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E-URAL European Union and RussiA Link for S&T co-operation in the area of the environment

Support Action in "Environment (including climate change)"

EU-Russia collaboration for the evaluation of climate change impacts

Workshop Proceedings

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EU-Russia collaboration for the evaluation of climate change impacts

Workshop Proceedings

Application of physically based models of runoff generation for estimation of extreme flood characteristics in climate change conditions

Prof. L.S. Kuchment

Leader of the project

Head of Lab of Hydrolocgical cycle of Water Problems Institute of the Russian Academy of Sciences,
3 Gubkina Str., 117735, Moscow Russia
kuchment@hotmail.com/Fax:+7-095-1355-415

1. Introduction

The extreme floods can in many cases be resulted from such unusual combinations of hydrometeorological factors that may be unobserved in the historical data. At the same time, because of nonlinearity of hydrological processes, the physical mechanisms of extreme flood generation are often quite different from such mechanisms for usual floods. A significant influence on the generation of extreme floods may have climate change and human activity (for example, deforestation, urbanization, change of land use). As a result, the hypothesis that the hydrological series are stationary stochastic processes that is widely used in engineering hydrology can lead to significant errors in estimation of extreme floods characteristics. The physically based model of runoff generation that simulates flood generation mechanisms for a wide range of possible combinations of meteorological and hydrological conditions including peculiarities of the extreme floods provides opportunities to avoid the hypothesis of stationarity. The coupling of this model with stochastic models of meteorological inputs (the weather generators) and with the Monte Carlo procedure of simulation of meteorological inputs is allowed to estimate probabilities of peak discharges and volumes of floods for all possible combinations of meteorological and hydrological conditions, taking into account the nonlinearity of hydrological processes, climate change and the change of drainage basin characteristics.

2. Project description

Project Title:

Application of physically based models of runoff generation for estimation of extreme flood characteristics in climate change conditions.

The objective of the project is to test opportunities of application of the physically based and dynamic -stochastic models of runoff generation for an improvement of methodology of estimation of extreme flood characteristics to comparison to the results given by the traditional approach, based the hypothesis of stationarity, for different physiographic zones and for climate and land use for change conditions. It is assumed to use for this study the distributed physically based model developed in the Water Problems Institute (WPI) of RAS which provides simulation of a wide diversity of runoff generation mechanisms including peculiarities of the extreme floods and is allowed to take into account of climate and land use change. The model is based on the finite-element schematization of river basin and includes the description of the following hydrological processes: snow cover formation and snowmelt, freezing and thawing of soil, vertical soil moisture transfer and infiltration, overland and channel flow. The coupling of this model with stochastic models of meteorological inputs and with the Monte Carlo procedure of simulation of meteorological series has shown an improvement of assessment of exceedance probabilities of extreme flood peak discharges with comparison to the results given by the traditional approach which is based on frequency analysis of measured flood peak discharges and extrapolating of a fitted statistical distribution of peak discharges to given exceedance probabilities. However,

numerical experiments show that the efficiency of this methodology may be satisfactory for events with the exceedance probabilities of 0.01-0.001 and for more rare events the uncertainty in peak discharges estimations can significantly increase because of errors caused by inadequacy of the stochastic models and shortness of the observed data series which put to use for assigning the model parameters. To decrease this uncertainty, an attempt has been done to combine the peak discharges series obtained by dynamic-stochastic simulation with the estimation of the probable maximum discharge (PMD) calculated through the physically based model of runoff generation with the probable maximum snowmelt rate as a model input. This PMD is utilized as a parameter to fit the exceedance probabilities of simulated flood peak discharges by the Johnson statistical distribution.

I am coordinating two Russian projects associated with the problem mentioned above:

1.Project of the Program No.16 of fundamental researches of Presidium of RAS “Development of methods for estimating change of the risk and scales of catastrophic floods at different scenarios of climate and land use change”

The theory of catastrophic floods based on investigation of main runoff generation mechanisms in different physiographic zone is developing. The improving of physically based and dynamic-stochastic modeling of hydrological systems is carrying out.

2.Project of the Program No.13 of Earth Sciences Division of RAS “ The influence of climate change on the hydrological cycle and the runoff of large river of Arctic region”.

The models of hydrological cycle of tundra and taiga river basins of permafrost zone have been developed. The sensitivity of the hydrological cycle components to climate change is estimating.

3. Case-studies and applications

The methodology of the flood risk assessment applying the dynamic – stochastic modeling based on the WPI model system and developed stochastic models of meteorological inputs was illustrated on the case studies for different physiographic zones of Russia: the Seim, Kolyma, Don and Vyatka River basins. I was shown that the suggested models and the flood risk assessment methodology are allowed to simulate the observed extreme flood hydrographs, provide accounting of human change of the river basin characteristics and give opportunities to project the extreme flood change at different sceneries of climate change.However, the improving of the physically based and dynamic-stochastic models carried out mainly for snowmelt floods and for plain rivers. It is very important to develop the suggested approaches for mixed rainfall and rainfall-snowmelt floods as well as for the mountainous river basins. In general, mechanisms of generation of rainfall runoff are more complicated than snowmelt runoff. Combining data, knowledge on hydrological processes and experience of construction of runoff generation models which there is in UN and Russia can be useful for improving of the physically based and dynamic-stochastic models of rainfall runoff and rainfall flood risk assessment.

4. Topics of collaboration between EU and Russia

1. Improving of the physically based and dynamic-stochastic models taking into account of differences in the mechanisms of runoff generation in different runoff physiographic zones of EU.

Exchange by ideas, hydrometeorological information and knowledge on mechanisms of generation of extreme floods in different runoff physiographic zones of EU and Russia can give opportunity to develop the physically based and dynamic-stochastic models which can be applied for wide range of physiographic conditions and types of runoff genesis.

2.Testing of developed models and corresponding methods of estimation of extreme flood characteristics taking into account of climate and land use change for different regions of EU and Russia.

These investigations are necessary mainly to understand how the developed models and methods of. flood risk assessment can work at available information for different regions of EU and Russia

3. Estimation of possible extreme flood characteristic changes caused by climate change for different regions of EU and Russia.

Applications of received methodology for estimating possible extreme flood characteristic changes caused by climate change for different regions of EU and Russia to obtain a general spatial projections of these changes and to compare these projections with results obtained by other methods

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CLIMB - Climate induced changes on the Hydrology of Mediterranean Basins – Reducing uncertainty and quantifying risk

Ralf Ludwig[1], Gudrun Lampart[1], Thomas Ammerl[2]

Coordinating Unit of CLIMB

[1] Ludwig-Maximilians-Universitaet Muenchen, Department of Geography, Luisenstrasse 37, D-80333 Munich, Germany; g.lampart@lmu.de
[2] Bavarian Research Alliance, Nussbaumstr. 12, D-80336, Munich, Germany

1. Introduction

According to future climate projections, Mediterranean countries are at high risk for an even pronounced susceptibility to changes in the hydrological budget and extremes. Threats include severe droughts and extreme flooding, salinization of coastal aquifers, degradation of fertile soils and desertification due to poor and unsustainable water management practices. These changes are expected to have strong impacts on the management of water and land resources as well as on key strategic sectors of regional economies, such as agriculture and tourism, and their macroeconomic implications. Such manifold developments bare a strong capacity to exacerbate tensions, and even intra- and inter-state conflict among the social, political, ecological and economic actors. However, current projections of future change, based on regional climate model results and subsequent hydrological modeling schemes, are still very uncertain and poorly validated. Thus, effective adaptation and prevention measures need multi-disciplinary preparation, analysis and action.

2. Project description

Project Title:

Climate induced changes on the Hydrology of Mediterranean Basins – Reducing uncertainty and quantifying risk

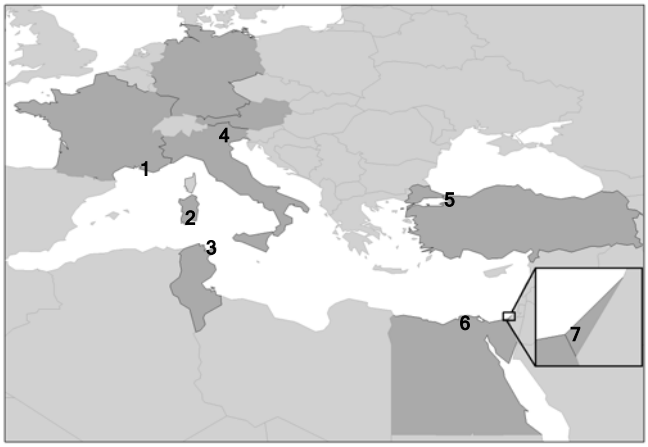
List of Project Partners:

1) Ludwig-Maximilians-Universitaet Muenchen, Germany
2) AGRIS Sardegna - Agenzia per la Ricerca de la Agricoltura, Italy
3) Christian-Albrechts-Universitaet zu Kiel, Germany
4) Centre national du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, France
5) Centre de Recherche et des Technologies des Eaux, Tunisia
6) Consorzio Interuniversitario Nazionale per la Fisica delle Atmosfere e delle Idrosfere, Italy
7) Centro di Ricerca, Sviluppo e Studi Superiori in Sardegna, Italy
8) Deutsches Zentrum fuer Luft- und Raumfahrt e.V., Germany
9) Forschungszentrum Juelich GmbH, Germany
10) Gebze Yuksek Teknoloji Enstitusu, Turkey
11) Institut National de la Recherche Scientifique, Canada
12) Joanneum Research Forschungsgesellschaft mbH, Austria
13) Université d'Angers, France
14) Islamic University of Gaza, Palestinian-administered areas
15) Università degli Studi di Padova, Italy
16) Università degli Studi di Trento, Italy
17) Zagazig University, Egypt

18) VISTA Geowissenschaftliche Fernerkundung GmbH, Germany
19) Bayerische Forschungsallianz gemeinnuetzige GmbH, Germany

In its 4-year design, the presented project CLIMB (FP7-ENV-2009-1) analyzes ongoing and future climate induced changes in hydrological budgets and extremes across the Mediterranean and neighboring regions. This is undertaken in study sites located in Sardinia, Northern Italy, Southern France, Tunisia, Egypt and the Palestinian-administered area Gaza. The work plan is targeted to selected river or aquifer catchments, where the consortium will employ a combination of novel field monitoring and remote sensing concepts, data assimilation, integrated hydrologic (and biophysical) modeling and socioeconomic factor analyses to reduce existing uncertainties in climate change impact analysis. Advanced climate scenario analysis will be employed and available ensembles of regional climate model simulations will be audited and downscaled. This process will provide the drivers for an ensemble of hydro(-geo)logical models with different degrees of complexity in terms of process description and level of integration. The results of hydrological modeling and socio-economic factor analysis will enable the development of a GIS-based Vulnerability and Risk Assessment Tool. This tool will serve as a platform for the dissemination of project results, including communication with and planning for local and regional stakeholders. An important output of the research in the individual study sites will be the development of a set of recommendations for an improved monitoring and modeling strategy for climate change impact assessment.
The project combines genuine science activities with a strong link to practical application in the targeted regions of the Mediterranean area and thus provides a balance between the three building blocks of environmental research, namely understanding, assessing impact and responding to threats to security in man-environment systems. An increase in general knowledge of water management issues in arid climate, can lead to the development of potentially innovative practical and/or theoretical approaches and technologies. It is intended to intensively share and exchange expertise with the Mediterranean Water Scarcity and Drought Working Group of the Mediterranean branch of the EU Water Initiative (MED-EUWI). This can be very beneficial to provide supportive guidance for a more concise implementation process for current water-related directives, such as the EU Water Framework Directive 2000/60/EC or the EU-Flood Risk Management Directive 2007/60/EC.
CLIMB, started in early 2010, is part of a research cluster with the projects WASSERMed (= Water Availability and Security in Southern Europe and the Mediterranean, FP7-ENV) and CLICO (= Climate Change, Hydro-Conflicts and Human Resources, FP7-SSH). This cluster has been formed under a coordinated topic between the Environment and Social Science and Humanities Programs of EC’s FP7 to better assess the manifold consequences and uncertainties in climate impact on man-environment systems and water security in Southern Europe and neighboring regions. It comprises a critical mass of researchers from 44 partners (29 institutions from the EU, 5 institutions from S&T countries and 10 international institutions) to foster scientific synergy and policy outreach and to tackle the challenging research questions with regard to climate change impacts on water resources as a threat to security. To initiate and maintain a sound and successful dissemination process, regional, national and international stakeholders and policy bodies are invited to express their research needs and recommendations.

3. Case-studies and applications



1) Thau – 280 km² - Coastal Lagoon - France
2) Rio di San Sperate – 473 km² - Sardinia - Italy
3) Chiba - 286 km² - Cap Bon - Tunisia
4) Noce - 1367 km² – Southern Alps – Italy
5) Izmit Bay – 673 km² - Kocaeli - Turkey
6) Nile Delta – 1000 km² - Nile - Egypt
7) Gaza Aquifer – 365 km² - Gaza – Palest.-admin. areas

Fig. 1: The partner countries of CLIMB (+ Canada) and the location of study sites

An analysis of climate change impacts on available water resources is targeted on mesoscale river or aquifer systems. Selection criteria included an expected high susceptibility to climate induced changes in water availability, runoff-regimes, runoff extremes and water quality. The selected sites comprise one to several of the following components, which impose a threat on future water security: high agricultural productivity, irrigation, heavy multi-source nutrient loads and pollution, sea water intrusion or growing water use rivalries.

4. Topics of collaboration between EU and Russia

1) *Climate Change Impacts on Runoff Extremes in Macroscale Eurasian Watersheds*

Research over the past decade has identified numerous constraints and highlighted the most important requirements for developing regional adaptations to climate change with regard to runoff extremes (drought & flood). A research concept involving EU and Russian partners should first address an improvement of processes understanding on the impacts of climate change on hydrologic variables. Further, the improvement of scaling procedures is mandatory for the utilization of regional climate model (RCM) results in regional watershed modelling and management. Existing databases from global and regional climate models (GCM and RCM) must be thoroughly analyzed for the estimation of their respective intrinsic variability and their contribution to the overall uncertainty related to climate change projections. These shall be applied to ensembles of hydrologic models for an improved understanding of the impact of the complexity of processes descriptions on simulated hydrological variables and their predictive power with regard to runoff extremes. The research effort shall ultimately contribute to the development of a water management model framework for linking hydrological model outputs to models simulating the decision making process. This will allow for a better evaluation of watershed adaptation options to climate change impacts on runoff extremes.

2) *Using Remote Sensing for the monitoring and modelling of permafrost degradation*

Global Circulation Models generally agree to predict the highest long-term temperature rise for the high latitudes of the northern hemisphere. These changes are expected to contribute to a strong increase of thickness in the active layer and eventually to a decline in permafrost distribution and stability, the solid foundation on which most of the region’s infrastructure is built. Impacts are manifold and include ecological, economical and social aspects. Among the most severe are the changes to the northern ecosystems, by ways of alterations of the hydrological regime and the change of vegetation cover, expanding marsh- and wetlands, the decline of slope compaction and thus an increased risk of land slide. Damage and increased remedial work and maintenance are expected for roads, runways, residences and community buildings in the settlements of the North. A research concept shall be developed to support adaptation strategies by means of a monitoring system strongly based on remote sensing imagery and data analysis. It shall be investigated, to which extent the interpretation of satellite imagery is feasible to partially substitute costly and

difficult geophysical point measurements and to provide spatial knowledge about the major indicators that are lent to describe permafrost dynamics and ecosystem change. Remote sensing shall be employed to feed modelling systems by ways of parameter retrieval and data assimilation. Two possible developments can be examined: i) a process-based environmental model to simulate spatial and temporal snow cover distribution and energy fluxes to assess the dynamics of permafrost under current and climate change conditions (then driven by regional climate models) and ii) an indicator-based model to describe permafrost distribution and dynamics by means of topographic, vegetation and soil indicators, which can be monitored spatially on a regular basis and may thus be transferable to larger areas.

3) *Developing a remote sensing based monitoring system for forest fire detection, prediction and management*

In the light of severe forest fires, recently striking Southern Europe and especially Russia in the summer of 2010, the demand for reliable tools supporting the prediction and management of wildfires is ever increasing. The impact of the climatic change on vegetation and fire activity is of great worldwide economic, social, ecological and of course security interest. Changes in frequency, size and severity of fires can be monitored and quantitatively described by means of long time series from satellite imagery, especially on a larger scale, using the well-suited NOAA-AVHRR and MODIS sensors. An attempt shall be made to correlate the detections of such events to a multitude of driving factors (fuel, land use, topography etc.) with an emphasis on climate variables. Such correlations serve to parameterize fire models on behaviour (e.g. Farsite, FlamMap), danger (e.g. WFAS) and occurrence at the landscape level. These can be combined in a novel and innovative fashion to develop a forest fire prediction tool using Regional Climate Model projections. Management options can then be tested in a scenario based model environment to support the development of sound adaptation strategies, balancing the requirements of multi-perspective stakeholders.

Climate Change Impacts on Permafrost

Prof. Oleg Anisimov, Vasiliy Kokorev, Svetlana Reneva, Julia Strelchenko

State Hydrological Institute, 23, Second Line V.O., 199053 St.Petersburg, Russia
E-mail contact: oleg@oa7661.spb.edu

1. Introduction

Permafrost was identified as a key uncertainty in impact assessments of climate change in Russia. Thawing of permafrost due to rising air temperatures may not only have an important impact locally, because of the consequences for the stability of buildings, roads, railways and pipelines, but may also provide a large positive feedback to the global climate as it would release large amounts of carbon currently stored as organic material in frozen soils. A widespread thawing of the permafrost would furthermore affect the hydrological system of arctic and subarctic landscapes and consequently the freshwater flux to the Arctic Ocean. Permafrost therefore plays a crucial role in determining the response of natural ecosystems at northern high latitudes, and yet it remains poorly represented in the land surface schemes of many climate models. Previous studies have projected dramatic reductions in permafrost extent due to climate change (e.g., Lawrence & Slater, 2005), but these studies have been criticised by others as being overly simplistic and ignoring some of the key processes that determine the response of permafrost to climate change (Desisle, 2007).

To date, few studies have tried to assess and quantify the uncertainties related to the response of permafrost to global warming. Anisimov et al. (2002) and Anisimov (2009) developed a stochastic approach to account for the high spatial variability in large-scale permafrost models. Aside from portraying the level of uncertainty in the input parameters, the output from such a model can be used to estimate the probability of permafrost temperature and thaw depth exceeding a given threshold at a certain location. Anisimov and Reneva (2006) used an equilibrium permafrost model to analyse changes in near-surface permafrost extent under scenarios of climate change from five different GCMs, and found considerable differences in the projected decline in surface permafrost extent in the Northern Hemisphere, ranging from 19% to 35% of the total permafrost area under the B2 emissions scenario of the Intergovernmental Panel on Climate Change (IPCC) (Nakicenovic & Swart, 2000) by 2080. The following sections present the results of this study.

2. Permafrost modeling

The response of the soil thermal regime in permafrost regions to climate change is likely to be complex and dependent on many factors, including local soil properties, the depth of the permafrost, ice content, vegetation cover, and depth and duration of the snow cover, as well as the congruent changes in some of these factors. Few models, if any, are currently able to represent all of these factors, and most models rely on parameterisations to account for the large spatial variability in them.

In this project ensemble climatic projections were used as input data in permafrost model to predict changes in the areal extent, temperature, and the depth of seasonal thawing of the frozen ground at the circumpolar scale. Computational setup was as follows. Coarse resolution data on projected changes of monthly air temperature and precipitation from each GCM were interpolated into a common 2.5º by 2.5º lat/long grid. These data were combined into ensembles and superimposed on a higher resolution (0.5º lat/long) baseline climatology. The equilibrium permafrost model was then run consecutively at each node of the finer spatial grid spanning the Northern Eurasian permafrost region. Calculations have been made with top-end ensemble climatic projection and with projections based on outputs from individual GCMs, and permafrost maps contrasting the results under different climatic forcing have been constructed.

We used an equilibrium permafrost model of intermediate complexity. The model is forced by mean monthly temperature and precipitation data and takes into account the effects of snow cover, vegetation, soil moisture, and soil thermal properties. We modified the conventional algorithm to account for the presence of an organic layer. Owing to substantially lower thermal conductivity when unfrozen, organic soils attenuate seasonal temperature variations and effectively preserve ground from warming and permafrost from thawing. The resulting model is based on evaluation of the annual temperature wave as it propagates through consecutive layers of vegetation, snow, organic and mineral soil.

The permafrost model has been tested in several studies and compared with observations at selected locations and over regional transects in Alaska and Siberia. Results indicate that, although differences between calculated and observed permafrost parameters for individual years can be quite large, when applied to long-term (decadal or longer time scale) averages this approach achieves accuracy of 0.2–0.4°C for permafrost temperature and 0.1–0.3 m for ALT calculations (Anisimov et al., 2007). At point locations, discrepancies with observations in individual years are attributable to the inherent limitations of the equilibrium modeling concept. The assumption of equality between air and ground-surface temperatures oversimplifies the atmospheric boundary layer processes that have significant effects on the thermal state of the ground and the depth of seasonal thaw propagation. The model assumes a thermal balance between climate and permafrost conditions, and when forced with annual climatic data does not account for the temperature inertia associated with deep, low-temperature permafrost layers that mitigate the propagation of heat from the surface.

An important concern in predictive permafrost modelling is the high spatial heterogeneity of local climatic, surface, and subsurface conditions. The new stochastic approach was developed to take into account the probabilistic nature of climatic projections and small-scale variability of soil, snow, and biophysiographic parameters in the calculations of the statistical ensemble representing potential states of permafrost under the prescribed conditions. This new methodology is fully harmonized with the ensemble approach that is used to construct probabilistic climatic projections on the basis of results derived from several GCMs. On the other hand, it provides important information that directly addresses the practical stakeholders needs and may be used in various applications such as the risk assessment of potential infrastructure damage and evaluation of other threshold-driven processes and impacts associated with thawing permafrost.

Stochastic model operates with the probability distribution functions of the parameters characterizing the state of permafrost. Air temperature, precipitation, snow depth, as well as vegetation and soil properties contribute to the variability of these parameters in space and over time, which is taken into account in the calculations of the statistical ensemble representing potential states of permafrost under the prescribed conditions.

Performance of the stochastic model was evaluated using the two-step procedure. At the first step calculated for individual years statistics of the seasonal thaw depth was tested against observations at selected 1 x 1 km permafrost sites representing different bioclimatic conditions along the Russian Arctic coast. At each site the calculated ensemble was in good agreement with observations indicating that the model captures the component of small-scale variability associated with the spatial heterogeneity of environmental parameters. In the second test the model successfully reproduces the interannual variability of the ensemble-mean thaw depths at each site in the period 1990-2008.

Results from stochastic model were used to construct the set of permafrost maps for the current and projected for the mid-21st century climatic conditions. To simulate the effects of small-scale variability in snow, vegetation, and soil moisture, we used the following approach. In different calculations snow depth varied in the range ± 50% from the mean climatological value; vegetation (moss) height varied between 5 and 10 cm, and organic layer thickness was in the range 5–20 cm. Moisture content in the organic layer varied between 0.3 and 0.5 m/m, and mineral soil moisture varied from 0.1 to 0.3 m/m. At each grid node we made 36 model runs using different combinations of the varying parameters to generate the ensemble of calculated results. These data were used to construct the probability distribution functions of permafrost parameters, particularly the active-layer thickness.

Results from the calculations are illustrated through maps indicating mean, minimum, and maximum ALT values (figure 1) and the probability maps of active-layer thickness shown in Figure 2. Results for 2050 were obtained using the 3 model ensemble climatic projection under B2 emission scenario. These maps indicate probabilities of active-layer thickness falling within prescribed classes. Unlike it is a case with conventional maps showing only mean values of permafrost parameters, probabilistic maps directly addresses the practical needs of engineers and land use planners in the northern lands.

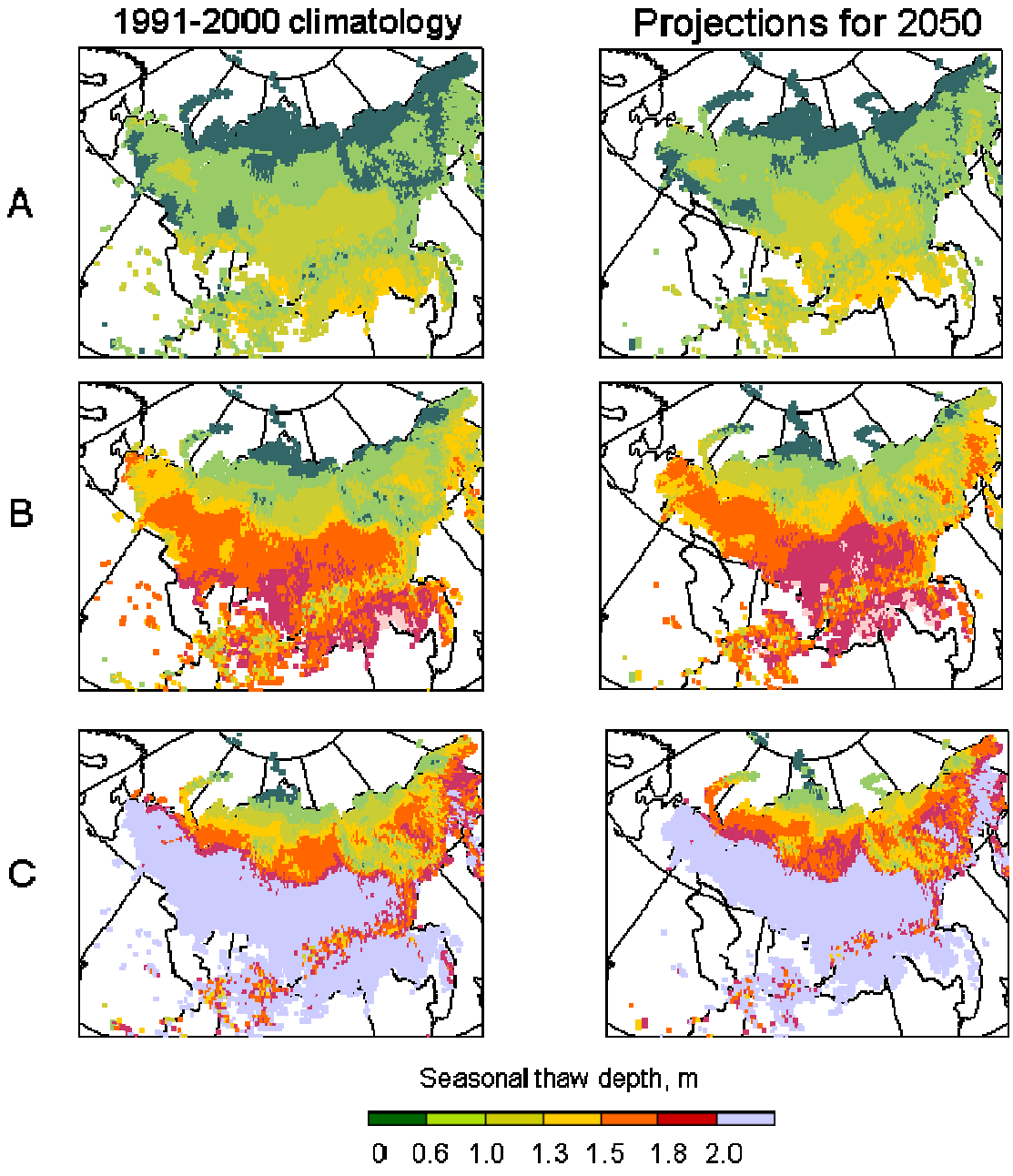


Fig. 1. Active-layer thickness in Northern Eurasia permafrost region under current and projected for 2050 climatic conditions. A – minimum estimate; B – mean estimate: C – maximum estimate based on ensemble calculations.

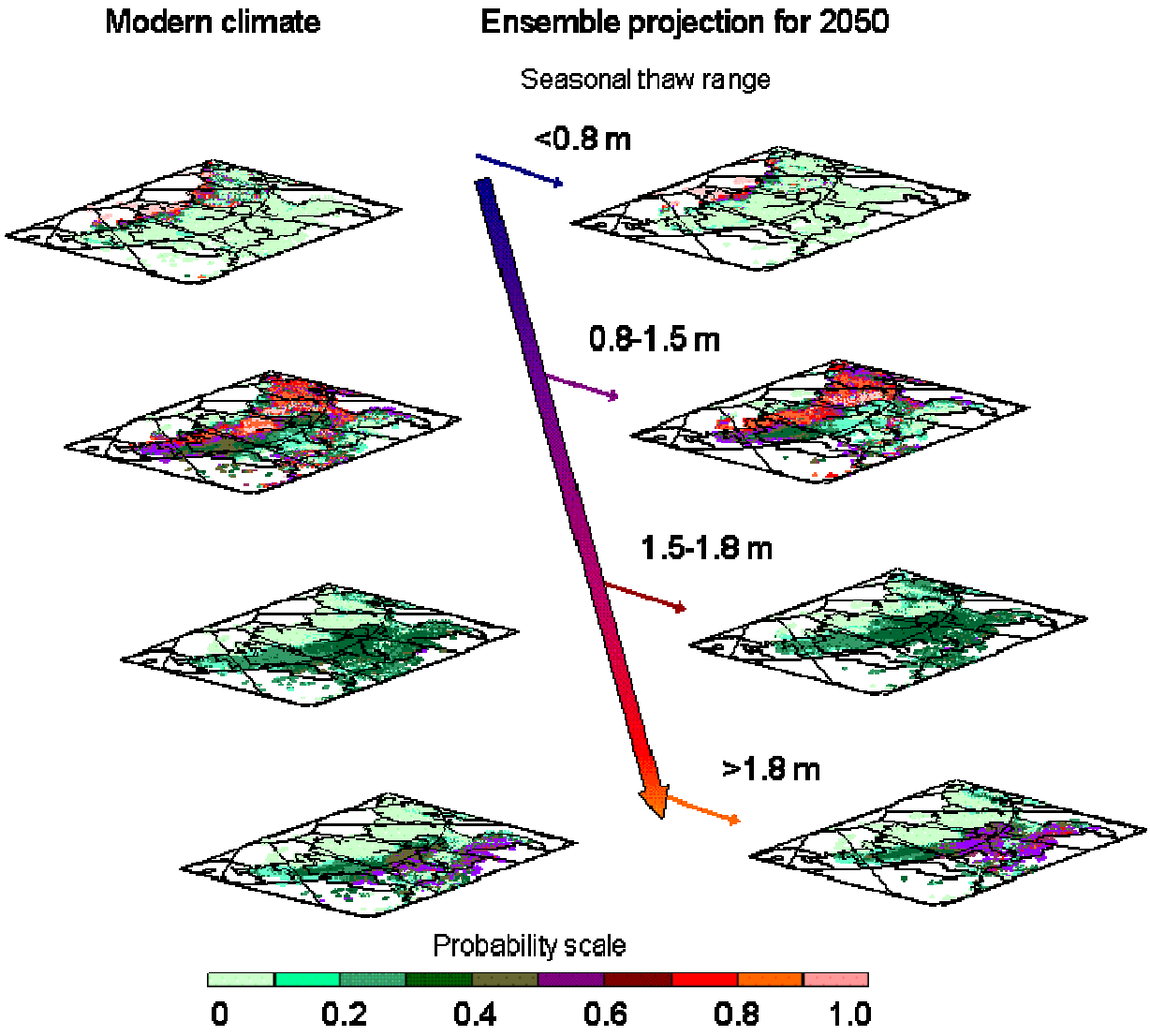


Fig. 2. Probabilistic ALT map for Northern Eurasia permafrost region under current and projected for 2050 climatic conditions.

The ultimate result of our study is the set of predictive probabilistic permafrost maps for the Northern Eurasia. Aside from portraying the "average" or "typical" active-layer thickness for the current and projected for the mid-21st century climate, such maps depict the probability of thaw depth exceeding given thresholds within specified regions. Such information has important implication in cold region engineering and risk assessment and may be used for predicting potential threats to infrastructure built upon thawing permafrost.

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MICORE - Morphological Impacts and COastal Risks induced by Extreme storm events

BALOUIN Yann[1], CIAVOLA Paolo[2] and the MICORE Group

Role of the speaker within the project: workpackage leader
[1] BRGM, French Geological Survey
Geological Service of Languedoc-Roussillon,
1039, rue de Pinville 34000 Montpellier, FRANCE
E-mail contact: y.balouin@brgm.fr
[2] Univertity of Ferrara, Earth Sciences Department, Ferrara, ITALY
E-mail contact: cvp@unife.it

1. Introduction

The impact of storms on coastal cities also has worldwide implication. With a multidisciplinary and integrated approach in natural hazards research, the MICORE project aims to provide an opportunity for European science to guide and support the implementation of the International Strategy for Disaster Reduction and its framework for action (2005-2015). According to the State of the World 2007 of the Worldwatch Institute, 21 out of 33 cities projected to have at least 8 million residents by 2015 are coastal cities. They will each have to take measures to deal with the combined impacts of rising sea level and increase storminess. The predictive tools to be developed in the MICORE project will make a significant contribution to the development of mitigation measures given a storm forecast, predicting where along the study coastlines rapid civil response measures are needed, following the occurrence of massive erosion events which may cause coastal flooding. MICORE aims to develop a strategy for coastal hazard assessments that takes into account basic steps which should be implemented in all locations (regardless of the socio-economic differences between coastal countries) and also to look at differences in the management approaches that varied socio-economic/development levels might require. The more strategic analysis will not be confined to planning direct response to a single event but also longer-term coastal planning. Coastal managers will use MICORE's outputs to decide where coastal protection works are needed and what kinds of coastal protection works are sustainable, in a cost-benefit context.

2. Project description

Project Title:

MICORE (Morphological Impacts and COastal Risks induced by Extreme storm events)

List of Project Partners:

University of Ferrara (I) (coordinator)

ARPA Hydro Meteorological Service of the Emilia-Romagna Region (I); Geological Survey of Emilia-Romagna (I); University of Algarve (P); University of Lisbon (P); University of Cadiz (S); BRGM – French Geological Survey (F); International Marine Dredging Consultants (B); University of Plymouth (UK); University of Szczecin (Po); Institute of Oceanology, Bulgarian Academy of Sciences (Bg); Stichting Deltares (NL); Technical University of Delft (NL); Proudman Oceanographic Laboratory (UK); University Pablo de Olavide (S)

The general **aim of the project** is to develop and demonstrate on-line tools for reliable predictions of the morphological impact of marine storm events in support of civil protection mitigation strategies. This is evidently in line with the scientific and environmental interests of TOPIC: ENV.2007.1.3.1.1. which aims to analyse and map storm related risks in sensitive European regions taking into account intensity, spatial extent, duration, hazard interaction effects. The project is specifically targeted to contribute to the development of a probabilistic mapping of

the morphological impact of marine storms and to the production of early warning and information systems to support long-term disaster reduction.
A review of historical storms that had a **significant morphological impact** on a representative number of sensitive European coastal stretches will be undertaken. The regional coastlines are selected according to wave exposure, tidal regime and socio-economical pressures. They include outmost regions of the European Union at the border with surrounding states (e.g. the area of the Gibraltar Strait, the Baltic and Black Sea).
All data will be compiled into a **homogeneous database of occurrence** and related socio-economic damages, including the following information on the characteristics of the storms, on their morphological impacts, on the damages caused on society, on the Civil Protection schemes implemented after the events.
Monitoring of nine selected case-study sites will take place for a period of one year to collect new data sets of bathymetry and topography using state-of-the-arts technology (Lidar, ARGUS, Radar, DGPS). The impact of the storms on living and non-living resources will be assessed using low-cost portable GIS methods and undertaking post-damage assessments.
Numerical models of storm-induced morphological changes will be tested and developed, using commercial packages and developing a new open-source morphological model. The models will be linked to wave and surge forecasting models to set-up a **real-time warning system** and to implement its usage within Civil Protection agencies. The most important end product will be the production of risk indicators with defined threshold for the identification of **major morphological changes and flooding associated vulnerability**. Finally, the results of the project will be disseminated as risk maps through an effective **Web GIS system.**

The specific objectives of the MICORE project are:

1. To undertake a review of historical marine storms that had a significant impact on a representative number of sensitive European regional coastlines. The diverse range of coastal regions of the European Union is selected according to wave exposure, tidal regime and socio-economical pressures. They include outmost regions of the European Union at the border with surrounding states (e.g. the area of the Gibraltar Strait, the Baltic and Black Sea), as well as coastlines bordering open ocean and semi-enclosed shelf seas.

2. To collate data related to occurrence of significative extreme events and socio-economic impacts in a database. Parameters will include:
    - characteristics of the storms: wind and wave measurements, wave hindcasts, tide measurements, surge computations;
    - morphological impacts including pre- and post-storm beach profiles, presence of dune overwashing/overtopping, damage to coastal structures;
    - socio-economic impact including cost of reconstruction, loss of lives and property, dune reconstruction and beach replenishment;
    - civil protection schemes, implementation of warning systems and preparation of hazard and vulnerability maps;
    - competent authorities and statutory bodies and voluntary organisations for warnings

3. To undertake monitoring of nine European case study sites for a period of 1 year with the following aims:
    - to collect new data sets of bathymetry and topography using state-of-the-art technology (Lidar, ARGUS, Radar, DGPS); to simultaneously measure the forcing agents (wind and waves, tides, surges) that trigger the events;
    - to map the impact of the storms on living and non-living resources using portable GIS methods.

4. To test and develop reliable methods for numerical modelling of storm-induced morphological changes for the following purposes:
    - to test the predictive capability of wave and surge hindcast models routinely used by end users in each region of interest;
    - to link morphological models with wave hindcast models;
    - to evaluate the accuracy of off-the-shelf morphological models for prediction of extreme erosion hot-spots;
    - to test and develop a new open-source morphological model for the prediction of storm impacts.

5. To set-up real-time warning systems and to implement their use within Civil Protection agencies with the aim of:
    - linking morphological models with wave hindcast models;
    - preparing early warning protocols;
    - developing an expert system in support of long-term disaster reduction including timely disaster relief operations.

6. To disseminate results to end users at national, European and International levels through:
    - a series of non-technical workshops;
    - production of a multilanguage report;
    - production of a storm impact video-clips;
    - implementation of an interactive website with Web-GIS technology.

3. Case-studies and applications

Severe storms have historically affected European coastlines and their impact has been evaluated in different ways in different countries, often using as criteria the socio-economic impact (e.g. loss of lives and damage to properties). An historical review of European storms was necessary: to collect all data and relate them to the forcing signals; to quantify and evaluate morphological responses; to assess the socio-economic impact; and to examine the effectiveness and efficiency of civil protection schemes and interventions. WP1 is related to establishing the “state of the art” for each selected regional coastline. The review explored information on critical storm events available on public databases for the following regional coastlines of member states:

1. Italy: northern Adriatic coastline (Archimede Database and CADSEALAND Project)
2. Portugal: Southern and Western Atlantic coastline (Portuguese Hydrographic Institute)
3. Spain: Gulf of Cadiz and Catalan coastlines
4. France: Atlantic Aquitaine and Mediterranean coastlines
5. United Kingdom: Eastern Irish Sea. Additionally, tide, surge levels and impacts of major storms will be reviewed for the remaining English coastline.
6. The Netherlands: whole coastline (Rikswaterstaat datasets)
7. Belgium: whole coastline (Flemish Government datasets and COMRISK datasets)
8. Poland: whole coastline
9. Bulgaria: western part of the Black Sea

Moreover, on these European coastlines, specific fieldsites were determined to have the role of “real-scale” laboratories, where high quality and high resolution datasets were collected. The chosen sites, that are the laboratory areas where to undertake field measurements, are representative of the range of morphological variability found across European coastlines, being exposed to different wave energy level, tidal ranges and with variable degree of human exploitations.

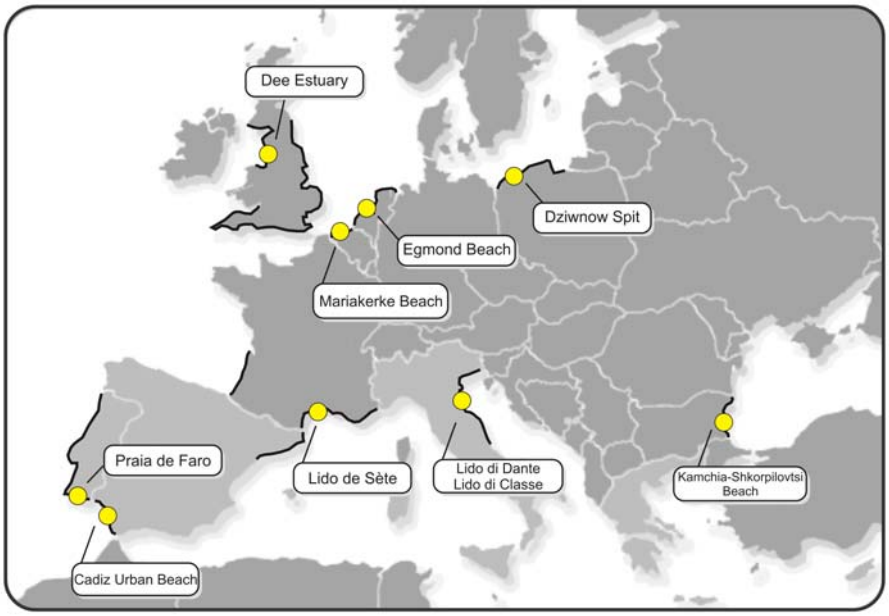


Figure 1. Regional coastlines covered by the storm databases developed in WP1 (bold coastlines) and location of case-study sites where detailed measurements were undertaken to calibrate predictive models.

Field monitoring on these specific fieldsites has provided high resolution datasets to be used in the calibration and developmeent of numerical modelling of morphological responses during storms. Improvements were done on the numerical modelling to take into account specific characteristics of european coastal regions.

The Work package 5 is specifically targeted at improving Civil Protection measures. In order to create new efficient warning systems, Civil Protection agencies require rapid and accurate information on natural hazards. In MICORE these will be based on model predictions from WP4, that predict water levels, erosion due to the storm and impact on coastal areas, the warning system facilitates the creation of risk maps that will be based on a combination of morphology maps, flood depth maps, erosion maps, economic impact assessments, etc.
This GIS based environment will be able to predict the risk of storms on coastal areas in Europe and could be easily and effectively transferred to other sites. It will be an excellent example of how the combination of coastal hazard research, remotely-sensed data, 3D visualization capability and GIS mapping technology can be used to determine acute coastal change and to develop site-specific warning system. The warning system will be coupled with meteorology forecasts to provide "live" risk assessments. The idea is to have a system comparable to those used for river flooding. Whenever there will be a storm warning from meteorological models, this will feed wave-prediction model, that in turn will work out where massive coastal erosion will occur. The hydraulic models will also work out where coastal flooding will likely take place, considering the coastal changes occurring during the storms. Finally the Civil Protection will be warned and they will be able to use the MICORE Risk Maps to decide how to act.

4. Topics of collaboration between EU and Russia

1) *Assessment of the morphological responses of coastal areas to extreme storm events and long term evolution induced by global climate changes as a contribution to the development of a long-term strategy of sustainable development and climate change mitigation.*

Coastal zones are transitional areas in which processes are controlled by complex interactions and fluxes of material between the land, ocean and atmospheric systems. Coastlines suffering from long-term erosion are particularly susceptible to the impact of high energy events. In such cases the beach sediments are depleted and can no longer provide defence against coastal flooding. Furthermore, the impact of storms, and variability in storm frequency on coastal morphologies, remains incompletely described in the scientific literature. The littoral zone is very

often the place of an important social and economic activity, with the increase in the attractivity of coastal cities, development of tourism, as well as economic activities relating to the exploration of oil and gas fields on the continental shelf. This area is submitted to important erosion and coastal flooding hazards, and impacts on the coastal zone are likely to increase with the global sea level rise.

Anticipating trends in coastal hazards evolution can help governments mitigate and adapt to climate change by implementing relevant policy measures. The more strategic analysis will not be confined to planning direct response to a single event but also longer-term coastal planning. The development of new approaches and modelling of both single extreme event and long-term evolution is thus an important and challenging research. Improvement of these approaches will be done taking into account both the short-term processes (storm events) and the long-term factors (change in sea level, variation in sediment supply, thermal abrasion processes).

2) *Evaluation of existing observation capabilities and databases of in situ data relevant to the objectives of coastal evolution induced by an accelerated sea-level rise*

The rapid rise of the Caspian Sea level (about 2.25 meters since 1978) has caused great concern to all five surrounding countries: Azerbaijan, Iran, Kazakhstan, Russia and Turkmenistan. Endowed with an oil-rich basin and one of the planet's most biologically productive water bodies, the region is characterized by many big cities and other human settlements along the sea coastal line. Observations and data acquisition in such a context are particularly pertinent to evaluate geomorphology evolution of low coastal plains with an accelerated sea-level rise. Assessing the existing data on the coastal natural adaptation to this very rapid transgression would permit to develop further research programs on coastal evolution that would benefit to both Russian and European governments and coastal managers.

Climate Changes Influence on Permafrost in East Siberia

Dr. A.N.Fedorov,

Group Research Director

Melnikov Permafrost Institute, Yakutsk, Sakha (Yakutia), Russian Federation
E-mail contact: fedorov@mpi.ysn.ru

1. Introduction

Warmer air and ground temperatures affect the stability of permafrost-dominated landscapes. The effects are most dramatic in open, forest-free areas. In central Yakutia, for example, the depth of seasonal thawing tends to reach the top of ground ice in recent decades. This triggers the rapid development of permafrost-related processes in cultivated lands, fallows, and meadows. Any man-induced disturbance in ice-rich permafrost terrain is now capable of producing serious consequences.

2. Project description

Project Title:
Climate Change Influence on Permafrost in East Siberia (Yakutia)

List of Project Partners:

1) RIGC, Yokosuka, Japan
2) Hokkaido University, Japan
3) RIHN, Kyoto, Japan
4) UMR 8148-IDES CNRS, University Paris-Sud-11, France

The project was initiated in 1996 as part of the GAME/GEWEX Program and was titled "LAND SURFACE OBSERVATION OF HEAT/WATER/VEGETATION CONDISTIONS IN YAKUTIA". The main partners were the FRSGC (Frontier System for Global Change/ JAMSTEC, Japan) and the Melnikov Permafrost Institute (MPI), Yakutsk, Russia. The main purpose was to study the dynamics of permafrost landscapes under contemporary climate change. This is the main topic of research by the MPI's Laboratory of Permafrost Landscapes. Later on, the Hokkaido University (Japan), RIHN (Kyoto, Japan), and UMR 8148-IDES CNRS, University Paris-Sud-11, France joined the project. Both the scope and aims of research have changed since then. The major focus of research has shifted from undisturbed permafrost landscapes to the effects of wildfires, permafrost degradation and thermokarst, permafrost recovery after disturbance, and permafrost successions on newly forming islands on the Lena River.
The results of investigations allow us to assess permafrost sensitivity to contemporary climate change. Data have been obtained on the degradation of ice-rich permafrost due to climate warming, as well as on the magnitude of associated disturbances. At the same time, we are studying the mechanisms by which permafrost landscapes recover and the permafrost stabilize under warming climate. These findings are aimed at minimizing the losses from environmental disturbances and are well presented in mass media.

3. Case-studies and applications

1) Spasskaya Pad Station. Larch forest of middle taiga, no ice-complex permafrost, Yakutsk. Upper part of permafrost temperature fluctuations, active layer thickness were studied by Permafrost Institute on special sites.
2) Neleger and Yukechi Station. Larch forest of middle taiga, ice-complex permafrost, Yakutsk. Permafrost degradation and thermokarst activity are a main characteristics of studies. At Neleger in 2000 near 1 ga of mature larch forest area was clear cutting and

until 2007 CO_2 flux, all meteorological characteristics were studied. At Yukechi from 1992 we studied surface subsidence on special levelling network and water balance of young thermokarst ponds. Surface subsidence rate are from 1-3 per year in dry undisterbed non-forested areas to 25-30 cm per year in young thermokarst depressions with ponds.

3) Tiksi Station. Typical tundra, no ice-complex permafrost, Tiksi. Upper part of permafrost temperature fluctuations, active layer thickness were studied by Permafrost Institute on special sites.
4) Tabaga. The Lena River Islands, Yakutsk. Thermoerosion rates and evolutions of permafrost in islands were are main problems of studies. For our studies we used old aero-photos of 1945 and 1952, and satellite images.

4. Topics of collaboration between EU and Russia

1) Climate Change Impacts on Permafrost in Eastern Siberia linking with extended of monitoring network.

2) Using Remote Sensing for the monitoring and modelling of permafrost degradation after anthropogenic disturbation and climate change, at first in Central Yakutia, Vilyui basin, Delta of the Lena River, Alazea basin.

Methods for the assessment of vulnerability in Europe: new challenges in a context of climate change

Fantina Tedim

Partner
Geography Department, Faculty of Arts,
University of Porto,Portugal
ftedim@letras.up.pt

1. Introduction

Over the years, climate research has been conducted in parallel with studies of hazards and disasters but many of the opportunities for collaboration and synergy have not been exploited. Only now this is beginning to change. One requirement is the need for a common terminology, language and framework between the two fields. Another is to understand the impact of predicted climate change in terms of specific weather phenomena, in particular more intense storms and longer periods of extreme temperature, rainfall or drought.
Although climatic averages will be important, many affects of climate change will come to a head through crises provoked by extreme events acting within the compass of long-term trends. Over the coming decades climate change is likely to result in more frequent and intense disasters. These will require communities to adapt to many different sets of conditions: rising sea levels, more widespread flooding, more concentrated storms, greater seasonal temperature extremes and longer droughts.
To be prudent it is necessary to consider the management of prospective risk (i.e., anticipating and controlling future risk) as a vital part of disaster preparedness. It is now recognised that much more than the physical impacts needs to be studied. It is now widely accepted that risk is a social construction. It is the society in its interaction with the changing physical world that transforms physical events into hazards and increases the exposure and vulnerability of infrastructures, population and their livelihoods.
Knowledge of the vulnerability of human societies to natural hazards in a context of climate change will be a valuable tool for disaster risk prevention. Over several decades of theoretical development, vulnerability has come to be seen as the most fundamental variable in determining the propensity of communities, environments, economies and people to suffer disaster. Moreover, the causes of vulnerability are generally multiple or complex, as are the ways in which it manifests itself.
As research on vulnerability necessarily involves the study of coping, adaptation and resilience, its counterparts, it provides the means to understand the mechanisms by which society will be able to adapt to climate change and mitigate its consequences.

2. Project description

Project Title:

MOVE- Methods for the Improvement of Vulnerability Assessment in Europe

List of Project Partners:

Beneficiary Number	Beneficiary name	Beneficiary short name	Country
1(coordinator)	University of Florence	UNIFI	Italy
2	BRGM, French Geological Survey	BRGM	France
3	Centre for Geoinformatics, University of Salzburg	Z_GIS	Austria

4	EURAC (European Academy, Institute for Applied Remote Sensing)	EURAC	Italy
5	Atlas Innoglobe Tervezö és Szolgáltató	ATLAS	Hungary
6	King’s College, University of London	KCL-AC	United Kingdom
7	Norwegian Geotechnical Institute	NGI	Norway
8	Rupprecht Consult Forschung und Beratung GmbH	RC	Germany
9	International Centre for Numerical Mathods in Engineering (CIMNE) Technical University of Catalonia	CIMNE	Spain
10	United Nations University, Institute for Environment and Human Security	UNU-EHS	Germany
11	University of Dortmund	UNIDO	Germany
12	University of Oporto	FLUP	Portugal
13	University of Vienna	UNIVIE	Austria

Project Description:

Knowledge of the vulnerability of human societies to natural hazards will be a valuable tool for disaster risk reduction in a context of climate change. *MOVE* provides a framework and a practical methodology for collecting and analysing data as well as define guidelines to support disaster risk reduction.

The conceptual framework (Figure 1) recognizes hazards, which can be natural or socio-natural, and the society, represented at international, national, subnational or local scale, as being part of the environment. Hazards and Society are two different elements that coexist and have constant interactions.

Vulnerability is affected by the exposure and reflects the susceptibility or the intrinsic predisposition to being affected or the conditions that favour or facilitate damage. The measurement of vulnerability is a challenge. It is related to the degree of exposure, susceptibility, fragility and lack of resilience of a socio-ecological system that favours adverse effects. Vulnerability of society is generated by factors which can be assorted by several dimensions (Physical, Ecological, Economic, Social, Cultural, and Institutional) that can be considered separately and through mutual interaction.

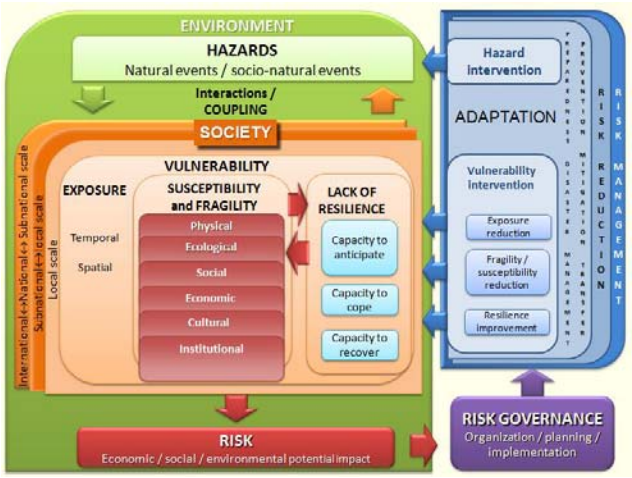


Figure 1- MOVE conceptual framework

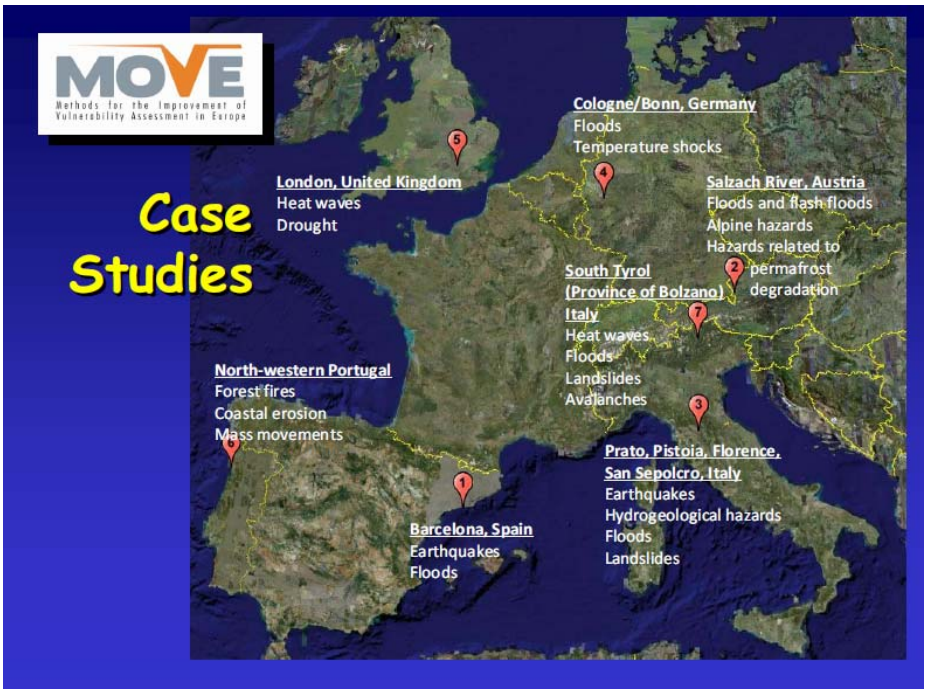
Vulnerability is also affected by the lack of resilience that is the limitations in access to and mobilization of the resources of the human settlements and their institutions. It includes the capacity to anticipate, cope and recover. In a context of climate change is particularly important the capacity of adaptation of the society to absorb and deflect the impact of hazards. It is seen as a long term response through exposure reduction, susceptibility reduction and resilience improvement.

Risk is defined as the potential occurrence of physical, social, economic, and environmental consequences or losses, in a given area and over a period of time, resulting from the vulnerability conditions of a socio-ecological system exposed to hazards. In order to face the recognized risk, it is necessary to involve the risk governance which includes the totality of actors, rules, conventions, processes and mechanisms concerned with how relevant risk information is collected, analysed and communicated and management decisions are taken. Governance is one of the key concepts in developing a holistic approach to vulnerability reduction.

The risk management decisions include tasks on risk reduction, prevention, mitigation and transfer and also preparedness and disaster management, which allow implementing measures for hazard intervention or vulnerability intervention that lead to exposure and susceptibility reduction and resilience improvement.
In order to measure properly vulnerability Move recommends a holistic approach. This type of integrated and multidisciplinary focus can more consistently take into account the non-linear relations of the parameters, the context, complexity and dynamics of social and environmental systems, and contribute to more effective risk management and governance of different critical actors or stakeholders in order to achieve a preventive attitude when faced with risk and disaster.
A central feature or objective of MOVE is to construct indicators or indexes that allow the identification of the principal vulnerability factors that contribute to the configuration of risk. These indicators will be constructed on the basis of a number of readily available and reasonably robust variables, which allow a vulnerability assessment and an analysis of risk at a scale appropriate for decision-making.
Ideally, the model will not only highlight the comparative levels of vulnerability, but also the factors that should be considered in order to reduce that vulnerability. It would be useful to inform decision-makers on priority areas for action and resource allocation. It would not replace the need for detailed hazard knowledge but will improve risk assessments and profiles as a basis for planning at the national and sub-national levels.

3. Case-studies and applications

Move project incorporate seven case studies in different countries with the purpose of testing and validating the conceptual framework in different scales and focused in different hazards. The transfer of methodology between partners is a way to enlarge the applicability of methods and the efficiency of the framework in different cultural contexts.



Source: http://www.move-fp7.eu

To obtain the project highest impacts in the improvement of risk management, Move defined an involvement of the end-users since an early step of the research. The major stakeholders and beneficiaries will include national, regional and local governments, with special reference to their civil protection and environmental management departments, but also other services, including economic forecasting and management, welfare and social services. The private sector and civil society organisations are also included among the stakeholders. The final outputs of Move intend to improve risk management at the local, regional and national level.

4. Topics of collaboration between EU and Russia

1) *Build communities resilience: the challenge of better living with the hazards*

Contemporary risk concept portrays risk and loss as synonymous. However the original concept of risk described the likelihood of an event occurring combined with an accounting for the gains and the losses that the event represents if it occurred (Dake, 1992; Paton, 2008). This paradigm is more and more present in scientific literature namely related with wildfires (Miller et al., 2000; Miller & Landres, 2004; Barrett et al., 2000; Calkin et al., 2008 Keanu & Karau, 2010).

In a context of climate change and of uncertainty is fundamental to increase the community capacity to co-exist with hazardous processes and to improve its capacity to manage and cope with hazard activity (Paton, 2008) and take advantages from it. Build a model of community's resilience to different hazards (natural, environmental, technological) applicable in cross-cultural contexts seems to be a useful tool to promote sustainable development under climate, socioeconomic, environmental and even political changes. This is a challenging task but some support from natural hazard literature and mainly from the knowledge developed by social psychology (to support a more efficient public education and enhance preparedness) and from social sciences (e.g. social capital theory) can support its development.

Integrated investigations of environmental changes in Siberia under Global Change: results and perspectives for international cooperation

Prof. Evgeny Gordov

Project Coordinator

Siberian Center for Environmental Research and Training and Institute of Monitoring of Climatic and Ecological Systems SB RAS, Akademicheskii Ave. 10/3, 634055 Tomsk, Russia
E-mail contact: gordov@scert.ru

1. Introduction

The Siberia Integrated Regional Study (SIRS) is a mega project within Northern Eurasia Earth Science Partnership Initiative (NEESPI) coordinating national and international activity in the region in line with the Earth System Science Program (ESSP) approach [1]. SIRS aims at investigations of environmental changes in Siberia under Global Change and their potential impact on the Earth system dynamics. Siberia is one of regions, which may function as "choke or switch points" for the Global Earth System, where changes in regional biophysical, biogeochemical and anthropogenic components may cause significant consequences for the Earth System at the global scale. SIRS is supervised by the Russian national Committee for IGBP and its Siberian Branch.

2. Project description

Project Title:

Siberia Integrated Regional Study (SIRS): investigations of environmental changes in Siberia under Global Change and their potential impact on the Earth system dynamics

List of Project key Partners:

Siberian Center for Environmental Research and Training (SCERT) - coordinator; Danish Meteorological Institute (DMI)**;** Institute for Numerical Mathematics RAS (INM RAS); International Institute for Applied System Analysis (IIASA); Institute of Forest SB RAS (IF); Institute of Monitoring of Climatic and Ecological Systems (IMCES); Max-Planck-Institute for Biogeochemistry (MPI); Siberian Federal University (SFU)

Description of the project

Regional consequences of global warming (in particular, anomalous increase of the cold season temperatures) have been already documented for Siberia [2]. This tendency is supported by the results of climate modeling for XX-XXII centuries [3]. The future climatic changes threaten Siberia with the shift of permafrost boundaries northwards, dramatic changes in land cover (redistribution among boreal forest, wetlands, tundra, and steppe zones and changes in the fire regime) and the whole hydrological regime of the territory [4-7]. These processes may generate feedbacks influencing the climate dynamics through exchange of energy, water, greenhouse gases and aerosols [8]. While a handful of national and international projects studied Siberian environment, scientists still know little about the processes that control changes in the main components of the regional climatic system, and about responses and feedbacks of terrestrial and aquatic ecosystems to these changes. All the above created a solid basis for the SIRS project.

SIRS coordinated investigations are currently concentrated on four major themes:

- Quantification of the terrestrial biota full greenhouse gas budget, with a focus on exchange between biota and atmosphere;
- Monitoring and modeling of regional climate change impact;
- Development of SIRS information-computational infrastructure; and
- Development of the regional strategy of adaptation to and mitigation of the negative consequences of global change.

SIRS coordinates relevant national and international projects and aimed at data/knowledge obtained sharing within the formed SIRS professional community comprising regional, national and international specialists dealing with Siberia environment dynamics study.

Developing within SIRS information-computational infrastructure provides a joint platform for a number of nationally and internationally distributed research groups involved into this multidisciplinary study. This infrastructure stimulates cooperative work, exchange of data and knowledge and co-ordinate activities optimizing the usage of resources, services and applications, and is now under intensive development [9]. The infrastructure is organized as a set of Internet-accessible information-computational systems for chosen thematic domains (thematic web sites and portals). Among those are the bilingual (Russian and English) scientific web portals ATMOS (http://atmos.iao.ru/), ENVIROMIS (http://enviromis.scert.ru/) and Enviro-RISKS (http://risks.scert.ru/) . Already these first elements of this web based environment have formed a powerful tool for better understanding of the interactions between the ecosystem, atmosphere, and human dynamics in the large Siberia region under the impact of global climate change. For example, the Climate site of the Enviro-RISKS portal ((http://climate.risks.scert.ru/)) is aimed at handling/processing different data sets coming from monitoring and modeling regional meteorology, atmospheric pollution transformation/transport and climate important for regional environment dynamics assessment under climate change.

One of major concern of SIRS management and community is the SIRS educational/capacity building programme, which includes [10] ENVIROMIS biannual Multidisciplinary Conference with elements of Young Scientists’ School (YSS, i.e., with embedded Invited lectures and thematic Workshops) and CITES (Computational and Information Technologies for Environmental Sciences) biannual YSS and International Conferences that include lecture courses, training sessions and invited lectures (http://www.scert.ru/en/conferences/). The both actions are aimed at diminishing discipline barriers between specialists from different fields of environmental sciences and early career researchers education and training.

3. Case-studies and applications

Some results gained in the course of SIRS projects being carried out were reported at the EGU 2009 NEESPI Session (http://neespi.org/meetings/), at the 2009 Regional NEESPI Research Workshop devoted to Climatic, Environmental, Land Cover-Land Use Change Studies in Siberia in Krasnoyarsk and ENVIROMIS-2010 Conference (http://www.scert.ru/en/conferences/enviromis2010/) , a majority of them has been published in Russian journals and are still unknown in the international climatic community. However these results were fully employed in the course of the FP6 EC Enviro-RISKS project and reviewed with proper references in its Final Scientific Report [11], mainly in the third volume devoted to climate change, terrestrial ecosystems and hydrology, which is available at http://www.dmi.dk/dmi/sr08-05-3.pdf. According to analyses performed, during the 1961-1990 period and in the following decades, major changes have occurred in regional temperature mainly in the cold season [12, 13], in particular it was shown that in some areas of Eastern Siberia winter temperatures were increasing with the rates up to 0.5 degrees per 10 years . While the number of frost days in central part of Eurasia has increased (by up to 1 day yr-1), the duration of the vegetation period in the same region has increased by 1 day yr-1 [13] that might manifest transient phenomena and nonlinear character of ongoing climatic changes.

4. Topics of collaboration between EU and Russia

There are 3 main scientific problems and one infrastructural task representing challenges to the SIRS community, which are candidates for collaboration between EU and Russia. The scientific challenges are very important for the Global Carbon Cycle and also could change significantly regional socio-economical situation. Each of the subsequent topics is quite a candidate for a large scale Integrated project within FP7 thematic area:

1. *Temperature/precipitation/hydrology regime change in the region*

A thorough research should be done to understand the processes that are driving the ongoing and future climate changes in the region and to elaborate a relevant adaptation strategy. On-going processes might also change region input into the Global Climate forming and provoke serious socio-economical consequences for local population. For example, potential drying of peat bogs (major ecosystems of Western Siberia) related to climate change and subsequent growing threat of peat ignition risks are still underestimated by researchers and decision-makers. Once started, peat fires cannot be extinguished, which will lead to injection into the atmosphere all of the carbon sequestered in peat during several thousands years. One of prerequisite for such study is development of a high resolution regional climate model that properly takes into account specifics of this region (e.g., presence of permafrost, interaction of the biosphere and terrestrial hydrology, etc.).

2. *Desert - steppe- forest-tundra ecosystems borders northward shifts*

Relevant regional processes are of importance for the Global Earth system. In particular, regional input into the carbon cycle might be changed under impact of those. Also, tundra greening leads to regional albedo diminishing which will accelerate on-going warming

3. *Permafrost fate, especially its border shift*

On-going processes might seriously threaten Northern Siberia infrastructure. Also appearing in this region thermocarst lakes might form a significant carbon source to the atmosphere.

As it was mentioned above there is also a candidate for a large scale infrastructure project, which might be useful addition to recently start by SB RAS the long-term integrated project "Development of the basic network for monitoring of natural and climatic processes in Siberia". The SB RAS project main objective is to establish in the region a network of dedicated sites and stations equipped with modern instrumentation to monitor environmental changes. Currently only the Zotino tall tower observatory (ZOTTO) launched into operation a few years ago (http://www.sfu-kras.ru/science/achievement/zotto/public) [14] is equipped with such instrumentation. It is anticipated that together with ZOTTO, the future SB RAS network will serve as an important source of reliable environmental data for analyses of the state of Siberia and processes occurring there. Joint development of such network by Russian and EU researchers within framework of a targeted FP7 infrastructural project would lead to its joint usage in future research activity in this important for the whole Earth system wellbeing.

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MESMA: for sustainable use of European seas and coastal areas

Remment ter Hofstede[1]

Coordinator

[1] IMARES, Haringkade 1, IJmuiden, the Netherlands
E-mail contact: Remment.terHofstede@wur.nl

1. Introduction

The seas around Europe are home to an exceptionally wide range of marine habitats which must also support a variety of marine industries. The challenge for marine spatial management is to find an optimal balance between the competing demands of economic use, ecological development, and nature conservation while at the same time maintaining sensitivity towards traditional practices.

The EU FP7 project MESMA (www.mesma.org) focuses on marine spatial planning and aims to produce integrated management tools (concepts, models and guidelines) for Monitoring, Evaluation and implementation of Spatially Managed marine Areas, based on European collaboration. The project will run from November 2009 to November 2013.

2. Project description

Project Title:

MESMA Monitoring and Evaluation of Spatially Managed Areas

MESMA is expected to supply innovative methods and integrated strategies for governments, local authorities, stakeholders, and other managerial bodies for planning and decision making at different local, national, and European scales, for sustainable development of European seas under changing environmental conditions. This will comprise an easy accessible data system, containing information on the distribution of marine habitats and species, economic values, and human uses. The main tasks in the project are the development of a generic framework, the testing and evaluation of this framework within several case-studies throughout Europe, and the development of a toolbox to support the dialogue between politicians, stakeholders and the public in general on marine spatial management. This approach makes it possible to compare pressures on an inter-regional level, and at a multi-pressure level for specific regions.

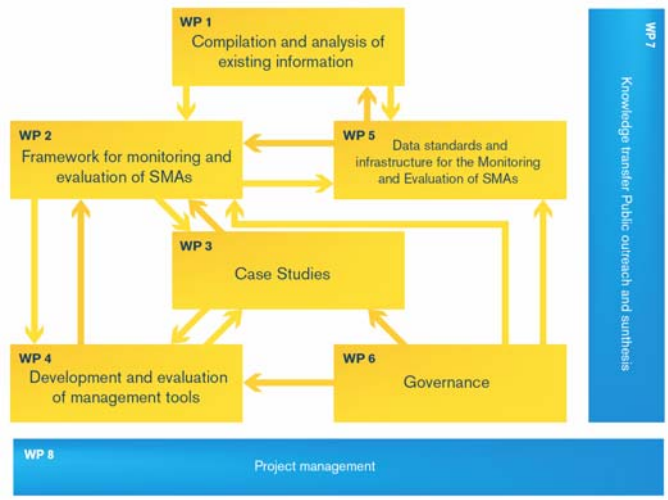

Figure 1

List of Project Partners:

	Beneficiary name		**Country**
1	IMARES - Institute for Marine Resources and Ecosystem Studies	IMARES	NL
2	University College London	UCL	GB
3	Senckenbergische Naturforschende Gesellschaft	Senckenberg	DE
4	Universiteit Gent	UGent	BE
5	Hellenic Centre for Marine Research	HCMR	GR
6	Institute of Oceanology – Bulgarian Academy of Sciences	IO-BAS	BG
7	Havforskningsinstituttet	IMR	NO
8	University College Cork, National University of Ireland, Cork	UCC Cork	IE
9	Consiglio Nazionale delle Ricerche	CNR-IAMC	IT
10	Fundacion AZTI/AZTI Fundazioa	Tecnalia AZTI	ES
11	Ministry for Resources and Rural Affairs	MRRA-MCFS	MT
12	Danmarks Tekniske Universitet	DTU AQUA	DK
13	The Secretary of State for Environment, Food and Rural Affairs	CEFAS	GB
14	Heriot-Watt University	HWU	GB
16	Stichting Deltares	Deltares	NL
17	Norsk Institutt for Vannforskning	NIVA	NO
18	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO	TNO BenO	NL
19	Vlaams Gewest	VlaGew	BE
20	Johann Heinrich von Thünen Institute - Institute of Sea Fisheries	vTI-SF	DE
21	Royal Belgian Institute for Natural Sciences – Management Unit of the North Sea Mathematical Models	MUMM	BE
22	Instytut Oceanologii Polskiej Akademii Nauk	IOPAN	PO

3. Case-studies and applications

Currently, 9 case study areas have been identified in which the tools, concepts and guidelines that are developed within MESMA will be tested. Such an approach will lead to products that are sufficient generic to be applied in other regions. Even more, additional case studies from other regions could be of aid during the term of the project, in order to test and thereby contribute to the development of the standardized, scientifically sound and acceptable methods for an integrated management and assessment of SMAs.

CASE STUDIES

1. Southern North Sea
2. Penland Firth & Orkney Waters
3. Barents Sea & Lofoten area
4. Celtic Sea
5. Basque country continental shelf (SE Bay of Biscay)
6. Strait of Sicily
7. Inner Ionian Archipelago & adjacent gulfs
8. Baltic Sea
9. Black Sea

4. Topics of collaboration between EU and Russia

1) *Expand our knowledge about impacts of climate change on the productivity and geographic distribution of fish and shellfish stocks, in order to achieve sustainable use of marine resources and conservation of marine biodiversity and ecosystem integrity through effective management measures*.

This objective should be effectuated by focussing on both Research and Management measures.

Research: Ecosystem models are important tools to improve our understanding of the impact of climate change on fisheries resources. Global climate models can be improved and down-scaled to regional model. Also, (regional) ecosystem models should capture both the full life cycle closure and the pelagic-benthic coupling, for which the experimental work on vital issues such as growth, survival rates and physiology for key species need to be enhanced, and the long-term monitoring of ecosystem components should be maintained and expanded.

Management: We should anticipate a number of changes in the marine environment due to climate change, which will make some current management measures and policies defunct. Due to changes in distribution patterns of species, for one the production and biodiversity of a region will alter, and secondly, as a consequence will have socio-economic implications on fisheries yields (which are predicted to increase in northern Europe, but decrease in southern Europe). The complexity of climate change and its interactions with the marine environment would favour a habitat-related systems-approach for biodiversity conservation, and fisheries management should focus less on individual fish species and more on the changing ecosystem.

Dynamic of Wildfires of the Altai-Sayan Ecoregion

Dr. Eugene I.Ponomarev

GIS-analisys leader

V.N. Sukhachev Institute of Forest SB RAS, Russian Federation, Krasnoyarsk, Akademgorodok, 50
E-mail contact: evg@ksc.krasn.ru

1. Introduction

The statistics of wildfire is high extremely annually for different regions of Russian Federation. So investigating of dynamic of wildfires activity is an actual theme. One of the project aims to analyze the impact of wildfires and to develop strategies to reduce fire danger risk in the Altai-Sayan Ecoregion. It has been fixed the increasing of quantity of fires in forest and steppe territories during last 10-year period. The rising of fire number as well as areas of damage increasing are resulted by human activity mostly and by some changing in weather conditions.

2. Project description

Project Title:

Development of the strategy of fire danger reducing for the territory of protected areas in the Altai-Sayan Ecoregion.

List of Project Partners:

Federal Ministry of Environment and Radiation Safety, Germany

V.N. Sukhachev Institute of Forest SB RAS, Russia

The Project “Development of the strategy of fire danger reducing for the territory of protected areas in the Altai-Sayan Ecoregion” was started in 2010. Results of the Project will based on the analysis of wildfires distribution during fire danger season as well as within landscapes and forest types. The main aim is development of the system of recommendations for fire preventing in specially protected areas (state reserve, national parks) under conditions of climate change and anthropogenic influence increasing.

Anticipated results are:

– classification and mapping of the territory according to natural wildfire danger levels;

– creating a plans of fire control arrangement for the individual existing protected areas in order to organize an effective system of fire management.

3. Case-studies and applications

1. At the study region there is more than 1500 fires annually, up to 60% in forests and 30% in the steppe zone. For 10 years, the frequency of recurrence of extreme fire seasons in the Altai-Sayan Region is 2 - 3 years. The tendency to increase the number of fires is observed in the last 10 years.

2. Up to 90% of wildfires recorded in the region are concentrated in zones of the first (the highest) and the second classes of natural fire danger. The greatest number of wildfires ignites in low mountains, plains and intermountain basins. Spring peak of fire activity is actual for Altai-

Sayan Region. The main causes of forest fires are careless use of fire in the forest (60-90%) and thunderstorm lightning - up to 36%.

4. Topics of collaboration between EU and Russia

1) *Climate Change Impacts on Wildfire in Eastern Siberia.*

Long-term trends in climate data are very important for understanding of wildfire dynamic in Regions. It is necessary to analyze temperature trends, precipitation dynamics as well as actual distribution of thunderstorm lightning. Data base of such information collected for different points in Region attached with coordinates should be base for development of meteorological maps interpolated in GIS.

2) *Using Remote Sensing for the monitoring of wildfire and analyzing of forest disturbances.*

For the Project realising we uses imagery daily receiving from satellites of low spatial resolution (NOAA, TERRA). The data are usefull for detecting and monitoring of wildfire activity. It is necessary to have an actual imagery data of high resolution for assessment and monitoring of post-fire disturbances (from Landsat, DMC satellites). Access to such kind of data will improve the reliability of results.

The SAFELAND Project: Meteorological and Climate Forecasting for Landslide Prediction

P. Schiano[1,2], E. Bucchignani[1,2]

WP 4.1 Leader

[1] CIRA – Italian Aerospace Research Center; [2] CMCC - Euromediterranean Center for Climate Change
E-mail contact: p.schiano@cira.it, e.bucchignani@cira.it

1. Introduction

The SAFELAND Project is a UE R&D FP7 project funded under Environment (including Climate Change) Work Programme. Specifically this talk will focus on the activities performed in the WP3.1 and WP4.1 related to the development of models, algorithms and software for the analysis of hydrogeological phenomena (floods and landslides) related to climate change and extreme meteorological events.

2. Project description

Project Title:

SAFELAND-Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies

***List of Project Partners*:**

The project involves 25 partners from many European countries. The coordinator is ICG - International Centre for Geohazards, Norway. Other partners are:

1 Universitat Politecnica de Catalunya UPC, Spain
2 A.M.R.A. s.c.a.r.l., Italy
3 Bureau de recherches géologiques et minières BRGM, France
4 Università degli Studi di Firenze UNIFI, Italy
5 International Institute for Applied Systems Analysis IIASA, Austria
6 Joint Research Centre JRC, Italy
7 Fundación Agustín de Betancourt FUNAB, Spain
8 Aristotle University of Thessaloniki AUTh, Greece
9 Università degli Studi di Milano - Bicocca UNIMIB, Italy
10 Max-Planck-Gesellschaft zur Förderung der Wissenschaften MPG, Germany
11 Centro Euro-Mediterraneo per i Cambiamenti Climatici CMCC, Italy
12 Studio Geotecnico Italiano S.r.l. SGI-MI, Italy
13 Università di Salerno UNISA, Italy
14 International Institute for Geo-information Science and Earth O. ITC Nertherlands
15 Eidgenössische Technische Hochschule Zurich ETHZ, Switzerland
16 Université de Lausanne UNIL, Switzerland
17 C.S.G. S.r.l. Centro Servizi di Geoingegneria CSG, Italy
18 Centre National de la Recherche Scientifique CNRS, France
19 King's College London KCL, United Kingdom
20 Geologische Bundesanstalt (Geological Survey of Austria) GSA, Austria
21 Ecole Polytechnique Fédérale de Lausanne EPFL, Switzerland
22 TRL Limited, UK
23 Geological Institute of Romanian GIR, Romania
24 Geological Survey of Slovenia GeoZS, Slovenia

SafeLand will develop generic quantitative risk assessment and management tools and strategies for landslides at local, regional, European and societal scales; it will establish the baseline for the

risk associated with landslides in Europe, in order to improve our ability to forecast landslide hazard and detect hazard and risk zones. To achieve this:

SafeLand will focus on improving the prediction of landslide triggering owing to climate change and other weather factors. The patterns of risk associated with landslides in Europe will be assessed for several different climate change scenarios and expected future human activity at selected hotspots in Europe.

SafeLand will identify “hotspots” in Europe where hazard and risk associated with landslides are highest.

SafeLand will develop monitoring, remote sensing and early warning system technology for mapping of previous landslides and prediction the behaviour of slopes.

SafeLand will develop a toolbox of risk mitigation measures for landslides. The toolbox will comprise both active and passive, and structural and non-structural, measures.

SafeLand will provide guidelines on choosing the most appropriate risk management strategy in a holistic approach, requiring close dialogue among technologists, social scientists, economists and stakeholders.

SafeLand will calibrate, validate and demonstrate the developed methodologies for quantitative risk assessment, prediction of slide triggering and run-out, remote sensing, monitoring and early warning, use of toolbox of mitigation measures and choice of appropriate risk management strategy through case studies.

Safeland will interact with international experts in landslide risk assessment and management to identify with solutions and strategies for Europe.

The scientific work packages in SafeLand are organised in five Areas: Area 1 focuses on improving the knowledge on triggering mechanisms, processes and thresholds, including climate-related and anthropogenic triggers, and on run-out models in landslide hazard assessment; Area 2 does an harmonisation of quantitative risk assessment methodologies for different spatial scales, looking into uncertainties, vulnerability, landslide susceptibility, landslide frequency, and identifying hotspots in Europe with higher landslide hazard and risk; Area 3 focuses on future climate change scenarios and changes in demography and infrastructure, resulting in the evolution of hazard and risk in Europe and at selected hotspots; Area 4 addresses the technical and practical issues related to monitoring and early warning for landslides, and identifies the best technologies available both in the context of hazard assessment and in the context of design of early warning systems; Area 5 provides a toolbox of risk mitigation strategies and guidelines for choosing the most appropriate risk management strategy. Maintaining the database of case studies, dissemination of the project results, and project management and coordination are defined in work packages 6, 7 and 8.

The talk will focus on specific activities of the SAFELAND project related to the future climate change scenarios in Europe and how they can modify the landslide risk. Other topics that will be shown are technical and practical issues related to monitoring and early warning for landslides. Related to this fields, the main goals of the activities under development in the SAFELAND project are the development of models, algorithms and software for the analysis of hydrogeological phenomena (floods and landslides) related to climate change and extreme meteorological events. Interest in these events occurs, especially in recent years, for a gradual increase in hydro-geological phenomena of failure. As shown in several studies, the causes of such disasters must be sought both in the climate changes and in an increasingly intensive exploitation of the territory (urbanisation widespread, funnel of rivers, intensive agriculture and so on).

The hydrogeological phenomena of interest are, generally, circumscribed (basin and/or slope scale) and, so, the tools for prediction and prevention require not only the development and the *ad hoc* optimization of numerical codes (accurate, robust, efficient), but also the coupling of the climate and meteorological model with models evaluating impact of such phenomena on the soil (i.e. hydrological-hydrodynamic models). The main result expected in this framework is a numerical simulation instruments that allows an extensive knowledge about the modification of hydrological instabilities phenomena (landslide, flood) connected to climate and meteorological events.

3. Case-studies and applications

In order to be able to produce results at the European scale, SafeLand needs to link hazards and risks at the local scale (i.e. individual slopes and slides) to the hazards and risks at the European scale. The smallest scale of interest refers to the local slope scale (less than 3 km²). The regional

studies, including the "hotspots" evaluations, form the intermediary scale (from 10 to 200 km²), depending of the site. The largest scale will be the "country" and Europe scales.
Several case studies have been chosen for testing and verification of the methodologies. The performance of the integrated models will be tested in some typical geomorphologic contexts of European and Mediterranean area, taking into account several landslide types. Climate change scenarios and the evaluation of landslide hazards and risks will be prepared for selected regions in Europe. In a similar way, scenarios of future human activity and demography based on expected and projected prognoses, will be prepared and the evolution of landslide risk in selected "hotspots" areas in Europe quantified. In this picture, the downscaling area for the climate models are identified by blue frames, while possible hotspots are identified by red points.

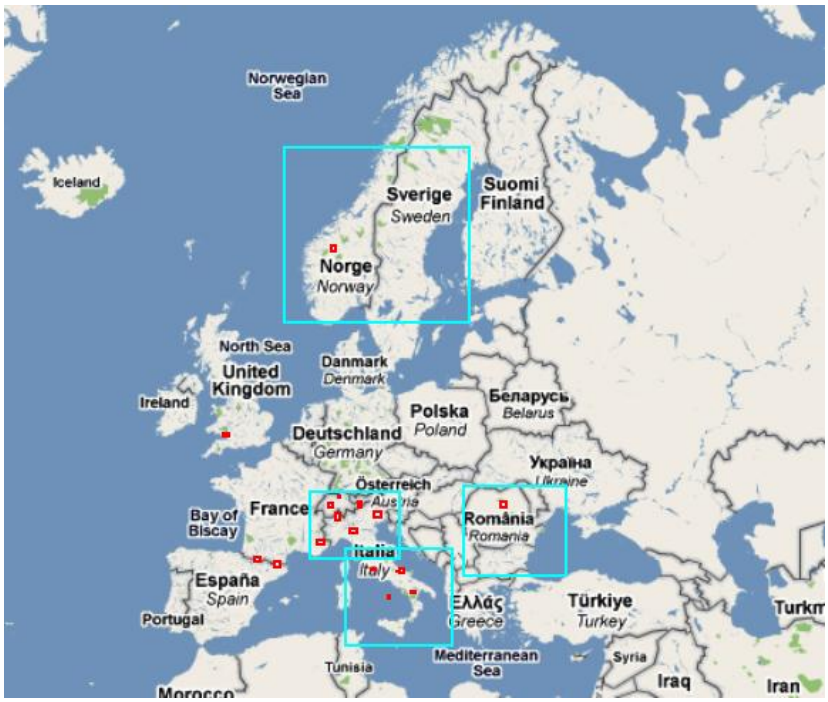

Figure 1

In the talk, we will show a general overview of the test cases and some applications of the numerical simulation tools under development within the WP3.1 and WP4.1 of the SAFELAND project to some specific case of landslides for the Campania region (Italy).

4. Topics of collaboration between EU and Russia

1) *Climate Change Scenarios on Regional Scale*

Some kind of landslides are strictly connected to the variation of atmospheric parameters as rainfall. It is possible to prepare very detailed analysis of all these variables performing simulations with climate regional models such as COSMO CLM. In this way, physically consistent simulations of small scale climatic features are possible (e.g. local precipitation extremes) and they can be linked to geo-mechanical models used for high resolution case studies. However, regional simulations at high resolution on Russian areas are still lacking and have to be performed. Their execution requires detailed information about the domain of interest, such as orography, soil and vegetation, so a cooperation with Russian consultants is desirable.

2) *Landslides Models*

Landslides are one of the most dangerous natural hazards:the effect at ground of the climate change on landslides triggering can be simulated trough the use of different methods: in general,

they are essentially physically based and empirical models, depending on the scale of the evaluation. They need accurate data regarding the geomorphology of the slope and the physical, mechanical and hydraulic properties of the soils. It is expected that the analysis of the available databases in Russia (and also in the former Soviet Union) could provide useful inputs for the assessment of the existing models.

Methane emission from Russian frozen wetlands under conditions of climate change

Prof. Oleg Anisimov, Svetlana Reneva

State Hydrological Institute, 23, Second Line V.O., 199053 St.Petersburg, Russia
E-mail contact: svetlana.reneva@hydrology.ru

1. Introduction

Recent findings suggest that pan-arctic permafrost together with the active layer above it contain up to 1850 Gigatonnes of carbon, including almost 300 Gt in the form of peat (McGuire et al. 2009; Tarnocai et al. 2009, Zimov et al., 2006). This is twice as much as in the global atmosphere. Carbon emissions from thawing permafrost can be in the form of cabon dioxide (CO_2) or, if the decomposition takes place in anaerobic conditions, as methane (CH_4). Production of methane is favoured in wetlands. Methane has 21-times stronger greenhouse effect than the equal amount of CO_2, and there are growing concerns that enhanced CH_4 emission may have significant effect on the global radiative forcing. The goal of our study was to estimate the potential increase in the methane emission from Russian frozen wetlands under the projected for the mid-21st century climatic conditions and to evaluate the effect it may have on global radiative forcing.

2. Modelling

We used digital geographically referenced contours of Russian wetlands from 1:1,000,000-scale topographic maps to calculate the total area (350 000 km^2) and the fraction of land they occupy in the nodes of 0.5 by 0.5 degree lat/long regular grid spanning permafrost regions. These data were overlaid with the results from predictive permafrost model (Anisimov & Belolutskaia 2003, Anisimov et al 1999) forced by CCC, HadCM3, GFDL, ECHAM and NCAR climatic projections for 2050 under B1 emission scenario (ref. http://ipcc-ddc.cru.uea.ac.uk/ and http://igloo.atmos.uiuc.edu/IPCC/). Ultimately, we calculated the increase in the amount of organic material that may potentially become available for decomposition due to deeper seasonal thawing of wetlands in the Russian part of Arctic. Following (Christensen et al 2003a, Christensen et al 2003b) we hypothesised that the temperature and substrate availability combined explain almost entirely the variations in mean annual methane emissions. We used the results of numerous calculations with the full-scale carbon model simulating a large variety of soil and temperature conditions to derive a simple parameterization that links the relative changes of methane flux with soil temperature and active layer thickness:

$$J_2/J_1 = \exp 0.1(T_2 - T_1)\sqrt{Hd2/Hd1},$$

where J – methane flux, T – ground temperature, H_d – thaw depth, subscripts 1 and 2 designate the baseline and future climatic conditions current and the future time slices (Anisimov et al 2005).

3. Conclusions

Our results for the mid-21stcentury indicate that the annual emission of methane from Russian permafrost region may increase by 20% – 40% over most of the area, and by 50% – 80% in the northernmost locations, which corresponds to 6–8 Mt y-1 (Fig.1).

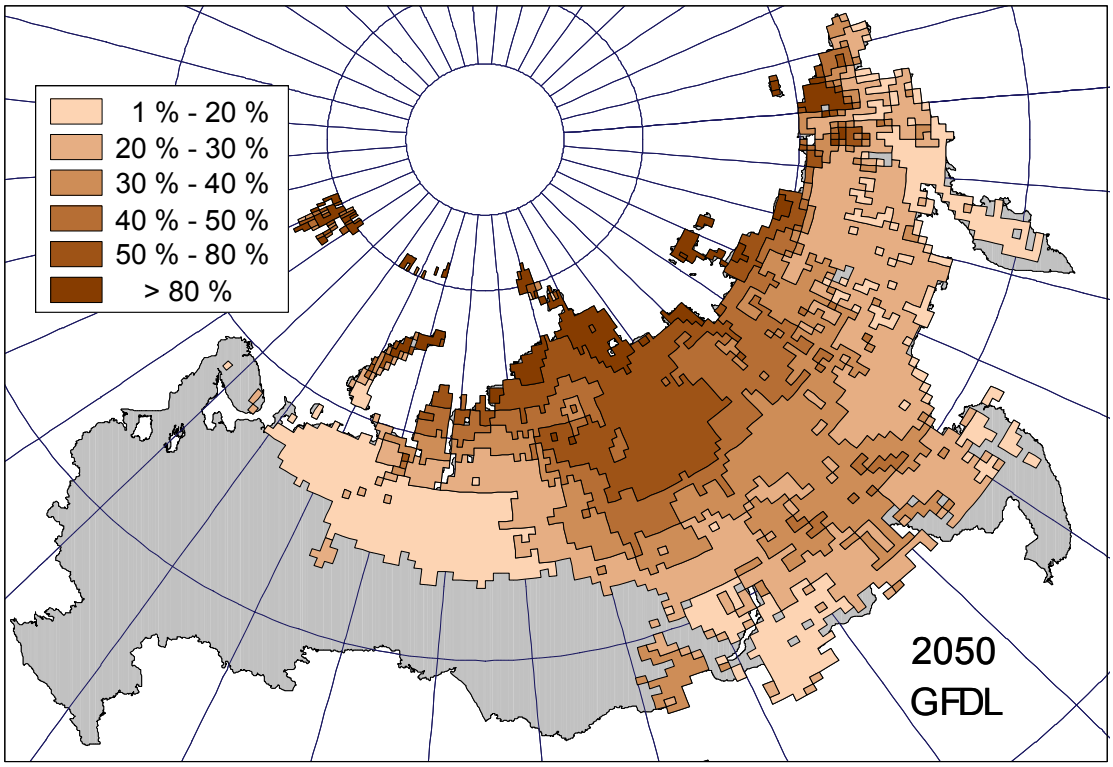

Fig.1. Predicted changes of methane emission from Russian Arctic wetlands, % from modern.

Given that the average residence time of methane in the atmosphere is 12 years, and assuming that other sinks and sources remain unchanged, by the mid-21st century the additional annual 6–8 Mt source due to thawing of permafrost may increase the overall amount of atmospheric methane by approximately 100 Mt, or 0.04 ppm. The sensitivity of the global temperature to 1 ppm of atmospheric methane is approximately 0.3 C (Ramaswamy 2001), and thus the additional radiative forcing resulting from such an increase may raise the global mean annual air temperature by 0.01 C.

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CIRCE - Climate Change and Impact Research: The Mediterranean Region and the Global Climate System

Enrico Scoccimarro[1], Silvio Gualdi[1,2], Antonio Navarra[1,2]

Coordinator of Research Line 2

[1] Istituto Nazionale di Geofisica e Vulcanologia (INGV), Via A. Moro 44, Bologna Italy
[2] Centro Euro-Mediterraneo per I Cambiamenti Climatici (CMCC), Via A. Moro 44, Bologna Italy

E-mail contact: scoccimarro@bo.ingv.it

1. Introduction

Future climate change could alter social and economic dynamics and has the potential to damage infrastructure, increase inequalities, economic migration, and poverty, and to impede access to essential resources. New hazards could appear on the horizon and existing ones could be exacerbated. Many risks like increased water scarcity, diminished food and water quality, ecosystem changes, increased south-north migration, and new emerging infectious diseases are of concern to Mediterranean populations. Considerations of future climate change should now be taken into account in all development strategies, especially in the Mediterranean region where it is expected to be significant.
CIRCE project has been designed to provide data and knowledge to deal with climate impacts in the Mediterranean. For the first time models and scenario ad hoc for the Mediterranean region have been prepared. Moreover, the project enhance the role of research as a tool to support actions and policies of adaptation to climate changes.

2. Project description

Project Title:

CIRCE Integrated Project - Climate Change and Impact Research: the Mediterranean Environment

Supported by the European Commission's Sixth Framework Programme, Sustainable Development, Global Change and Ecosystems. Project No. 036961.

List of Project Partners *(see appendix for the complete list):*

64 Partners from: ITALY, GERMANY, SPAIN, GREECE, UK, PORTUGAL, ISRAEL, FRANCE, SWITZERLAND, EGYPT, TUNISIA, AUSTRIA, SYRIA, DENMARK, ALGERIA, THE NETHERLANDS.

CIRCE aims at developing for the first time an assessment of the climate change impacts in the Mediterranean area. The objectives of the project are:
- to predict and to quantify physical impacts of climate change in the Mediterranean area;
- to evaluate the consequences of climate change for the society and the economy of the populations located in the Mediterranean area;
- to develop an integrated approach to understand combined effects of climate change;
- to identify adaptation and mitigation strategies in collaboration with regional stakeholders.

The knowledge yielded by the different specialised investigations will be linked in an integrated inter-disciplinary approach designed to study the total effect of climate change and to make a powerful contribution to the definition and evaluation of adaptation and mitigation strategies.
CIRCE brings together the natural sciences community and social community in a new integrated and comprehensive way through the following 14 Research Lines (RLs): (0) Coordination and Communication. (1) Identification and attribution of present climate trends. (2) The Mediterranean Region and the Global Climate System (3) Radiation, clouds, aerosols and climate change. (4) Scale Interactions and Feedback processes. (5) Water Cycle. (6) Extreme Events. (7) Impacts of Global Change on Ecosystems and the services they provide. (8) Air Quality and Climate. (9)

Human Health. (10) Economic Impacts of Climate Change. (11) Integrating case studies. (12) Relevant Societal Dynamics. (13) Induced Responses and Policies.
The main scientific objectives of RL2 are to provide climate evolution scenarios for the period 1950-2050 over the Mediterranean region for use in impact studies, and to understand the underlying processes and their links to global climate, through an analysis of existing and new model simulations. The new climate scenario simulations used throughout the project, are performed with a set of new climate models which have been assembled with a focus on the Mediterranean region. In particular, three regional (Regional Climate Models, RCM) and three global models (Atmosphere Ocean General Circulation models, AOGCM) have been developed to simulate the second half of the 20th century and the first half of the 21st century climate over the Euro-Mediterranean region. The focus on the Mediterranean region has been considered also in the AOGCMs development. For instance in the INGV-CMCC AOGCM the atmospheric model exchanges the surface fluxes with two ocean models (Figure 1): a global ocean model with a spatial resolution of 0.5^{o}- 2^{o} and a regional ocean model with a $1/16^{o}$ of resolution, independently. Thus the Mediterranean sea-surface temperature (SST) is overwritten on the SST produced by the global model for the same region. The communication between global ocean and Mediterranean Sea is then performed as follows: the Mediterranean model receives the information from the global ocean by means of an Atlantic box with three lateral open boundaries, where fields and fluxes are exchanged. The outflow from the Mediterranean Sea into the Atlantic Ocean, on the other hand, is treated as a river outflow (on the oceanic vertical column) at the Gibraltar Strait.
Both the regional and global models are coupled atmosphere-ocean models. The data sets produced within RL2 are available to the other RLs for impact studies.

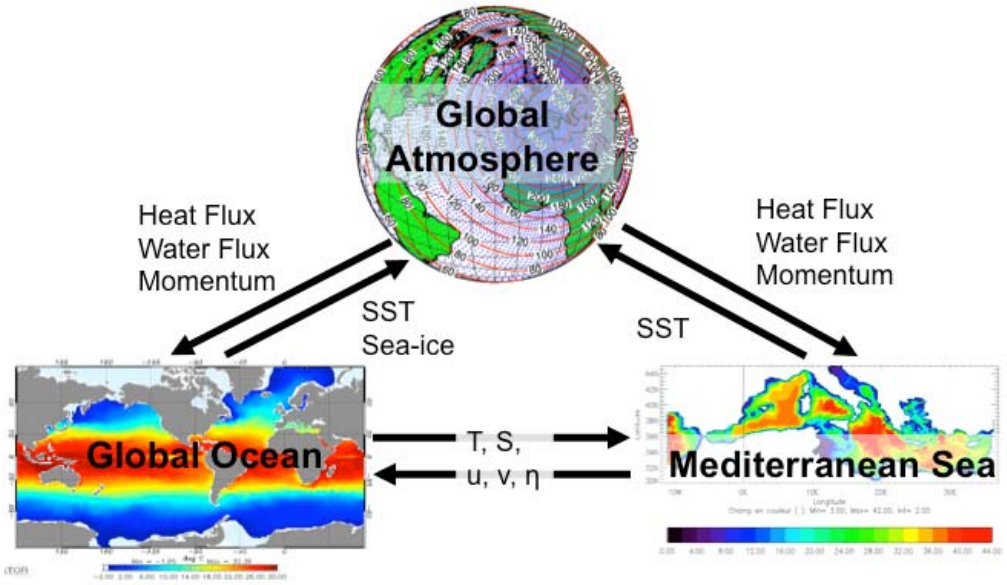

Figure 1: schematic of the global models with interactive Mediterranean Sea model used in the RL2 integrations.

3. Case-studies and applications

CIRCE wants to understand and to explain how climate will change in the Mediterranean area. The project investigates how global and Mediterranean climates interact, for instance in terms of modifications in the water cycle. The economic and social consequences of climate change shall be evaluated by analysing direct impacts on migration, tourism and energy markets together with indirect impacts on the economic system. CIRCE moreover investigates the consequences on agriculture, forests and ecosystems, human health and air quality. The variability of extreme events in the future scenario and their impacts must be assessed. A rigorous common framework, including a set of quantitative indicators developed specifically for the Mediterranean environment is under developement and it will be used in collaboration with regional stakeholders. The results will be incorporated in a decision support system tool and disseminated to the relevant users.

The sectoral approach to climate change impacts followed in the RLs 3 to 11, along with the work on past and future climate in RLs 1 and 2, will allow very detailed and rigorous analyses of climate change.
Three generic case-study types have been identified: urban, rural, and coastal. For each of the generic types, case studies have been chosen to reflect the east-west and north-south contrasts across the Mediterranean. The following criteria were used to select these case-study locations: vulnerability to climate change; availability of appropriate data; and, access to regional stakeholders, including decision and policy makers.
The eleven case-study locations are:
Urban: Athens, Greece; Alexandria, Egypt; Beirut, Lebanon
Rural: Tuscany, Italy; Puglia, Italy; Judean Foothills, Israel; Tel Hadya, Syria
Coastal: Gulf of Valencia, Spain; Gulf of Oran, Algeria; Gulf of Gabes, Tunisia; Western Nile Delta, Egypt

4. Topics of collaboration between EU and Russia

1) *Definition of boundary conditions for regional climate studies*

i. The AOGCM implemented at INGV-CMCC is a state of the art climate model with relatively high spatial resolution (T159 ~= 75Km in the atmosphere) and it is capable to provide boundary conditions for regional modelling studies over the whole Russian domain and Arctic Ocean, under present climate conditions and future scenarios. Future scenarios can be provided following the old A1B and A2 SRES (the one used for IPCC AR4) and also following the new Representative Concentration Pathways (RCPs, i.e. RCP4.5) developed for the CMIP5 experiments.

ii. To better assess and predict changes in the Black Sea ecosystems several work has been done during the past years (i.e. SESAME EU project, 47 partners). Part of the SESAME analysis have been performed using long-term (decadal) basin scale simulations and short-term regional scale simulations with coupled circulation-ecosystem models to predict the responses of ecosystems during the next five decades, based on consensus scenarios of changes in the forcings. During the SESAME project INGV-SXG (the previous version of the INGV-CMCC model) scenario simulations have been used to force ocean basin scale and regional models, showing an adequate performance in the Mediterranean region but considerable biases at the sub-regional scale, particularly in the Black Sea. The new INGV-CMCC simulations (as described in i.) could be used to provide an improved set of boundary conditions for future modelling studies over the Black Sea region.

2) *Improvement of the Dardanelles Strait parameterization*

In the INGV-CMCC AOGCM the water flux into the Mediterranean Sea through the Dardanelles Strait is represented using the water balance (Precipitation + River Runoff – Evaporation) over the Black sea as simulated by the atmospheric model component. The representation of the water inflow in the Mediterranean Sea using a state of the art Black Sea circulation model might contribute to better represent the climate of the eastern Mediterranean Sea.

APPENDIX
CIRCE Partners list:

ALGERIA
ARCE-ASSOCIATION POUR LA RECHERCHE SUR LE CLIMAT ET L'ENVIRONMENT
AUSTRIA
BOKU-UNIVERSITY OF NATURAL RESOURCES AND APPLIED LIFE SCIENCES- Department of Water, Atmosphere and Environment-Institute of Meteorology
DENMARK
DMI-DANISH METEOROLOGICAL INSTITUTE
EGYPT
CEDARE-CENTRE FOR ENVIRONMENT AND DEVE- LOPMENT FOR ARAB REGION AND EUROPE
FRANCE
CIRAD-CENTRE DE COOPERATION INTERNATIONALE EN RECHERCHE AGRONOMIQUE POUR LE DEVELOPPEMENT
CNRS-CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE
IDDRI-INSTITUT DU DEVELOPPEMENT DURABLE ET DES RELATIONS INTERNATIONALES METEO-FRANCE
MEDIAS-FRANCE
GERMANY
GKSS-INSTITUTE FOR COASTAL RESEARCH, GKSS RESEARCH CENTER
PIK-POTSDAM INSTITUT FOR CLIMATE IMPACT RESEARCH
MPG-MAX-PLANCK INSTITUTE - BIOGEOCHEMIE - CHEMISTRY - METEREOLOGY
UNI-HH-UNIVERSITAET HAMBURG
FU Berlin-FREIE UNIVERSITAET BERLIN
ECF-EUROPEAN CLIMATE FORUM
GREECE
UOC-UNIVERSITY OF CRETE, ENVIRONMENTAL CHE- MICAL PROCESSES LABORATORY
IASA-INSTITUTE OF ACCELERATING SYSTEMS AND APPLICATIONS
NOA-NATIONAL OBSERVATORY OF ATHENS
NKUA-NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS
UNIAEGAN-UNIVERSITY OF THE AEGEAN
HCMR-HELLENIC CENTRE FOR MARINE RESEARCH
ICCS-INSTITUTE OF COMMUNICATION AND COM- PUTER SYSTEMS
ISRAEL
HU-UNIVERSITY OF HAIFA, Natural Resource and Environmental Research Center
TAU-TEL-AVIV UNIVERSITY
HUJI-THE HEBREW UNIVERSITY OF JERUSALEM
BGU-BEN-GURION UNIVERSITY OF THE NEGEV
ITALY
INGV-ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA - Co-ordinator
CLU-CLU ltd
ENEA-ENTE PER LE NUOVE TECNOLOGIE, L'ENERGIA E L'AMBIENTE
FEEM-FONDAZIONE ENI ENRICO MATTEI
CNR-CONSIGLIO NAZIONALE DELLE RICERCHE
ASLRME.DE-AGENZIA SANITARIA LOCALE ROMA E, Department of Epidemiology
UNITUS-UNIVERSITY OF TUSCIA, Department of Forest Environment and Resources
ZADIG-ZADIG SRL
CETEMPS-UNIVERSITÀ DEGLI STUDI DELL’AQUILA UNILE-UNIVERSITY OF SALENTO
CMCC-CENTRO EURO-MEDITERRANEO PER I CAMBIAMENTI CLIMATICI
OGS-ISTITUTO NAZIONALE DI OCEANOGRAFIA E DI GEOFISICA SPERIMENTALE
UNIBO-ALMA MATER STUDIORUM, UNIVERSITA' DI BOLOGNA, DIPARTIMENTO DI COLTURE ARBOREE
PORTUGAL
ICAT-UL-INSTITUTO DE CIENCIA APLICADA E TECNOLOGIA DA FACULTADE DE CIENCIAS DA UNIVERSIDADE DE LISBOA
SPAIN
CSIC-CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS
CEAM-FUNDACION CENTRO DE ESTUDIOS AMBIENTALES DEL MEDITERRANEO
UCM-UNIVERSIDAD COMPLUTENSE DE MADRID
UPM-UNIVERSIDAD POLITECNICA DE MADRID
PCB-LRC-PARC CIENTIFIC DE BARCELONA UPV/EHU-UNIVERSIDAD DE PAIS VASCO
UPC-UNIVERSITAT POLITECNICA DE CATALUNYA UAH-UNIVERSIDAD DE ALCALA
UIB-UNIVERSITAT DE LES ILLES BALEARS- Departament d'Economia Aplicada
USC-UNIVERSIDAD DE SANTIAGO DE COMPOSTELA
SYRIA
ICARDA-THE INTERNATIONAL CENTER FOR AGRICULTURAL RESERARCH IN THE DRY AREAS
SWITZERLAND
UNIBERN-UNIVERSITY OF BERN, Institute of Geography
PSI-PAUL SCHERRER INSTITUT
TUNISIA
INSTM-NATIONAL INSTITUTE OF MARINE SCIENCES AND TECHNOLOGIES
IPT-INSTITUT PASTEUR DE TUNIS
THE NETHERLANDS
VUA-VRIJE UNIVERISTEIT AMSTERDAM, Faculty of Earth and Life Sciences, Department of Hydrology and Geo-environmental Science
UK
NERC-NOCS-NATURAL ENVIRONMENTAL RESEARCH COUNCIL
METOFFICE-MET OFFICE, HADLEY CENTRE
SEY-YO-UNIVERSITY OF YORK, STOCHKOLM ENVI- RONMENT INSTITUTE

UBIRM-UNIVERSITY OF BIRMINGHAM
UEA-UNIVERSITY OF EAST ANGLIA
UNI-SOTON-UNIVERSITY OF SOUTHAMPTON
INTERNATIONAL
WHO-WORLD HEALTH ORGANISATION, EUROPEAN CENTRE FOR HEALTH AND ENVIRONMENT
EC-DG-JRC-EUROPEAN COMMISSION DG JOINT RESEARCH CENTRE, Institute for Environment and Sustainability