EUROPEAN COMMISSION
Community research

is-enes
INFRASTRUCTURE FOR THE EUROPEAN NETWORK FOR EARTH SYSTEM MODELLING

IS-ENES2 DELIVERABLE (D -6.3)

Prototype master classes for SMEs and corporates

File name: {IS-ENES2_D*6_3*.pdf}

Author(s): ***Erik van Slobbe (WU)***
Ronald Hutjes (WU)

Reviewer(s): ***Christian Pagé (CERFACS)***
Janette Bessembinder (KNMI)

Reporting period: e.g. *01/10/2014 – 31/03/2016*

Release date for review: ***01/09/2015***

Final date of issue: ***11/12/2015***

Revision table			
Version	**Date**	**Name**	**Comments**
1	1-9-2015	IS-ENES_6.3v.1	for internal review
2	11-12-2015	IS-ENES_6.3v.2	internal review processed

Abstract

This deliverable presents a prototype masterclass on the use of climate services for SMEs and larger business. The prototype course is tailored to the needs of companies to enhance their skill to translate CMIP5 and CORDEX data to address their client's policy challenges. The course uses real life case studies and active dialogue among climate experts and company representatives. A first attempt to test this prototype with SME representatives failed due to a disappointing number of participants. After this the prototype was successfully tested in a Wageningen University course with 50 international master students and this document reports on both the course and on lessons learned.

Project co-funded by the European Commission's Seventh Framework Programme (FP7; 2007-2013) under the grant agreement n°312979		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants including the Commission Services	
RE	Restricted to a group specified by the partners of the **IS-ENES2** project	
CO	Confidential, only for partners of the **IS-ENES2** project	

Table of contents

Executive Summary

One of the IS-ENES2 program's objectives is to facilitate innovations through the transfer of climate knowledge to SMEs and larger companies providing such climate services. In view of this objective a master class prototype for this group was developed. This deliverable report presents the prototype. It also reports on experiences with a pilot training.

The master class aims at training SMEs and larger companies using CMIP5 and CORDEX data on the application in different decision maker's contexts, assuming the need for climate data use in such contexts is growing. Company representatives, following the master class, enhance their capacity and skills to apply climate model data in a correct way and to assess the possibilities, limitations and uncertainties of data. Climate data providers following the master class benefit through interactions with information users.

The master class has an interactive character with dialogues between providers and users on real life decision-making contexts. The exchanges are based on case studies provided by participating companies.

The prototype course consists of:

- A structural alignment between eight learning objectives, methods to be used (presentations, group work, case study work) and assessment strategy (formulation and evaluation of personal learning objectives and peer review of case study results);
- Topics related to a climate information data chain model (like: articulation of information needs for sectors, use of CORDEX and CMIP5 data in case studies, use of meta data, use of processing tools, etc.);
- A 3 day program;
- Some example case study descriptions. Participants, however, are requested to prepare a case study based in their own working environment and to bring relevant information on context and data needs to the master class.

Together with the European Climate Knowledge Innovation Community a pilot was organized for SMEs and larger companies, but due to a disappointing number of registrations it was decided to do the pilot in a consultancy course for 50 Wageningen University students in March 2015. The course was slightly adapted (case studies were added and the program was fitted in four afternoons).

Important lessons learned are:

- To reach SMEs and larger companies a better understanding of what such companies need and/or new marketing strategies are needed.;
- Topics covered in the pilot were much appreciated by the students, especially the skill to use climate data, process and assess climate model data;
- Working from real life climate service problems proved very valuable;
- Skill analysis of various models against CRU data was very do-able. Bias correction proved more difficult, but first order corrections of annual biases were managed by all students;
- The climate4impact.eu portal proved very valuable in data search and access.

1. Introduction

1.1 Context climate services

Attention for the provision and use of climate services is growing. "*Climate Services have the potential to become the intelligence behind the transition to a climate-resilient and low-carbon society*" (EU, 2015, foreword)[1].

Much effort is being invested in the creation of easy-to-use climate information websites and other information outlets. But most analysts agree that just presenting relevant information on websites is not sufficient to make a difference in climate policies and practices. Differences in terms of knowledge basis and understanding between climate change experts and policy makers and practitioners are simply too big. The EU Roadmap's[1] account of its stakeholder consultation resulted in the observation that a: "stronger focus on the demand-side and on the provider user interface is needed for a proper market development, whereas climate services so far have been mainly supply driven" (p. 17).

Intermediary or boundary organisations, defined as: "*people or organisations who work as intermediaries assisting stakeholders in decision making, helping them in specifying information requirements, applying information and sharing experience*[2]" are seen as potential facilitators to span the gap between knowledge suppliers and users. And there is a small but growing market for SMEs and consultants operating as intermediaries.

One of the IS-ENES2 program's objectives is to facilitate innovations through the transfer of climate knowledge to SMEs and consultants. In view of this objective and in view of the need to reinforce climate data provider and user interactions a master class prototype for this group was developed.

This deliverable report presents the prototype. It also reports on experiences with a pilot training held at Wageningen University on March 20th, 23th and 24th, 2015. Initially an attempt was made to organize a master class course for SMEs and consultants on 18-20th of March 2015. Due to a disappointingly low number of participant registrations it was decided to cancel this course and to do a pilot at Wageningen University instead. In the last section we reflect on the difficulties to interest sufficient companies in following the master class and we present lessons learned and recommendations.

1.2 Objectives

The ISENES2 Description of Work defines WP6 task 2 as follows:

"*Develop concise master classes tailored to users - such as SMEs providing consultancy services and large companies - to guide them on the use of CMIP5 and CORDEX data and explain associated uncertainties. Such master classes will require a general curriculum*

---

[1] EU DG Research and Innovation (2015) European Research and Innovation Roadmap for Climate Services.

[2] (CLIPC D2.1, p. 12). This report will call this category 'boundary organisations'.

development and some preparation work to tailor courses according to (e.g. sectorial) needs. *Costs are associated to meetings organised to develop the master classes as well as for supporting teachers to participate in a prototype course. Companies are expected to pay for their travel expenses. These courses will be coordinated with ongoing and future EC (Horizon 2020) projects that have training activities planned, e.g. MEDIATION*".

From this we distilled two objectives:

1. Develop a master classes tailored to users - such as SMEs providing consultancy services and large companies - to guide them on the use of CMIP5 and CORDEX data and explain associated uncertainties, recognizing the need for an intensive engagement on a co-learning basis between providers and users of climate data
2. Give a prototype course in coordination with ongoing and future EC projects that have training activities planned.

2. Design of the master class for SMEs and consultants

This chapter presents a master class design based on section 1.2 objective number 1.

2.1 Purpose and design principle

The master class aims at training SMEs and consultants using climate model data and providers of CMIP5 and CORDEX data on the application in different decision maker's contexts. SMEs and consultants, following the master class, enhance their capacity and skills to apply climate model data in a correct way and to assess the possibilities, limitations and uncertainties of data. Climate data providers following the master class benefit through interactions with information users.

Given the complexity of decision making processes a simple transfer of raw data is never possible and translation and tailoring of raw data into formats useable for decision-makers asks extra efforts. Data providers therefore require detailed accounts of user information needs to be able to provide adequate formats and tools.

The master class is designed on the basis of intensive engagement on a co-learning basis between providers and users of climate data (see figure 1). Therefore, the 3-day master class has an interactive character with dialogues between providers and users on real life decision-making contexts. The exchanges is based on case studies provided by participating SMEs and consultants. Development of the case studies during the training will be reported on in so-called 'storylines' (a description of an adaptation situation, including context, challenge, information needs, and of how relevant climate model data were assessed and used).

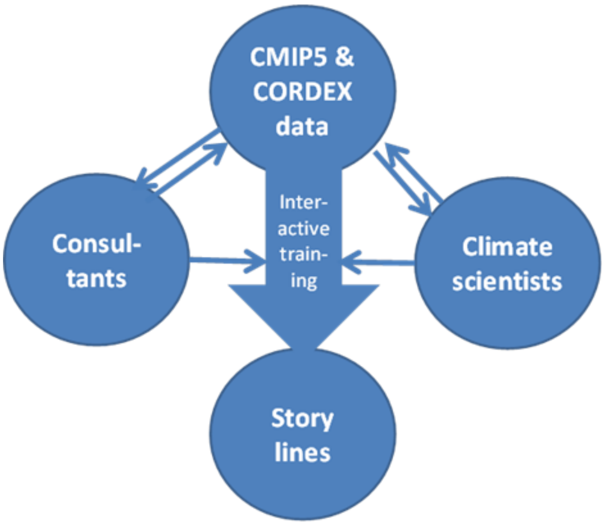


Figure 1: Main elements of the course. CMIP5 and CORDEX data will be processed based on real life case study challenges provided by SMEs and consultants and climate scientists. Results will feed into storylines for climate information use.

2.2 Content

Preparation: Participants are requested to prepare a case study based on their own working environment and to take relevant information to the master class.

Topics presented (see program) and used for case study analysis:

- Articulation of information needs for sectors (energy, water management, agriculture, insurances, infrastructures)
- Rules regarding access for commercial use of CMIP5 and CORDEX data
- Use of CORDEX and CMIP5 data in case studies
- Model, scenario and data uncertainties
- Use of metadata
- Use of post processing tools (statistical analysis, bias correction...)
- Visualisation of data
- Mapping and plotting of data
- Reflection on ethical issues related to the case studies

The choice for these topics is based on the logic of the climate information chain as depicted in figure 2.

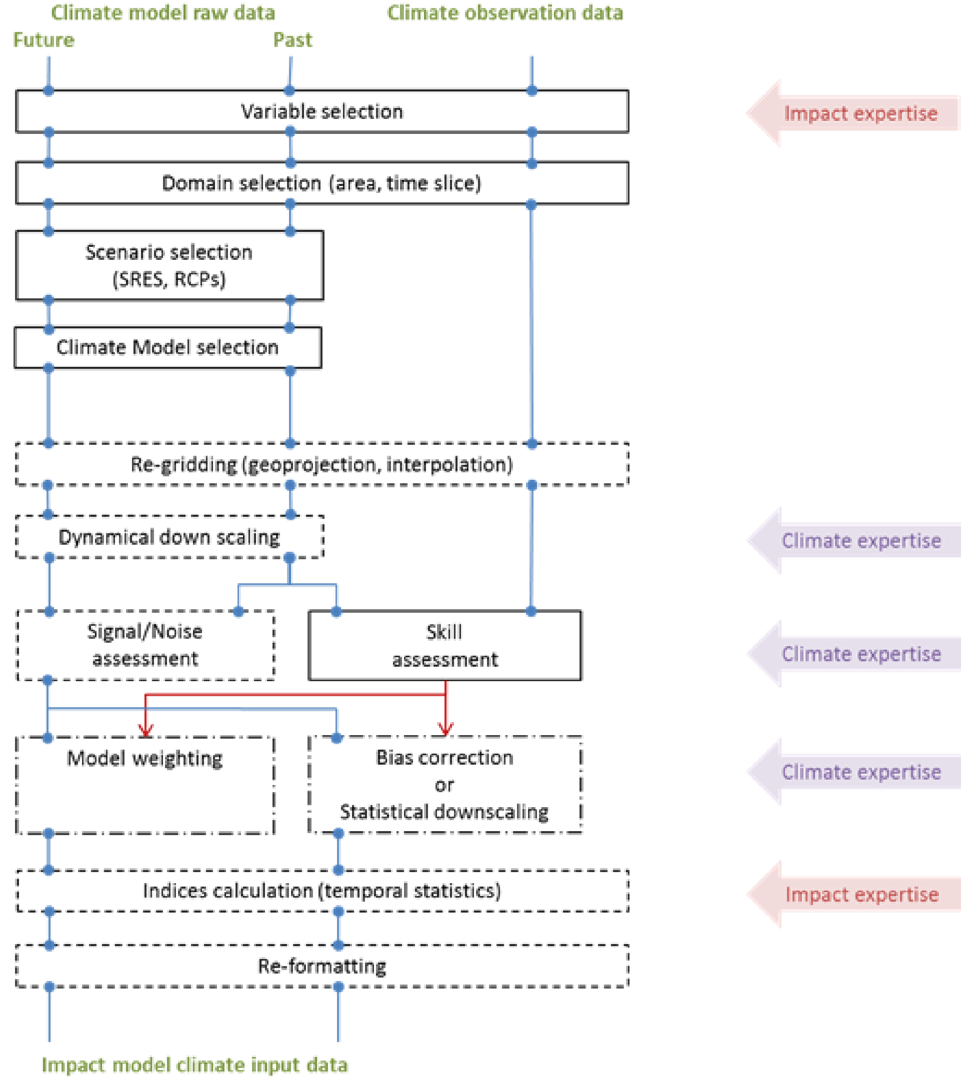


Figure 2: Climate data processing chain (presentation Hutjes at the 2015 pilot course). See also section 2.4; program (day 1, 13.30)

2.3 Learning objectives, methods and assessment

Table 1 presents a list of learning objectives and aligns this with the use of methods. Because of the character of a master class the assessment strategy is based on self-reflection and peer review.

Learning objectives	Methods	Assessment strategy
Understand the opportunities of CMIP5 and CORDEX data for use in practice.	Presentation of the climate4impact portal. Application of data in real life case studies.	1. Participants will be asked to formulate their personal learning objectives at the beginning of the course. At the end these will be evaluated and progress will be (self) assessed. 2. The final result of group work is a set of storylines on real life case studies. The quality of the resulting storylines will be peer reviewed among participants.
Understand the limitations of CMIP5 and CORDEX data for use in practice.	Presentation of uncertainties and limitations. Analysing the consequences in real life case studies.	
Be able to access and use the climate4impact portal.	Presentations. Real life case studies.	
Be able to formulate improvements of the climate4impact portal	Reflections on experiences in real life case studies. Plenary discussion and brainstorm.	
Understand and be able to apply bias correction tools.	Presentations. Application in real life case studies.	
Apply climate model data in different practical contexts and adjust data to requirements of users.	Presentation on typology of decision makers contexts. Reflection on the experiences in real life case studies.	
Understand ethical issues associated with the use of climate model data in decision making.	Reflection on experiences with real life case studies. Paper discussion.	
Create storylines on the use of climate model data in decision makers contexts.	Reporting of real life case studies. Critical discussion on reports.	

Obviously, a few days training does not make the student an experienced or expert climate service provider. Rather we aim to give them an overview of many of the issues, potentials and limitations involved, allowing you to start developing a climate service project and to hopefully better interact with the meteorologist on one hand and with the impacts stakeholders on the other.

2.4 Program

A three-day master class program was drafted, considering an international group of participants (allowing for travel times)

Day 1

Morning arrival participants

11:00 Introduction to the course and participants
12:30 Lunch
13:30 Lecture: The information chain from climate model to policy advice
15:00 Data exploration using the climate4impacts portal
16:00 Case study inventory, presentation and selection
19:00 Joint dinner

Day 2

8:30 Lecture: Dealing with Uncertainties in Climate projections
9:30 Case study development in teams of 2-4 people. Definition of adaptation and

	data needs
12:30	Lunch
13:30	Lecture: Bias Corrections and Downscaling of climate data
14:30	Case study development (cont’d)
18:00	Dinner
19:30	Case study presentation preparation
22:00	Drinks
Day 3	
8:30	Lecture: Visualisation of Climate Data: Info graphics for policy makers
9:30	Case study presentations and discussion on results
11:30	Reflection and wrap-up
12:30	Optional lunch

2.5 Case studies and the climate data processing chain

Participants are requested to prepare a case study based on their own working environment and to bring relevant information on the context and data needs to the master class. Annex 2 presents six case study examples. In the text box one of these is presented here as an example. A typical case study needs to address a policy makers adaptation challenge. Development of the case studies during the training will be reported on in so-called ‘storylines’. This is a description of a situation where adaptation is required, including context, challenge, information needs, and how relevant climate model data were processed, assessed and used. Departing from the challenge, the information chain (see figure 2) is followed towards the required climate data.

Through these exercises climate data providers and users have to engage with each other and through these discussions learning takes place.

Text box : example of a policy makers case: Providing high-resolution climate change scenarios for impacts and adaptation in the Gironde Estuary

Estuaries are the transition zones between the river and the sea. The combined flows of river-borne freshwater and sea-spawned saltwater provides variations on the balances of nutrients in the water and sediment, making estuaries among the more productive of natural habitats. The Gironde exemplifies all these estuarine characteristics.

Covering about 635 square kilometres, the Gironde Estuary is the largest estuary in western Europe. Because of a strong tidal regime and wealth of sediments it is the habitat of abundant and diverse fish, invertebrates and birds. Gironde Estuary constitutes a complex environment characterized by high ecological and biological values (e.g. habitat for many species, nursery, refuge or growth area) and undeniable economic value (e.g. fishing ground, important tourism, industrial, and traffic area.

The impacts related to climate change are frequently described in two processes: surface water warming with incidence on the hydrological properties and an increase of salt water intrusion. Spatial and temporal changes occurring along an estuary are governed by the parameters of temperature and salinity. The dynamic regime of the estuary is related to the thermal regime. Temperature effects on biological processes (e.g. speed of enzymatic reaction, increase in metabolism) and ecological processes (e.g. reproduction, locomotion, feeding rates and species interaction).

The spatial distribution of a species through the estuary is mostly linked to salinity, as each especial is adapted to live in a specific salty conditions. Changes in the salinity indeed may produce osmotic stress that increases the risk of mortality of individual species and lead in some cases to a reduction in inter-specific competition. Recently, the estuary has been increase in salinity as a response to a general reduction of freshwater discharges, due to anthropogenic drivers.

See also annex 2

2.6 Collaboration with Climate KIC and CLIPC

The organization of the master class was coordinated with the CLIPC activities on User requirements and strategies for user consultation and engagement. Most important a joint address list of users was produced with a special category on SMEs and consultants. This list was used to invite climate data users for CLIPC workshops and for the pilot master class.

The Dutch Education pillar of the Climate Knowledge and Innovation Consortium (CKIC) sees an interest in supporting the master class. It therefore has collaborated in the organization of the pilot program, through promotion and advertisement and through discussions on future integration in its own ‘short courses’ program curriculum.

See annex 1, for a brochure text that was disseminated through the IS-ENES2, CLIPC and CKIC websites.

3. Pilot course report

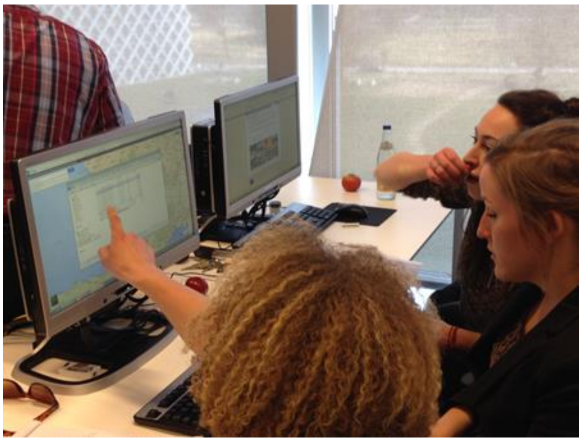
This chapter reports on the implementation of the master class design into a pilot at Wageningen University.

3.1 Disappointing SME and business participation

A pilot course was programmed in Wageningen on March 18 – 20. The course was integrated in the Climate KIC 'short course' program and the Dutch Climate KIC education pillar logistically supported the initiative. Advertisements were published (see annex 1) on Climate KIC and IS-ENES2 websites. Also a dedicated email was distributed to 600 addresses of European climate data users. This email list was produced by CLIPC for its own survey. IS-ENES2 contributed to the email list by performing an inventory and adding a list of European SMEs and companies.

Two weeks before the start of the course we had 6 registrations only, including only a single SME representative, and after consultation with Climate KIC it was decided to cancel the master class.

3.2 Climate Services Training at Wageningen University



As at the same period a consultancy course[3] for 50 Wageningen University students (see annex 4) was running, it was decided to integrate the master classes into this course. The initial master class program was used, with one major modification only. The idea to develop story lines on the basis of case studies provided by participants was changed, because we could not expect students to have relevant professional experiences. Instead we prepared a set of case studies beforehand (see annex 2 and this report's section 2.5) and students had to use these and develop as final result a presentation on climate data use strategies for the case study.

Thus the Climate Services Training followed largely the same format as the originally planned course for SMEs. Four afternoons were used for this: one for lectures, two for performing a climate change assessment related to a specific case study, one for preparing a presentation and presenting it.

For the case studies ('real-life') climate services problems from enterprises, governmental and non-governmental organisations etc. are used. See annex 2. This provided a context to the quantitative analysis that had to be performed.

[3] Academic Consultancy Training: ESS-60812 Design of Climate Change Mitigation and Adaptation Strategies

Prior to the group work three lectures focussed on respectively a) climate data selection, search, access and processing (skill assessment, bias correction, change assessment); b) contextualisation and tailoring of the climate services ('asking the right questions...') for adaptation (using the 'Mediation' framework); and c) visualisation and presentation of climate change analysis results and uncertainties.

3.3 Approach and Results.

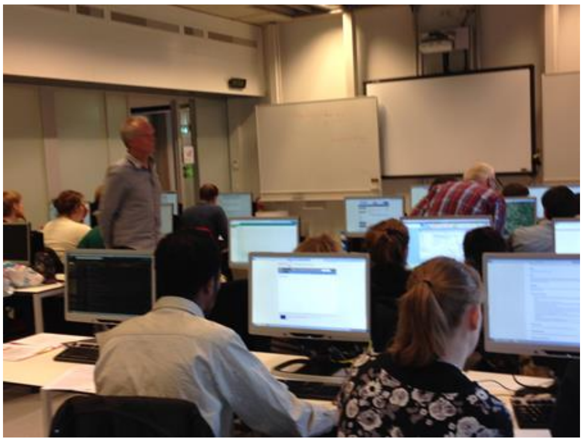
Students were asked to form groups of 3-4 and select a case study (see annex 2). For this case they then had to study and discuss the climate information needs in relation to others factors relevant for the problem. Next they had to specify the climate variables that will be relevant for their case and define the time horizon, geographical region (for pragmatic reasons in this very short study, one location had to be selected within that area to obtain the data for). Then, relevant scenarios and models had to be selected, data downloaded and some simple analysis performed (see appendix 3 for the use of relevant data sources and tools). They had to justify each of their choices and put them in the context of what they knew about the total uncertainty regarding climate change for their region of interest. Next, model skill and biases had to be analysed for the chosen region, and differences in predicted future changes between scenarios and models analysed, as relevant for the problem (for a few more suggestions of these 3 steps see below).

To assess the climate model skill

Students had to compare the model output for (part of) the 20th century (minimum 30yrs) scenarios with the observed data from the CRU database (CRU is used because of pragmatic reasons, other potential reference datasets are discussed in the lecture, assess and quantify the differences in means and variances (or standard deviation) at various time scales, e.g.:

- for the whole period 1901-1999
- for the whole period, but per month or season
- for some sub periods, e.g. 1901-1930, 1931-1960, 1961-1990

Then they had to use these biases in means and variances to correct the model output for future scenarios, a spreadsheet example on how this could be done was provided. Alternative, more complete, but more complex bias correction methods (e.g. Quantile-quantile mapping) are discussed in te lectures)



To analyse the scenario(s) of your choice
Students had to :

- quantify the change in their variables of interest between present day averages (e.g. 1961-1990) and a few time slices in the future (e.g. 2020-2030, 2050-2060 and 2090-2100
- not only look for changes in means, but also for changes in variances, extremes, PDF's, rate of change, including non-linear trends, etc.
- to compare scenarios from various sources (models) with respect to mean change, rate, PDFs?
- make and annotate some graphs, tables, etc. Future changes could be assessed with present day observations if available. To circumvent the need for bias corrections they could choose to assess future changes also relative to present day simulations of the same model. Then they had to discuss the limitations of this approach based on the outcomes of the skill analysis

To assess the implications of their results
Students had to answer the following questions

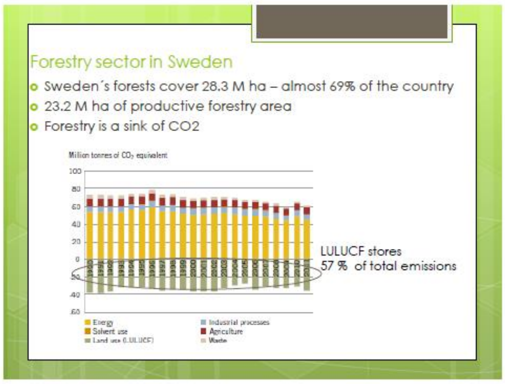
- what are your main conclusions? what would they imply for your case study
- what future research would you recommend to refine your scenarios

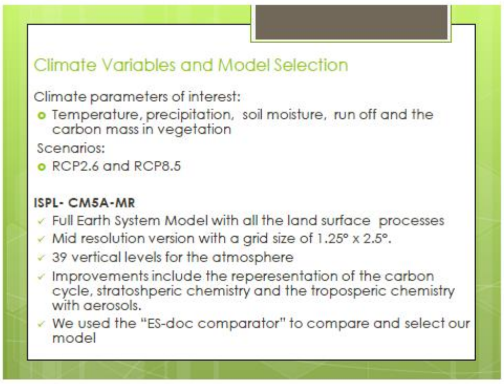
Finally, they had to prepare and present a PowerPoint presentation describing their results
Max about 5 slides

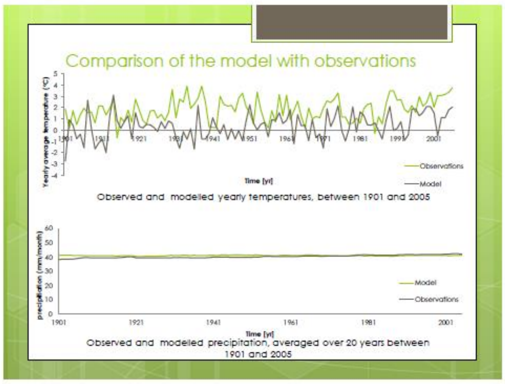
1. information needs case study + context (and possible adaptation decision?)
2. climate data selections
3. skill assessment chosen models
4. climate change signal chosen models/scenarios
5. recommendation to improve the original adaptation challenge's scenarios, implications for impact assessement and adaptation options

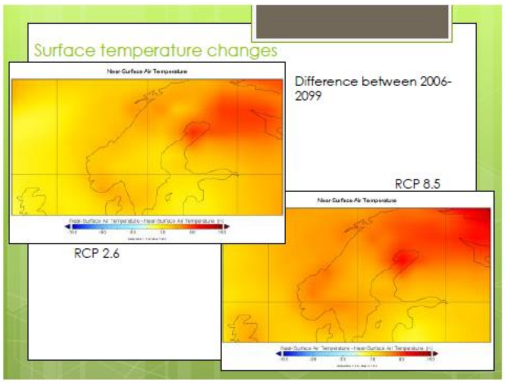
In total 12 student teams worked on 5 different case studies (see appendix 2: Gironde - 1 team; Sweden – 6; Colombia – 1; Kenya – 2; Netherlands – 2) . The students background varied widely: coming from 9 nationalities (5 EU, 4 outside Europe), 7 students came from a social science background (e.g. Environmental or Development Policy); the other 41 from a natural sciences background; only 24 students had some formal training in atmospheric sciences. See appendix 4 for more details. Despite the fact that half the students population had no formal training in any atmospheric sciences (which responds well with the course's aim to address non specialist businesses), all teams were able to come with satisfactory results w.r.t. a quantitative climate change analysis for their case study, within the allotted time

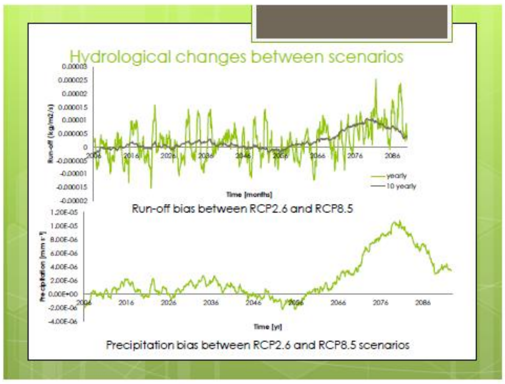
An example of one such result is shown below.

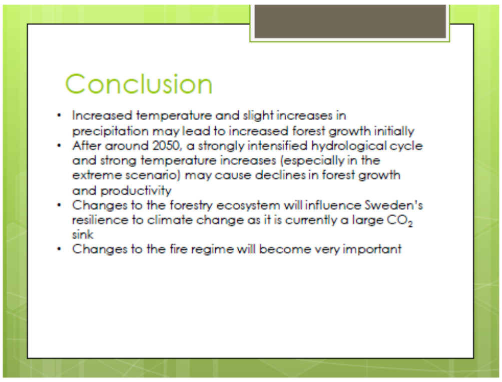


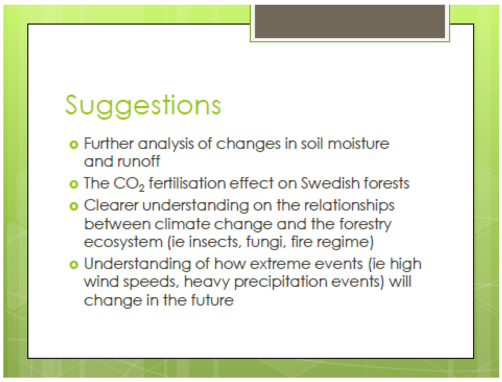












Final student presentation of the Swedish forest (see annex 2) case study.

3.4 Evaluation

The final student presentations were assessed and table 1 presents the main lessons learned from and feedback to their analyses.

Table 1. Lessons learned and trainer's feedback to the various student analyses.

SUBJECT	MESSAGES
Bias correction/Skill	Bias correction (BC) on annual means is not sufficient: seasonality and extremes needs to be addressed in bias correction (perform BC month by month)
	When the interest is on the climate change (CC) signal (ΔT, ΔP), no bias correction is needed, just compare two time slices from same model
	Bias correction is especially important for impact modelling, where absolute values are often important
Statistical downscaling	Statistical downscaling (and downscaling in general) is very important in mountainous areas, where model resolutions (also not in CORDEX) are almost never sufficient to capture the local topography: need good observations
Time horizon	With CMIP5/CORDEX do not look at next decade or so to distinguish climate signals from natural variability; would need special initialised decadal runs for that.
	For change assessment consider periods of 20-30 year minimum (and/or use more than one ensemble member if available)
CC signal	Consider not only changes on the mean but especially! Also on extremes (ideally consider a full PDF)
	Indices / thresholds generally are more meaningful to sectorial experts or stakeholders, but experience learns that sectorial experts and stakeholders can give thresholds, only in very broad ranges
	Using more than one Global Climate Model (GCM) gives good impression of inter-model spread (uncertainty)

	With *limited time/resources*: prior to ~2050 neglect representative concentration pathways (RCP) differences, focus on model spread instead; after ~2050 neglect model spread, focus on RCP spread instead
Communication	Put any analysis in broader CC context, is the chosen GCM more/less sensitive than others, what RCP was chosen (e.g. worst case: high RCP + sensitive model)
	Use easy to understand graphics - avoid time series to show differences between scenarios (they can be useful to show variability aspects), plot averages as e.g. bars instead - avoid scatter plots - avoid presenting two maps (with different colour scale) for comparison; do present difference maps - for specialists (C)PDF's can be very informative Pay attention to good infographics
	Present main message in few graphs/tables; move details to appendix

Evaluation of the Climate Services Training as a total with the students resulted in the following points:

- Some students initially had trouble to connect the level and the scale of climate variables and GCM output to their case study issues. They encountered some difficulties choosing the proper indicator and the related variable to capture a particular sector's climate vulnerability: biodiversity, water management, agriculture, etc. At the same time to think about this in a structured way was one of the most significant learning results of the training.
- Access to data was OK despite some initial technical issues (OpenID registration), and the climate4impact.eu portal was found very useful. Actual downloading of data required more time than expected. Still students expressed satisfaction with the acquired skill to access climate data, which they see as a valuable asset for the future.
- According to the course participants, the training is a useful tool for finding the right information. The course has helped them to find, access and apply climate model data in a correct way and to assess the possibilities, limitations and uncertainties of data.
- Students recommended for future training the development of a more detailed guidance on proper selection and processing of variables as part of the course. However, few students took notice of the guidance provided on the climate4impact.eu portal (lack of time?). Too prescriptive exercises also may prevent students from thinking themselves, and miss learning opportunities from feedback on errors made.

4. Perspectives

4.1 Lessons learned

Reaching the target audience

- Advertising in proper media. Advertising for this Climate Services Training was done mainly thought the ISENES, CLIPC and Climate-KIC websites and mailing their address collections. Apparently, the intended target audience (consultancy firms providing climate services) was not sufficiently reached this way.
- To reach SMEs and larger business new marketing strategies are needed. The websites we used are targeting broad audiences, including business, but the climate information service niche is small and apparently requires different advertisement strategies, like social media, direct contact, information through professional networks (like Twitter, ResearchGate, Linkedin).
- The course's focus on (raw) climate model data may not sufficiently motivate SME's and consultants, because they might prefer to have already processed datasets. Commercial climate service providers generally focus on other aspects of climate services (impacts + adaption, strategic advice, producing support in the adaptation process (more governance, communication, etc.)
- Lead time. Some applications from outside EU were received. These need more time for travel visa arrangements and securing financial support.

Course setup

- Overall course setup could be adapted to better mix lectures/practical work; to use about one day more. Basically as was planned for the original course.
- Lectures. Topics covered were much appreciated by the students. A bit closer link to the practical work (giving more examples) might improve subsequent application of lessons learned.
- Cases studies. Working from (in this case pre-defined) real life climate service problems proved very valuable. Some could have been worked out a bit more to enable students more easy delineation of the climate dimension and appropriate choice of climate variables.
- Exercises and analysis. Skill analysis of various models against CRU data was very do-able (pity these cannot be accessed through the climate4impact portal). Bias correction proved more difficult, but first order corrections of annual biases were managed by all. Some teams managed to do this on a monthly basis correcting also for variance differences. Computing indices other than very simple thresholds was not possible with the available software. Due to time constraints and to the level of prior knowledge only 2 out of 12 teams managed to analyse probability density functions.
- Data search and access: the climate4impact portal proved very valuable. Initial (compulsory) registration posed some problems. Better option would be to require students to create an account before the course begins. Search was greatly facilitated

by pre-set filters in search page. Download volumes were greatly reduced by geographical and temporal subsetting possibilities. Spatial subsetting is easy for regular lat/lon datasets, but some CORDEX data proved difficult to process due to ‘exotic’ native projections, while others are available in both unprojected and projected format. With many teams downloading data simultaneously some data transfer was slowed down somewhat (capacity limitations at ESFG data nodes or at connections?).

Facilities needed

- Supervision: the data search retrieval and processing required quite intensive technical assistance; we had three teachers at hand with extensive climate data analysis and climate4impact portal expertise, for a group of <50 students of mixed background and with varying computer skills. This proved to be rather minimal, especially for starting up this work. Once underway with their analysis less assistance was needed. Supervisors all had experience as both data provider and data user. This proved very valuable
- Hardware facilities: good computers, software and Internet connections were necessary for each student so that within each team work could be done in parallel.
- Allotted time. Two afternoons for actual quantitative climate data analyses is an absolute minimum to reach meaningful results. One or two half days more would probably have augmented the analyses considerably.

4.2 Recommendations

- More target audience oriented advertising. New ways to contact and approach SMEs and large business involved in consultancy work using climate information services are required. A way forward is to involve companies (or their professional organisations) in the course design and thus becoming part of their networks and their own sectoral information sharing methods.
- Students need to bring their own case studies, in order to make the course salient and close to their own experience basis.
- A three full days course is a minimum to cover the content.

Annex 1; Brochure

Climate Services training: application of climate data in policy and planning for consultants.

Are you a consultant or a specialist working on climate change impacts and adaptation problems? Or do you have climate data on offer and want to facilitate potential users of those data? Do you need to translate the information contained in climate model projections to your client's wishes? And do you want to enhance your capacity and skills to process and apply such data in a correct way? Do you want to make sure your advice on climate change problems are based on a sound understanding of the possibilities, limitations and uncertainties of those data?

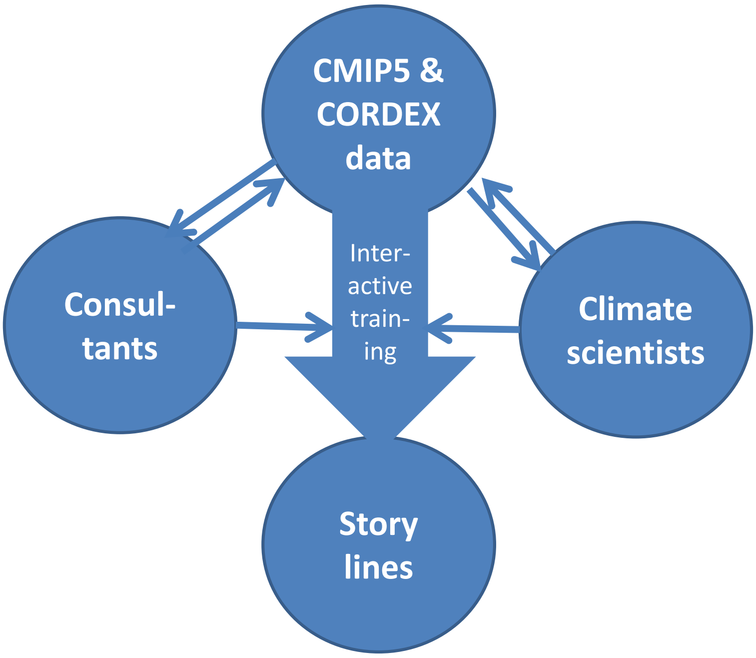
In that case you are invited to follow a 3 day training (organized by the ISENES2 project[4]) on the application of climate model projections in different decision maker's contexts. This 3 day training will have an interactive character with dialogues between users / boundary workers and providers in real life decision making contexts and includes hands-on exercises to find, access, process and analyse climate data relevant to the problem at hand. The exchanges will be based on case studies provided by participating consultants and specialists from various sectors.

Target Audience: This training aims at training consultants using global and regional climate model data, and providers of climate data (CMIP5 and CORDEX data, resp.) on their application in different decision making contexts.

[4] https://verc.enes.org/ISENES2

What's in it for consultants using climate model data?- Consultants will enhance their capacity and skills to find, access and apply climate model data in a correct way and to assess the possibilities, limitations and uncertainties of data.
What's in it for providers of climate model data? Given the complexity of decision making processes a simple transfer of raw data is most often not possible and translation and tailoring of raw data into formats useable for decision-makers asks extra efforts. Data providers therefore require detailed accounts of user information needs to be able to provide adequate formats and tools.

Intensive engagement on a co-learning basis is considered essential for a productive exchange between users and providers of climate data.



Course topics

- Articulation of information needs for sectors (energy, water management, agriculture, insurances, infrastructures) in discussion and co-creation between user and provider
- Use of climate observations and scenarios in case studies
- Dealing with Model, scenario and data uncertainties
- Use of meta data and background literature on data/model quality and skill
- Use of processing tools Visualisation of data
- Reflection on ethical issues related to the case studies
- Rules for access for commercial use of climate (model) data

Preparation[5]: Development of the case studies during the training will be reported on in so-called 'storylines' and development of typical work flow. This is a description of an adaptation situation, including context, challenge, information needs, and of how relevant climate model data were processed, assessed and used. Participants will be invited to prepare a case study based in their own working environment and to bring relevant information on context and data needs to the master class. Participants should also bring their own laptop.

[5] After registration students will receive detailed instructions.

Programme:

Wednesday: 18 March 2015
morning arrival participants

11:00 Introduction to the course and participants
12:30 Lunch
13:30 Lecture: The information chain from climate model to policy advice
15:00 Data exploration using the climate4impacts portal
16:00 Case study inventory, presentation and selection
19:00 Joint dinner

Thursday 19 March 2015

8:30 Lecture: Dealing with Uncertainties in Climate projections
9:30 Case study development in teams of 2-4 people
12:30 Lunch
13:30 Lecture: Bias Corrections and Downscaling of climate data
14:30 Case study development (cont'd)
18:00 Dinner
19:30 Case study presentation preparation
22:00 Drinks

Friday 20 March 2015

8:30 Lecture: Visualisation of Climate Data: Info graphics for policy makers
9:30 Case study presentations
11:30 Reflection and wrap-up
12:30 Optional lunch

Cost

Participation and stay €500, including two nights, all meals and refreshments, course material
Participants need to cover their own travel expenses

Date and venue

March 18-21; 2015.
Course: Impulse building, Wageningen Campus, Netherlands.
Overnight: a block reservation has been made in Hotel "Hof van Wageningen"

Registration and contact

This training is organised by the Climate KIC organisation in close collaboration with the IS-ENES and CLIP-C and through these supported by the European Commission.

Registration and contact: Pauline Ticheler pauline.ticheler@climate-kic.org +31-(0)317-481786

Information: www.climate-kic.org; verc.enes.org; www.clipc.eu; climate4impact.eu

APPLICATION FORM

Course Title: **Masterclass Climate Service Training**

A. Personal information

Title	
First Name	
Last Name	
Address	
Contact Address (line 1):	
Contact Address (line 2):	
City/Town:	
State/Province/County:	
Zip/IP/Postal Code:	
Country:	
Contact	
Email address:	
Mobile phone number:	
Office phone number: (incl. country code)	

Note: If your city/country of residence is different from that you have mentioned above, please indicate your city/country of residence:

Academic/Professional Qualification

Qualification	Institution	Year of Completion	Result

Current Job (Position/Company/Institution):

B. Other Information

Please briefly outline the motivation to attend the course. (200 words)

If you have a specific case study or problem that you want the course to address, please briefly outline it below. (100 words)

How do you expect to utilise the knowledge and experience gained from the course? (100 words)

How did you find out about this course? You may tick more than one answer.

- ☐ Climate KIC central website
- ☐ Regional Climate KIC announcements
- ☐ University notices
- ☐ Other website
- ☐ Social media
- ☐ Word of mouth

Please send this form along with your latest CV to pauline.ticheler@climate-kic.org

Annex 2: Short case study descriptions

These case studies, though short, have proven to contain sufficient detail for the type of exercise done during the course. In the original setup of the course it would be the students own cases. In that situation they bring more knowledge on the case, of course, than written in these outline. Just like the teachers have for the below examples.

France: Providing high-resolution climate change scenarios for impacts and adaptation in the Gironde Estuary

Estuaries are the transition zones between the river and the sea. The combined flows of river-borne freshwater and sea-spawned saltwater provides variations on the balances of nutrients in the water and sediment, making estuaries among the more productive of natural habitats. The Gironde exemplifies all these estuarine characteristics.

Covering about 635 square kilometres, the Gironde Estuary is the largest estuary in Western Europe. Because of a strong tidal regime and a wealth of sediments it is the habitat of abundant and diverse fish, invertebrates and birds. Gironde Estuary constitutes a complex environment characterized by high ecological and biological values (e.g. habitat for many species, nursery, refuge or growth area) and undeniable economic value (e.g. fishing ground, important for tourism, industry, and traffic)

The impacts related to climate change are two-fold: surface water warming with effects? on the hydrological properties and an increase of salt water intrusion.

Spatial and temporal changes occurring along an estuary are governed by the parameters of Temperature and salinity. The dynamic regime of the estuary is related to the thermal regime. Temperature affects biological processes (e.g. speed of enzymatic reaction, increase in metabolism) and ecological processes (e.g. reproduction, locomotion, feeding rates and species interaction).

The spatial distribution of a species through the estuary is mostly linked to the salinity level, as each species is adapted to live in a specific range of salty conditions. Changes in the salinity indeed may produce osmotic stress that increases the risk of mortality of individual species and lead in some cases to a reduction in inter-specific competition. Recently, the estuary has seen an increase in salinity as a response to a general reduction of freshwater discharges, due to anthropogenic drivers.

References

- Pagé, C., J. Boé, et L. Terray, 2008 : Projections climatiques à échelle fine sur la France pour le 21ème siècle: les scénarii SCRATCH08. Technical Report TR/CMGC/08/64, CERFACS, Toulouse, France. http://www.cerfacs.fr/~page/publications/report_cerfacs_regional_scenarii_scratch08.pdf

- Quintana-Segui, P., Le Moigne, P., Durand, Y., Martin, E., Habets, F., Baillon, M., Canellas, C., Franchisteguy, L. and Morel, S., 2008: Analysis of Near-Surface Atmospheric Variables: Validation of the SAFRAN Analysis over France. J. Appl. Meteor. Climatol. 47, 92–107.

Sweden: Initial assessment of climate change impacts on the forestry sector

The Swedish Commission on Climate and Vulnerability was instigated by the Swedish Government to carry out a comprehensive cross-sectorial assessment of climate and vulnerability in the Swedish society (SOU, 2007:60). In recent years, a number of floods and storms have had a major impact on Sweden. These weather events are not necessarily linked to climate change. Only in the future, once statistical material over a prolonged period is available, will it be possible to establish a link. However, climate scenarios do show an increase in extreme precipitation and high temperatures. A reduction in vulnerability to extreme weather events is therefore important in terms of the current situation and ongoing and future climate change. One of the most important businesses in the country is the Swedish forest industry. The consequences of climate changes for Sweden's forests and forestry will be significant. Some forestry impacts of climate changes were already well covered by impact modelling or otherwise research findings. Other possible climate change impacts were identified during the course of the Panel discussions:

- Increased forest growth will result in greater timber production
- Extent of damage primarily from insects, fungi and extreme weather? events
- Risk of poorer quality conifers in a warmer climate − better for some broadleaved trees
- Increased risk of wind damage in a changed climate
- Risk of more damage caused by fires, fungi, insects and game in a changed climate
- More difficult logging conditions

Some adaptive and preventive measures in the forestry sector were identified already:

- Preventive action against root rot through stump treatment at the time of felling is a relatively cheap measure.
- An improvement to the standard of existing forest roads and public roads for an unstable winter climate.
- Clearer inclusion of issues related to climate change in all basic forest-related training and further education.

Objectives

Provide the Agricultural and Forestry Expert Panel within the Swedish Commission on Climate and Vulnerability (2005-2007) with initial ideas of climatic factors relevant for impacts. The aim of the commission is to examine Swedish society's vulnerability to global climate change and the regional and local consequences of these changes, and to assess the cost of any damage which climate change may cause. Of special interest here is the impact of climate change on forestry.

References

- Persson, G., Bärring, L., Kjellström, E., Strandberg, G. & Rummukainen, M., 2007: Climate indices for vulnerability assessments. SMHI Reports Meteorology and Climatology No. 111, SMHI, SE-60176 Norrköping, Sweden, 64 pp + DVD.
- SOU, 2007:60: Sweden facing climate change – threats and opportunities. Final report from the Commission on Climate and Vulnerability. Swedish Government Official Reports 2007:60. 679 pp. http://www.sweden.gov.se/sb/d/574/a/96002

Colombia: Improved climate change information for the coffee culture

The Colombian Government considers Coffee as one of the five driving sectors for the country's progress. Colombia is the fourth coffee producer after Brazil, Vietnam and Indonesia. The coffee sector generates 17% of the national agricultural GDP and 9% of the overall agricultural and livestock sectors. 2.1 million people directly depend on coffee production (25% of rural population). Colombia is considered one of the five "mega diverse" and “freshwater rich” countries in the world, which makes it a strategic location for the conservation and future availability of these natural resources at global level. The Andean region is one of the biologically richer geographic regions of the world and it contains several very diverse ecosystems (due to variations in altitude, climate and geology). The coffee production is settled in these mountainous regions and coffee farms are spread over the country on an area of about 3,9 million hectares. Coffee harvesting and processing depend on freshwater for good farming and processing, because the quality and quantity of water influence productivity and bean quality, both before harvesting and during the farm wet coffee processing, characteristic for 'soft washed coffee' like the Colombian.

Regarding to Climate Change, there is scientific evidence on the increase of temperatures in the Andean region and its impact on coffee productivity and quality. As an example, the phenomenon La Niña 2010/11 is considered the strongest event in the last 60 years, with rainfall above the historical average by 37%. In terms of coffee production, the significant increases in humidity, sunlight and temperature had important consequences for the coffee flowering, cherry development and tree growth, causing a 12% production decline compared to the previous year. Water excess counteracted by widespread droughts caused by a strong El Niño. This phenomenon caused a serious lack of rain and in 2012 and some plantations and harvest land was lost due to fires and the coffee harvest was presenting poor bean development and increase of pests and diseases.

Objectives

To assess the impact of variability of climate on the coffee sector

- Due to a hotter climate, the coffee culture may have to move higher on the slope?
- The changing climate conditions will make the coffee plants more vulnerable to plagues?
- More shading of coffee trees may be needed because of climate change (drought or heat impact)?

Northern Kenya: Climate change scenarios for Eastern Africa

In 2011, Oxfam Novid reported a major food crisis in East Africa:12 million people were in dire need of clean water and food. Crops and livestock were lost at a massive scale. Similar disasters are expected to become common in the near future. Changing weather patterns may play an important role. An adequate response to meet humanitarian needs is essential, but certainly it is also important to address the underlying problems.

Currently Acacia Water is contributing to projects in Djibouti, Somaliland, Sudan, South Sudan, Uganda, Tanzania and Kenya. Most of these projects aim to improve access to (drinking) water, increase livelihood resilience and promote sustainable environmental management. For the studies, and more even for the identification and design of interventions, it is fundamental to take into consideration projected climate change. E.g. when designing a set of water buffering interventions the duration of the dry season has to be taken into account to calculate the storage capacity needed.

Currently, there is no synthesis document wherein the impacts of climate change in these areas are thoroughly described, mapped and quantified. In general, reports only state rather vague descriptions as e.g. 'increased intensity' and 'more erratic'. This project aims to cover this knowledge gap and will be fundamental for a biophysical assessment to be developed for Northern Kenya.

Objectives

- Describe the impact of various climate change scenarios on the climate in the region, including a quantification of uncertainties;
- Develop a scientifically based method to predict future rainfall and evapotranspiration in the study area, including average, recurrence and extreme predictions of precipitation and droughts;
- Provide future precipitation, evapotranspiration, drought and flood occurrence projections for Northern Kenya;
- Identify land, water and environmental management aspects that will be most affected by these predicted changes;
- Indicate possible strategies and/or solutions to anticipate or deal with these changes.

References

- www.acaciawater.com
- www.bebuffered.com
- www.ipcc.ch
- www.hoarec.com

Netherlands: Adaptation of urban water system to impacts of changing rainfall patterns, Wageningen Area

The topography of Renkum, Wageningen and Rhenen is characterized by sandy hills. Increasing intensities of rainfall in recent years causing fast surface run-offs on sloping streets and in some cases floods have raised concerns about a climate proof future. The design of sewage systems and storm water run-off systems is based on existing Dutch urban water management standards, using statistical analysis of historic rainfall events. Are these existing drainage infrastructures sufficient? And if they are not, what needs to be done to adapt them? And how to prevent maladaptation (investing too much or too little)?

Importantly, it is not only extreme rainfall events which cause concern. The surface water system of Wageningen is vulnerable to periods of low rainfall and drought as well. In recent years, for example, the water levels in the city canal were occasionally found too low for certain functions.

Issue: Debate on the adaptation of storm water runoff infrastructures in the cities of Renkum, Wageningen and Rhenen. Urban water managers need to find solutions for the short term, to avoid flood damages, while considering growing vulnerabilities to periods of low and high rainfall in the long term. Special attention goes out to floodwater discharge and damage in sloping streets. In addition the Municipality is interested in the role that green areas can play in water management and adaptation.

Objectives

Project area includes Renkum, Rhenen, Wageningen and Waterboard region (so-called ‘R2W2’-area).

- Assess current and future climate for the project area, paying special attention to extreme rainfall events (regional climate models and observation of a.o. Haarweg meteorological station)
- Identify impacts and vulnerabilities in project area to climate change and extreme rainfall (incl damages due to water and soil erosion from sloping streets and whether existing drainage infrastructures are sufficient)
- Identify and appraise adaptation options to cope with climate vulnerability, paying special attention to extreme rainfall events, infiltration and controlled run-off and the role of green areas in water management

References

http://www.ruimtelijkeadaptatie.nl/nl/handreiking

Austria: Assessment of climate change impacts on snow making capabilities in the area of Stuhleck (Fischbacher Alpen) until 2050

The economic welfare of ski areas highly depends on the ability to cover the slopes with a given amount (height of snow) of either naturally or technically produced (“artificial”) snow for a defined period of time. From today’s point of view, there does not exist any possibility to sufficiently adapt product strategies to scenarios without skiing or snowboarding on slopes as a main selling proposition, as 90 per cent of tourists, visiting ski areas in winter declare “skiing or snowboarding” as the main motive for their buying decision.

The minimum volume of snow that is required to provide acceptable skiing conditions depends on the type of surface prevailing on the mountain (e.g. ski areas with rocky surfaces need greater amounts of snow than mountains with surfaces, mainly consisting of grassland).Also the period of time whilst skiing conditions will be available in future, is a key variable for the economic welfare of companies operating ski areas. Due to the characteristics of Stuhleck’ s customers, an early beginning of the winter season (e.g. by end of November) is more important than a late ending of the season (e.g. mid or end of April). This might not be true for other ski areas.

One possible adaption strategy for ski areas is to intensify the means of producing artificial snow in order to substitute decreasing amounts of natural snowfalls and/or rising temperatures or combinations of meteorological factors that threaten a sufficient snow cover on the slopes. As adaption measures are expensive, time consuming and hard to re-adapt afterwards, the goal of Stuhleck ski area is to adapt its snow production capacities to the extent needed to provide stable winter seasons without neither under- nor overestimating the required dimensions of production facilities.

Objectives

- How will temperatures and relative humidity at Stuhleck develop during the time period of October until April until 2050 (mean values, extreme values)? How will other weather extrema develop – e.g. will the number of days per winterseason with high windspeed increase or decrease?
- The ski area ranges from 800 mtr. a. s. to approx. 1800 mtr. a. s. – how long will the periods of time be, where production of technical snow is possible on the whole mountain (given a wet-bulb temperature of -4 to -3°C) ?
- What kind of changes in weather situation do we have to expect in future (e.g. longer periods of southerly or northerly winds, strength of wind, inversions, foehn etc.)

References

http://www.stuhleck.at

Annex 3; Information sources and tools

CLIMATE4IMPACT data portal
As also mentioned in the lectures the primary search engine for climate data is http://climate4impact.eu.

To search and visualize climate data you don't need to register/login. However, if you want to download data for analyses on your own computer, you need to obtain a so-called OpenID from https://esg-dn1.nsc.liu.se/esgf-web-fe/createAccount. Next, make sure you are member of the CMIP5 and CORDEX Research groups (not the Commercial groups, you will be more restricted in downloading data).

Please register and copy your OpenID, which should look something like https://esg-dn1.nsc.liu.se/esgf-idp/openid/username. Whenever you need to login copy this entire address, not only your username.

First play around a while with the various possibilities of the data search facilities, the mapping facilities and the downloading facilities.

Portal Use
For model data go to the Data discovery/Search tab and tick all the appropriate tick boxes, always working the widgets from top to bottom. Arriving at the Domain widget, press the ↻ symbol first and select a domain (relevant only for CORDEX data). Then, press ↻ again on the Models widget and select the model of your choice. Finally, press ↻ again on the Search datasets widget. Generally the results here may be presented as a bit cryptic data set names. However, if you sufficiently narrowed down your search criteria in all the respective widgets, you should find here between 1 and max ~20 datasets, generally reflecting different ensemble members, sometimes reflecting different model versions. At this point you can add the one you need to your basket, but often it will be a very big file. Better is to browse it further first, so click *browse*. Then you can select and download the variables you really need, and moreover make maps already with these without actually downloading anything by clicking *view* in the OPENDAP column. A new tab will be opened in your browser with you map(s); you can add any number of layers to the map. Now you can zoom in to the map, and copy the picture of the map, or download just this cut-out from the dataset.

Comment: if you plan to use CORDEX data, i.e. high spatial resolution data, please realise these are organised by continent (e.g. EUR, AFR, etc.) and that they come in two formats: data are provided on the RCMs native grid (e.g. AFR44) and on regular grids (equiv. AFR44i). Make sure you use the latter as they are much more easy to handle in this short exercise.

For daily observations in Europe go to the Data discovery/Catalogs tab and open the *KNMI-NMDC* catalog. There you will find the *E-Obs dataset* with all the station data of Europe from 1950 till present, gridded on a 0.25^{o} grid. For monthly observations globally since 1901 till present generally the CRU-TS dataset is used. These very big files can be found at \\wur\dfs-root\Student\Shares\Omgeving\ESS60309\ClimateServiceTraining

All datasets you may download are presented in a so-called self-descriptive format: NetCDF. This has become a de-facto standard for storing gridded climate data (https://www.unidata.ucar.edu/software/netcdf/docs/). To visualise these offline you can use Panoply installed on your computer (to install on your own laptop go to http://www.giss.nasa.gov/tools/panoply/

). With this tool you can also extract data for one specific location ('create a line plot along time axis'), set you lat/lon and then copy from the Array tab to e.g. excell.

Panoply use

In Panoply first open the file you want to access. Then double click the variable you want to plot (not the dimension variables lat, lon or time). Next you chose which type of graph to make, for maps chose *Create geogridded lon-lat plot* for a time series *Create line plot along time axis*. A new window will appear. In either case you can view the plot (tab Plot) or the numbers directly (tab Array). From the Array tab you can select and copy any subset you like to e.g. excell for further analysis.

If you have two maps opened in Panoply, say a map with data from model 1 and one from model 2, or even two maps from the same file/variable, you can also make e.g. a difference map. Use the *Combine Plots* button.

For more extensive manual see http://www.geo.uni-bremen.de/Interdynamik/images/stories/pdf/visualizing_netcdf_panoply.pdf

MS EXCEL use

You can export the data you found to an Excel file for easier further analysis. We provide you with one example, again to be found at \\wur\dfs-root\Student\Shares\Omgeving\ESS60309\ClimateServiceTraining . Select the file *Rhine_Delta_Rotterdam.xslx*. In this file we downloaded data from 5 CMIP5 models for two scenarios/RCPs, and made an analysis of model skill, simple bias corrections, predicted climate change for one gridbox centred on Rotterdam (lat 51.75^o, lon 4.25^o). This may give you suggestions how to do an analysis for the area and topic of your interest, as discussed next.

The file contains a number of worksheets, one for each of the 5 models and the 2 two scenarios selected here, containing daily data for rain, tmin and tmax and one for the observed data from CRU containing monthly data for the same variables.

In addition a few worksheets containing some example analyses are given. Follow the various cell references or formulas how to do this. In the *Summary* worksheet an analysis is made of seasonal dynamics (monthly weather) for the various models scenarios and periods. In the *Bias* worksheet a simple skill assessment of the various models has been made. In the *MME* worksheet we compute multi model means and plot MME future changes. In the PDF worksheet some probability density functions (i.e. histograms) are computed for a single model, and analysed in terms of shifts in the occurrence of hot days and frost days respectively and that changes in the extremes are larger than changes in the median.

Annex 4; Characteristics of student population partaking in the climate services training

	no of students	of which included some formal training atmospheric sciences	of which included no/very little natural sciences at all
Social sciences			
Development studies	3		3
Environmental studies	7		4
Natural sciences			
Forestry & Agriculture	4		
Earth & Environmental sciences	11	9	
Atmospheric sciences	5	5	
Hydrological sciences	12	7	
Soil sciences	4	3	
Biological sciences	2		
Total	48	24	7