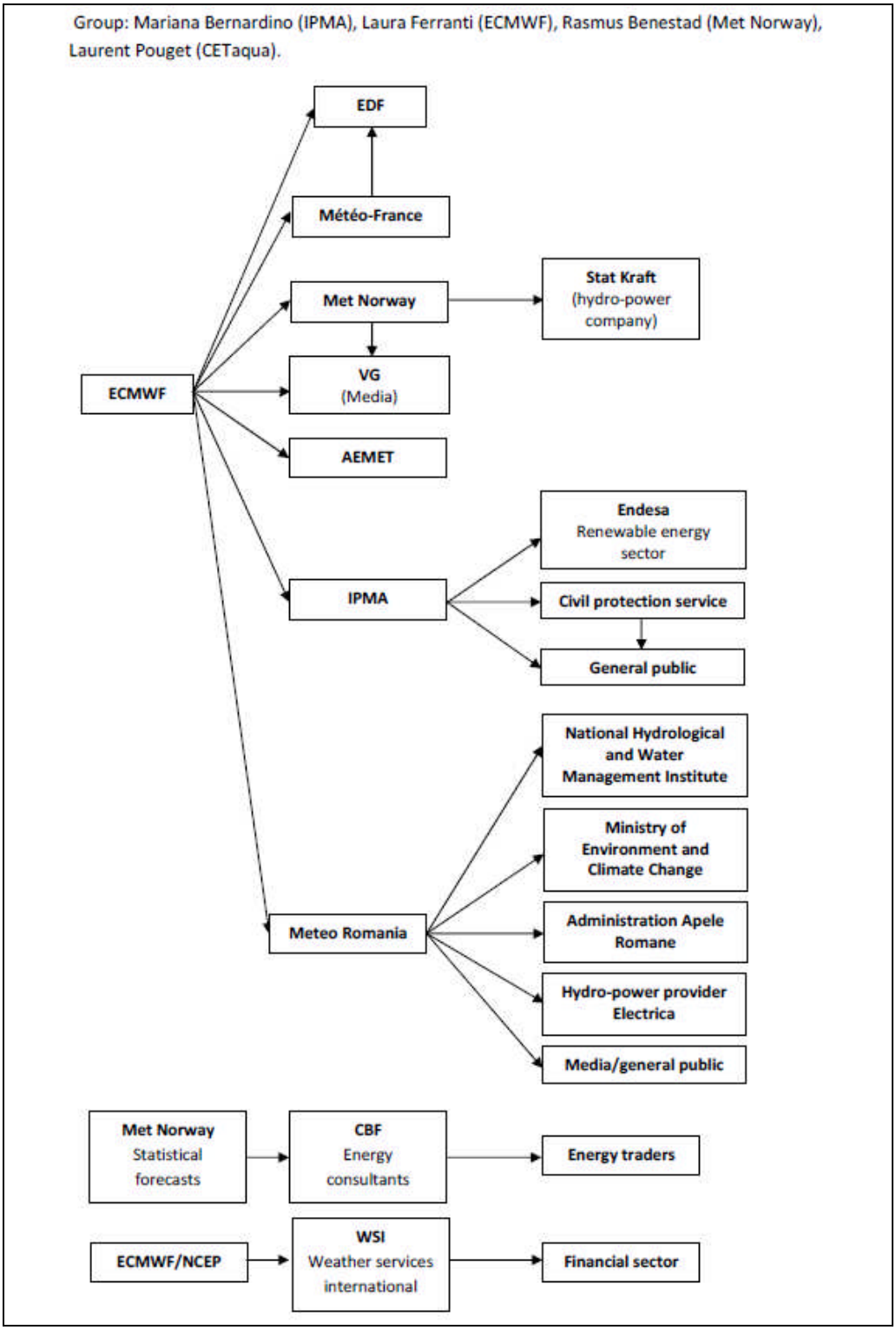
- CETaqua (Spain) - River basin agencies would be the main beneficiary of using S2D climate information in the water sector since they manage the resources and have some room for actions. There is also some potential of using climate information for water operators, which distribute or treat the water at the local level, but this would probably bring less benefit.

- University of Cantabria - No direct involvement with end-users. The university has started collaboration with users with the agriculture section (although full interaction has not occurred yet - similar experiences in Météo-France but once directly contacted users tend to become more engaged). They have used S2D information but probably didn't have enough infrastructure for using it.

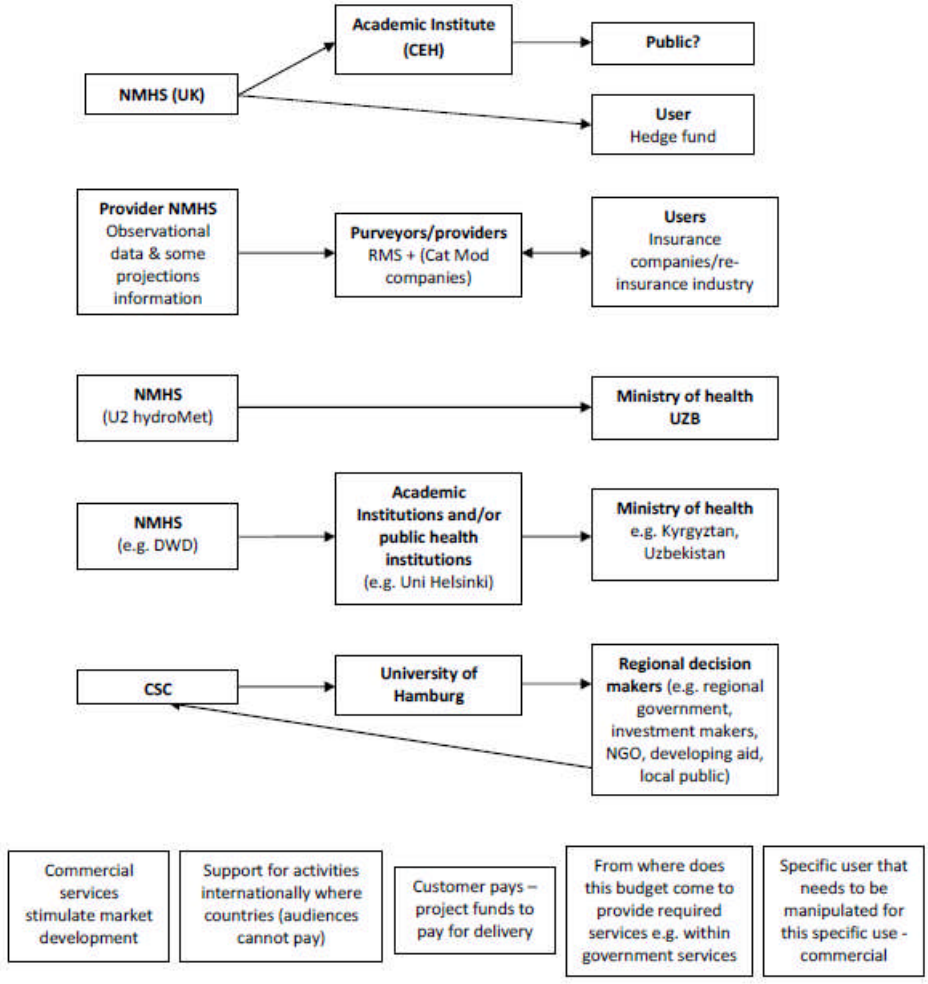
- Climate Insight (UK-based consultancy) - Starting with monthly forecast – demonstrated skills. Different sectors (transport, agriculture, energy, insurance…). No development in Europe yet but development in LDC (Africa).

Appendix 3 – Chains of provision identified in session 6

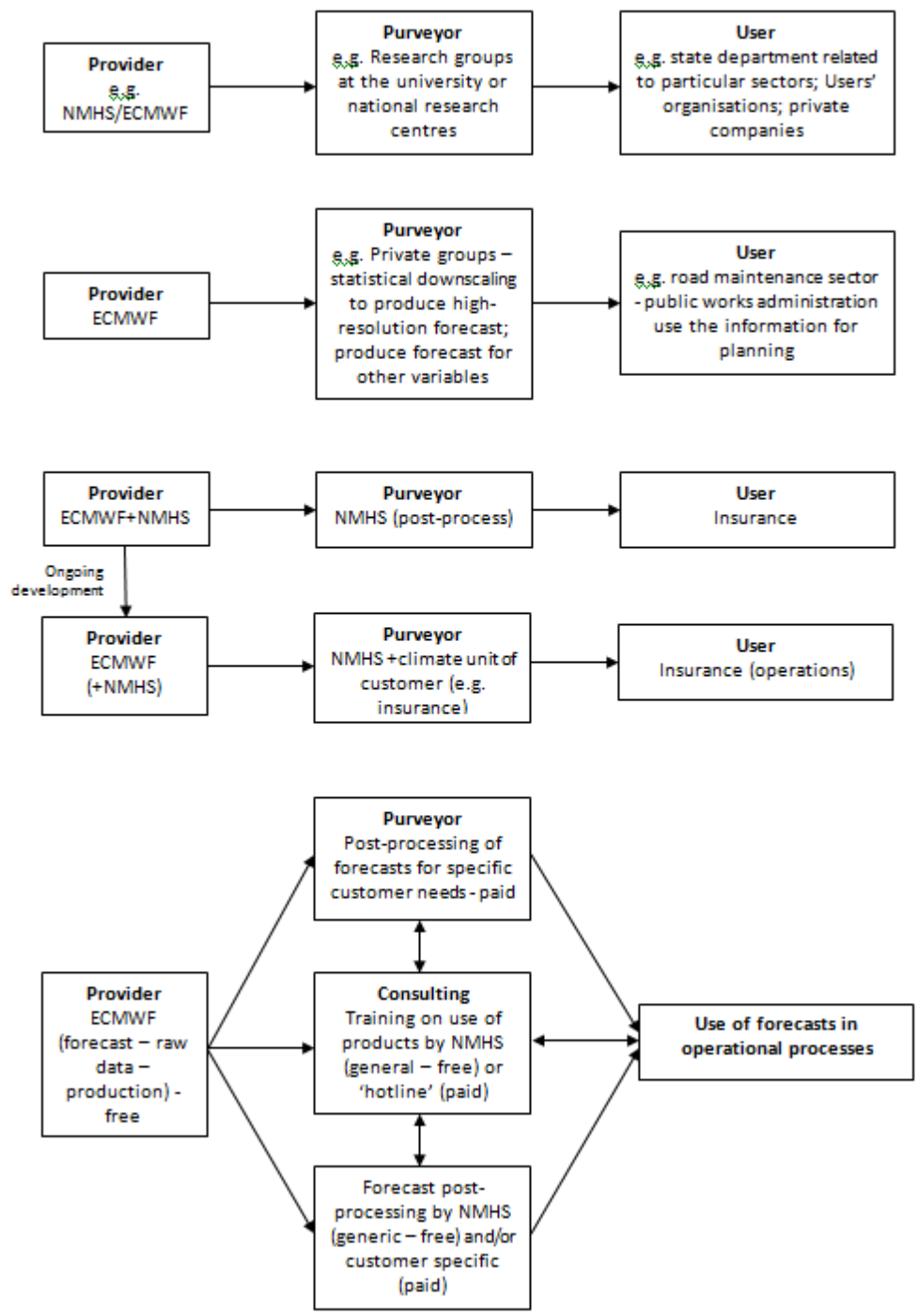
The figures below show the various chains of S2D provision identified by the various groups during the interactive session 6.



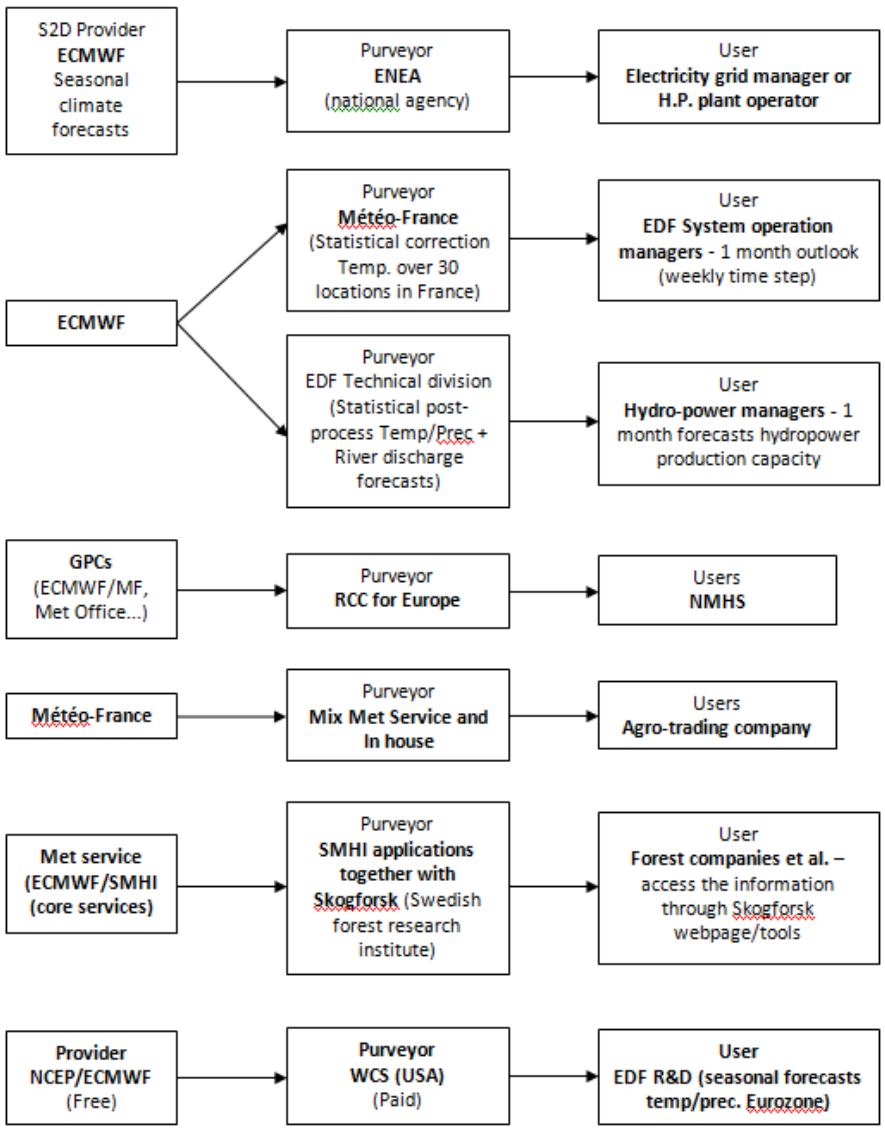
Group: Roger Street (UKCIP), James Creswick (WHO), Anca Brookshaw (Met Office), Teresa Zolch (CSC)



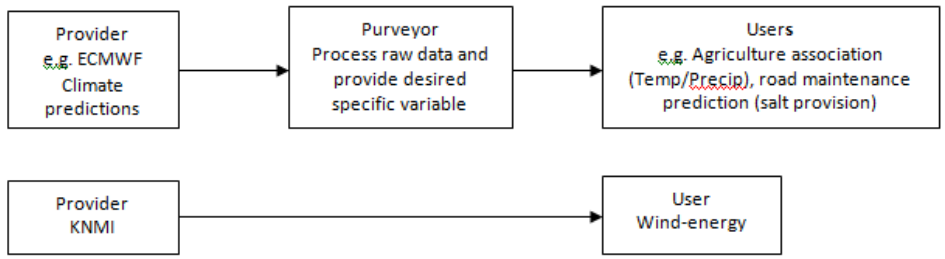
Group: Daniel San-Martin (Predictia), Maria Dolores Frias (University of Cantabria), Chirstoph Spirig (MeteoSwiss)



Group: Lars Barring (SMHI), Matteo De Felice (ENEA), Laurent Dubus (EDF), Jean-Pierrer Ceron (Météo-France).



Group: Max Tuni (Predictia), Maria Eugenia (University of Cantabria), Mike Harrison (Climate Insight), Janette Bessenminder (KNMI).



Appendix 4 - Summary papers

Ahead of the workshop, participants were asked to prepare a summary paper summarising their experiences and knowledge of the interface between climate services providers of S2D climate predictions (of climate and its impacts) and the users of such information. The aim for doing this was twofold: on the one hand, it would provide us an overall picture of the requirements for, and use of, S2D climate information across European sectors/countries. On the other hand, these papers would help us to shape the format of the workshop.
Participants were asked to prepare the summary paper by responding to six questions:

1. **Demand for information about future climate and its impacts**
   Describe what users are requesting/demanding in terms of information about future climate and its impacts in your country/sector (e.g., global climate model outputs, climate scenarios, climate indices, climate impact assessments).

2. **Demand for S2D climate and climate impact information**
   Describe what users are requesting in terms of S2D climate and climate impact information in your country/sector (e.g., seasonal forecasts for particular climatic or impact variables; decadal predictions) and how are they using it.

3. **Identifying the users of S2D predictions and its use**
   Provide details of who are the users of S2D predictions in your country/sector, how they are using such information in their activities (e.g., for operational activities, for developing their strategic/corporate plans) and what difficulties they are facing when using this information (e.g., too much data, too costly, too scientific).

4. **Tracing the interactions between climate services providers and users**
   Describe the relationship between those developing and providing S2D information in your country/sector and its users i.e., do the providers of S2D reach out to the users to develop the information or are the users of S2D that seek out and go to the providers to obtain the information? How does the interaction process starts and develop?

5. **Potential users of S2D**
   Within your country/sector, who do you think should be using S2D predictions? Why do you think these organisations are currently not using S2D predictions (i.e., what are the difficulties and barriers in obtaining and using S2D climate information)?

6. **Supply of S2D climate and climate impact information**
   In your opinion, which organisation(s) should be responsible for providing S2D climate and climate impact information in your country/sector (e.g., National Meteorological and Hydrological Services, private climate services providers, research organisations, others)?

Table of contents – summary papers

Summary from AEMET

E. Rodríguez-Camino, AEMET

0. Introduction

As background information, I will summarize the current situation at AEMET in connexion with climate services provision and user requirements which can be relevant for EUPORIAS WP2.1. Also some comments and personal thoughts are included to compensate the lack of sufficient objective sources of information.

AEMET currently provides S2D predictions on a very limited scale as compared with other climate services related e.g. with climate monitoring or climate change scenarios.

In order to have a clear picture of user needs and in response to our national responsibilities associated with the deployment of the WMO GFCS, AEMET has recently established an internal working group on GFCS: i) to examine the responsibilities at national level derived from the creation of the GFCS; ii) to identify synergies with different activities already conducted by AEMET and iii) to plan a strategy for the participation of Spain in the GFCS.

Among other activities, this working group is conducting a survey based on a questionnaire which has been distributed among approximately 150 users covering different sectors, regions and administrative levels. The selection intends to be representative of a wide variety of climate services and users. The questionnaire encompasses climate services broader than those related to S2D predictions. The questionnaire intends to characterize among other items the following ones:

i) Type of information most relevant for each sector.

ii) Climate services currently used and providers.

iii) Needed climate services not currently provided.

iv) Main hurdles to obtain or access to needed climate services.

v) Deficiencies on I+D climate related.

vi) Estimation of future needs.

vii) Their possible contribution to a user's platform.

viii) Their capacity for processing of information.

The questionnaire will be returned by mid-March 2013 and analysed by April 2013 and will provide a new picture of our current and potential users of climate services. Part of this work could be used for the design of a questionnaire targeted on S2D prediction users as part of the EUPORIAS works. Apart from the feedback information from the users, the AEMET working group is preparing a comprehensive report containing information on many other different aspects related with the implementation of the GFCS at national level. Most of our

answers to your proposed template are still our first guess mainly obtained from past experience and communication with existing users.

1. Demand for information about future climate and its impacts.

At Spanish national level, one cornerstone of the institutional response only restricted to climate change is the National Climate Change Adaptation Plan (PNACC in Spanish). This programme was adopted in October 2006 after endorsement by the Cabinet of Ministers. The PNACC is the reference framework tool for the coordination of Public Administrations' efforts dealing with the assessment of impacts, vulnerability, and adaptation to climate change in the Spanish sectors acknowledged as potentially affected, being water management the sector first cited in the documents due to its paramount role among the Spanish activity sectors. The National Adaptation Plan provides tools for the elaboration of diagnosis analyses and the development of more efficient measures for adaptation. One of the first activities carried out to facilitate the development of the PNACC was to prepare a series of regional climate change scenarios for Spain throughout the 21st century. AEMET was appointed as focal point to coordinate the national effort for the generation of downscaled climate change scenarios.. Thus, one of the challenges faced by this Plan was to have sufficient operational capacity, continuously progressing, to carry out the production of the successive scenarios at the regional level. The PNACC established certain priorities in its implementation plan for climate change impact studies and therefore climate information generation and provision was partly subordinated to such priorities. Sectors as biodiversity, water, coasts, energy, health, agriculture, tourism, etc were the first to be provided with specific information after knowing their needs and strategic plans.

Currently there are no institutional arrangements similar to PNACC covering climate services related with S2D predictions. The intention of the mentioned working group is to make a proposal for an institutional response to all activities contemplated in the GFCS. For specific requests/demands in terms of information only restricted to S2D predictions the main source of information will be the mentioned questionnaire.

2. Demand for S2D climate and climate impact information

Two strategic sectors have since long approached to AEMET demanding climate information: water and energy. In both cases we provide them tailored products on short and medium term forecasts and climate change scenarios. For seasonal forecasts we provide information based on a consensus forecast released after examination of all available sources of information mainly from global models. The renewable energy sector has greatly grown in Spain and has repeatedly expressed their interest in better and more accurate S2D predictions. Also water management authorities have to cope with frequent droughts affecting general population and agriculture over already water stressed regions. For them improved S2D prediction information is essential to plan contingency measures in water emergency situations.

3. Identifying the users of S2D predictions and its use

The low predictability of S2D predictions in Spain is the main impediment for a wider use of this information. Nevertheless some sectors –like water- making use of integrated information achieve higher levels of predictability. Whereas the water management sector uses S2D prediction information mainly to program its operational activities -even with the current low predictability- other sectors like energy uses S2D prediction information principally for developing their strategic plans.

Users of S2D predictions can also be classified by their capacity to use and process information provided in probabilistic terms. Some sectors, like the above mentioned water and energy sectors, frequently have their own research departments with climate experts either generating their own S2D prediction information or closely collaborating with other climate information providers to better exploit the available information. However, in our experience many users or sectors are overwhelmed by the amount of available information relative to climate predictions and they have asked us to process and simplify the huge volume of data. Simple postprocess –like interpolation, monthly average, ensemble average, etc- is a clear obstacle for many users preventing them to exploit S2D prediction information.

More details about who are the users of S2D predictions in Spain and how they are using such information in their activities will result after analysing the questionnaire prepared by the our working group.

4. Tracing the interactions between climate services providers and users

Generally speaking, there is not a clear and well defined model of relationship between those developing and providing S2D information. So far, some institutions in Spain mainly focused on research have developed some interaction with specify users in the frame of research projects. In fact, some successful examples of relationship between research institution and specific sectors can be mentioned as an example thinking of a future operation. However, outcomes from this research projects have not to date become an operational activity as such. The experimental character of most of the initiatives has in general terms prevented their crystallization as a long term operational activity.

With respect to the interaction process, whether the providers reach out to the users or on the other hand the users seek out and go to the providers, there is no clear picture in Spain at the S2D scales. However, the example of climate change scenarios for adaptation purposes, shows us that the establishment of a framework included some users interface platform has greatly facilitated the exchange of information and the whole interaction process.

5. Potential users of S2D

We appreciate that the final list of sectors clearly benefiting from S2D prediction information in Spain should include sectors like water management, energy, agriculture, health, forestry, tourism, environment …

Most sectors are currently not using S2D predictions mainly because of the low predictability shown in our region. Of course, in many cases also they are not enough aware of the

existing windows of opportunity allowing higher predictability under certain circumstances, e.g., some seasons, variables, clear ENSO signal, etc.

Finally, with regard to the difficulties and barriers in obtaining or using S2D climate information, we can mention the insufficient information meeting the needs of users. S2D is a relative novel activity for many NMHSs and other data providers. They do not have well established standards and formats for supplying information frequently affected by a high degree of uncertainty. Perhaps a certain parallelism can be done with the information on climate change scenarios. Only until recent years routinely production of downscaled climate change projections with expression of uncertainty was implemented in many NMHSs as part of their operational activities. Now most met services have groups specially dedicated to such quasi-operational activities supporting national activities on climate change adaptation. Probably, the deploy and implementation of the GFCS will mean the operational implementation of S2D predictions which still have a experimental consideration in many NMHSs.

6. Supply of S2D climate and climate impact information

In my opinion, NMHSs should be responsible to provide operational S2D predictions information. Operational activities are very demanding in terms of resources and sustained funding. This long term funding is very difficult to be guaranteed both by private providers and by research organisations. Most research institutions organize their activities based on funded projects with a relatively short time horizon. Of course, research aspects of S2D prediction activities can and should be also conducted by research organisations. Aspects related with climate impacts can be shared either by private climate service providers, research organisations, NMHSs or other governmental bodies.

Finally, we estimate from AEMET that the implementation of a User Interface Platform, as it is contemplated by the GFCS, will facilitate the interaction process among all actors participating in generation and usage of S2D prediction information.

Summary paper from CETaqua on climate services: Water Sector – Spanish context

Laurent Pouget, CETaqua

This paper summarizes CETaqua knowledge and experience of the interface between climate services providers of Seasonal to Decadal (S2D; which includes timescales from 1 month up to 10 years) predictions (of climate and its impacts) and the users of such information. The final aims of these papers are to provide to WP12 with an overall picture of the requirements for, and use of, S2D climate information in your country and/or sector.

The papers help WP12 team to shape the format of the workshop. It also allow us to put together a summary paper that moves forward our understanding of users' needs of S2D predictions across European society and sectors; this currently does not exist in the peer-review literature to our knowledge. The papers follow the 6 points template provided by University of Leeds.

The answers mainly reflect the water sector in the Spanish context but some information could also be applicable to other context.

1. Demand for information about future climate and its impacts.

Describe what users are requesting/demanding in terms of information about future climate and its impacts in your country/sector (e.g., global climate model outputs, climate scenarios, climate indices, climate impact assessments).

- **For water resources management (basin scale)**
  - No operational used of seasonal climate prediction identified
  - In CHEbro some test have been done to look for correlation between indicators from GFS model (AEMET). No significant results.
  - Other tests done in Catalonia for the Ter-Llobregat river basin (SOSTAQUA project in 2009). Good results for the test done.
  - S2D information would be useful to upgrade current management practices. The management of the resources by CHEbro (and possible restrictions) is based on a comparison of the current state with pre-defined thresholds and indices elaborated from historical data
    - Analysis done for the general meeting with CHEbro and users (“junta de explotación” with representative of agriculture sector, etc.) (in October and March) :
      - in October (start of hydrological year): they talk about the current situation (reserve in dam), and expected state in the next 6 months (based on experience and historical average)
      - in March: look at current state of water levels in dams and snow, and decide on water allowance for the irrigation period (April-October)

        - map comparing average resources with last 10 years
    - Monthly calculation of drought indices (as define in Management Plan, by sub-basin) that is used take measures for drought management (restrictions, emergency infrastructure operation, increasing monitoring and surveillance, minimum ecological flow discharges, etc.)

- **For water distributors/operators (city or district scale)**
    - The main use of S2D information is at the basin scale (River Basin Agency) but it could also be useful for local water distributors/operators
    - Information could be useful for the following purposes:
        - selecting sources of water resources (in case on interconnected catchment and combined subterranean and superficial sources of water)
        - managing in advance change in quality parameters (e.g. ammonium, turbidity)
        - operational management (e.g. contact with external provider for some chemical reactive, etc.)
        - financial planning (e.g. potential risk / opportunity, work with insurances)
        - prediction of water demand (climate condition could increase 15% demand between summer and winter)

- **Other sectors**
    - River Basin Agency such as CHEbro provide information on the state of the resources that is used by other end-users:
    - **Agriculture**, so farmers can plan the year accordingly (type of crop to sow), Short term predictions used to adjust irrigation, For red-fed agriculture ("agricultura de secano") CHEbro does not have responsibility
    - **Hydroelectric** (not responsibility of CHEbro), since part of the production has to be reserved to the energy market (not sold by the producer) where it is possible to sell/buy a few months ahead energy (e.g. 3 months ahead). It seems that ENDESA (Spanish electricity provider) use 3 types of predictions (AEMET, CHEbro, other).

2. Demand for S2D climate and climate impact information

Describe what users are requesting in terms of S2D climate and climate impact information in your country/sector (e.g., seasonal forecasts for particular climatic or impact variables; decadal predictions) and how are they using it.

No operational used of seasonal climate prediction.

S2D information could be integrated as a new input to the current decision support systems, which mean that ideally the scale of the information should be similar to the one used for other purposes, such as dams management for reducing flood risk.

Below details of how short term forecast information is used for flood management in CHEbro:

- Decision Support System (DSS) that make use of the data gathered by the hydrologic information system (SAIH) – Pioneer system in Spain (since 2002)
- use of 3 weather predictions :
  - WRF model (University of León) : 48 hour horizon and 0.03ºgrid resolution
  - HIRLAM model (AEMET) : 72 hour horizon and 0.16º grid resolution
  - GFS model (DWD) – 168 hour horizon and 0.5º grid resolution (Free data)
- Automatic link with several mathematical models (data transformed by CHEbro and used as input for a set of hydrological / hydraulic models).
- Daily modeling of the all system with the predictions, testing of different strategies of flood mitigation.
- CHEbro predictions on volumes stored at dams and river discharges are available free of charge via internet and are currently used by many end-users from many sectors (agriculture, energy, tourism)

3. Identifying the users of S2D predictions and its use

Provide details of who are the users of S2D predictions in your country/sector, how they are using such information in their activities (e.g., for operational activities, for developing their strategic/corporate plans) and what difficulties they are facing when using this information (e.g., too much data, too costly, too scientific).

Having reliable seasonal and multi-annual forecasts could be of great use for providing additional information for different type of uses:

- Water resources management – short term (operation) ➔ seasonal predictions
  - Ongoing test – no current use of seasonal forecast: no reliable information
- Water resources management – medium term (planning) ➔ decadal predictions
  - Use of climate change prediction for hydrological planning (horizon 2015 estimated no change, horizon 2027 consider climate change)
  - review of hydrological planning every 6 years (WFD)
  - plan or prioritize infrastructure, actions.
- Water operators
  - Ongoing test – no current use of seasonal forecast: no reliable information
- Agriculture
  - It may exist current applications (e.g. Cargill). No details.
- Hydroelectric
  - Some applications of climate forecast. No details.

4. Tracing the interactions between climate services providers and users

Describe the relationship between those developing and providing S2D information in your country/sector and its users i.e., do the providers of S2D reach out to the users to develop

the information or are the users of S2D that seek out and go to the providers to obtain the information? How does the interaction process starts and develop?

- No operational used of seasonal climate prediction.

5. Potential users of S2D

Within your country/sector, who do you think should be using S2D predictions? Why do you think these organisations are currently not using S2D predictions (i.e., what are the difficulties and barriers in obtaining and using S2D climate information)?

- See point 3.
- Main barrier is that no reliable S2D prediction is available.

6. Supply of S2D climate and climate impact information

In your opinion, which organisation(s) should be responsible for providing S2D climate and climate impact information in your country/sector (e.g., National Meteorological and Hydrological Services, private climate services providers, research organisations, others)?

- National Meteorological Agency (AEMET) in collaboration with private climate services providers that adjust the information to specific end-users

Climate services providers and users' needs – CLIM-RUN case studies

Clare Goodess, UEA

1. Demand for information about future climate and its impacts

The CLIM-RUN perception questionnaire (see 4 below) asked respondents to rank (as essential, desirable, not important, don't know) the potential different roles of climate services: provision of observed climate & weather data; provision of seasonal forecasts; provision of decadal predictions; provision of climate change projections; tools for displaying climate data; tools for analysing climate data; guidance in using tools and data; training in using tools and data, education and awareness raising within your profession. While noting that CLIM-RUN is focused on climate information, we also asked whether climate services should be extended to cover data and tools for climate impacts assessment, adaptation assessments and other applications issues.

A full quantitative analysis of responses across all case studies has not been possible but generally the emphasis of respondents was on observed data and forecasts/predictions/projections – and to a somewhat lesser extent some of the supporting tools and guidance. The responses may, however, have been influenced by the perceived focus of CLIM-RUN and the fact that other elements of the questionnaire focus very specifically on observed data and forecasts/predictions/projections.

In general, the specific requests and needs from users (see 2) are related to climate information, rather than to wider environmental or socio-economic data (though the importance of non-climate issues in decision making was raised in all stakeholder workshops). One specific request did, however, relate to the potential for developing seasonal hydrological forecasts for the Croatian hydro energy stakeholders.

In general, there is more interest in the near-term future (the next 20-30 years and the next 50 years at most) rather than the longer-term (end of century). Thus there appears to be strong interest in decadal timescales and in many cases, also an interest in seasonal forecasting (though with some questions concerning current reliability). There is also strong interest in the recent and historical past (i.e., in observed data).

2. Demand for S2D climate and climate impact information

It is evident, and not surprising, that user needs vary both between and within sectors, depending on the particular focus and responsibilities of the particular stakeholder/actor (e.g., whether they are more involved in operational issues or longer-term strategic issues relating to policy and/or infrastructure). There is, however, no evidence that users are requesting different variables or resolutions depending on the timeframe of interest (historical, seasons, decades, climate change), i.e., they want the same variables and resolutions for all past and future time periods (or have not specifically thought about this issue).

The most common requests are for temperature and precipitation and indices calculated from these variables, together with other meteorological variables such as wind (speed, direction and 'consistency'), snow, humidity and cloud cover. Radiation (in particular, DNI – direct normal irradiance) is important for the energy (solar – PV and CSP) sector. Extremes

of temperature, rainfall and wind are also requested for all case studies. For the coastal tourism case studies of Tunisia and Croatia, information about sea bathing water temperature is requested, and for the Tunisian and Venice case studies, information about sea level rise, storm surge and wave heights. Information about local winds (Bora and Scirocco) is requested for Croatia (tourism and energy) and there is an interest in dust storms for the energy case studies and the Tunisia tourism case study. The tourism case studies have expressed an interest in biometeorological comfort indices (based on temperature and/or humidity), as have some of the energy case studies (in the context of electricity demand for cooling). Fire Weather Indices are also of interest to a few stakeholders beyond the wildfires case study.

3. Identifying the users of S2D predictions and its use

For the non-renewable energy case studies, very few stakeholders are currently using seasonal forecasts. For the Greek wildfire case studies, for example, most respondents currently use historical observations, only around half currently use future climate projections or daily weather forecasts, and only a handful currently use seasonal forecasts. The lack of use appears to be primarily due to a lack of access – 2/3 of Greek respondents said they did not have access to seasonal forecasts. For this particular workshop, the majority of attendees/respondents came from public service or research institutes.

Some of the case-studies attempted a more systematic mapping of stakeholders (e.g., for the Tunisian tourism case study from small operators to a more strategic level). The Veneto case study used a ranking scheme from social scientists based on: importance; influence; effects; relevance; attitude.

4. Tracing the interactions between climate services providers and users

CLIM-RUN is working on specific case studies focused on renewable energy (Morocco, Spain, Croatia, Cyprus), tourism (Savoie, Tunisia, Croatia, Cyprus) and wild fires (Greece) as well as one cross-cutting case study (Veneto).

Members of the research team have been allocated to the Climate Expert Team or the Stakeholder Expert Team – with specific experts named for each case study. The CET and SET have engaged with local stakeholders using general co-ordinating project guidance and protocols. During the first ‘stage setting’ stage of the project, this was done through local workshops (in local languages where appropriate) and through use of perception and data needs questionnaires (mapping the issues). Following this, the CET members have been responsible for ‘translating’ the user needs. Needs have been categorised (not possible to provide, already available, easy to provide, able to provide, but with a lot of work) and first examples of products and outputs are currently being produced (and additional modelling tools developed). These products are being presented initially as two-page information or briefing notes with the following headings: Target groups; Relevance to the case-study requirements; The approach; Product example; Making the product usable. A number of these first products relate to seasonal/decadal prediction.

Planning has now started for the second round of CLIM-RUN stakeholder workshops that will be held for each of the case studies in Spring 2013. The second round of workshops is an essential part of the fourth CLIM-RUN key stage: Consolidation and collective review/assessment. The intention is to review both the process of interaction between CLIM-RUN scientists and case-study stakeholders, as well as the utility of the products and information developed in CLIM-RUN. Review questions will include: How far have we got?

How successful have we been? What are the remaining problems/gaps? How to sustain and extend the interactions?

From the experience so far, it is evident that there are difficulties and differences (both between and within case studies and sectors) in the level of stakeholder/user engagement (related to differences in expertise/motivation). New strategies are needed to improve participation where it is weak – and in these cases a need to demonstrate the 'value' of climate services (and in some cases to demonstrate that climate change and variability should be a concern for the particular sector/region).

5. Potential users of S2D

Potentially could be useful to most of the CLIM-RUN case studies and interest has been expressed by many stakeholders, but given the current uncertainties and limited predictability/reliability, help is needed in how best to extract the usable information and use it in decision making. A lot of the barriers relate to communication issues. For many users, there is still a need to clarify the differences between forecasts, predictions and projections. Lack of access to observed historical data may also be a barrier to wider use of future climate information.

6. Supply of S2D climate and climate impact information

There is a need for partnership working. Clearly the raw products/input need to come from public bodies. But particularly in the development stages, there are roles for research organisations. And all should be done in partnership with users (encompassing impacts application modelling as well as stakeholders). Given the current stage of development of S2D for Europe, there are particular responsibilities on the part of whoever are the final providers in terms of communicating the associated uncertainties/reliability.

ECMWF experience in providing seasonal forecast information

Laura Ferranti, ECMWF

Introduction to ECMWF

The European Centre for Medium-Range Weather Forecasts (ECMWF) is an intergovernmental organisation supported by 34 States, based in Reading, west of London, in the United Kingdom. The principal objectives of the Centre are:

a) Development and operation of global models and data-assimilation systems for the dynamics, thermodynamics and composition of the Earth's fluid envelope and interacting parts of the Earth-system, with a view to:

- preparing forecasts by means of numerical methods;
- providing initial conditions for the forecasts;
- contributing to monitoring the relevant parts of the Earth-system;

b) Carrying out scientific and technical research directed towards improving the quality of these forecasts;

c) Collection and storage of appropriate data.

In addition, the Centre:

- makes available to the Member States, in the most appropriate form, the results provided for in (a) and (b) and the data referred to in (c)
- assists in implementing programmes of the World Meteorological Organisation;
- provides advanced training to the scientific staff of the Member and Co-operating States in the field of numerical weather prediction;
- Makes the data in its extensive archives available to outside bodies.

ECMWF provides its numerical products to the meteorological offices of the Member States via a dedicated telecommunications network. The Member States use these products to prepare forecasts for end users. A selection of the most useful products of the Centre's forecasting system is made available to all countries of the world via the Global Telecommunications System, operated by the World Meteorological Organisation. A range of graphical products (some with limited access) is also available at: www.ecmwf.int.

The ECMWF provides:

- twice a day an ensemble of forecasts valid up 15 days in the future (medium range forecasts);
- twice a week the forecasts are extended to 31 days (extended range forecasts) ;
- once a month an ensemble of forecasts valid up to 7 months (seasonal range forecasts).

Decadal forecasting is not part of the ECMWF activity.

Seasonal forecasting at ECMWF and its demand

The prediction system currently used for seasonal timescales is known as System 4. It consists of an ocean analysis to estimate the initial state of the ocean, a global coupled ocean-atmosphere general circulation model to calculate the evolution of the ocean and atmosphere, and a post-processing suite to create forecast products from the raw numerical output (see Molteni et al. 2011; ECMWF report N.656 available at http://www.ecmwf.int/publications/library/ecpublications/_pdf/tm/601-700/tm656.pdf). System 4 includes the representation of uncertainties due to initial conditions and model formulation.

ECMWF has been issuing global seasonal predictions every month since 1997. In 2000 the seasonal forecasts became part of the operational products, and by mid- 2000 some of those products became available to all WMO Members. ECMWF is one of the Global Producing Centres for Long-Range Forecasts (GPCs) for the WMO. Consistent with the role of a GPC, the Centre aims to develop products that may be of benefit not only to the ECMWF Member States, but also to international organisations involved in providing guidance on climate-sensitive applications for developing countries.

Seasonal forecasts provide a range of possible climate changes that are likely to occur in the season ahead. Therefore seasonal predictions are typically expressed in terms of probabilities. Global maps of probabilities of tercile-based categories for three-month mean anomalies have been produced since the introduction of the first operational seasonal forecast system at ECMWF. In most cases, users are interested in spotting regions where significant deviations from climatological values may occur. To provide such information in a synthetic form, a plot with probabilities only plotted in those areas where (a) the highest probability among the three tercile-bounded categories is predicted for one of the two extreme categories and (b) such a probability exceeds 40% is produced.

Forecasts of tropical storm activity it is in great demand. This product is based on high frequency values (every 6 hours) for a set of atmospheric variables, so it is an expensive product to run for some users that have limited resources. At present ECMWF issues 5 different types of tropical-storm indices including a measure of forecast uncertainties.

Monthly mean time series of indices representing: area-averaged anomalies of Sea Surface temperature, precipitation and 2 m temperature, extra-tropical teleconnection indices based on mean-sea-level pressure or geopotential height anomalies and rainfall-based monsoon indices are also in great demand among the users. Time series allow the comparison between the forecast and climatological distributions in graphical form. This gives the user a visual impression of the difference between the forecast distribution and its climatology, and therefore of the significance of the predicted anomalies. Also, by comparing the model climatological distribution with the observed one, a user gets information about the ability of the forecast model to reproduce the observed anomaly range. Some users prefer to look at the differences between the climate and the real-time forecast distribution rather than using pre-defined categories. Some users are interested in assessing the tail of the forecast

distribution (extreme events) and this can be difficult to achieve by only looking at an ensemble with 51 members. Ideally users would like a clickable forecast map that could display any time series of forecast and climate distribution at any grid-point. Currently this facility is not provided simply because at grid point level the significance of any detectable difference between the forecast and climate distribution is likely to be rather small. Equally one may even wonder whether there is any predictive information in the monthly values. Although the seasonal forecast skill in capturing the monthly anomalies is small, typically the relative variations of monthly anomalies within the seven-month period have a counterpart in the observations. The use of the monthly means time series is a great example to show how crucial is to inform the users about the limitation of the forecasts. Forecast information should be used correctly and this is possible only by informing the users about the level of accuracy they can expect.

The principal aim of seasonal forecasting is to predict the range of values which is most likely to occur during the next season. In some parts of the world, and in some circumstances, it may be possible to give a relatively narrow range within which weather values are expected to occur. Such a forecast can easily be understood and acted upon; some of the forecasts associated with strong El Nino events fall into this category. More typically, the probable ranges of the weather differ only slightly from year to year. Forecasts of these modest shifts might be useful for some but not all users.

The benefits of seasonal forecasting are most easily established in forecasts for some areas of the tropics. This is because many tropical areas have a moderate amount of predictable signal, whereas in the mid-latitudes random weather fluctuations are usually larger than the predictable component of the weather. The point at which seasonal forecasts become good enough to be useful to a particular user will depend on the user's requirements. In some cases, today's systems are already useful, although care should always be taken to interpret model outputs appropriately. As reliability continues to improve, a wider range of applications should become possible, and the value of seasonal forecasts will further increase. More work is still needed to relate probabilities of large-scale weather patterns to detailed impacts and applications. It must be remembered, however, that there are limits on what it is physically possible to achieve with a seasonal forecast system. It will only ever be possible to predict a range of likely outcomes. In many cases this range will be relatively large, and there will always be a risk of something unexpected happening. In many parts of the world, most of the variability in the weather will remain unpredictable at the seasonal time scale.

Some seasonal forecasts available today are issued with probabilities (or error bars) which have been properly calibrated against past cases. A proper calibration of a forecast system against data is not always easy to do. This is primarily because of the limited availability of past data. The problem is especially severe when the level of predictability is low so that many years of data are needed. Relatively low predictability on the seasonal time scale is a feature of much of the globe, but especially in mid- latitudes, and for smaller spatial scales (several hundred km, rather than several thousand). At the moment, the ECMWF seasonal forecasts are not issued with calibrated probabilities. However, information about the reliability seen in past performance is available, in plots displayed together with the forecast

products. The limited number of past forecasts means that we can only give a rough estimate of the reliability, particularly for smaller regions or local values. It is clear that the direct model output is still quite some distance from being perfectly reliable, although the level of reliability is improving.

A correct interpretation of seasonal forecast products depends both on understanding the products, and on understanding the characteristics of the forecasting system as a whole. In particular it is essential to use information about the past performance of the seasonal forecast, the spatial distribution of the forecast skill and the forecast reliability. Remember that the number of past cases is limited, and although we can gain some indication of model performance, sampling errors mean that it is easy to either over- or under-estimate model skill.

The seasonal forecast products may be further expanded in the future according to users' needs. In order to progress with the product development, feedbacks from both operational and research communities are essential.

Seasonal forecast users

The main seasonal forecast users are: the National Meteorological Services of the ECMWF and WMO Member, the Cooperative States, several other international Organisation and few commercial users.

Typically the National Meteorological Services have their own climate unit that prepares the forecast statement, might apply some statistical corrections and/or downscaling, issues the forecast and deal with their local end-users and decision makers.

Some commercial users issue seasonal predictions for insurance, risk management companies and financial institutions around the globe. These users tend to take the ECMWF seasonal forecasts and combine it with other statistical and dynamical predictions.

ECMWF relationship with the users

The creation and issuing forecast statements is not part of the ECMWF duties. National Meteorological Services and other appropriate international organisations are dealing with such task. However, as a forecast producer, ECMWF is committed to provide the best possible forecast information.

ECMWF organizes annually a meeting of users of its products. The purpose of the meeting is to engage the users in contributing with their experience and to exchange views on the use of the products. In the meeting the Centre present a review on the development of the operational systems and encourage discussion about future developments including forecast products. Typically at the end of the user meeting a new list a requirement is agreed and that is one of the inputs for the products development.

On daily basis users receive assistance regarding data availability, software support, and request of additional information through the appropriate contact points.

ECMWF has an extensive education and training programme to assist Member States and Co-operating States in the training of scientists in numerical weather forecasting, and in making use of the ECMWF forecast products and computer facilities. Use and interpretation of ECMWF Products for ECMWF and WMO Member is a module that runs several time a year and is tailored to any users with some meteorological background. The aim of the module is to increase the student's ability to examine and assess ECMWF output products, and to produce user-oriented products. A basic purpose of this part of the course is to assist Member States and Co-operating States and WMO users in improving the interface between the Centre and the end users of its forecasts.

ECMWF has been involved in several collaborations working with end-users on seasonal forecast applications. One of the important objects of an EU-funded project entitled "Development of a European Multimodel Ensemble system for seasonal to inTERannual prediction" was to establish the practical utility of seasonal predictions, particularly to the agriculture and health sectors. Outputs from individual members of the multi-model ensemble were linked with tropical disease prediction models and European crop-yield models. Sensitivity and downscaling studies have also been undertaken.

At present ECMWF works in collaboration with the project QWECI (Quantifying Weather and Climate Impacts on Health in Developing Countries). The project, funded by the European Commission Seventh Framework programme, focus on climate and disease in Senegal, Ghana and Malawi and aims to give decision makers the necessary time to deploy intervention methods to help prevent large scale spread of diseases such as Rift Valley Fever and malaria. Scientists across 13 European and African research institutes are working together in order to integrate data from climate modelling and disease forecasting systems to predict the likelihood of an epidemic up to six months in advance.

ENEA experience with climate S2D data end-users

Matteo De Felice, ENEA

ENEA Climate Modeling and Impacts laboratory (UTMEA-CLIM) has been collaborating with TERNA, the Italian Transmission System Operator, since 2010. One of TERNA main issues is related to electricity demand in Italy during summer, where due to high-temperatures that can be reached in many parts of the country the use of electric air conditioning and ventilation becomes particularly evident and critical for electricity management.

Demand for information about future climate and its impacts

Currently TERNA is not using any climate information to plan and manage operations, and like other grid managers, TERNA is using historical demand data as the best estimation for the future for their monthly demand forecasts.

Demand for S2D climate and climate impact information

TERNA would like to have a forecast/outlook for the incoming summer temperatures in March-April. Their interest is not only on electricity demand forecast, given that they are also managing hydro-power production, they would like to have a prediction about river flows in the North of Italy.

Identifying the users of S2D predictions and its use

TERNA is not currently using S2D information for more reasons: difficulty to change decision-making processes, accuracy of S2D predictions over Italy, difficulties in understanding what S2D “really” are.

Tracing the interactions between climate services providers and users

UTMEA-CLIM laboratory has been contacted directly by TERNA because they needed more effective methods to deal with their more recent issues (electricity demand peaks during summer, renewable energies integration)

Potential users of S2D

Italy is experiencing a massive increase of electricity production from solar and wind power, not to mention hydro-power (Italy is the fourth country in Europe considering electricity generated). This means that all the companies on the energy sector can be a potential S2D user: TERNA, GSE (Italian renewable energies manager), electric utilities (e.g. ENEL and ENEL Green Power), wind/hydro/solar plant managers, etc. The reasons behind not using S2D climate information are probably similar to the ones we learned in our collaboration with TERNA.

Supply of S2D climate and climate impact information

Research institutes (like ENEA) can be directly responsible for providing climate data to end-user and, more important, support end-user and make data usable for their aims. In fact, institutes involved in climate services can be considered a kind of “interpreter” of climate data, the bridge between climate modelers and climate data end-users.

Climate services providers and users' needs – Renewable Energy (Wind & Solar)

Melanie Davis, IC3

1. Demand for information about future climate and its impacts

Describe what users are requesting/demanding in terms of information about future climate and its impacts in your country/sector (e.g., global climate model outputs, climate scenarios, climate indices, climate impact assessments).

Global Climate Model probabilistic forecasts for wind speed, wind direction and solar radiation (both DNI and GHI) over s2d timescales, including information on extremes. Ideally these forecasts should be included within industry standard energy impact models (e.g. WAsP for Wind and PV Syst for Solar), although some models need to be redesigned to be able to handle probabilistic forecasts.

2. Demand for S2D climate and climate impact information

Describe what users are requesting in terms of S2D climate and climate impact information in your country/sector (e.g., seasonal forecasts for particular climatic or impact variables; decadal predictions) and how are they using it.

Climate variables and its use as outlined in 1. This information is used during the site assessment stage of a new wind or solar project (where inter-annual and decadal forecasts are needed), and at the operational stage to predict energy yields over future timescales (where sub-seasonal forecasts of 1 month ahead are preferred, followed by seasonal forecasts of 3 months).

3. Identifying the users of S2D predictions and its use

Provide details of who are the users of S2D predictions in your country/sector, how they are using such information in their activities (e.g., for operational activities, for developing their strategic/corporate plans) and what difficulties they are facing when using this information (e.g., too much data, too costly, too scientific).

Key renewable energy (RE) users are the wind and solar forecasting companies who provide prediction services for RE project operators, enabling them plan the sale of energy back to the grid, and for RE project investors for strategic planning of their energy portfolios and risk assessments. In the future, there is also the potential for insurance companies to become a key user and to provide insurance covers for low RE generation due to low wind resources.

The difficulties that these users currently face in using climate information is the availability of forecasts is limited and not cheap, post-processing of the data to make it relevant to the RE projects is not well understood outside the climate community, and their is an overall lack of confidence in the skill of s2d forecasts.

4. Tracing the interactions between climate services providers and users

Describe the relationship between those developing and providing S2D information in your country/sector and its users i.e., do the providers of S2D reach out to the users to develop the information or are the users of S2D that seek out and go to the providers to obtain the information? How does the interaction process starts and develop?

The climate service providers generally approach the RE users. Users are, in general, interested to understand more about s2d climate services and can see its potential benefit, however, there are a lack of mechanisms in place to facilitate an ongoing collaboration (e.g. Few funds for joint programs that allow a transfer of scientific knowledge and techniques in both directions). As a result, interaction develops at an informative level, but rarely allows for in-depth, long-term collaborations. Such collaborations are also limited due to the difficulties outlined in 3.

5. Potential users of S2D

Within your country/sector, who do you think should be using S2D predictions? Why do you think these organisations are currently not using S2D predictions (i.e., what are the difficulties and barriers in obtaining and using S2D climate information)?

As outlined above in 3. There are no real users of s2d information at present in the RE sector, so all are potential users.

6. Supply of S2D climate and climate impact information

In your opinion, which organisation(s) should be responsible for providing S2D climate and climate impact information in your country/sector (e.g., National Meteorological and Hydrological Services, private climate services providers, research organisations, others)?

Raw s2d climate forecasts (i.e. without post-processing), should be provided by a public body. It is most important that these forecasts (their methodological approach, model ensembles, baseline information etc.) is homogeneous across all countries, otherwise their credibility will be lost. Private companies such as meteorological forecasting services can then use such information to tailor it to the specific needs of their users, which can stimulate business opportunities within the field of climate services.

IPMA

Mariana Bernardino, IPMA

1. Demand for information about future climate and its impacts

Describe what users are requesting /demanding in terms of information about future climate and its impacts in your country/sector (e.g., global climate model outputs, climate scenarios, climate indices, climate impact assessments).

The users contacting IPMA, request information about current and future climate and impacts of change in Mainland Portugal and Madeira and Azores archipelago. They require information on observed climate changes and future climate scenarios. Requests include climate variables such as temperature and precipitation but also sector specific information on their areas of activity. Requests for data are sometimes complemented by joint studies between IPMA and the user.

2. Demand for S2D climate and climate impact information

Describe what users are requesting in terms of S2D climate and climate impact information in your country/sector (e.g., seasonal forecasts for particular climatic or impact variables; decadal predictions) and how are they using it.

Currently, there are no requests for information beyond the seasonal range. Requests for seasonal forecasts are limited to a few sectors. For climate impact information, see answer to the previous question.

3. Identifying the users of S2D predictions and its use

Provide details of who are the users of S2D predictions in your country/sector, how they are using such information in their activities (e.g., for operational activities, for developing their strategic/corporate plans) and what difficulties they are facing when using this information (e.g., too much data, too costly, too scientific).

Users of (mainly) seasonal prediction information are of two kinds: (a) Private or state owned companies; and (b) Public Institutes or government offices. Sectors include energy production and distribution, water management, agriculture, and tourism.

4. Tracing the interactions between climate services providers and users

Describe the relationship between those developing and providing S2D information in your country/sector and its users i.e., do the providers of S2D reach out to the users to develop the information or are the users of S2D that seek out and go to the providers to obtain the information? How does the interaction process starts and develop?

Climate and seasonal prediction information generally compiled by us and provided generally is of limited relevance to the users. Most user requests can only be dealt with by setting a working group between us and the users to define the information needed. Specific activities follow to create such information. Typically, this process is iterated between us and the users.

5. Potential users of S2D

Within your country/sector, who do you think should be using S2D predictions? Why do you think these organisations are currently not using S2D predictions (i.e., what are the difficulties and barriers in obtaining and using S2D climate information)?

Users that could benefit from S2D information include: (a) Private or state owned companies; and (b) Public Institutes or government offices. Sectors include energy

production and distribution, water management, agriculture, and tourism. So far, the limited use of yearly to decadal information is due to (a) the size of the group at our Institute dealing with such issues, and (b) User awareness of recent progress on yearly to decadal outlook. We joined EUPORIAS, among other reasons, to facilitate the work with interested users.

6. Supply of S2D climate and climate impact information

In your opinion, which organisation(s) should be responsible for providing S2D climate and climate impact information in your country/sector (e.g., National Meteorological and Hydrological Services, private climate services providers, research organisations, others)?

Currently, National Meteorological Services have privileged access to the relevant information to provide S2D services. Research groups could complement the offer where the NMSs do not produce added value. If the fast growing S2D current research activities (e.g. EUPORIAS) deliver the promised developments, the balance of activities could be tilted towards the Universities and private service providers. Collaboration between public and private service providers could co-exist with benefit to both.

Met Office

Anca Brookshaw and Carlo Buontempo, Met Office

1. **Demand for information about future climate and its impacts**

Describe what users are requesting/demanding in terms of information about future climate and its impacts in your country/sector (e.g., global climate model outputs, climate scenarios, climate indices, climate impact assessments).

In our experience users approach producers of climate change information for a number of different reasons. More specifically there is a clear divide between multi-decadal climate projections and seasonal and decadal forecast. While the first tend to attract the interest of politicians and few strategic planners, the S2D forecasts have more of a direct impact on industries. At present very few sectors have an obligation by law to consider long-term climate change impact on their activities. For most decision makers multi-decadal information is only useful to put into context present variability and trends. For strategic decision on long-lasting assets (bridges, dikes, airports, power-plants) there are so many uncertain variables that actually climate often appears to be a small, and in some sense more predictable, component.

So here I only consider near-future time scales here. Even so, we need to consider a very large set of different customers and needs. In my experience the insurance sector is not only aware but also interested in the most recent science developments. Their ultimate goal is to increase the predictability of some specific event, but there is also interest in funding projects which are enhancing the general understanding of the climate system (e.g. Willis Research Network, AXA projects, prizes etc.,) As a sector they are also interested in the interdependence of specific events/perils (e.g. Tropical cyclone in the north Atlantic and wind storms over Europe) and their statistical characteristic (e.g. clustering).

After insurance companies the next most clued-up set of customers are the energy companies. As a sector they have generally a good understanding of how weather affect them. As for many other sectors the difference between weather and climate is not usually well understood. Seasonal information is used already by many traders in this field. Interestingly seasonal predictions have value for them also in absence of skill. For example, the fact that the experts expect a, let's say, cold winter, is known to have an influence on gas prices.

Water companies are normally smaller players and in my experience and with few noticeable exceptions only partially use S2D information in their decisions. This can potentially be an area to look at more closely within EUPORIAS as we know that large basin act as integrator (in time and space) and may help adding further predictability to the seasonal predictions.

On S2D timescale agriculture is probably the sector we currently work with the least.

2. **Demand for S2D climate and climate impact information**

Describe what users are requesting in terms of S2D climate and climate impact information in your country/sector (e.g., seasonal forecasts for particular climatic or impact variables; decadal predictions) and how are they using it.

Type of information requested and provided:

- variables: seasonal temperature, precipitation, atmospheric circulation, tropical storm activity, anomalous onset of season, flow into reservoir
- timescales: seasonal, sub-seasonal (15-30 days ahead), annual, decadal
- geographic regions: UK, Europe, Africa (especially East and West), southern Asia, tropical ocean basins
- type of forecasts: processed information at appropriate scales (country or region averages), qualitative assessments, graphical displays, data

Also requested, but not yet provided: wind, risk of snow, duration of spells, threshold exceedence, storm landfall.

Examples of users/uses:

- UK government: contingency planning
- regional climate centre, regional climate outlook forums: regional outlooks to assist with early warning and planning at national level
- water management company: planning and operational management of water resources
- insurance/reinsurance: planning

3**. Identifying the users of S2D predictions and its use**

Provide details of who are the users of S2D predictions in your country/sector, how they are using such information in their activities (e.g., for operational activities, for developing their strategic/corporate plans) and what difficulties they are facing when using this information (e.g., too much data, too costly, too scientific).

Main UK users:

- contingency planners and other government agencies (e.g. Environment Agency)
- Defra and DECC – especially longer-term predictions
- DfID
- traders (energy)
- energy companies

Main impediments to use:

- level of forecast skill
- lack of geographic specificity and information on timing

Recent developments: with hydrological research institute (CEH), develop a seasonal outlook of UK ‘hydrology’ (e.g. ground water storage, river flow), informed by seasonal prediction of meteorological variables

4. **Tracing the interactions between climate services providers and users**

Describe the relationship between those developing and providing S2D information in your country/sector and its users i.e., do the providers of S2D reach out to the users to develop the information or are the users of S2D that seek out and go to the providers to obtain the information? How does the interaction process starts and develop?

Full range of types of interactions:

- science (provider)-defined products: e.g. to UK government

- user-defined requirement: e.g. data to some traders

- products developed by provider-user collaboration: e.g. reservoir inflow, products for some traders

In all cases, interaction between provider and user is ongoing, whether aimed at reviewing format or content of products, or simply as update on changes to operational systems.

The provider offers training in the use of the information; the users present occasionally their experience with using the information.

We have experience of both approaches by individual users and initiatives originating with the provider.

5. **Potential users of S2D**

Within your country/sector, who do you think should be using S2D predictions? Why do you think these organisations are currently not using S2D predictions (i.e., what are the difficulties and barriers in obtaining and using S2D climate information)?

Long-range predictions are inevitably probabilistic and typically have lower skill than weather forecasts; they relate to large areas and relatively long time periods. This has implications for potential users: anybody with significant vulnerability to climate and weather variations, whose decision-making process allows for probabilistic inputs may benefit from using seasonal forecasting information. As with other types of probabilistic information, usefulness can only be assessed on a set of, rather than individual, 'events', which poses the risk of losing interest if the first few issues are not perceived as 'correct'. (long-term commitment to the use is needed before the usefulness can be quantified meaningfully). Skill of long-range forecasts (and, potentially, their usefulness) is dependent on the geographic area they refer to: users with exposure in parts of the world with high seasonal predictability would benefit most (e.g. crops in Australia, water management in western Africa, southeastern Asia).

Predictive skill over Europe is currently limited; here the potential is for identifying windows of opportunity for predictability. Potential users in this region would be those who can exploit this feature.

6. **Supply of S2D climate and climate impact information**

In your opinion, which organisation(s) should be responsible for providing S2D climate and climate impact information in your country/sector (e.g., National Meteorological and Hydrological Services, private climate services providers, research organisations, others)?

Any organisation with relevant expertise, operational capability and commitment to scientific integrity would be suitable.

However, it is very important to ensure that long-range prediction products are scientifically-based; this requirement can often come under pressure from the perceived needs expressed by some users and the provider's desire to meet them as stated. In particular, the information on the uncertainty in the forecasts is at risk of being discarded or disregarded.

Long-range predictions are not fully useful in isolation, but make most sense as part of a continuum of forecasts for decreasing timescales; predictive capability on a range of timescales would be an advantage, and this makes NMHSs obvious candidates.

Météo-France

Jean-Pierre Ceron, Météo-France

1. Demand for information about future climate and its impacts

Describe what users are requesting/demanding in terms of information about future climate and its impacts in your country/sector (e.g., global climate model outputs, climate scenarios, climate indices, climate impact assessments).

Climate scenarios at regional scales, climate indices. A specific web portal so-call "Drias" has been developped for France.

2. Demand for S2D climate and climate impact information

Describe what users are requesting in terms of S2D climate and climate impact information in your country/sector (e.g., seasonal forecasts for particular climatic or impact variables; decadal predictions) and how are they using it.

Information at seasonal scale (Decadal is not operationnal yet). Energy domain, Ministeries (tourism, water, health), water dam management (trans-boundary catchement), Regional authorities, RCOFs, WMO, NMHS, International Organisations (RCCs, ...), ... Generally needs of climatic variables (or equivalent). Some impacts infered (e.g. IFRC, New-Caledonia, ...).

3. Identifying the users of S2D predictions and its use

Provide details of who are the users of S2D predictions in your country/sector, how they are using such information in their activities (e.g., for operational activities, for developing their strategic/corporate plans) and what difficulties they are facing when using this information (e.g., too much data, too costly, too scientific).

4. Tracing the interactions between climate services providers and users

Describe the relationship between those developing and providing S2D information in your country/sector and its users i.e., do the providers of S2D reach out to the users to develop the information or are the users of S2D that seek out and go to the providers to obtain the information? How does the interaction process starts and develop?

The interaction process starts with consultations at the national level via our "Conseil Superieur de la Meteorologie" which is a council where all the relevant sectors are represented (inside thematic commissions). So there is regular meetings to advertise on the state of the art and to
discuss about specific questions/requests from the user domain. Once a year, there is a plenary meeting under the umbrella of our ministery where the different commission ask MF to adress specific wishes. MF is committed to answer on the feasability and possible dates and a follow-up is done (yearly).

5. Potential users of S2D

Within your country/sector, who do you think should be using S2D predictions? Why do you think these organisations are currently not using S2D predictions (i.e., what are the difficulties and barriers in obtaining and using S2D climate information)?

Energy, Water, Agriculture, Insurance, Tourism, Health awareness of potentialities of S2D, relevance of proposed products (tailoring), data from the user domain (knowledge of impacts of climate
variability and tailoring) some reluctance to change the current practises in operations, data access/data merging (related to the UIP), demonstration of benefits of the use of climate information,

6. Supply of S2D climate and climate impact information

In your opinion, which organisation(s) should be responsible for providing S2D climate and climate impact information in your country/sector (e.g., National Meteorological and Hydrological Services, private climate services providers, research organisations, others)?

That's depends on the economical models imposed to the NMHS and other political/economical choices in the country. The question of climate vs impact information can be treated differently with respect of NMHS capacities and users capacities and needs. Generally speaking, the
research side is not well shaped to provide information on a regular basis (operationnal provision)

Seasonal to Decadal User's Needs @MeteoSwiss

Christoph Spirig, MeteoSwiss

1. Demand for information about future climate and its impacts

As national weather and climate service MeteoSwiss is expected to provide up-to-date and well-founded information about future climate for Switzerland. Governmental and political bodies as well as the general public basically wish as much information as possible at the best spatial and temporal resolution available. It is our responsibility and everyday challenge to respond to this "infinite" demand by providing robust information on future climate with a clear communication on the uncertainties and limitations.

Current activities and services of MeteoSwiss:

- Public information on climate forecasts for Switzerland on all time scales.
- National climate change scenarios (in collaboration with the Swiss climate research community, www.ch2011.ch).
- User specific climate scenarios for particular regions or applications.
- Participation in selected impact studies (impact studies are not a core activity of MeteoSwiss)
- MeteoSwiss provides climate forecasts on a commercial basis to customers.

2. Demand for S2D climate and climate impact information

MeteoSwiss' current product portfolio of monthly and seasonal forecasts (no decadal forecast services are currently provided):

- Monthly forecasts (ECMWF monthly forecasts):
- Probability maps (upper, medium and lower tercile probabilities of weekly temperature, precipitation and 500 hPa pressure)
- Tercile data for selected locations and regions (same parameters as for maps)

- Seasonal forecasts (ECMWF System 4):
- Probability maps (upper, medium and lower tercile probabilities of 3-monthly temperature, recalibrated temperature, and precipitation), months 2-4, 3-5, 4-6, and 5-7.
- Tercile data for selected locations and regions (upper, medium and lower tercile probabilities of monthly temperature, recalibrated temperature, and precipitation, months 1-7).
- Climagrams of monthly temperature and precipitation anomalies for months 1-7

All these products are available worldwide.

Additional demands/wishes from our customers:

- Forecasts of all ensemble members at daily time steps
- Seamless ensemble forecasts
- Decadal services

3. Identifying the users of S2D predictions and its use

Users of our monthly and seasonal forecasts (MFC and SFC)

1) General public (we provide MFC and SFC on our web site for Switzerland) MFC is more frequently visited than SFC
2) Insurances
   Within insurances, application seems to focus on agricultural and energy sector, forecasts are mainly used in their operational activities (contracting) in the weather derivative market. Some information is also needed for prizing and market strategies in the context of natural hazards.
3) Energy companies (energy trading, production planning, consumption forecast)

Difficulties:

- limited skill, particularly in Central Europe.
- costs (not only the forecasts, but also the necessary post-processing infrastructure for benefiting from S2D FC)
- missing internal knowhow and resources to interpret the forecasts for the particular application.

4. Tracing the interactions between climate services providers and users

Almost all S2D information we provide today had its origin in common research efforts between users and us (providers). It is the regular and continuous exchange between the users and providers that drove the developments.

The initial idea for a common research effort came rather from the provider, in search of an attractive application for the new tool of SF.

5. Potential users of S2D

- Governmental and regulatory agencies (e.g. basis for calculating customs tariffs for agricultural products)

- Nutrition industry

- (renewable) energy producers

Difficulties and barriers in obtaining and using S2D climate information:

- see difficulties under section 3, plus temperature and precipitation alone are not sufficient, other parameters including indicators desirable

- missing knowledge of the users on possibilities and limitations of S2D forecasts

- interpretation depends on application, provider needs detailed knowledge on the costumers application case.

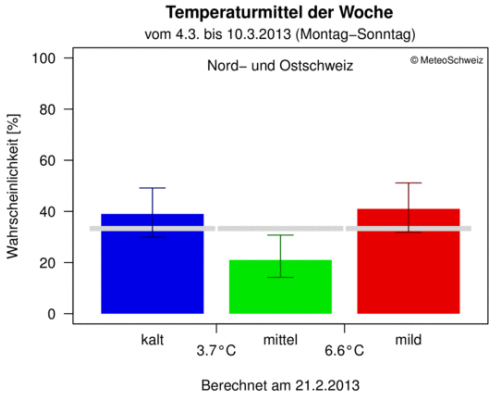
6. Supply of S2D climate and climate impact information

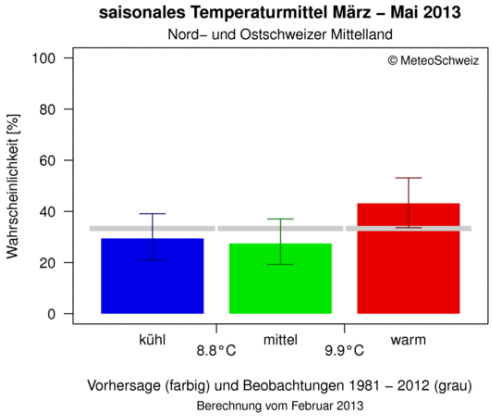
National Met/Hydro Services should provide S2D climate information. Climate impact information may also be provided by the Met Services or in close collaborations with organisations/researchers specialized on the respective application field. Probably no general recommendation possible, as this depends very much on the organisation of the Met Services, climate research, environmental agencies etc. and their interaction in individual countries.

Appendix: MeteoSwiss monthly and seasonal forecasts

Web forecasts:

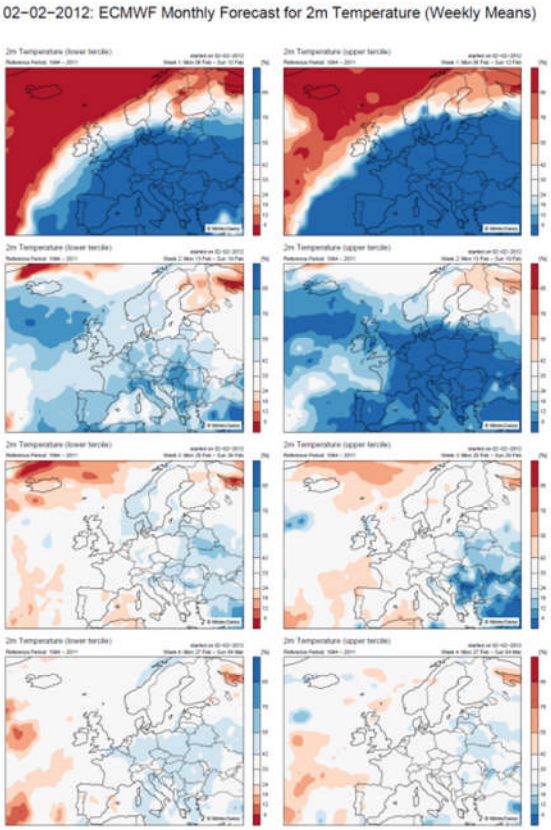
Tercile plots for weekly temperature anomalies from monthly forecasts(left) and for monthly anomalies from seasonal forecasts (right) for Switzerland.

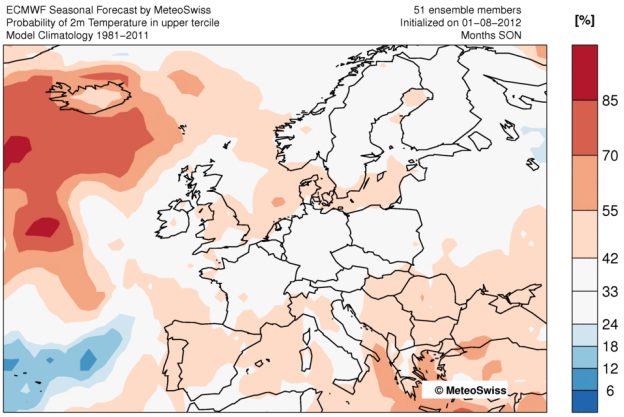




Probability maps:

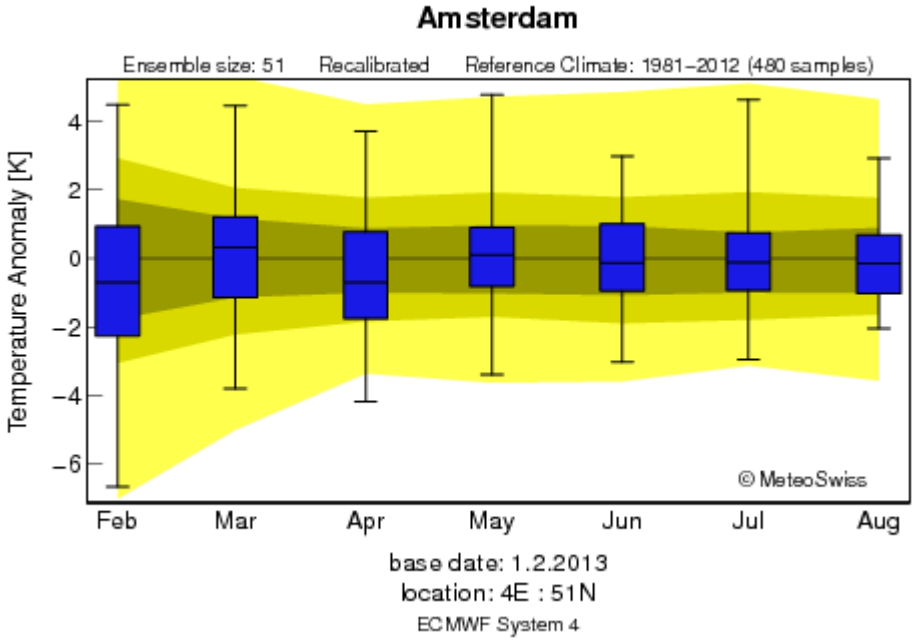
Tercile maps of weekly temperature anomalies from monthly forecast(left) and corresponding map of 2-4 month temperature anomalies from seasonal forecasts (right).

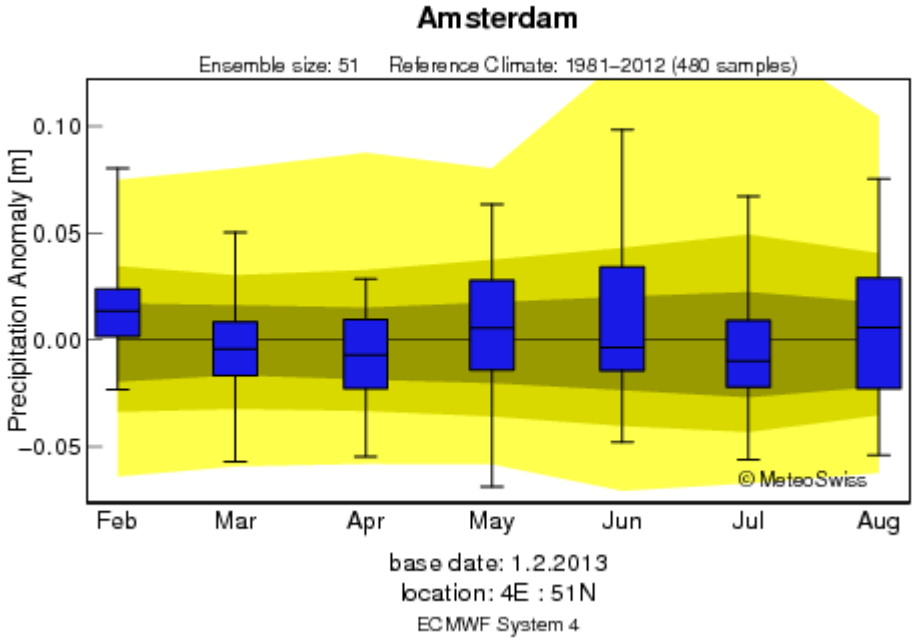




Climagrams

Ensemble distribution (boxes) and climatology (shading) of temperature, recalibrated temperature and precipitation for months 1-7.





Climate services providers and users' needs: experience from the Norwegian Meteorological Institute

R.E. Benestad and A. Mezghani, Norwegian Meteorological Institute

1. Demand for information about future climate and its impacts

Describe what users are requesting/demanding in terms of information about future climate and its impacts in your country/sector (e.g., global climate model outputs, climate scenarios, climate indices, climate impact assessments).

In general downscaled scenarios, and usually not raw climate model results. Often they want advice about which model to use rather than considering the entire ensemble. Sometimes, they ask for two 'extreme' (but reliable) models or the median/mean model.

Hydrologists want time series of precipitation and temperature as input to their hydrological models. The spatial and temporal consistences are important, and they preferably want daily or higher time resolution. Sometimes, monthly data may do. Often, their demand is for local climate information.

The hydro-electrical sector wants to plan production and maximize their returns by selling off surplus energy, stored as water mass in dams. However, if they tap the dams before a dry spell, then they may deplete their magazines for subsequent power production. In Norway, the power producers want to know the likelihood of a sequence of dry autumns (low accumulation) followed by a cold winter (high demand). Hence, monthly and seasonal temperature and precipitation are important, but they may also find information about the NAO valuable, especially since much of the precipitation in southwestern Norway is orographic and depends on the westerly flow.

The electric-grid providers want to make strategic decisions about the network load and want to make sure that electricity can be safely delivered without interruptions. They want to know the mean demand and supply (mean temperatures) in addition to frequencies and spatial extent of exceptionally cold snaps. This information may involve monthly or seasonal scales, but on a regional basis. Both regional temperature and precipitation as important.

The insurance industry is interested in extreme precipitation (flooding) and storms (wind). These are local data, often on daily or sub-daily scales. Climate information as a function of geography/location.

Tourism & recreation. The city of Oslo is contemplating arranging winter Olympics in 2022, and the successful outcome and cost of this arrangement depends on the weather during the fortnight. Hence sub-monthly temperature statistics is important. Moreover, the sequence with dry cold condition followed by a warm period with rain may cause problems for skiing and winter recreation.

Ski races (e.g. Birekbeineren) have been cancelled due to lack of snow or blizzards. Snow cannons. Mountain lodges may go out of business if the traditional Easter an winter-break tourists cease to come to the mountains due to lack of snow. Local/regional climate information.

For forestry, storms and wind falls are important. These also affect the bark beetle population, which also is affected by the temperature. Temperatures above a certain threshold may result in two breeding cycles within the warm season, imposing a greater bark beetle stress on both dead and living trees. Regional/local climate information.

Extreme events such as flooding, frost, and hail affect agricultural crops, however, farmers also state that soil that is too wet for ploughing also is a big problem. Good local seasonal forecasts can help them plan the season, and aid the decision of whether plough the fields in the autumn or in the early spring. Local decadal forecasts can provide information needed to dimension drainage. Hence, the farmers need a wide range of climatological data, on various time scales of local hourly statistics (risk of hail) to seasonal and annual.

The media is very interested in regional seasonal forecasts and the prognoses for the summer holiday season.

For municipals, climate information can aid designing the infrastructure and dimensioning of drainage to cope with intense short-term precipitation (hours). Flooding may also affect transport systems and mud slides/rock slides represent a considerable hazard. Regional precipitation on hourly to monthly scales are relevant.

2. Demand for S2D climate and climate impact information

Describe what users are requesting in terms of S2D climate and climate impact information in your country/sector (e.g., seasonal forecasts for particular climatic or impact variables; decadal predictions) and how are they using it.

Energy brokers are interested in local and regional seasonal forecasts. Dry autumn followed by cold winter strains the hydroelectric energy supply. The energy producers aim to maximize their profit and want to know how much electricity they can sell to Europe during the autumn, however, the higher autumn production may mean depleting their water reservoir and the supply for the late winter.

3. Identifying the users of S2D predictions and its use

Provide details of who are the users of S2D predictions in your country/sector, how they are using such information in their activities (e.g., for operational activities, for developing their strategic/corporate plans) and what difficulties they are facing when using this information (e.g., too much data, too costly, too scientific).

The power producers have used local/regional seasonal forecasts as an input to decisions regarding the energy stock market.

4. Tracing the interactions between climate services providers and users

Describe the relationship between those developing and providing S2D information in your country/sector and its users i.e., do the providers of S2D reach out to the users to develop the information or are the users of S2D that seek out and go to the providers to obtain the information? How does the interaction process starts and develop?

The Norwegian Meteorological Institute has presented the seasonal forecast for temperature on its web page, but has been very cautious about promoting this - due to low skill. The media has, however, often reported on the seasonal forecasts. Furthermore, a project on seasonal forecasting of temperature (moth to season) based on statistical means was carried out for the a trading company. The project was terminated partly due to the lack of robust and strong signal.

5. Potential users of S2D

Within your country/sector, who do you think should be using S2D predictions? Why do you think these organisations are currently not using S2D predictions (i.e., what are the difficulties and barriers in obtaining and using S2D climate information)?

Farmers: plowing fields. The forecast products are not yet sufficiently reliable, and there is furthermore a lack of awareness about these products:
Energy producers: for planning tapping or accumulating water in dams.
Health:
Municipalities: droughts and wild fire hazards.
Manufactures:
Tourism:

6. Supply of S2D climate and climate impact information

In your opinion, which organisation(s) should be responsible for providing S2D climate and climate impact information in your country/sector (e.g., National Meteorological and Hydrological Services, private climate services providers, research organisations, others)?

National Meteorological and Hydrological Services and the ECMWF. There is a need for a certification scheme for the products, involving standards for validating and hindcasting. A clearing house mechanism for the S2D products (inventories which provide skill scores and benchmark tests) would be useful to the users. There is also a risk of liability, if stakeholders make large investments on information which later on turns out to be non-robust or non-representative. Furthermore, there is a risk that S2D gets a bad reputation if it is over-sold.

University of Lund and SMHI
Anna-Maria Johnson, University of Lund and Lars Bärring, SMHI

1. Demand for information about future climate and its impacts
Climate change impact assessments to answer the following questions:
1) How do the choice of tree species, thinning intensity and rotation period influence forest productivity and carbon sequestration?
2) What is the risk of storm damage and insect attacks given different management strategies?
3) How to handle nature protection and preservation of biodiversity?

Climate scenarios: In Sweden, a warmer climate will lead to a shorter period with ground frost. In large parts of the country, timber harvesting is carried out during the cold season to avoid damage on wet forest soils and small country roads caused by heavy timber transports. Some forested areas are easy to reach as long as the heavy harvesting machines can move over frozen bogs/peatlands, if this is not the case these areas virtually becomes impossible/uneconomical to harvest (given present-day technology). A warmer climate will require investments in forest-roads that can be used for timber transport also during non-frozen conditions (which are much more costly compared to simpler roads that depend on ground frost conditions).

2. Demand for S2D climate and climate impact information
Seasonal forecasts to find out the optimal timing for
1) Insect traps (capturing forest pests such as the spruce bark beetles(damage control after wind storm damage), also used as an early warning system for invasive pests)
2) thinning and clear-cutting, to avoid forest soil damage and compression due to high soil water content or unfrozen ground conditions
3) planting of seedlings (to avoid early summer drought or spring backlashes)
4) surveillance of forest fires
A substantial component of these components are related planning of logistics and resources/man-power

3. Identifying the users of S2D predictions and its use
no current use of S2D data, too scientific, difficult to interpret

4. Tracing the interactions between climate services providers and users
Scientists (within the fields of climate modeling and impact modeling) initiating collaboration with stakeholders

5. Potential users of S2D
The Swedish forest agency, a wide range of forest companies and plant nurseries

6. Supply of S2D climate and climate impact information
In your opinion, which organisation(s) should be responsible for providing S2D climate and climate impact information in your country/sector (e.g., National Meteorological and Hydrological Services, private climate services providers, research organisations, others)?

SMHI

Here are some input pertinent to the Swedish County Admins (LST), of which Östergötland (Anna Bratt) and Skåne are stakeholders in the project.

1. Demand for information about future climate and its impacts
Describe what users are requesting/demanding in terms of information about future climate and its impacts in your country/sector (e.g., global climate model outputs, climate scenarios, climate indices,climate impact assessments).

A lot and varied. Basically they want as much information they can get, but consolidated and digested in a way that is useful for non-experts. C.f. http://www.regeringen.se/sb/d/108/a/94595 , which is the base (now slightly dated) for their work.

2. Demand for S2D climate and climate impact information
Describe what users are requesting in terms of S2D climate and climate impact information in your country/sector (e.g., seasonal forecasts for particular climatic or impact variables; decadal predictions) and how are they using it.

Not generally much demand. But we know that it is on the wishlist ...

3. Identifying the users of S2D predictions and its use
Provide details of who are the users of S2D predictions in your country/sector, how they are using such information in their activities (e.g., for operational activities, for developing their strategic/corporate plans) and what difficulties they are facing when using this information (e.g., too much data, too costly, too scientific).

The LST are responsible for all aspects of emergency contingencies. Clearly any useful (skilful ;-) seasonal predictions would be helpful in this respect (risk for floods, windstorms, heatwaves ...).Also they have central role in communicating climate change information. And in this respect a recurring pedagogic problem is to explain the difference between [long term / century scale] climate change in relation
to inter-annual --- decadal climate variability.

4. Tracing the interactions between climate services providers and users.

Describe the relationship between those developing and providing S2D information in your country/sector and its users i.e., do the providers of S2D reach out to the users to develop the information or are the users of S2D that seek out and go to the providers to obtain the information? How does the interaction process starts and develop?

Basically no seasonal predictions are issued (because of low skill). Decadal predicitions are still a research task --- EUPORIAS

5. Potential users of S2D Within your country/sector, who do you think should be using S2D predictions? Why do you think these organisations are currently not using S2D predictions (i.e., what are the difficulties and barriers in obtaining and using S2D climate

information)?

LST are the users and their users in turn range across all/many sectors...

6. Supply of S2D climate and climate impact information.
In your opinion, which organisation(s) should be responsible for providing S2D climate and climate impact information in your country/sector (e.g., National Meteorological and Hydrological Services, private climate services providers, research organisations, others)?
SMHI which is the NMS, when relevant in collaboration with other agencies and or sector organisations.

EUPORIAS

EUPORIAS – Climate services providers and users' needs – Tourism sector
Adeline Cauchy, TEC

Based on existing literature and ongoing activities in other projects (especially through CLIMRUN in which TEC leads the tourism case studies work package) this paper aims to make a first analysis of the provision, needs and the potential use of S2D climate forecasts in the tourism sector.

1&2: Demand for S2D climate and climate impact information

The tourism sector is particularly sensitive to weather and climate conditions. It faced different types of impacts (Scott at al, 2012) :

- Direct impacts on tourist safety, comfort and health (social impacts) : heat waves, storms, heavy rains, forest fires, urban pollution etc.);
- Indirect impacts via environmental and landscape concerns : scarcity of resources (e.g. water resources), loss of resources (e.g. biodiversity, coral reefs, snow cover);
- Financial impact (loss of revenues, heating-cooling costs) ;
- Institutional impact (e.g. risk of reputation).

Risks are seasonal but also may affect the viability of a destination in a long timescale.

If the tourism sector shows on one hand, a growing perception of the issue of climate change as a key issue affecting ongoing and future development, on the other hand, there is a very low level of awareness and use of climate services.

The tourism system is complex, with a combination of public and private, tourism and non-tourism players at all scales. Due to this great variety of tourism stakeholders (tour operators, tourism and destination offices, professional organisations, planners, practitioners, receptive agencies, tourists etc.), tourism activities (bathing, trekking, etc.), host environments and climate locations (coastal, mountain, rural etc.), the potential demand for S2D may be very different from a stakeholder to another.

If there are very few users of S2D forecasts, there is s a growing interest for this kind of products, as shown in the tourism case studies carried out in CLIMRUN project (see the box below).

Box 1 : CLIMRUN : focus on tourism case studies

CLIM-RUN

Climate Local Information in the Mediterranean region Responding to User Needs

www.climrun.eu

There are 4 case studies within the project:

- **Savoy region** in French Alps, focusing on summer tourism conditions ;
- **Tunisia,** focusing more on beach tourism with some diversification aspects (desert tourism, golf etc.);
- **Croatia**, also a seaside tourism destination, with a clear focus on diversification (yachting, winter and snow tourism, cultural tourism);
- **Cyprus**, also a seaside tourism destination, with some rural locations in the hinterland.

During the first phase of the project, about 50 face-to-face interviews and 4 workshops (one per case study) have been conducted to assess the stakeholder's needs about past and future climate information and services.
Among the diversity of the requests we can identify more precisely common issues and more specific requests.

Needs in terms of seasonal forecasts

- ***Common needs***

The demand is primarily focused on predicting **seasonal temperature** not only at destination level but also in the home market. The temperature difference between the country of origin and the destination is a factor for choosing this destination. For instance, someone may argue that if the climate is particularly rainy and stormy in UK in spring and summer, Brits will tend to travel more to Cyprus, and this is therefore valuable information for Cyprus Tourism Offices, tour operators and travel agencies.
The regional scale of the forecast is really desired here.

- ***Seaside tourism – indicators of bathing seasons***

An important expectation of stakeholders concerns the **sea surface temperature** (including very locally, immediately along the beach). This request is related to the problem of jellyfish that is becoming increasingly alarming for some stations bathing (especially in Tunisia and Cyprus) and also as assistance in planning beach activities on the fringe of the season.

- ***Mountain tourism – Indicators for summer seasons***

In line with the "seasonal assessment culture" (Philippe Bourdeau) underlying much of the Savoy tourism industry, an important request has been formulated by the tourism stakeholders. They would like to combine seasonal climate assessments with seasonal economic assessment. The seasonal climate assessment could be improved by taking into account users' expectations in terms of variables: rainfall, temperatures, and extreme weather events. At the same time, the economic assessment could be reworked to show the direct impacts of climate observations on economic activity (customer behaviors, steady activities, and neglected activities).
Even if this tailored product is mainly focused on the past season, we could also envisage focusing on the coming season to anticipate the planning of activities.

A seasonal forecast for air temperature would be potentially very relevant for the winter season (see box 2).

Seasonal to long-term indices (3 months to decadal)

- ***Tourism comfort indexes***

This demand was clearly expressed in Tunisia and Croatia and mentioned in Savoy workshop. There is a need to improve existing tourist comfort indexes that usually combine several climate parameters such as temperature, humidity, wind, sunshine. This index is based on oriented tourism activities sensitive to weather and climate and should be based on knowledge of the climatic requirements of tourists through a survey that targets different categories of tourists and tourist activities (TEC-CREDOC-2008, ongoing protocol within the CLIMRUN Tunisia case study).
These indexes should be able to express the level of comfort from seasonal to decadal scale for different nationalities and to model changes in tourist flows regarding changes in the climate conditions. Those improvements could help to exploit the climate potential of the destination and diversify the tourism products. This concerns particularly intermediate seasons (spring, autumn...), which could offer opportunities for tourism in a warmer climate.

- ***Various climate data requirements (from 5 to 20 years)***

Among the case studies, there are specific climate parameters or derived indexes requested by stakeholders. Here is a sample of requests that concerns the short and medium term :

- High mountain future climate conditions (air temperature) for hiking and mountaineering during the summer season;
- Alpine lakes and rivers climate conditions (wind for sailing, temp for bathing, hydrological regimes for floods and natural disasters...);
- Accelerated sea level rise along the coast and beach erosion (seaside tourism/ hotel facilities and resort);
- Extremes events for all the case studies (heavy precipitations, heat waves, droughts etc. for nature sports for instance in Savoy);
- Spring conditions in the middle and high mountains (temperature, precipitation, sunshine duration) to seize the opportunities of a possible advance of the summer season.

Further developments to do within Euporias project :
Through a survey and face to face interviews, it will be necessary to better classify stakeholders needs in terms of parameters and indices regarding the main vulnerabilities of the tourism activity.

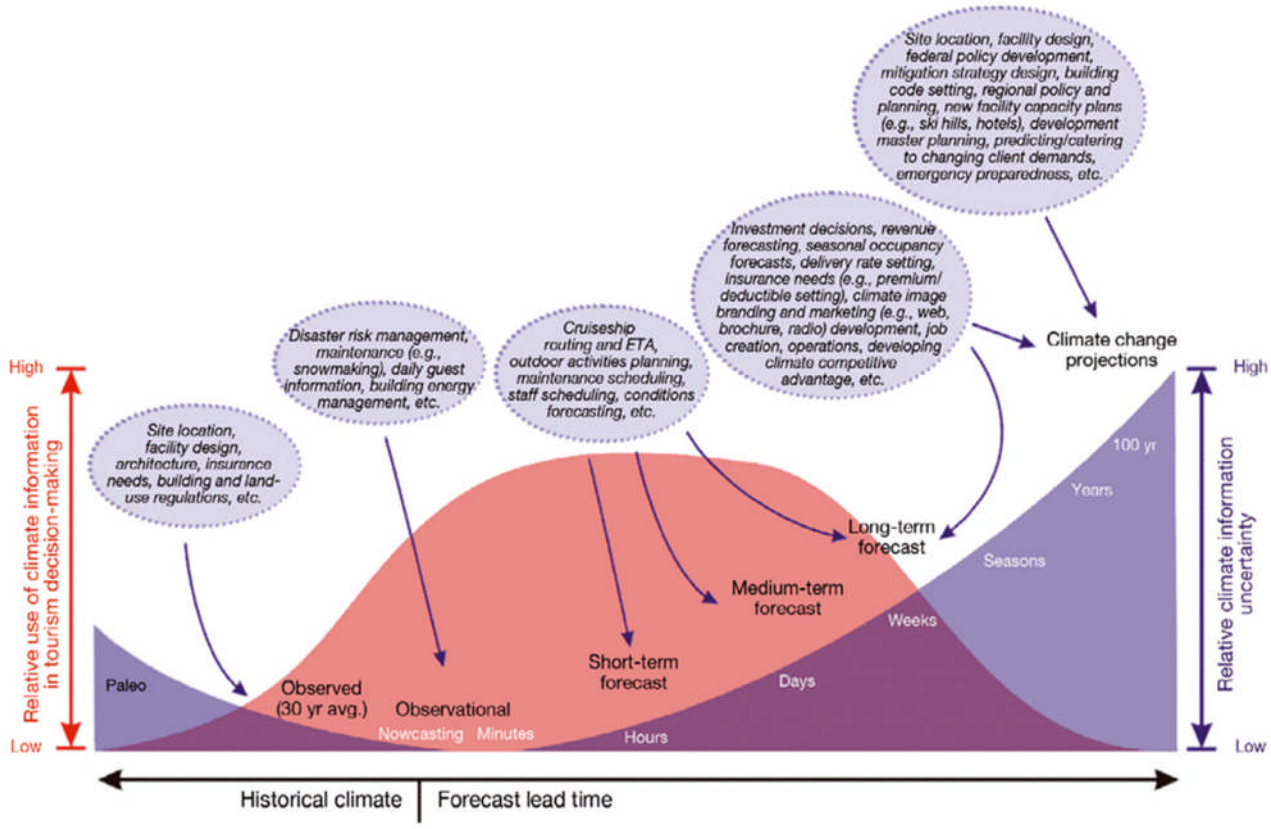
3&5: Potential users of S2D predictions and benefits of using them

"The potential use of climate information within the tourism sector is tremendous given the high number and diversity of end-users" (Scott at all, 2012).

The S2D forecasts could be potentially used for various activities, at different spatial scales and by different stakeholders. Scott at all (2012) tried to represent the potential use of

weather and climate information by tourism operators and travel planners according to the time horizon:

Figure 1 : Potential uses of weather and climate information by tourism operators and travel planners



Source : Scott et al., 2012.

As it is shown, S2D predictions can influence the decision-making process from different types of activities: operational destination management (outdoor activities planning, maintenance scheduling etc.), marketing and communication plans (brand, brochure etc.), long terms investments and strategies (hotel facilities). Using S2D predictions could represent an economic advantage in some situations and would minimize the risk of losses in other situations. That means that every tourism stakeholder could be a potential user of S2D predictions.

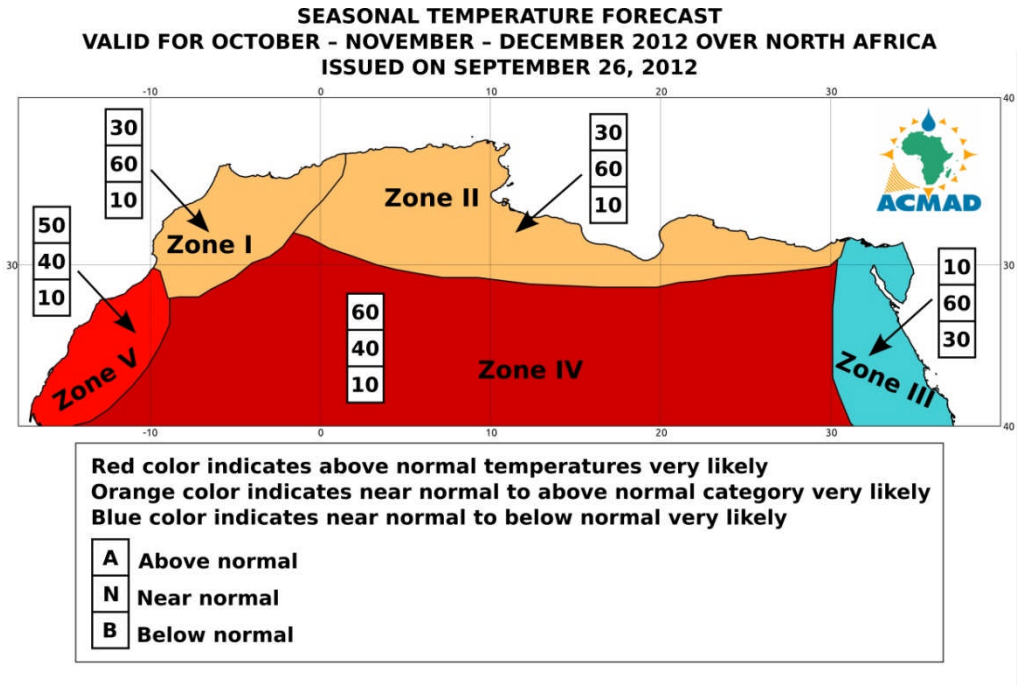
Here are 3 examples of potential users and benefits of using S2D predictions for tourism stakeholders:

When Climate experts meet tourism stakeholders during the PRESANOR Regional Forum (ACMAD, INM, WMO, 2012)

During the PRESANOR regional forum which took place in Tunis in September 2012, tourism stakeholders from different countries (Tunisia, Algeria, Morocco) were asked to think about the potential benefits of using a seasonal temperature forecast in their activities. The panel of tourism stakeholders was composed of various types of SHS: representatives of

ministries, hotel managers, receptive agencies etc.

Figure 2 Seasonal temperature forecast valid for October-November-December 2012 over North Africa



Here are the main points which were discussed with tourism stakeholders :

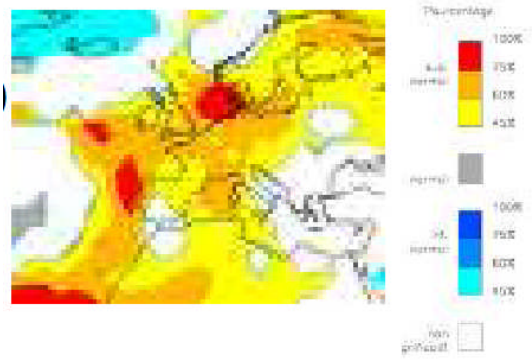
In the short-term planning, it clearly appears that seasonal forecasts can help operators from tourism industry to organize the coming season. Attention is focused above all on temperature and precipitation in Tunisia but also in issuing countries. A temperature difference, particularly in winter, between the country of origin and the destination may be a decisive factor in the choice of tourist destination in the future.
Tour operators and national tourist information offices can use seasonal forecasts to implement effective and targeted communication campaigns depending on clienteles. Furthermore, those intermediaries, who will directly collect information (tour operators and tourist information offices), may have a considerable role to play with local tourist operators (hoteliers, receptors). It will be about informing them about targeted clienteles for the coming season in order to adjust services' prices accordingly. It is also useful information for any changes in sojourn or trip proposed by agencies or tour operators.
They will also be used by receptive agencies to inform tourists about tool(s), materials and clothes to plan for the type of tourism they chose. For late bookings, it allows the tourist season to be curtailed or prolonged for the activity in question.

Managing the current climate situation : provision of monthly to seasonal forecasts for the French mountainous areas

During the winter 2006, Météo France was asked to provide the French tourism ministry with a seasonal forecast (temperature and precipitation) in order to anticipate the climate situation in the French mountainous areas (Alps and Pyrenees). During the season, Météo France provided also monthly forecasts. The analysis showed that there was a clear trend to

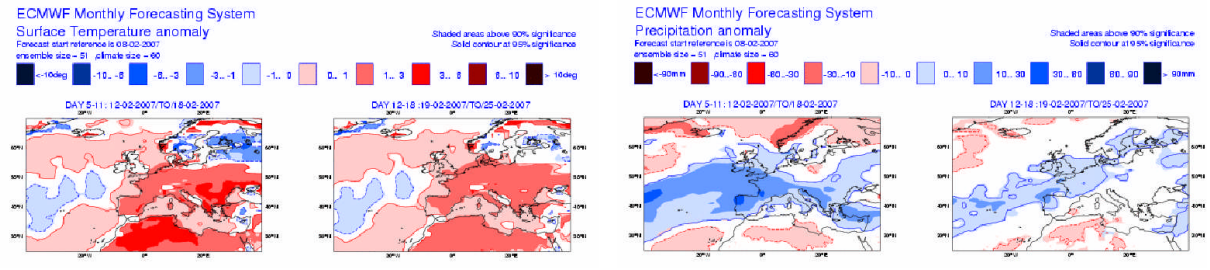
warmer temperatures than the seasonal average and the risk of less snow was likely.

Figure 3 : Seasonal forecast JFM 2007, T2M (for anticipation)



Source : Météo France

Figure 4 : Monthly forecast 2007, T2M/Precipitation (for "in live adaptation")



Source : Météo France

Seasonal forecast can help a destination to anticipate the season to come whereas monthly forecast can encourage "in live" adaptation (Météo France).
The French Ministry of Tourism has disseminated these forecasts to the mountain stations/resorts. Apparently some of them have used it to diversify their activities during the season.

The Potential use of seasonal forecast in the French Alps : the view of Mitra Tourism (France)

This organisation operates at a regional level in French Alpine area to support and assist the tourism industry and professionals in their business. More precisely, its missions are related to :

- Accompanying the professionals in the development of their activity
- Communication and promotion of the destination in the French and international market
- Crisis management during the season

According to Hugues Beesau, director of Mitra Tourism, S2D could represent a serious advantage for the destination at different levels of intervention.

- Communication and promotion of the destination (anticipation)

Seasonal forecast could help to define the communication campaign for the coming season and to target the potential customers with more accuracy.

- Operational management (anticipation and “in live” adaptation)

Seasonal forecasts allow to think about reply strategies concerning the coming season. With a lack of snow, we can imagine various ways of “in live” adaptation: encouraging indoor activities (like spas), setting up shuttle buses between stations, and organizing ephemeral events.
With anticipation, it could allow to optimize the financial costs and to limit the risks: adjusting employment and personnel according to the forecast, diversification of the activities, closing a station rather than keeping it open without customer’s attendances.

- Medium term planning – 5 years

Medium term forecasts (5 years) with a confidence index could help to find solutions with tourism professionals in the organisation of tourist seasons:
- Reorganisation of the offer according to the different mountain areas;
- Strengthening the diversification of the activities (e.g. activities without snow);
- Creating a new marketing position with new customers.

- Long term planning – 5-20 years

Long term forecasts could allow to think about more structural adaptation of the destination :
-Development of ski areas (profile tracks, new architecture resorts)
-Abandonment of certain areas for skiing activities
-Diversification of the tourist seasons (strengthening the summer and inter-seasons for example) and mountain activities.

According to these 2 examples, we can see the large range of potential beneficiaries and use of S2D forecasts:

- From institutional organisations at different scales (Ministry of Tourism, professional agencies in the destination, regional tourism agencies, tourism offices etc.)…
- To private actors: tour operators, incoming agencies, professionals of tourism, private investors (hotels etc.).

Further developments to do within Euporias project :

Through a survey and face-to-face interviews, it will be necessary to better identify and prioritize the tourism stakeholders in the European market: who are the main beneficiaries, who are the indirect ones.

3’: Difficulties they are facing when using this information

There is a very low level of awareness and use of climate services in the world of tourism. Several hypotheses can be advanced regarding CLIM-RUN projects and others experiences:

Lack of knowledge about the existing climate products

Stakeholders are not familiar with the concept of climate services and often do not know they can access to a range of products that could be interesting for them. Climate providers need to better communicate about what they can provide and what they are not able to provide. They also have to communicate about the potential benefices of this products for the sector. Awareness should be improved as well as communication between providers and users. The role of intermediaries can be very relevant in this case.

Complexity and level of uncertainty of the products

Tourism stakeholders are not familiar with the use of climate and scientific information. The information is sometimes too complex and quite difficult to interpret. There's a need to communicate the information in an appropriate and understandable format for the stakeholders. There's also a need to better understand what level of uncertainty each stakeholder can accept to take a decision.

Value of services

SHS do not always see the value of the service. It is related to the accuracy of the products (too large scale, not enough parameters) but also to the reliability of the information (large uncertainty, low skills etc.).

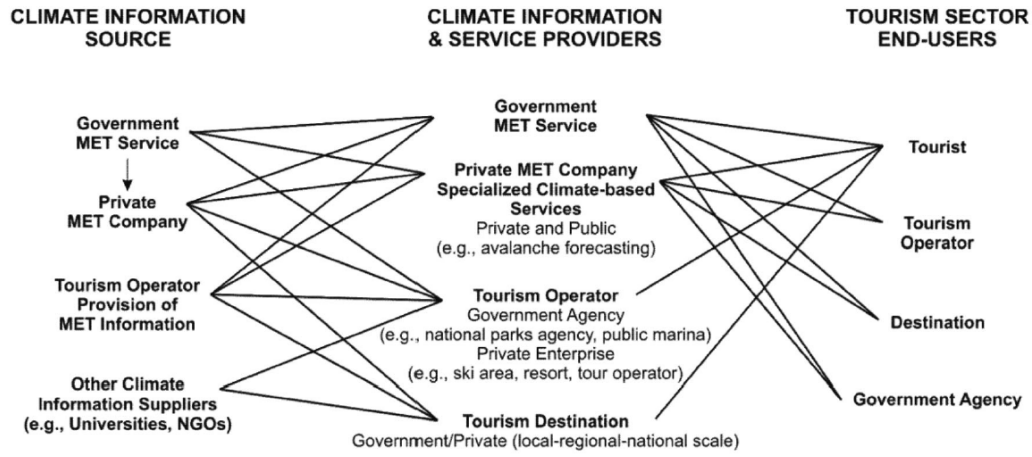
Further developments to do within Euporias project :

A strong interaction and interactive dialogue between SHS and climate providers will be required to improve the format of the products and to answer in a relevant form to SHS needs. Training of both communities can also be envisaged/considered as part of the solution.

4&6 : Supply of S2D climate information and interactions between climate services providers and users

Scott at all (2012) provides a conceptual framework of the supply of climate information and services and interactions with end users in the tourism sector.

Figure 5 : Conceptual framework of climate information in the tourism industry



Source : Scott at al, 2012.

This article explains the main evolution concerning the provision of weather and climate information in the world of tourism and interactions between providers and users:

- **National meteorological services** (NMS) and private meteorological companies (e.g la chaîne météo – the weather channel) are the primary sources of data;
- Even if the quantity of weather and climate services provided by NMS to the tourism sector is currently limited, these offices are **key players** in providing climate information to the mass media and other tourism-specific outlets (tourist guides, travel planning websites etc.)
- "Private-sector climate service providers have led the way in terms of innovation of specialized climate services tailored to specific tourism destinations, individual tourist activities and subsectors" e.g. iSki App, The North Face® Snow Report, SkiResort, and SnoCountry, boating (TideApp), surfing (Oakely® Surf Report), and fishing (Fishing Calendar).

Further developments to do within Euporias project :

There is a need to better understand the way SHS and climate providers interact with each other especially on S2D forecasts (bottom-up approach or top-down approach for instance) and to deepen what could be the best way to provide S2D services (needs of intermediaries between climate service providers and user needs for instance).

Climate Services Providers and Users' Needs

Teresa Zölch, Climate Service Center

The Climate Service Center (CSC) in Germany is part of the JPI Climate Module 2 “Research for climate service development and deployment” (Joint Programming Initiative Climate). Within that, we are focussing on the fast track activity “Mapping climate service providers within Europe”. This activity aims at collecting and analysing information on climate service providers within 2013. We are planning to conduct direct interviews and questionnaires with climate service providers in Germany asking them who are their users/clients, what kind of information they are providing to them and how they are getting in contact to each other. Thus, we are currently asking similar questions as the EUPORIAS WP12. At the present date we have only started to collect contact information about providers on national scale. Nevertheless until the workshop we will be able to present some of our results.

Our answers to the following questions are therefore based on other activities of the CSC and our previous experiences.

1. **Demand for information about future climate and its impacts**

The users are requesting climate projections until 2100. Within the projections they are interested in information about

- temperature (annual mean, minimum and maximum)
- precipitation
- actual evapotranspiration
- climatic water balance
- mean wind speed
- mean radiation
- heat waves and cold spells
- dry periods
- extreme events (precipitation and wind)
- sea level rise
- range of possible outcomes.

2. **Demand for Seasonal to Decadal (S2D) climate and climate impact information**

The users request S2D projections, especially seasonal information for a specific sectoral use and for a specific region. Projections for a shorter time scale than 2100 are also requested as well as information on the expected climate impacts from changes in temperature and precipitation.

Additionally, there is a demand for guidance in assessing data of climate and climate impact models. In return, the CSC offers e.g. a compilation of different statistical approaches for climate model assessments.

3. Identifying the users of S2D predictions and its use

The clients of the CSC come from various backgrounds and sectors. Nearly one third of the users sending requests to the CSC are working in science, the two other main groups are education and economy. Few requests are received from politics, media or private users, too. One big user is e.g. a promotional bank (KfW Bank) which uses the climate information as background information for their projects. Therefore, the information has to be available in a standardised format. Before requesting the CSC service, this user's employees researched the climate information for their respective projects themselves, what led to very different results.

4. Tracing the interactions between climate services providers and users

The CSC offers an enquiry service on its website, where potential users of climate information can get answers to their questions and formulate their requests for information. Often this is the starting point of the interaction between climate service providers and users. Moreover, interaction develops from events, workshops as well as existing contacts. One example is the compilation of statistical approaches, which evolved from a KLIMZUG workshop. KLIMZUG[8] involves 7 projects about managing climate change in 7 German regions, to which the CSC gives advice and support.

5. Potential users of S2D

As climate service providers we understand not only providers of climate predictions, but also providers of climate impact and adaptation data and climate consultants. The broad range of providers leads to a broad range of users respectively and thus, potential users of S2D data can be very diverse. They can be intermediary or end-users and vary in their sectoral focus, their intended use and their capability of understanding the provided information. Examples for user types are

- applied researchers
- policy makers
- consultants
- practitioners (engineers, utility companies, insurance companies etc)
- environmental educators
- NGOs
- media
- general public.

The biggest barrier for these users to use climate information is the availability of information tailored to their specific needs and expertise and respectively the costs for the provision of user specific information.

[8] www.klimzug.de

6. Supply of S2D climate and climate impact information

Besides the organisations you already mention (national meteorological services, research organisations) we include (federal) state agencies or ministries, universities, NGOs and dedicated climate service providers to the group of providers of climate information. Also private companies such as consultancies and engineering offices are information providers. The providers vary in their sectoral approach, their spatial focus, organisational structure and key focus (adaptation, mitigation, risk reduction). For us it is important to not limit the providers to providers of pure climatologic data, but to include providers of socioeconomic information related to climate change, too. These providers would not only offer basic climate data and climate change scenarios to their users, but impact and vulnerability studies, climate risk assessments, cost-effectiveness analyses and guidance and education.

Climate services providers and users' needs - Agriculture

Maria Dolores Frias, University of Cantabria

1. Demand for information about future climate and its impacts.

In general, users are familiar with observed data and short term forecasts. In particular the organisations provide access to the National Met Service forecasts through their web pages. Moreover, there is also great interest in the near future (the next 20 years) and the information about climate change.

2. Demand for S2D climate and climate impact information.

Temperature and precipitation are the variables most demanded by users with particular interest in extremes. We are not aware of S2D information being used in this sector. There is a lack of information about S2D predictions and the potential use of this information in the agriculture sector.

3. Identifying the users of S2D predictions and its use.

Agriculture is one of the main beneficiaries of S2D forecasts, but it seems that nowadays this information is not considered in agricultural activities. This is mainly due to the lack of awareness about these time-scale forecasts, but also to the lack of skill of these forecasts in our latitudes. The probabilistic information derived from these predictions by using multi-model ensembles can also complicate the dissemination and interpretation of this information.

Organisations or National services directly related to farmers could be potential users of S2D predictions. As they provide farmers with forecasts from the National Met Services, they could also inform them about the most relevant information derived from the S2D forecasts, which can be applied by the farmers to particular activities like irrigation, pest disease control, etc.

4. Tracing the interactions between climate services providers and users.

There is a gap between the users and the providers of S2D. In most cases, users do not have access to this information or have not even heard about it. On the other hand, climate services do not provide the information in an appropriate format to be understood by users. An effort should be made by climate services and farmers organisations in order to establish a more sound collaboration that offers advantages in both directions.

5. Potential users of S2D.

As mentioned above, we are not aware of any organisation currently using S2D predictions in Spain. Organisations of farmers and also national/local services in direct contact with farmers are potential users of these forecasts. Some of the problems in using S2D forecasts were already mentioned in 4.

6. Supply of S2D climate and climate impact information.

Raw S2D predictions should be provided from public institutions. An important contribution can be performed by research organisations at different stages. In the whole process the role of users should be taken into account in order to focus the products to the different potential applications. This will give an interesting feedback related to the usefulness of the S2D predictions in different sectors.

Demand and potential for S2D projections in the health sector

James Creswick, Tanja Wolf, Gerardo Sanchez, Bettina Menne, WHO
WHO Regional Office for Europe
(Draft paper)

Demand for information about future climate and its impacts

Climate impact assessments are the most relevant information used by the health sector in planning and developing vulnerability, impact and adaptive capacity assessments[9]. However, there is general not a strong demand for climate information from the health sector, but this does not mean that there is not a strong potential for its use, particular for more downstream data. The WHO global research priorities[10] in 2009 identified that research should build stronger bridges between assessment of the immediate health risks of climate variability and the effects of long-term climate change. This should include improved estimation of the contribution of both meteorological hazards and climate change to the burden of mortality and morbidity. Global climate model outputs are rarely used, however climate indices are used in (shorter-term) planning and preparedness and a national climate impact assessment would feature prominently in a national health adaptation strategy development for climate change. Recent example of climate impact assessments on health conducted in the WHO European Region have been in Albania, Kazakhstan, Kyrgyzstan, Russian Federation, Tajikistan, the former Yugoslav Republic of Macedonia, and Uzbekistan.

Information need	Time scale	Improvements needed
Heat Cold Rainfall (extremes) Infectious disease outbreaks	Weeks to seasonal	Higher resolution Better understanding of users Use of satellite technology Risk modelling of exposed health infrastructure Complex interaction of topography Communities at risk
Rainfall (flooding) Landslides Droughts Vector distribution	Decadal	

In some cases, specific health-relevant climate indices are even developed by actors in the health sector (e.g. new climate-relevant indicators being developed and piloted by the WHO[11]) to support broad health adaptation policy to climate change and to stimulate policy development. These can then be used to develop specific climate impact assessments in particular areas (e.g. vector-borne diseases).

On the whole, seasonal-to-decadal (S2D) climate information is not used by health services as it is poorly available to the health sector. There is a potential demand for seasonal forecasting, and for example, ENSO data is used by affected countries (not particularly relevant for Europe)[12]. Accurate seasonal forecasting would definitely feed into public health

[9] http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/Climate-change/country-work/national-assessments
[10] WHO (2009) Protecting health from climate change; Global research priorities http://www.who.int/globalchange/publications/9789241598187/en/index.html
[11] Exposure to heat-waves and exposure to flooding: http://www.euro.who.int/__data/assets/pdf_file/0004/164398/e96499.pdf
[12] WHO (1999) El Niño and Health www.who.int/globalchange/publications/en/**elnino**.pdf

preparedness procedures were it readily available for particular climatic variables such as precipitation or temperature, and free. It could then feed into already-developed action plans, such heat–health action plans; knowledge of an upcoming summer that is predicted to be exceptionally hot could help in resource allocation and preparation, and thus lead to a reduction in heat-related mortality. The WHO recommends that when developing heat–health actions plans[13], a heat–health warning system should be developed in collaboration with meteorological services to trigger the warnings, determine the threshold for action and communicate the risks. Projections on the decadal scale are not so much used except in general climate impact assessments at a national or perhaps regional scale.

Identifying the users of S2D predictions and its use

There is a strong discrepancy between current users and potential users of S2D predictions in the health sector. At some level, current users could be classified into international organisations working on health or health-related areas, national and regional ministries or authorities, some municipal authorities (especially for large cities), and the academic community. The degree to which each of these stakeholders has access to, and actively uses, S2D information varies considerably.

At the international and national level, longer-term predictions are used in health policy planning, resource allocation and adaptation strategy development. This then translates into development and preparedness and action plans for specific events, particular for extreme weather such as heat-waves, cold-waves and flooding. As the information flows further down the chain to more regional and local levels, shorter-term (i.e. seasonal) predictions become more relevant and can feed into local preparedness and action plans, particularly for extreme weather events such as heat-waves. One example is the medium-range heat information tool[14] developed within the EuroHEAT project.

Two of the major issues faced when using this information is cost of access, and perceived uncertainty. Generally, public institutions and health authorities are either not prepared to, or not able to, pay for access to S2D information, and thus would only use the data that is available to them free of charge. The second problem is the perceived uncertainty of the information provided.

Interestingly, the how the data is used can also vary between developing countries and developed countries. In developing countries, where infectious diseases account for a larger proportion of mortality, and are more sensitive to climatic variability, S2D prediction can and could play an important role in modelling disease distribution. Although this is still partly the case in the developed world, non-communicable disease are a greater cause of mortality and are far less climate-sensitive. Nevertheless, some vector-borne diseases have come under scrutiny, such as dengue[15] and other communicable diseases.[16]

[13] WHO (2008) Heat–health action plans — Guidance http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/Climate-change/publications/pre-2009/heathealth-action-plans
[14] http://www.euroheat-project.org/dwd/
[15] http://www.ecdc.europa.eu/en/publications/Publications/Forms/ECDC_DispForm.aspx?ID=934
[16] ECDC (2010) Climate change and communicable diseases in the EU Member States http://ecdc.europa.eu/en/publications/Publications/1003_TED_handbook_climatechange.pdf

Tracing the interactions between climate services providers and users

There is generally no formal channel for the flow of S2D information between providers and users within the health sector. In some countries, cross-sector committees have been established at national level to 'force' the flow of information between health policy planners and national meteorological and hydrological services. Often, any requests for S2D data would be reactionary, such as after the heat-wave in 2003 when many countries and municipalities started to develop heat–health action plans.

One issue is the lack of understanding of what data is even available, and there is definitely a role in providers disseminating the data, as there are many more potential users that are unaware of what can be provided. Through the work of the WHO in supporting national authorities in developing national vulnerability and impact assessments and strategy development, we have encouraged greater collaboration between the NMHSs and the health sector.

Generally, the health sector is not an active user of S2D data, and only passively uses the data that is readily available. At national level, this most likely comes from the NMHS and it is then fed down through the national structures to various other users. This information flow is very much top–down with little active demand.

Potential users and providers of S2D climate and climate impact information

In addition to the users identified earlier, there is potential for more local authorities and primary health care providers to use the data. Local health agencies/trusts and general practitioners could use it in planning and advising vulnerable patients; pharmacies could use it in stocking. However, the use of this information would unlikely come directly from the provider, but rather through a chain of authority with the national health sector. Civil society could also be a potential user as they are often involved in national and local preparedness planning for extreme events. Indeed, in some instances, they are even involved in the action plan development process, as was the case with the involvement of the Macedonian Red Cross in the development of the Macedonian Heat–Health Action Plan.[17]

When considering the use of S2D climate and climate impact information for the health sector, it is also important to consider the users in other sectors which are also responsible for public health, whether directly or indirectly. Such sectors would include water (particularly during extreme weather events), energy, transport, and tourism, amongst others.

National meteorological and hydrological services are the most likely, and traditional, provider of climate services to the health sector. This is largely due to the fact that in many countries, much of the health sector is public and this interaction can be supported through national frameworks. It is also important that this data is free, hence a public institution NMHS can usually provide this information to other public institutions/authorities free of

[17] WHO (2011) Heat–health action plan to prevent heat waves consequences on the health of the population in the former Yugoslav Republic of Macedonia http://www.euro.who.int/en/where-we-work/member-states/the-former-yugoslav-republic-of-macedonia/publications3/heat-health-action-plan-to-prevent-the-heat-wave-consequences-on-the-health-of-the-population-in-the-former-yugoslav-republic-of-macedonia

charge. There also exists a reasonable strong association with the academic community, and in many cases, extreme weather action plans are develop in close collaboration with local universities.

Users' requirements for climate data and information in the Netherlands

Janette Bessembinder, KNMI

Since I'm working for KNMI, my knowledge about users' requirements is mostly limited to requirements for climate data and information (is also part of my work to collect information on that). I know less about requirements for impact information. What I know is through the requests of impact researchers for climate data.

1. Demand for information about future climate and its impacts

The requirements of several sectors for climate data in the Netherlands are described in the report: Bessembinder, J., B. Overbeek & G. Verver, 2011. Inventarisatie van gebruikerswensen voor klimaatinformatie [Inventary of user requirements concerning climate information]. KNMI, Techincal report TR317.

Main conclusions from this report

The inventories, particularly the workshops and the tailoring projects resulted in a better mutual understanding, thanks to the personal contact between climate scientists and users of climate information. For climate scientists it has become clearer which climate data are needed. They also have more understanding of the importance of climate data for several users and of the way climate information is used. For users it became clearer what are the possibilities to generate specific climate data, what are the advantages and disadvantages of probability distributions and the way uncertainties are presented. They also were motivated to look critical to their list of requests, especially to those requests which are difficult to comply with.

Below a summary of the requests (additional with respect to the KNMI'06 scenarios) is given for all sectors together. Those requests which are considered most important by the users are underlined. All user requests are seriously considered during the development of the KNMInext climate scenarios, but for practical and scientific reasons it is unlikely that all can and will be met.

Requests per climate variable

- Temperature: <u>minimum- and maximum day temperature</u> (means and extremes, like "once per year" and "once per 10 year"). This is more important for most users (nature, agriculture, recreation, health, etc.) than the average day temperature;
- Precipitation: <u>other extremes</u> than "once per 10 year" (more and less extreme), <u>good day-to-day variation and variation between years</u>, duration of precipitation (especially during heavy rainfall: the intensity increases, but does the duration of showers decrease?). Water boards would like similar statistics for the future and for the current climate. <u>Extremes for various forms of precipitation</u> such as fog, hail, black ice and snow (transportation, agriculture, insurance, nature);

- Potential evaporation (and derived precipitation deficit): the change in amplitude within the year (such as described in the brochure "supplements to the KNMI'06 climate scenarios[18]"). The influence of higher CO_2 concentrations on the potential evaporation;
- Wind: besides wind speed during the year (not just extremes in winter, but also in other seasons and also averages, for example for wind energy production), wind direction is of importance for a limited group of users, especially within the water safety sector. Also other extremes of wind than "once per year" (especially more extreme winds) and extremes for shorter periods than one day (wind gusts) are requested for example for construction, air traffic and road traffic. The variation within a year and within seasons is also of importance for wind energy production;
- Radiation: of importance for several groups within agriculture, nature, recreation, health, hydrology (for evaporation). For these groups also the differences between years and within seasons is of importance (variation and persistence);
- Humidity: time series with daily values, seasonal means. Less important than radiation, but often also important for groups within agriculture (for evaporation, the spreading of diseases), nature, recreation and health (comfort index) and hydrology (for evaporation). Researchers want especially time series with daily values;
- Sea level: extremes: are the estimates of KNMI / IPCC not too conservative? For water safety time series with water levels for several places along the coast are interesting;
- CO_2 concentration: time series (especially for agricultural production). Indicate which time series with CO_2 concentrations, used as input for global climate models, fit the best to the KNMI*next* climate scenarios.
- Soil and water temperatures: time series (for agriculture and nature).

Requests for a higher time resolution

Next to information per day, month, year, there is request for heavy precipitation (mainly for urban water management) per hour (or rather per 10 minutes). For (water) safety information about the direction of wind and the wind speed per hour or per three hours is of importance.

Requests for a higher spatial resolution

Effects of climate and climate change are mainly visible on a local scale. Therefore, a lot of impact models have a high spatial resolution (or at least they calculate with relative small units). Especially information about spatial differences in the current climate is of importance. No large spatial differences in climate change are expected within the Netherlands: a division in coastal and inland areas or per catchment would be sufficient. For spatial differences in the current climate a higher spatial resolution is requested: also differences between city centres and the outskirts and between several regions are of importance. The North Sea and the IJsselmeer specific attention concerning wind.

Requests for time series

[18] Klein Tank, A. en G. Lenderink, Climate change in the Netherlands; supplements to the KNMI'06 scenarios. **KNMI-publication**: Scenario brochure 2009. http://www.knmi.nl/climatescenarios/documents/KNMI_2009_EN.pdf.

For most users time series are very relevant, especially for temperature and precipitation, but also for wind en potential evaporation and to a lesser extent for the other climate variables. For a lot of users both good day-to-day variation and year-to-year variation (and persistence) are of importance, as well as consistency between climate variables.

Requests for information about probabilities and uncertainty

Most users request more information about the probability of extremes within a plausible scenario. For water safety also information about probabilities within an extreme (less probable) scenario is of importance. Information about the probability of a specific scenario is less relevant (a qualitative indication would be sufficient: more or less probable). Some users requested more information per variable about uncertainty in climate change per scenario, presented by "probability density functions", e.g. like UKCP does.

Requests for time horizons

For many sectors (water deficit, water quality, agriculture, nature, energy, transportation, health and recreation) information about the climate around 2050 and 2100 is important, but also information around 2030. Only for water safety requests information on the longer term (2200).

Requests about the context and form of the KNMInext climate scenarios

- To put the KNMInext scenarios in European and international context (show the link with IPCC emissions scenarios).
- The basic assumptions for the analysis of the discharge in the several catchments should relate to countries around us. Specific scenarios for the catchments of Rhine and Meuse are requested.
- Show differences and similarities with the KNMI scenarios and the scenario of the Deltacommittee.
- Information of colleague research institutes about the "secondary" effects of climate change (air quality/salinity, water quality, ground water levels, river discharges etc.) to be published shortly after the presentation of the KNMInext climate scenarios. Several sectors have mentioned that they would like to contribute to this[19].

Requests for guidance in the use of climate scenarios

- Manual about how to deal with different scenarios, uncertainty, probabilities and extremes. Specific explanation for each group of users (politics / governance, policy, research, citizens);
- Guidance in using the transformation program[20] (manual and workshops).

Some additional information from own experience

Many of my experiences with users and users' requirements inventories are also described in the following document: Bessembinder, J., R. Street, M. Themeßl, E. Baños de Guisasola, P. Delecluse, R. Benestad, 2012. Guidance to support the identification and assessment of

[19] Within the research programme "Knowledge for Climate", Theme 6 several institutes work on this "coupling".
[20] Background information and a manual are already available at climpexp.knmi.nl/Scenarios_monthly. Before summer 2011 a more elaborate report on the transformation programme will be published.

users' requirements. Concept. Report for JPI-Climate, Working Group 2 on Climate services, Fast Track Activity on users' requirements.

What do users ask for and what do providers need to know about users?

Until now most inventories of users' requirements focused especially at what type of data or information is needed. However, for users the form of presentation may also be important, or the availability of guidance, overview etc. Some efforts on identifying users' requirements paid attention to one or more of these aspects. To get a more comprehensive understanding (and to be able to provide better and more relevant services) information is needed on presentation and support, as well as on why and how the requested data/information is to be used (context, strategy, framing, etc.). These latter aspects have had relatively little attention (or at least little has been documented), possibly as this type of information is more difficult to get.

To understand users' requirements both information about the services that users require (what do users ask for/need?) and information to better understand the requests (why do users ask for these services, how will they use the data/information?, etc.) are required.

When a user requests data/information, ideally climate service providers should first get information on the intended use, context, framing within which the data/information will be used before providing the requested data/information. It may be that users do not need the data/information that they requested at first. This only becomes clear when providers and users of climate services discuss the intended use and context of the requested data[21].

Types of users

Users of climate services (they may also be intermediary users (e.g. researchers and consultancy) and end-users) can be categorized in different ways. They can be divided according to sector(s) of interest, intended use (e.g., communication, research, decision/policy making) or capabilities all with their specific needs. For example, impact researchers often need time series of climate variables and indices as input for their impact models. Adaptation researchers requirements depend on what aspect of the assessment process they are considering (e.g., risk assessment, adaptation options assessment, implementation or evaluation of implemented measures). Decision makers needs vary considerably from more general information to information related to sensitivities and the chances that certain thresholds will be surpassed.

Researchers, particularly those with a climate science or impacts background generally have a relatively high level of knowledge about climate change and the possibilities and limitations of climate data. Politicians and others that might want to raise the profile of climate change on the political or public agenda may be more interested in information about extremes, maps or (photo) graphs that illustrate clearly climate trends and projected change, including information on recent extremes that have had large socio-economic impacts (to illustrate the vulnerability and to emphasize the need for action).

[21]Based on experiences of contributors to this document (e.g. in the Netherlands spatial planners once asked for maps of various average climate variables in the Netherlands according to the KNMI'06 climate scenarios. The spatial differences in average temperature, precipitation, etc. do not influence spatial planning in the Netherlands; differences in the occurrence of extremes may. Although maps were requested for use in spatial planning it appeared after some time that they would be used especially for creating public awareness (including in the government organisations) related to spatial planning and climate change.

Different sectors may also require quite different data and information, as well different capacities to access and use the available information, knowledge and data (see Table 1). There may also be users that do not necessarily need climate variables. They may want to use story lines that are based on the different climate scenarios (e.g., qualitative information related to exceeding a particular threshold).

A few more remarks not treated in the documents mentioned above

Few users ask directly for climate model output. They ask for climate data for the current and future climate. It often does not matter how climate data for the future are generated as long as the quality is good and that the important aspects for their field of interest are well represented. Sometimes also consistency with other sectors is important (although often not requested at first).

Few users ask for additional climate scenarios beside the generic set of climate scenarios. I know only three examples (http://www.knmi.nl/climatescenarios/additional/index.php):

- the Delta commission that wanted a more extreme climate scenario for coastal protection for sea level rise up to 2100 and further

- The NAM (natural gas producer): a more extreme scenario for especially summer temperatures based on observed trends up to about 2030

- TNO a more extreme scenario that represented the upper limit of the probable range of IPCC in 2007

2. Demand for S2D climate and climate impact information

For almost all sectors seasonal forecasts are very interesting for operational purposes (it would make life a lot easier), and are therefore regularly requested (users of weather data and information). However, until now the predictive value of seasonal forecast for the Netherlands are of very little value.

Some weather providers in the Netherlands do issue now and then news items in which they announce e.g. a very cold winter, a warm and/or wet summer. These news items are picked up very often by the media without properly checking the value of these “forecasts”.

Decadal “predictions” are very new, and therefore not often explicitly requested. However, many users of climate and climate change information are interested in information for 2020-2030 (this is already the long term for them), and this is requested very often explicitly. In the inventory about users’ requirements in the Netherlands mentioned above, you will often see the time horizon of 2030 mentioned. Contrary to the users of seasonal forecasts the potential users of decadal forecasts are people working on e.g. impact assessments, adaptation strategies, policy makers

The term “predictions” is very misleading in my opinion. It suggests often that there is less uncertainty. I have the impression that many users find it difficult to distinguish between the various types of uncertainties, to distinguish between climate scenarios and S2D predictions, and therefore to oversee the options and limitations of both.

3. Identifying the users of S2D predictions and its use

See under 2.

Many users find it difficult to get overview of available data and information about climate and climate change, also many of the impact/adaptation researchers.

4. Tracing the interactions between climate services providers and users

As far as I know it is only KNMI in the Netherlands that is producing and providing S2D information at the moment (in consortia with other insititutes). In these projects interaction with users (mainly impact researchers?) is included as well as case studies.

5. Potential users of S2D

More in general, not specific for S2D:

- anyone who considers climate change relevant for his/her sector: whether climate change is relevant depends on many aspects, e.g. the life time of structures (sewerage systems are constructed for 40-80 years in the Netherlands, for this climate change is relevant, but for structures with a life time of only 10 years probably not), can adaptation measures be taken within a few to 10 years or does it take much longer?, etc.
- does the user know how to deal with uncertainties (e.g. with natural variability, and due to lack of knowledge)?

Barriers:

- lack of availability and/or quality/usefulness

- difficulties in using it: technical (e.g amount of data) and lack of understanding what the data can be used for.

6. Supply of S2D climate and climate impact information

It seems most logical that National Meteorological (and Hydrological) Institutes produce the S2D information (required resources), and therefore also provide the raw data. However, any other provider (including the SM(H)I's) with good knowledge of the methods, assumptions behind it, how to find out the real questions of the users, etc. could help users with the use, analysis and interpretation of the S2D data and information.

Knowledge and experience of the interface between climate services providers of seasonal to decadal

L. Dubus, S. Parey, J. Najac, EDF, France

1. Demand for information about future climate and its impacts

The needed information about climate and its impacts goes from key messages on the possible local to regional changes and their uncertainties, to climate model outputs in order to drive internal impact studies.

For operational applications, different processes are at stake: (this block answers question 2 in the same time)

- "mid-term" projections try to envisage how the energy mix will evolve over the next 10-30 years. Hence, these processes need information about the "expected climate" over the period of time considered. The current practise is to use historical times series (3 hourly data), corrected to take into account the observed trends over the past ~30 years (make a linear extrapolation, but keep the past observed variability, hence homoscedasticity assumption). The variables concerned are temperature (for demand forecasts), precipitation, or rather hydropower production capacity. Wind and solar (PV) productions are becoming increasingly important. The basics of such models is to run different scenarios taking into account a "normal climate" typical of the next decade(s) with a high temporal resolution (3h). When dealing with the whole power system at the European or national level, an important point is to have physical relevance between the different times series for the various variables, both in time and space.

- 1-year forecasts: the main goal here is the management of large dams, and the calculation of "the value of water" in order to plan as precisely as possible the optimal use of (large) water stocks. Such calculations are done at least once a month. The hydropower production capacity are done using

    - either discharge climatology (~60 years of data),

    - or forecasts from an hydrological model fed by temperature and precipitation historical times series (see Dubus's talk about the analog method during the Stakeholders meeting inRome)

    - or … under development, an hydrological model fed by seasonal forecasts of temperature/precipitations from dynamical models, which can be downscaled by dynamical or statistical methods (e.g. analogs)

- "weekly" forecasts (in fact, lead times ~10-15 days):

    - Hydropower production forecasts are done using hydrological models, forced by temperature and precipitation forecasts (combination of analog based and raw model outputs from ECMWF's VarEPS)

    - Demand forecasts are made using VarEPS temperature forecasts

- Wind/solar: not really done, NWP used up to day 4-5, then climatology

2. Demand for S2D climate and climate impact information

For S2D, the main needed information concerns the forecasted trends for the next decade: will the trend (in air temperature) be steeper or lower than the observed trend over the last 30 years or so? Projected daily air temperature results (daily minimum and maximum) could be useful to answer the question and compute future extremes.

With regard to 1 to 30 year time scales, as stated above, the need concerns mainly physically consistent data, both in time and space, at the regional scale for the main variables: temperature, precipitation, wind, solar radiation … in order to take simulate different scenarios for energy demand and production capacities (thermal, hydro, wind, solar …)

3. Identifying the users of S2D predictions and its use

The users of key messages are different colleagues in charge of production facilities or supply-demand balance. The model outputs will be used by EDF R&D to produce tailored information for different internal clients according to our defined methodologies.

In more details:

- R&D division: people who make “upstream” and applied studies, to evaluate the quality of S2D with regards of the operational needs (not only e.g. verification/scores of Z500 over Northern hemisphere, that’s’ to say the “standard verification scores”);
- Operational division in charge of hydropower forecasts: they don’t take S2D info into account currently, but will be an important user as they provide a key information (hydropower production forecasts) to the whole system managers;
- Energy system management people (at the country scale): what they need is not the info on temperature/precipitation … but rather their impacts in terms of demand, hydropower production (and, soon, wind and solar);
- Decadal : as stated in question 1, people in charge of “mid-term” (10-30 years) projections;
- People from the commercial and marketing division: if fed with relevant information, they can imagine/design new services and products for customers;
- Energy traders: always interested in forecasting information, at all time scales.

4. Tracing the interactions between climate services providers and users

The interaction process goes in both ways: sometimes the providers invite us to join projects or we come to them to get information and answers.

This is a crucial point according to our experience. Weather/climate is a field in which one really needs to involve deeply in order to stay up-to-date with the science and its applications. But the complexity of processes in the energy sector is such that the interaction can hardly be direct between the energy end-users and the weather/climate services and

products providers. There is really an important need of experts at the interface, either in the energy company, or the met services, or in third-party companies.

The first option (internal skills in the energy company) is probably the most relevant to the confidentiality and competition problems in the sector.

Some key points of the organisation at EDF:

- Research projects and formal or informal collaborations with Météo-France, ECMWF and most of the relevant partners in Europe, notably via European and National Projects (PROVOST, ENSEMBLES, EUPORIAS, ANEMOS, SAFEWIND, KIC…)

- Development studies done in partnership (mostly EDF/Météo-France)

- Commercial contracts for the delivery of data and forecasts (with Météo-France). On this aspect, a formal organisation has been set in place, with at least formal meetings twice a year for the evaluation of the forecast (over the period since the last meeting, and an actualization over the whole period), discussions about new needs (from the users point of view) or presentation of new services/data/products (from the provider) …

  In particular, in the frame of these formal meetings, an important item consists in developing users's skills and knowledge by e.g. commenting special situations (for instance low cloud cover days during which temperature predictions failed by several degrees at D+1 …), introducing probabilistic forecasts …

- EDF is also involved in different bodies : CSM (Conseil Supérieur de la Météorologie, the Superior Council of Meteorology, which is the users decicated body at Météo-France), Council of the Météo-France National School of Meteorology (engineer degree), WMO (in particular, participation in the Tak Force / Forum for socio-economic benefits of weather/water/climate information), expert group on energy in GEO/GEOSS

- Researchers at EDF are also members of scientific associations (EGU, EMS, France Met Society, AGU …) and attend the major meetings or co-organize major events (ICEM2011, ICEM2013…)

5. Potential users of S2D

EDF should certainly be using S2D but this is still a research area up to now. Before being used operationally, the liability and robustness of the expected information has to be well established, as well as the best way to use such information.

See again point 2. The most relevant applications would certainly be in hydropower production forecasts (for seasonal to 1 year forecasts) and people in charge of projections of the European energy mix on annual to decadal time scales.

6. Supply of S2D climate and climate impact information

As climate information may be used in important decision processes or calculations, with impacts on EDF's strategy and investments, the information needs to be scientifically

validated, and so the preferred origin is National Meteorological and Hydrological Services, or well known universities, involved in international working groups/bodies (IPCC, CMIPs …)

In addition, private companies' services are regularly tested. For example, a test is currently run with World Climate Service, a joint enterprise of Prescient Weather Ltd in the U.S. and MeteoGroup in Europe, U.S., and Asia. They provide NCEP and ECMWF seasonal forecasts in a user friendly form, and adds their own forecasts based on statistical/analogs methods and combine all the available information to a consensus forecast.

But third parties are probably not the most relevant, as their business implies they would generally sell the same services to competitive companies.

Up to now, the most relevant / efficient seems to be an interface inside the power company (experts who now the "energy business", and who are also experts in weather/climate science applications, able to talk efficiently with data/products/services provider

Climate Services' Providers and Users' Requirements: Summary Paper

Roger Street, United Kingdom Climate Impacts Program

Demand for information about future climate and its impacts

There is a spectrum of information and knowledge that users are requesting to support their intended use (e.g., that based on climate information, socio-economic, land-se, risk, vulnerability and adaptation information and evidence). These services based on observations, forecasts and projections/scenarios) should be mutually supportive of the decision-making process and framing or those of the other intended use. As such the information and knowledge required is that to support policy and practice – more than just description of the current and future climate or impacts.

In addition to services needed to specifically support sectors, users also need information to support systems analyses and spatial analyses that cross sectors. This need is particularly acute where interdependencies and related trade-offs and synergies across sectors are being considered.

Defining what is required should start with the decision or policy framing and reflect the relative role of climate and the other information that is supporting the decision. This needs to be balanced with scientific credibility, but also a clear understanding of the spectrum of users, their intended uses, capabilities and resources. There is not a single uniform user community.

Characteristics of the information that users have identified as crucial are that the information and knowledge provided must be credible, legitimate and salient. From the users perspective credibility (scientifically sound) comes from:

- Accompanying documentation – clear understanding of science behind information and of the associated limitations and assumptions;
- Endorsement / acceptance by the scientific community (peer reviewed) and other authorities;
- Recognised form of quality assurance and quality control; and
- Realistic – linking past, present and future.

Legitimacy (who providing and how provided) comes from:

- Recognised and trusted source of information;
- Stable / reliable source with a track record (and a future);
- Perceived as investing in climate information to inform; and
- Providing information that recognises the needs and capabilities of different users (e.g., hierarchical presentation).

Saliency (relevance to the users' requirements) is seen differently by different users and is related to the complexity of the services; the manner and means they are presented; what

information/support is included (and not included); and how assumptions, limitation and uncertainties are considered and presented. Saliency can be improved by:

- Flexibility in the manner that services are provided that recognises different users' capabilities and resources
- Easily accessible information at various spatial (local to global) and temporal scales (consistent with the science and the requirements)
- Information about uncertainties that supports its inclusion within decision and policy making processes – requires and understanding of the users framing and risk tolerance
- Accompanying documentation (metadata, assumptions and limitations), support (guidance and case studies) and information that gives the services provided credibility
- Offering opportunities for co-generation and co-production of the services and fora for discussions with other users – share experiences and lessons learned

In terms of what information is needed, users have expressed a desire for:

- Clear, simple, understandable (hierarchical) and scientifically credible information – access to what can (should) be used not just what is available;
- Different formats (data files, maps, summaries, graphs) consistent with different uses and users' capacities – decision framing and process;
- Historical and current climate information
    - Summaries and trends related to thresholds, risks and vulnerabilities
    - Reliable user-defined information on current climate, including that related to extremes, variability and uncertainties
- Future climate information
    - Next 1-3 years, next decade, next 20-50 years and the next 50-100 years
    - Variability and extremes, along with associated uncertainties
    - End-user defined variables and derived metrics (thresholds and sensitivities)
- Different temporal and spatial scales – local to regional, but also access to global

Demand for S2D climate and climate impact information

The requests for S2D information and knowledge are related to those decisions for which the timeframes are consistent with those of S2D predictions. Information on users' requirements is limited as there is limited access and little experience with using services that could be derived from these predictions.

What information on users' requirements is available suggests that there is interest in the traditional climate variables at seasonal and annual time periods, but also with respect to decision trigger points (relative to thresholds and sensitivities of operations or the need to introduce or cease remedial/mitigating measures). To support decision-making users require information regarding variability, trends, anomalies and extremes. Many adaptation

decisions relate to measures that address risks and vulnerabilities arising from variability, anomalies and extremes. There is some evidence / expectation that the services derived from S2D will be particularly useful to those businesses, organisations, agencies and communities whose activities are affected and influenced by climate variability (and change) by informing decisions, improving operational activities or enhancing sales and increasing profitability.

Once again, in developing and delivering services to address these requirements, focus should be on supporting the types of decision being made (operational, programme and policy) much of which relate to user-defined definitions of variability, anomalies and extremes. As in the case of all climate services, those derived from S2D information must also be credible and thus include information on limitations, assumptions and uncertainties that can support the use of the resulting services.

Identifying the users of S2D predictions and its use

As mentioned above, experience with S2D climate services is limited with targeted use by a small number of sophisticated users (e.g., energy and other utility companies). The primary reasons for using S2D information are to support decisions and investments related to better understanding demand and supply.

Reasons behind the limited use relate to limited accessibility to S2D information and the complexity of that information both of which have implications for the capacity required for those using the information. The real or perceived robustness of the predictions also limits users' interest and motivation.

Further limiting the users is that in most cases that being supplied is data (or information) in the form of climate predictions. There has been limited movement to more than targeted S2D climate services with a primary focus on sophisticated, high-capacity users.

Tracing the interactions between climate services providers and users

There is a desire by those develop S2D predictions and by the climate services community to reach out to and engage existing and potential users. Dialogues with the research community (providers) indicated a desire to better understand:

- Users' decision spaces (sectors and organisations where the needs are greater, where vulnerabilities / risk are high, drivers of concern, risk appetite and times frames for decisions / policies)
- How climate information fits into users' decision making process
- Where users currently access climate information
- Nature and scope of current and future users' needs (foresight)
- Users' current and changing technical capacity to ingest climate services
- Capacity (including funds) and willingness to be engaged in developing and delivery of climate services and in the science behind those services
- Breadth of users those engaged represent and how better to engage the spectrum of users.

In terms of informing the development of S2D predictions, researchers have also expressed a need to understand users' requirements in relationship to where there are skills:

- How would S2D information be used? What kinds of decisions / uses?
- What variables / events are most important?
- What timeframes (seasonal, annual or decades) are most important in terms of decisions and policies?
- How often do users want / need the projection information to be updated?

The engagement process starts with a willing and able provider and user (or set of users). The current climate services approach that recognises and legitimacies this engagement has established an enabling and empowering environment. Evidence does suggest that a boundary organisation with legitimacy and credibility within both the providers' and users' communities can be effective facilitate this engagement process.

Potential users of S2D

There is increasing interest in the use of S2D predictions to support decisions. This interest is coming from a broad spectrum of users for whom the time frames and nature of decisions and policies are consistent with those of the S2D predictions. This includes the more obvious sectors where seasonal to decadal variability is particularly important for decision and investments (e.g., agricultural, energy and water sectors) but also where there are service and security concerns (e.g., emergency services and planning, health and well-being programmes, and transportation operations and maintenance).

There is also interest in local authorities in terms of planning and delivery of programmes and services. For these and other organisations and agencies the planning horizon is normally 3-5 years and there is an expectation that S2D will fill the information gap to support these decisions.

In terms of difficulties and barriers in obtaining and using S2D, these have been discussed above (accessibility, capacity of providers and users, user-friendliness of information, limited support for the users' and the real/perceived robust of the outputs).

Supply of S2D climate and climate impact information

There should be a community of providers (and purveyors) of S2D climate and climate impact information. This recognises the nature of the services required by the spectrum of users, including the need for generic and bespoke services, and the specific nature of their requirements. It also recognises that developing and delivering S2D climate services that can both reflect these users' requirements (evolving both in terms of scope and number and nature of users) and has the capacity to contribute to the fundamental climate science and that associated with the delivery of salient climate services requires an engaged community of providers and purveyors.