SIXTH FRAMEWORK PROGRAMME
PRIORITY 1.1.6.3
GLOBAL CHANGE AND ECOSYSTEM

Contract for:

INTEGRATED PROJECT

Annex I - "Description of Work"

Project acronym: **CIRCE**
Project full title: **Climate Change and Impact Research: the Mediterranean Environment**
Proposal/Contract no.: **036961**
Related to other Contract no.: *(to be completed by Commission)*

Date of preparation of Annex I: **29 June 2006**

Date of revision of Annex I: **6 December 2006**
Date of 2nd revision of Annex I: **7 March 2007**

Date of 3rd revision of Annex I: 23 May 2007

Start date of contract: *(to be completed by Commission)*

Table of Contents

1. Project summary

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

CIRCE wants to understand and to explain how climate will change in the Mediterranean area. The project will investigate how global and Mediterranean climates interact, how the radiative properties of the atmosphere and the radiative fluxes vary, the interaction between cloudiness and aerosol, the modifications in the water cycle. Recent observed modifications in the climate variables and detected trends will be compared.
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 will moreover investigate the consequences on agriculture, forests and ecosystems.
human health and air quality. The variability of extreme events in the future scenario and their impacts will be assessed.
A rigorous common framework, including a set of quantitative indicators developed specifically for the Mediterranean environment will be developed and used in collaboration with regional stakeholders. The results will be incorporated in a decision support system tool and disseminated to the relevant users. Possible adaptation and mitigation strategies will be identified.
The integrated results discussed by the project CIRCE will be presented in the first Regional Assessment of Climate Change in the Mediterranean area.

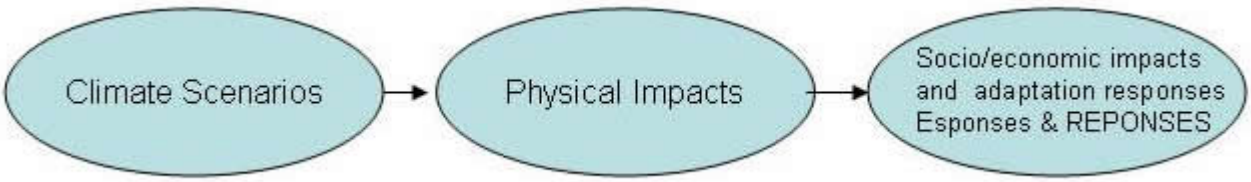
2. Project objectives

The main objectives of CIRCE are to predict and to quantify the physical impacts of climate change in the Mediterranean, and to assess the most influential consequences for the population of the region. The knowledge yielded by the different specialised investigations will then be linked in an integrated inter-disciplinary approach designed to study the **total** effect of climate change. CIRCE will integrate cutting-edge scientific research with the needs of end-users and communities. Thus, CIRCE will be able to quantify the impact of global warming on Mediterranean climate variables, whilst also taking into account the regional social, economic and policy aspects of the process. In this way, CIRCE will make a powerful contribution to the definition and evaluation of adaptation and mitigation strategies.

Recent observed changes in climate variables will be documented. Detectable trends and variability will be identified and described, and then compared with a series of possible explanations. An optimal mix of plausible forcing factors will be derived as the best explanatory interpretation of ongoing changes. In this way, a comprehensive set of data describing the physical impacts of climate change will be developed, and then used to assess the consequences of climate change for human society and ecosystems. CIRCE will analyse a number of climate parameters including: temperature, precipitation, atmospheric humidity, wind, waves, sea-level rise, surface radiative fluxes, balance between evaporation-precipitation, saline output to the Atlantic, water vapour export, frequency and distribution of extreme events, nutrient load into the sea, and sensitivity to water stress. CIRCE will build on the extensive modelling experience already available, but it will develop specific modelling scenarios for the Mediterranean, in terms of resolution, process and feedback inclusions, understanding and specific diagnostic studies for the Mediterranean area.

The impacts of climate change will be analysed and evaluated in their oceanographic, meteorological, ecological, economic and societal dimensions. Information will be provided in terms of economically meaningful variables such as productivity changes, variation of resource stocks, shifts in technology and demand patterns. Economic consequences for agriculture will be evaluated through estimation of agricultural productivity, management and profit. Similarly, impacts on forestry and on biodiversity will be investigated. CIRCE will focus particularly on the direct economic impacts for four crucial sectors for the Mediterranean region: health, tourism, energy demand, and human migration. The project will provide the advances required to meet policy needs in these sectors. To do that CIRCE aims to build a new vision of the interactions between climate factors and socio economic evolutions trying to overcome two classical obstacles faced by a number of research projects on climate impacts.

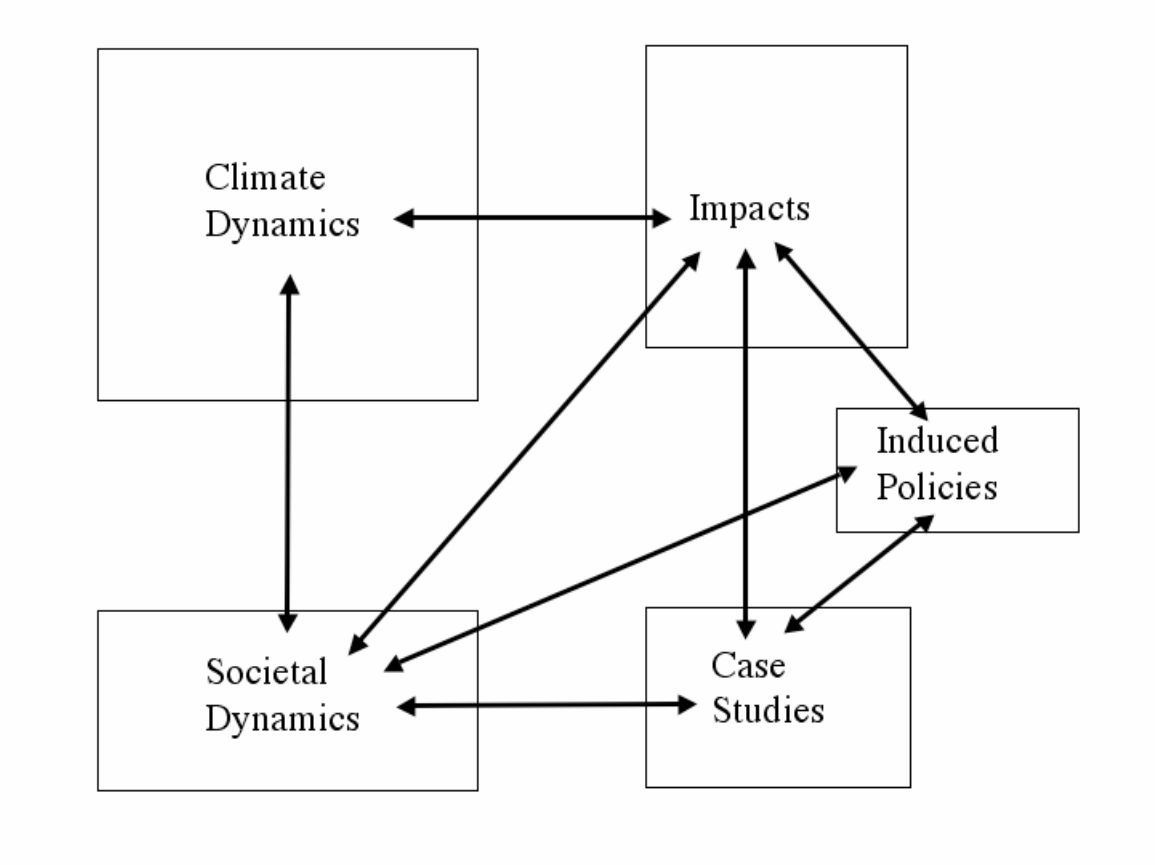
The first obstacle is often the imbalance between physical and natural science and social sciences. In Circe this imbalance has been corrected and social sciences are a strong component of the project. CIRCE brings together the natural sciences community and social community in a new integrated and comprehensive way.



The second obstacle is linked to the first, a “climate all vision of society” that is to put climate as the major constraint of human behaviour to understand adaptation. This bias is sometimes necessary for the needs of modelling but then produces irrelevant elements of analysis for policy making. A more realistic approach is needed to match stakeholders and policy maker’s demands.

Most climate impact assessments so far have focussed on a causal chain from climate change to economic and social impacts, adaptation policies being the direct responses to climate impacts.

CIRCE analyse climate impacts as the “joint product” of climate change and socio economic dynamics/ human behaviour which are most of the time independent of climate change. In this non linear approach, impacts of climate change are analysed with reference to specific socio economic scenarios, with particular attention to relevant sector and policies which can actually emphasize or reduce effect of climate change. On the other side responses strategies are not pure “adaptation” responses to climate change but a mix of long trends evolutions, progressive reorientation of sectoral policies which can also have positive or adverse effects on resilience or vulnerability to climate change. CIRCE makes a strong point in producing relevant research for the actors of the region. For that reason it is essential to provide assessments that can be integrated in practical decision making, therefore this more comprehensive method is necessary and more able to represent the reality as many impacts – on health, tourism, migration, etc. – cannot be reliably expressed as a function of climate change alone. The end result of the political economy of economic and social policies of the region will not be “climate first” but “development first” for a number of years to come. Keeping that framework in mind give the best chance to reach relevant actors and improve relevant strategies. That is the underlying concept of the CIRCE project



The CIRCE concept

To integrate the assessment of cross-sectoral impacts of climate change, for selected case-study regions, CIRCE will adopt a risk-based approach based on the conclusions developed in the specialised investigations. A rigorous common framework, including a set of quantitative indicators tailored specifically for the Mediterranean environment will be developed and used in collaboration with regional stakeholders and policy makers. The results will be incorporated in a decision support system tool and disseminated to the appropriate end-users. Likely adaptation and mitigation strategies will be identified using bottom-up (via regional workshops) and top-down approaches. The case-study areas will include North African, Middle Eastern and European locations.

The end products of CIRCE will be published in the open scientific literature and summarised in less technical terms in the Final Report - Regional Assessment of Climate Change in the Mediterranean (RACCM). The Report will be organized in three parts. The first part will be a synthesis report of the entire RACCM. The second part will contain the results from the thematic assessments described in the section on Research Lines (RLs). The third part will contain the results from the test-cases for selected regions and areas, and will show how the general results obtained in the RLs can be applied and integrated to real cases.

The RACCM will be produced in close consultation with stakeholders. The start-up meeting of the project will be held jointly with carefully-selected stakeholders, who will contribute to better-defined and more relevant priorities and issues. Thus CIRCE will develop an understanding of the different needs of the European Region, and enhance and develop analysis methods, models and indicators. Under the project, the interactive effects of climate change will become better understood, and predictions of risk and the prior assessment of policy effects will be improved.

To this end, CIRCE will invite continued contributions from Mediterranean stakeholders from the outset (**RL0**), whilst providing clear scientific evidence on the observed climatic trends (**RL1**), climate evolution scenarios for the 21st century (**RL2**) and radiation changes (**RL3**), and evaluating

local processes of the Mediterranean (**RL4**). The potential for changes in the frequency, intensity, and duration of extreme events is of immediate importance to policy makers and will be a central question to the project (**RL6**). Future changes in the water cycle (**RL5**), agriculture and ecosystems (**RL7**), air quality (**RL8**) and the economy (**RL10**) will be evaluated. Impacts on health (**RL9**) will also be assessed. The integration of results in a series of case studies (**RL11**) will be driven by stakeholder questions, geography, and temporal scale. The relevant societal strategies interacting with the climate drivers to determine impacts will be examined (**RL12**) and the derived induced policies will be also addressed (**RL13)**. The project will thus provide cutting-edge scientific results that will help establish:

- The methodology for including stakeholders needs and questions in the scientific discourse,
- The information on possible climate changes for the 21st century in the Mediterranean Area
- A framework for the preparation, reviewing and dissemination of the Regional Assessment Report.
- A set of policy-specific indicators and assessments that can be used to:
- Inform environmental reporting;
- Enable international comparisons in terms of quality of life, environment, economy and health
- Define a set of objectives and targets, and to monitor trends and progress towards these targets

The construction of the assessment report will occupy the second half of the project. At the end of the second year, a second conference with stakeholders will define a draft version of the report and the review process will start. The Draft Report will be reviewed by scientific experts external to CIRCE, and discussed with stakeholders in workshops, consensus conferences, and focus groups as part of the integrated case studies work. At the end of the third year, a Revised Report will be prepared, finally reviewed, edited and completed at the end of the fourth year. This will be an interactive process, involving the incorporation of new results and continuous updating. The whole process will be supervised by the CIRCE Executive Board. The duration of CIRCE is set at four years. The RL will be described in the following section B4.1.

3. Participant list - CIRCE PARTNERS

Participant Role	Participant No.	Participant name	Participant org. Short name	Country
CO	**1**	Istituto Nazionale di Geofisica e Vulcanologia	**INGV**	IT
CR	**2**	Consejo Superior de Investigaciones Científicas, Instituto de Ciencias de la Tierra "Jaume Almera"	**CSIC**	ES
CR	**3**	Fundación Centro de Estudios Ambientales del Mediterráneo	**CEAM**	ES
CR	**4**	CLU Ltd	**CLU**	IT
CR	**5**	Danish Meteorological Institute	**DMI**	DK
CR	**6**	University of Crete, Environmental Chemical Processes Laboratory	**UOC**	GR
CR	**7**	Ente per le Nuove Tecnologie, l'Energia e l'Ambiente	**ENEA**	IT
CR	**8**	Fondazione Eni Enrico Mattei	**FEEM**	IT
CR	**9**	Universidad Complutense de Madrid	**UCM**	ES
CR	**10**	Institute for Coastal Research GKSS	**GKSS**	DE
CR	**12**	Institute of Accelerating Systems and Applications	**IASA**	GR
CR	**13**	Consiglio Nazionale delle Ricerche	**CNR**	IT
CR	**14**	Potsdam Institut für Klimafolgenforschung	**PIK**	DE
CR	**15**	Centre de Coopération Internationale en Recherche Agronomique pour le Développement	**CIRAD**	FR
CR	**16**	Centre National de la Recherche Scientifique	**CNRS**	FR
CR	**17**	Universidad Politecnica de Madrid	**UPM**	ES
CR	**18**	World Health Organization, Regional Office for Europe	**WHO**	INT
CR	**19**	Institut du Développement Durable et des Relations Internationales	**IDDRI**	FR
CR	**20**	Natural Environment Research Council	**NERC-NOCS**	UK
CR	**21**	Max-Planck-Society for the Advancement of Science	**MPG**	DE
CR	**22**	National Observatory of Athens	**NOA**	GR
CR	**23**	National Institute of Marine Sciences and Technologies	**INSTM**	TN
CR	**24**	University of Haifa	**HU**	IL
CR	**25**	University of Natural Resources and Applied Life Sciences	**BOKU**	AT
CR	**26**	European Commission DG Joint Research Centre	**EC-DG-JRC**	INT
CR	**27**	Parc Cientific de Barcelona	**PCB -LRC**	ES
CR	**28**	Azienda Unità Sanitaria Locale Roma E	**ASLRME.DE**	IT
CR	**29**	Meteo-France	**METEO-FRANCE**	FR
CR	**30**	Met Office	**METOFFICE**	UK
CR	**31**	Università degli Studi della Tuscia	**UNITUSCIA**	IT
CR	**32**	Stochkolm Environment Institute - University of York	**SEI-YO**	UK
CR	**33**	University of Birmingham	**UBIRM**	UK
CR	**34**	Universidad del Pais Vasco	**UPV-EHU**	ES
CR	**35**	Universitat Politècnica de Catalunya	**UPC**	ES
CR	**36**	National and Kapodistrian University of Athens	**NKUA-UAT**	GR
CR	**37**	Tel-Aviv University	**TAU**	IL
CR	**38**	Univerdidad de Alcala	**UAH**	ES
CR	**39**	Zadigroma srl	**ZADIGROMA**	IT
CR	**40**	University of East Anglia	**UEA**	UK
CR	**41**	Universitat de les Illes Balears	**UIB**	ES
CR	**42**	Instituto de Ciência Aplicada e Tecnologia da Faculdade de Ciências da Universidade de Lisboa	**ICAT-UL**	PT
CR	**43**	Universität Hamburg	**UNIHH**	DE
CR	**44**	University of the Aegean	**UNIAEGEAN**	GR
CR	**45**	Centre For Environment and Development For Arab Region and Europe	**CEDARE**	EG
CR	**46**	University of Bern	**UNIBERN**	CH
CR	**47**	Università degli Studi - L'Aquila	**CETEMPS**	IT
CR	**48**	Freie Universität Berlin	**FU Berlin**	DE
CR	**49**	Università del Salento	**UNILE**	IT
CR	**50**	European Climate Forum	**ECF**	DE
CR	**51**	Vereniging voor Christelijk Hoger Onderwijs Wetenschappelijk Onderzoek en Patientenzorg	**VUA**	NL
CR	**52**	The Hebrew University of Jerusalem	**HUJI**	IL
CR	**53**	Università di Santiago di Compostela	**USC**	ES
CR	**54**	Centro Euro-Mediterraneo per i Cambiamenti Climatici	**CMCC**	IT
CR	**55**	Institute Pasteur de Tunis	**IPT**	TN
CR	**56**	Association pour la Recherche sur le Climat et l'Environnement	**ARCE**	DZ
CR	**57**	International Center for Agricultural Research in the Dry Areas	**ICARDA**	SY
CR	**58**	Hellenic Center for Marine Research	**HCMR**	GR
CR	**59**	University of Southampton	**UNI-SOTON**	UK
CR	**60**	Ben-Gurion University of the Negev	**BGU**	IL
CR	**61**	Paul Scherrer Institut	**PSI**	CH
CR	**62**	Institute of Communication and Computer Systems	**ICCS**	GR
CR	**63**	Istituto Nazionale di Oceanografia e Geofisica Sperimentale	**OGS**	IT
CR	**64**	Alma Mater Studiorum – Università di Bologna – Dipartimento di Colture Arboree	**UNIBO**	IT
CR	**65**	MediasFrance	**MEDIAS**	FR

4. Relevance to the objectives of the activity objectives

CIRCE will fully respond to the call for an Integrated Project on the topic I.3.1 "Climate Change Impacts in the Mediterranean area" by developing the first comprehensive assessment of climate change impacts in the Mediterranean. CIRCE will consider how past and future changes in Mediterranean atmospheric and oceanic circulations, including their feedbacks with land use, relate to the global climate system. To this end, it is important to understand not only how the climate system is likely to change, but also to consider the nature of impacts on other systems and to identify appropriate and effective remedial responses. CIRCE will address changes in the water cycle, in air quality, and in social and economic sectors including: health, migration, tourism, energy availability and distribution. It will also examine changes in agriculture, forest ecosystems, and in extreme events, with particular emphasis on their economic impact. Adaptation and mitigation policies will also be evaluated.

Future climate change could also 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. The Mediterranean is very diversified in its cultures, protocols, and social and political development. Economic and environmental changes at the global and regional level threaten to create new hazards and to exacerbate existing ones such as: flooding, heat waves (e.g., Mediterranean region, 2003), droughts (e.g., Spain and Portugal, 2005). Other risks from, for example, increased water scarcity, diminished food and water quality, ecosystem changes, increased south-north migration, and new emerging infectious diseases are also of concern to Mediterranean populations. Addressing these problems is a major social objective in the EU and neighbouring Mediterranean countries. CIRCE will help to meet this objective by:

Integrating and adding value to information from a wide range of EU-funded projects;
Performing focused high-quality research on areas with severe knowledge gaps;
Combining research efforts from many disciplines;
Combining top-down and bottom-up approaches, with the ultimate goal of producing a Regional Assessment Report on the impacts of climate change for the Mediterranean.

A prime consideration will be the involvement of stakeholders and communities in a project producing sound scientific results, whilst always acknowledging the needs and priorities of end-users and vulnerable sectors. The integrated aspect of climate change impacts will be addressed by examining contrasting environments (e.g., urban/rural, coastal/internal), with crucial participation from stakeholders and local institutions. CIRCE will establish a liaison with other areas covered by different topics in the same call; for example, impacts of climate change on marine ecosystems, water policy and flash floods. A liaison group will be set up to ensure an efficient and effective transfer of information between CIRCE and other projects addressing topics of relevance to CIRCE.

CIRCE will also contribute with science and knowledge towards a better understanding of how to target long range sustainable development policies. A primary objective of the Joint Declaration of the Barcelona Conference (12 Mediterranean partners and 15 EU member states, November 1995) stressed the importance of creating a Euro-Mediterranean Research and Innovation Area. CIRCE will assess how to cope with climatic change in the context of transnational economic, environmental and socio-political problems. This will include promoting the production and exchange of knowledge, technological know-how, innovation, and investment in people and institutions in order to foster socio-economic progress throughout the Euro-Mediterranean area. The CIRCE project will provide knowledge to a number of international initiatives: the national communications to the UNFCCC, the IPCC, the UNECE Convention on transboundary waters and air pollution, the European Climate Change Programme, the European Environment and Health Strategy and the European Environment and Health Action Plan, and the implementation of directives such as the EC Ozone Directive 2002/3/EC and the Water Directives. By combining active stakeholder participation with a coordinated oceanographic and climatic research programme

for the Mediterranean, CIRCE will also be in the vanguard of promoting the forthcoming EU Marine Strategy Directive.

A coherent approach toward providing this information for the Mediterranean is currently lacking and CIRCE will fill the gap. As the recently launched Global Monitoring for Environment and Security (GMES) program has also argued, monitoring and understanding of the environmental and socio-economic conditions needed to underpin science and policy in this area are limited, and need to be developed. As many agencies have recognized, methods of integrated assessment such as CIRCE, which trace and quantify the links between different systems, and which base their activities on policy-relevant questions, are needed to help guide policy and to assess appropriate climate change mitigation and adaptation actions.

5. Potential Impact

The Mediterranean is positioned at the border between the tropical climate zone and the midlatitude climate belt. In most of the region, precipitation is concentrated in the winter months and the summers are relatively dry and hot. Summer storms, however, are very important in some regions (islands, for example). Climate change could modify this equilibrium. Regional water resources are already under severe economic and demographic pressure, and the effects of climate change could pose serious questions about the sustainability of the region. In particular, climate change and increased severity of weather extremes and land-use change may add to the existing problems of desertification, water scarcity, and food production; and introduce new challenges to human health, ecosystems, and national economies.

For instance, trends in European agriculture are dominated by the EU Common Agricultural Policy (CAP). The CAP reform of 1992 reduced intervention prices by one third and substituted this by area payments, including set-aside schemes. This process of reducing and transforming subsidies is continued in the Agenda 2000 reform. In 2003 it was decided to totally decouple agricultural subsidies from production. Future payments to farmers will be linked to environmental issues, food safety, animal and plant health, and animal welfare standards, as well as the requirement to keep all farmland in good agricultural and environmental condition ("cross-compliance"). Climate change could wreak havoc with this scenario, changing established methods and practice, reducing biodiversity, and resulting in huge financial demands from the sector. CIRCE will produce the first comprehensive integrated regional assessment of climate change impacts in the Mediterranean region, attempting to integrate knowledge from several disciplines, focusing on the Mediterranean area and filling up research gaps when necessary.

The project will foster regional cooperation, infrastructure establishment, scientific training and dialogue with policy makers. It will also constitute a coherent contribution to the IPCC process and to major international programs such as IGBP. CIRCE will also respond to the ESSP (Earth System Science Partnership) initiative on helping to understand the Earth System, the changes that are occurring to the System, and the implications of these changes for global sustainability. Considering specifically the Mediterranean area, the objectives of CIRCE reflect important issues and motivations raised by the scientific community in the MedCLIVAR project (endorsed by CLIVAR and ESF) for which CIRCE represents a fundamental support.

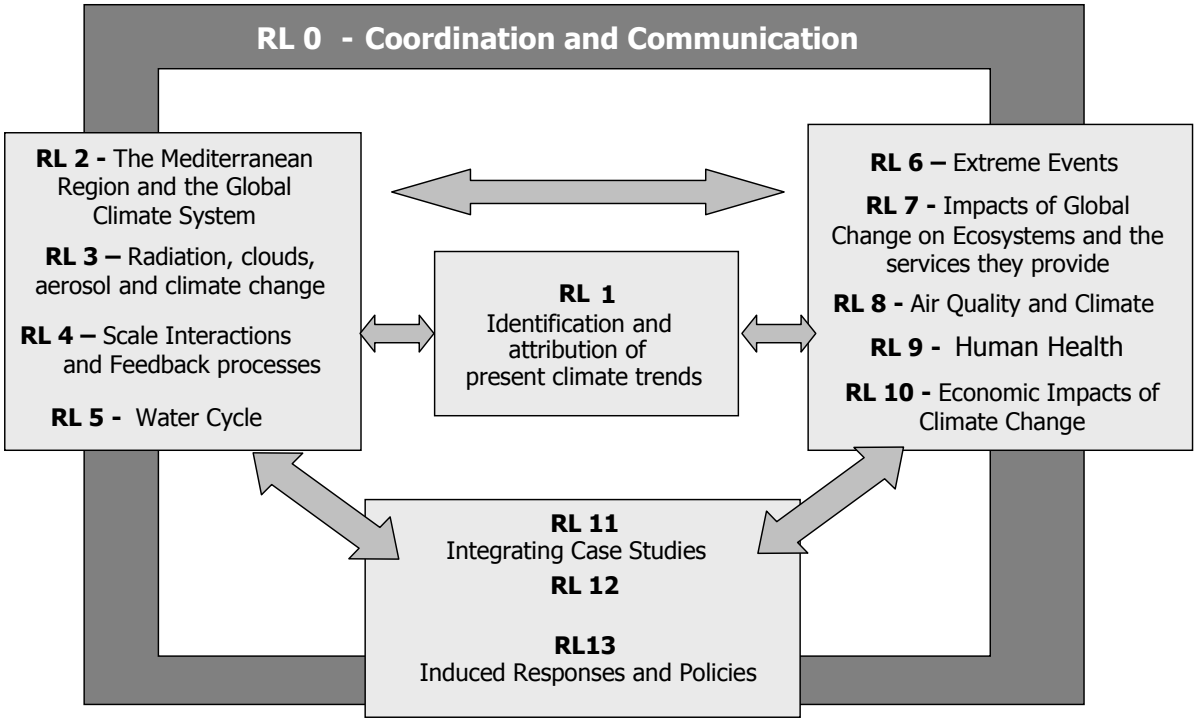
CIRCE will integrate scientific effort within a wider social and economic context. The direction of the scientific discourse will be discussed with diverse stakeholder groups through focus groups, consensus conferences, scientific forums, and workshops. This interaction will help to better define the questions and issues addressed by the scientific analyses. A communication strategy will be defined to disseminate the results of the project to the media and the public. This will include assessing the impact of the project and its results on the media and public events; and also the implementation of specific actions, for example, consensus conferences, and events held in science museums.

A number of essential stakeholders have already been identified through existing cooperation with CIRCE partners. These currently include: the Ministries of Environment of Italy, Spain, Algeria and Greece; Ministry of Health of Italy; Consorzio Venezia Ricerche, Italy, Ministère de l'Agriculture et des Ressources Hydrauliques – Algerie; Regional Government of the Valencia Region and of Tuscany Region; Hellenic National Meteorological Service (HNMS); General Secretariat for Civil Protection (GSCP), Greece; Athens International Airport (AIA); European Environmental Agency; European Technology Platform on Forestry and Forest Products; Corpo Forestale dello Stato (Italian Forest Service) and other National Forest Services in Europe and NorthAfrica/Middle East; European Observatory of Mountain Forests – EOMF; CEPF- Conseil Europeenne de Proprietaires Forestiers; FEDERFORESTE-Associazione Italiana Consorzi Forestali pubblici e privati; FEDERPARCHI-Associazione Italiana dei Parchi e Riserve naturali; Environment and Natural Resources Service (SDRN-FAO); The Agricultural Research Organization of Israel; Entreprise Nationale d'Aménagement des Réserves des Parcs Nationaux et de Loisirs – ENARP, Algeria; and, Fondation Déserts du Monde. Other stakeholders will become involved as the project progresses via CIRCE partner networks such as the EXCITE network of science museums, the Mediterranean Program of the WWF, and so on.

6. Outline implementation plan for the full duration of the project

6.A Activities

The activities of the Research Lines will be described in detail in the following.



List of Work Packages

RL 0
WP0.1 Coordination, Management and Assessment Report
WP 0.2 Web Based Reporting and Management
WP 0.3 External and internal communication office
WP 04 Network of museums and science centers

RL 1
WP 1.1 Coordination
WP 1.2 Data collection and informational content of data
WP1.3 Detection of systematic changes, attribution of plausible causes

RL 2
WP 2.1 Global climate evolution scenarios including a detailed representation of the Mediterranean Sea
WP 2.2 Climate evolution scenarios from regional models for the Mediterranean area
WP 2.3 Impacts of global climate change on the Mediterranean climate
WP 2.4 Coordination on production of scenarios and distribution of datasets

RL 3
WP 3.1 Surface radiation from existing observations
WP3.2 Model reconstruction of recent and present conditions
WP 3.3 Impacts of future climate change on the surface radiation
WP 3.4 Coordination of RL 3

RL 4
WP 4.1 Atmospheric flow regimes in the Mediterranean Basin
WP 4.2 Rain regimes and precipitation components across the basin
WP 4.3 Land-Atmosphere-Oceanic interactions. Integrated regional studies
WP 4.4 Feedbacks within the Global Cycle
WP 4.5 Coordination

RL5
WP 5.1 Analysis of changes in Atmospheric water budget
WP 5.2 Variations in the precipitation component of the water cycle in the Mediterranean Region
WP 5.3 Variations in the terrestrial component of water cycle
WP 5.4 Changes in Mediterranean Sea water cycle and implications for water mass characteristics
WP 5.5 Coordination

RL 6
WP 6.1 Mediterranean extreme characterization and indices
WP 6.2 Diagnosis of trends/variability in extremes during the 20th century
WP 6.3 Extremes: causes and links to large scale patterns
WP 6.4 Extremes in future climate scenarios
WP 6.5 Data for the estimation of future impacts of weather and climate extremes
WP 6.6 Coordination

RL 7
WP 7.1 Coordination of RL7, data distribution and network consolidation
WP 7.2 Climate change impacts on forests, agriculture, food products and livestock production
WP 7.3 Fire and other disturbances
WP 7.4 Integration of ecosystem services at the regional scale
WP 7.5 Climate impacts on biogeochemical cycling

RL 8
WP 8.1 Emission inventories and scenarios
WP8.2 Observational data base and trend analyses
WP8.3 Integrated Limited Area Modeling System
WP8.4 Air Quality and Climate: Case Studies
WP8.5 High Resolution Reanalysis data set for the Mediterranean Region and the surrounding Areas
WP8.6 Coordination and Communication

RL 9
WP9.1 Methods, policy development and integration
WP9.2 Assessment of Health impact of extreme temperature and air pollution in the MedRegion
WP9.3 Risk assessment on infectious diseases
WP 9.4 Management of RL

RL 10
WP10.1 Coordination
WP10.2 Tourism
WP10.3 Migration
WP10.4 Extreme weather
WP10.5 Energy
WP10.6 Sea Level Rise
WP10.7 CGE Development and Interface
WP10.8 Valuation of Ecosystems
WP10.9 Agriculture

RL 11
WP11.1 RL11 Coordination
WP11.2 Common tools and central datasets
WP11.3 Urban case studies
WP11.4 Rural case studies
WP11.5 Coastal case studies
WP11.6 Synthesis and wider implications of the case-study work

RL 12
WP12.1 Coordination
WP12.2 Patterns of economic growth
WP12.3 Development policies
WP12.4 Unemployment disparities
WP12.5 Risk Management

RL 13
WP13.1 Coordination
WP13.2 Identification and screening of adaptation options
WP13.3 Integrated management of vulnerability in agriculture and health
WP13.4 Integrated management of the vulnerability to climate change in touristic coastal zones

Table1.CIRCE RL	GEOGRAPHICAL SCOPE
0	
1	Mediterranean Basin/Sea
2	Mediterranean region
3	Mediterranean Region
4	Mediterranean System/basin, 8 air/watersheds
5	Mediterranean Environment/Sea
6	Mediterranean area
7	Mediterranean Region (several study regions)
8	Mediterranean Region (plus several case studies)
9	6 Cities plus Turkey and Tunisia
10	Mediterranean Region/Italy/Isreal/UK migration/urban areas to be decided
11	3 Urban, 4 rural, 4 coastal
12	Mediterranean basin economic area and its interaction with the rest of the European Union.
13	Mediterranean Region/coastal zones

Table 2	LINKAGES BETWEEN RL AS MENTIONED IN DOW													
TO:	RL				Input received by:									
FROM:	0	1	2	3	4	5	6	7	8	9	10	11	12	13
0														
1			X	X	X	X	X	X	X	X	X			
2		X			X	X	X	X	X	X	X	X	X	X
3		X					X		X	X		X	X	
4			X			X	X		X			X		
5			X				X	X		X	X	X	X	
6		X	X			X		X	X	X	X	X	X	X
7											X	X	X	X
8					X	X	X	X				X		
9											X	X	X	X
10												X	X	X
11											X		X	X
12							X	X	X	X	X	X		X
13							X	X	X	X	X	X	X	

6.1 Research, technological development and innovation activities

RL1 - Identification and attribution of present climate trends

Von Storch Hans (GKSS), Xoplaki Elena (UNIBERN)

Objectives:

- To document recent trends in climatic variables, such as near surface air temperature, precipitation, storminess in the Mediterranean Basin and the thermohaline state of the Mediterranean Sea, to assess their strength relative to the range of natural variations and to interpret non-natural trends in the framework of climate change scenarios.

- To complete homogeneous data sets of a variety of atmospheric and oceanic variables of the Mediterranean Sea Basin climate for the past few decades, to estimate the signal-to-noise ratios of trends versus natural climate variability (detection of anthropogenic signals), and to check the consistency of expected future climate change with ongoing trends (attribution to anthropogenic causes).

Description:

RL1 research will be divided in two research topics/work packages that ensure the progressive achievement of the objectives. These work packages focus on:

a) Data Collection and informational content of data (WP1.2)

Data collection

Data will be collected and analysed in order to assess whether systematic changes in the past few decades are beyond the range of variations seen in the instrumental record of the last around 200 years ("Detection"), and if the recent changes are consistent with changes envisaged by climate models as a response to assumed climate forcing (in particular greenhouse forcing, but also industrial aerosols or aeolian forcing) – ("Attribution"). The work will focus on (a) atmosphere and climate observations, (b) ocean observations and c) ocean analyses with models. This work will build on work in the projects MFSTEP, MEDAR/MEDATLAS, ADVICE, IMPROVE, EMULATE, HIPOCAS and also rely on global reanalysis from NCEP and ERA40. Further, additional data will be collected from areas as the Northern Africa and the Near East.

Homogenization

The newly collected data for both the atmosphere and the ocean will be homogenized and all atmospheric station data be examined jointly and an assessment will be made on whether they can be considered to represent a regionally representative climate signal. Homogenisation techniques will be developed, tested and implemented on the different atmospheric and oceanic data sets. The various time series of the variable oceanic and atmospheric state will be described in suitable space-time statistics. This effort serves the purpose of determining if the estimates of natural (non-anthropogenic) climate variations derived from the instrumental record are adequate, or if earlier climate variations indicate a larger level of natural climate variability.

b) Detection of systematic changes, attribution of plausible causes (WP1.3) The "detection" can be done mainly for selected local atmospheric variables and SST. Scenarios of anticipated anthropogenic climate change prepared within RL2 and available from sources outside CIRCE (e.g. ENSEMBLES) will be assessed using the "fingerprint"-approach to identify modal structures with low signal-to-noise ratios. This identifies recent changes beyond the range of natural variations for the earlier periods. Long term climate model simulations with natural forcing, or intra-ensemble variability within scenario experiments, will be used to improve the estimation of levels of natural

variability. For the sake of "attribution", recent changes, derived from oceanographic box data and atmospheric re-analyses, will be subjected to a series of different possible explanations, and an optimal mix of plausible forcing factors will be derived as the best interpretation of ongoing change. These possible explanations are derived from scenario simulations of the coupled atmosphere-ocean system of the Mediterranean Sea basin.

The collaboration with researchers from Northern Africa and Near East countries and data collection from these areas is of great importance for the RL1 research. The preparation of the original budget has foreseen the reserved amount of 10'000 Euros in the budget of UNIBERN for specific tasks to be carried out by new contractors and/or data costs identified during the course of the project.

WP1.1: Coordination
Responsible: Von Storch Hans (GKSS)

Total project description: Review of achieved progress in detection and attribution of climate change in the Mediterranean region

WP1.2: Data collection and informational content of data
Responsible: Theocharis Alexander (HCMR), Marina Baldi (IBIMET-CNR)

Total project description: The WP concentrates on the collection, validation, homogenization and preliminary statistical analysis of a number of variables with special importance for climate research, in particular detection and attribution studies, such as precipitation, near surface air temperature or storminess seawater temperature and salinity and sea level.

Data Collection

Oceanic and atmospheric data in the Mediterranean region, suitable for climate research, will be collected and will be subject to quality control. The data sets will be enriched with additional data from North Africa and Near East and updated until 2005. Final databases, namely the Mediterranean Data Base for Climate Research (ocean and atmosphere components), will be constructed and delivered for analysis. Ocean reanalysis will be performed and the results will be compared with the oceanic subset of Mediterranean Data Base for Climate Research and climate change scenarios performed in RL2.

Homogenization

The newly collected data of both the atmosphere and the ocean have to be homogenized. Furthermore, all atmospheric station data have to be examined jointly – across countries and sources – whether they can be considered to represent a regionally representative climate signal (as opposed to a local signal, possibly contaminated by non-meteorological influences). Raw data with as much metadata as possible is required in order to perform coherent treatment of the full dataset. At monthly time-scale, homogenization will be carried out using standard methodologies for all variables (e.g. Brunet et al., 2006; Della-Marta et al., 2006). At daily time-scales, more advanced methods will be developed and tested for temperature data (Della-Marta and Wanner, 2006). For precipitation, monthly adjustments will be used as no other technique has been proven to work correctly. In addition, the various time series of the variable oceanic and atmospheric state need to be described in suitable space-time statistics.

References

Brunet, M., Saladié, O., Jones, P.D., Sigró, J., Moberg, A., Aguilar, E., Walther, A., Lister, D. Y López, D.(2006): "The development of a new daily adjusted temperature dataset for Spain (1850-2003)", International Journal of Climatology, DOI: 10.1002/joc.1338.

Della-Marta, P.M. and H. Wanner, 2006: A method for homogenizing the extremes and mean of daily temperature measurements. J. Climate, in press.

Della-Marta, P.M., Luterbacher, J., von Weissenfluh H., Xoplaki E., Brunet M., and Wanner H., 2006: Summer heat waves over western Europe 1880-2003, their change and relationship to large scale forcings, in review.

WP1.3: Detection of systematic changes, attribution of plausible causes

Responsible: Planton Serge (METEO-FRANCE)

Total project description: The trends and variability of oceanic physical parameters (such as temperature, salinity, ocean column stratification) will be analysed from the collected data over specified ocean boxes (key and/or process oriented locations) identified in WP1.3. The detection of climate change will be extended in different directions. First of all, new scenarios performed within the framework of the project (RL2) with coupled global models including a high resolution Mediterranean sea (T18) and coupled regional climate models (T24) will be considered. Other atmospheric parameters like precipitation or oceanic parameters like Sea Surface Temperature and ocean surface heat content, will be considered. The advancement of the project will also allow using a more complete set of observed data series.

As part of attribution studies, the multi fingerprint approach (Hegerl et al., 1996) will be applied to homogenized long term data series of different atmospheric parameters (near surface temperature, ...) and to an ensemble of regional climate simulations using different forcing (natural and anthropogenic). The attribution of climate change signal in the atmosphere compared to the noise of internal plus ocean induced variability will in particular profit by an ensemble of existing simulations performed with the variable resolution ARPEGE-Climat model with different anthropogenic (greenhouse gases, sulphate) and natural forcings (Solar + volcanic) over the 20th century. Specific coupled scenarios developed within the framework of the project will also become available from RL2 activity. This will allow to apply the multi fingerprint approach with a larger ensemble of simulations.

RL2 - The Mediterranean Region and the Global Climate System

Li Laurent (CNRS/IPSL), Silvio Gualdi (INGV)

Objectives:

(i) Assemble meta-data on existing scenarios that are relevant to the Mediterranean region.
(ii) Perform a limited set of global scenarios with improved horizontal resolution in the atmosphere and active coupling to a Mediterranean ocean circulation model.
(iii) Perform a limited set of scenarios with regional coupled models (Mediterranean simulators), using boundary conditions from existing and new global scenarios.
(iv) Investigate and understand the changes in climate variability over the Mediterranean region and their relationship with remote forcing and teleconnection patterns.

Description: The main scientific objectives of RL2 are (1) to provide climate evolution scenarios for the 21st century over the Mediterranean region for use in impact studies, and (2) to understand the underlying processes and their links to global climate, through an analysis of existing and new model simulations. The new models will be assembled with parameterization appropriate, and tested, for the region, such as air-sea coupling and boundary layer climatology. This RL will contribute to the climate scenarios that will be used throughout the project.

The issue of uncertainties of future climate projection is a main concern and will be treated by a carefully-combined multi-model approach. We use both regional and global models and statistical downscaling to bring the information of climate change to the necessary spatio-temporal scale of impact studies. Three global ocean-atmosphere coupled climate models will be coupled to a high-resolution Mediterranean model, to produce a set of present and future climate simulations. This will provide, for the first time, the possibility to accurately assess the role and feedbacks of the Mediterranean Sea in the global climate system through both the atmosphere and the Gibraltar Strait (Artale et al., 2002; Calmanti et al., 2006).

Three regional models of the Mediterranean region, comprehensive of atmospheric, oceanic and land-vegetation components, will be assembled in order to make the linkage between the global climate change and impact studies. The dynamical downscaling will allow us to have a spatial resolution around 20 km. Statistical downscaling methodology will be also developed to further increase the spatio-temporal resolution of climate information. Climate of the Mediterranean area is strongly connected to other major climate patterns and events of the world (Rowell 2003; Raicich et al. 2003). We are thus planning to investigate teleconnection patterns between the Mediterranean region and remote areas, and to explore how these links might be affected by the climate change. We will thus provide a comprehensive assessment of the Mediterranean climate teleconnection for both current climate and future climate. There is a strong interaction with other RLs of CIRCE through the identification and analysis of teleconnection patterns, and through the realisation of well-targeted and mechanism-oriented simulations.

WP2.1: Global climate evolution scenarios including a detailed representation of the Mediterranean Sea

Responsible: Silvio Gualdi (INGV)

Total project description: In WP 2.1, three high-resolution global ocean-atmosphere models will be coupled with models of the Mediterranean Sea able to reproduce the main features of the ocean dynamics in this basin (Demirov and Pinardi, 2002), and the interactions with the global ocean (Sannino et al., 2002 and 2004). This multi-model system will be used to produce a set of climate

simulations, both present climate and future scenarios, which will provide, for the first time, the possibility to accurately assess the role and the feedbacks of the Mediterranean Sea in the global climate system, and how these feedbacks might be affected by the global climate change. Furthermore, the simulations will be downscaled both dynamically, with regional models and with statistical techniques (by ARPA) in WP2.2 to provide a unique climate data sets for the impact studies that will be performed in others RLs.

Comparative diagnostics with scenario simulations already available (such as those produced for the IPCC or in the ENSEMBLES project) will be carried out to show the contribution of a nested Mediterranean model in terms of both global and regional climates. We will then obtain a more quantified understanding for the role of the Mediterranean Sea in affecting the climate of nearby and remote regions. The diagnostic analyses will be carried out by the groups that have performed the simulations (INGV,CNRM and DMI), in collaboration with ENEA (Paolo Ruti) and ISAC-CNR (Susanna Corti), and exploiting possible synergies with the activities performed in WP2.3.

This WP will be accomplished during the first 30 months of the project.

WP2.2: Climate evolution scenarios from regional models for the Mediterranean area
Responsible: Artale Vincenzo (ENEA)

Total project description: Three models of the Mediterranean region comprehensive of the atmospheric, oceanic and land-surface (Pal et al. 2000) components will be assembled in order to make the linkage between the global climate change and impact studies. The dynamical downscaling will allow us to have a spatial resolution around 20 km. Statistical downscaling methodology will be also developed to further increase the spatio-temporal resolution of climate information. This WP will take place during the first 24 months, with model assembling and validation during the first 18 months. The next 6 months will be assigned for scenario simulations and production of statistic downscaled datasets.

WP2.3: Impacts of global climate change on the Mediterranean climate
Responsible: Li Laurent (CNRS/IPSL)

Total project description: Climate of the Mediterranean area is strongly correlated to other major climate patterns and events of the world. This WP is devoted to the understanding of teleconnection between the Mediterranean region and remote areas, and of the possible changes that these links might undergo as a consequence of the climate change (Giorgi et al. 2004 and Giorgi et al. 2006). We will thus provide a comprehensive assessment of the Mediterranean climate teleconnection for both current climate and future climate. The first part of this WP is the identification and analysis of such teleconnection patterns. And the second part will be to perform specially-targeted experiments by using the global and regional models assembled here in RL2 to investigate mechanisms controlling the scale interaction between the global climate and the regional climate of the Mediterranean. This WP is also in strong interaction with other RLs of the CIRCE by providing the basic simulating infrastructure (global and regional models) to test any physical mechanisms.

WP2.4: Coordination on production of scenarios and distribution of datasets
Responsible: Li Laurent (CNRS/IPSL)

Total project description: RL2 plays a key role in CIRCE, as this is the Research Line where the principal model simulations used throughout the project are produced. Specifically, RL2 will collaborate with RL1 for the assessment of the scenario simulations; will interact with RL3, RL4 RL5 and RL6, providing data and boundary conditions for the analysis of scale-interactions and feedback processes, and the assessment of the impact of climate change on the occurrence of extreme events in the Mediterranean region; will cooperate with RL7 and RL8 providing data for the analysis of the impacts on the ecosystems and air quality; will provide climate indexes and downscaled data for the impact studies performed in RL9, RL10 and for the case studies performed in RL11

Therefore, it is clear that a fruitful interaction and integration of the activities performed within RL2 with the activities performed in all the others RLs is of crucial importance for the success of the project.

The RL2 coordinators and the WP leaders will provide management and coordination of the activities within RL2 and will stimulate the interaction and the integration with the activities carried out in the other CIRCE RLs, through a series of joint-workshop.

References:

Artale V., S. Calmanti and A. Sutera, 2000: North Atlantic THC sensitivity to Mediterranean waters, Tellus, Series A, Vol.54, Issue 2, 159-174.
Calmanti S., Artale V and A. Sutera, 2006: Meridional overturning circulation variability in the presence of subsurface heat/salt anomalies; TELLUS A in press.
Sannino, G.M., A. Bargagli, and V. Artale; 2004: Numerical modeling of the semidiurnal tidal exchange through the Strait of Gibraltar, J. Geophys. Res.,Vol.109,No.C5,C05011, 10.1029/2003JC002057.
Sannino, G.M., A. Bargagli, and V. Artale; 2002: Numerical modeling of the mean exchange through the Strait of Gibraltar, J. Geophy. Res C, Vol. 107, no. C8, 10.1029/2001JC000929.
Demirov E. and N. Pinardi; 2002: Simulation of the Mediterranean Sea circulation from 1979 to 1993: Part I. The interannual variability. J. Mar. Sys., 33, 23-50
Gao, X., J.S. Pal and F. Giorgi, 2006: Projected changes in mean and extreme precipitation over the Mediterranean region from high resolution double nested RCM simulations. Geophysical Research Letters, 33, L03706, doi:10.1029/2005GL024954.
Giorgi, F., X. Bi and J.S. Pal, 2004: Mean, interannual variability and trends in a regional climate change experiment over Europe. Part II: Future climate scenarios (2071-2100). Climate Dynamics, 23, 839-858. Pal, J.S., E.E. Small and E.A.B. Eltahir, 2000: Simulation of regional - scale water and energy budgets: Representation of subgrid cloud and precipitation processes within RegCM. J. Geophys. Res., 105, 29579-29594
Raicich F., N Pinardi, and A. Navarra; 2003: Teleconnection between Indian Monsoon and Sahel rainfall and the Mediterranean, J. of Intern. Climatology, 23, 73-186.
Rowell, D. P., 2003: The impact of Mediterranean SSTs on the Sahelian rainfall Season. J of Clim., 16, 849-862.

RL3 - Radiation, clouds, aerosols and climate change

Le Treut Herve (CNRS/IPSL), Lelieveld Jos (MPICH)

Objectives:

i) To establish a climatology (means and variations) of the surface radiation energy budget for the Mediterranean area, for both present-day and future climate conditions.
ii) To investigate the variables that control the surface radiation energy budget, in particular clouds and aerosols.
iii) To investigate the feedbacks between radiation changes and climate.

Description: Surface radiation is an important resource which directly affects many sectors of activity (agriculture, tourism, production of energy). Changes in radiation therefore constitute one of the main direct impacts associated with climate change. Radiation changes furthermore act on the climate system itself and constitute a local feedback, which represents a key link between the atmosphere, land surface and ocean/sea (Stocker et al., 2001). Remote radiation forcing also acts on the Mediterranean region through teleconnections. The available radiation energy is strongly modulated by clouds. Investigating radiation changes requires the study of a dedicated set of available data (satellite and in situ), and specific model evaluation, both at global and regional scales.

The radiative environment measured and perceived at the surface is also an important facet of the local or regional climate that in turn conditions the evolution of living habits, infrastructures and economies. As it is directly associated with clouds and cloud structures, it is also strongly interlinked with the atmospheric hydrological cycle, and the regional patterns of precipitation. Furthermore, human-induced aerosol radiative forcing can be significant at the regional scale (e.g. sulfate and black carbon), with potential feedbacks to the global climate (Le Treut et al., 1998).

In the context of climate change there is a broad interest to investigate if the radiative environment may be subject to changes, either through continuous trends or through more complex variation patterns. These evolutions themselves depend on the potential changes in clouds, aerosols and radiatively active gases including H_2O, CO_2 and O_3 and their contribution to the radiative environment. Potential changes may occur in terms of the amount of absorption and scattering of solar radiation in the atmosphere or at the surface. For example, aerosols that scatter and absorb solar radiation heat the lower atmosphere and cool the surface, and thus reduce evaporation and moisture transports from the sea to the surroundings (Lelieveld et al., 2002). Changes in UV-B fluxes are of interest in view of health impacts.

A specific complexity in these studies is associated with the atmospheric circulation over the Mediterranean area, characterized by a complex combination of orographic effects and land-sea contrasts. Cloud structures are organized at a wide range of spatial scales and a large part of the water resources in the coastal regions is related to very specific meso-scale processes. Further, the Mediterranean region is close to the North African deserts, a dominant source of mineral dust aerosols.

This RL will analyse cloud structures over the complete range of observable time scales. It will infer their dependence to large-scale atmospheric conditions, and to potential climate changes. The interaction between cloudiness and aerosols will also be considered. The radiative properties of the atmosphere will be related to the distribution and characteristics of clouds, aerosol and gases. Radiative fluxes will be investigated for the thermal, visible and UV spectral ranges, accounting for

both natural (e.g. solar cycle) and anthropogenic influences.

Clouds and aerosols strongly influence the radiation that enters the Mediterranean Sea. The amplitude of this effect as a local feedback, which may modulate the large-scale cloud and climate feedbacks, is largely unknown and will be assessed. Cloud regimes also determine precipitation patterns, and the link between radiation and hydrological cycle will be addressed.

The work is subdivided into three main work packages using existing observations (3.1), the reconstruction of recent and present conditions (3.2) and impacts of future climate change (3.3).

References

Stocker, T.F. Clarke, G.K.C., H. Le Treut et al., Physical climate processes and feedbacks. In: Climate Change 2001, the scientific basis. Eds. J.T. Houghton et al. Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, 2001.

Lelieveld, J. et al., Global air pollution crossroads over the Mediterranean. Science, 298, 794-799, 2002.

Le Treut, H., M. Forichon, O. Boucher, and Z.-X. Li, Sulfate aerosol, indirect effect and CO_2 greenhouse forcing: Equilibrium response of LMD GCM and associated cloud feedbacks. J. Climate, 11, 1673-1684.

WP3.1: Surface radiation from existing observations
Responsible: Le Treut Herve (CNRS/IPSL)

Total project description: The objective is to bring together existing observational data to produce a reliable climatology of surface radiation, aerosols and clouds, and to study their variability modes for the Mediterranean region. Several data sets are available: Clouds: (International Satellite Cloud Climatology Project; AQUA-train -Parasol - ; Meteosat second generation; in situ); Aerosols (Aeronet, MODIS, MISR, SeaWiFS), Radiation (GEBA, BSRN, ERBE, CERES). These data sets are quite specific, there are not fully considered within current reanalysis and their assessment at a regional scale is at best limited. Four tasks are planned.

Task 1: Cloud data set (Le Treut, CNRS/IPSL)

Objective: Establish a high quality cloud data set

The CIRCE project planning coincides with a large number of new satellite instruments: MSG, Aqua-train instruments (CLOUDSAT, CALIPSO, PARASOL), which will provide new opportunities to investigate the roles of clouds and aerosols. Studies at the scale of the Mediterranean Sea are necessary, but some case studies concerning more specific cloud regimes are needed to diagnose the structure of meso-scale cloud systems, cloud microphysics and the relation between clouds and aerosols (see also RL8). There exists a long record of consistent cloud observations (ISCCP) and weather reanalysis (NCEP, ERA40), which can serve as a basis to study the statistical relation between cloud systems and large-scale climate conditions. These studies may be extended to radiative components.

Task 2: Aerosol data set (Kanakidou, UOC)

Objective: Establish a high quality aerosol data set

Global aerosol maps have become available recently from satellite instruments (e.g. MODIS, MISR, SeaWiFS). Aerosol parameters will be analyzed for the Mediterranean region, compared to

local measurements (e.g. Aeronet), and made available for data assimilation planned in WP3.2.

Task 3: Water vapor and ozone data sets (Lelieveld, MPICH)

Objective: Establish high quality water vapor and ozone data sets

Water vapor and ozone profiles as well as column amounts will be derived from radiosonde measurements and satellite observations, and data gaps may be filled with ERA40 reanalyses and other data sources.

Task 4: Radiation data set (Lelieveld, MPICH)

Objective: Establish high quality surface radiation data sets

The GEBA database contains data of several sites in the Mediterranean region to quantify local surface fluxes. High quality BSRN radiative fluxes are available at a few stations in the region. A few sites provide separate measurements of diffuse and direct SW fluxes. Top of the atmosphere fluxes are available from a number of satellite sensors (e.g. ERBE). This activity will provide Mediterranean surface radiation fields.

WP3.2: Model reconstruction of recent and present conditions
Responsible: Kanakidou Maria (UOC)

Total project description: This WP is dedicated to a careful analysis of radiation fields in present climate conditions using model simulations. The objective is to reconstruct the recent and present variations of the surface radiation from large-scale and regional-scale climate modeling and measurement data.

The results of several global or regional model simulations will be available within the context of CIRCE. The IPCC AR4 simulations are available already now, ENSEMBLES simulations will become available during the project, and CIRCE experiments will also be carried out. We will assess the quality of these simulations in comparison with observed data. Meso-scale models will be used to analyze in more details the structure of clouds and aerosols over the Mediterranean area. These models will include aerosol transport and chemistry, and will be tested against observations.

Validation of models at different scales may follow two approaches: direct comparisons associated with the studies mentioned in the preceding WP, and statistical comparisons over long periods of time. The latter approach includes the evaluation of climate simulations at global and regional scales.

Task 1: Clouds (Le Treut, CNRS/IPSL)

Objective : Reconstruct cloud fields and assess cloud effects on radiation.

The results of recent climate modeling studies, with a focus on cloud properties, will be analysed using the data sets compiled within WP3.1. This will provide important indications of the quality of general circulation models in representing the recent and present climate conditions. A meso-scale model will be applied in downscaling studies of the effects of clouds on the Mediterranean radiation budget.

Task 2: Aerosols (Kanakidou, UOC; Lelieveld, MPICH)

Objective: Reconstruct aerosol fields and assess aerosol feedbacks on solar radiation.

The aerosol data sets compiled within WP3.1 will be assimilated in a global/regional zoom chemistry-transport model and in a global high resolution chemistry-general circulation model. The assimilation will distinguish between fine mode aerosols (mostly anthropogenic) and coarse mode aerosols (mostly natural). As the comparison between model results and measurement data will provide indications of the model performance, the data assimilation will actually help quantify model errors. The data assimilation will also be used to reconstruct recent aerosol distributions for use in Mediterranean radiation and climate studies. The model simulations will include direct and indirect (through clouds) effects of aerosols on the surface radiation budget.

Task 3: Surface UV radiation (Manzini, INGV; Giorgetta, MPIM)

Objective: Evaluate surface UV radiation fields and assess trends.

The surface UV radiation fields for the past decades from the available simulations with general circulation models including variations in clouds, aerosols and ozone changes will be evaluated. Seasonal UV trends will be analysed with a focus on the Mediterranean region.

WP3.3: Impacts of future climate change on the surface radiation
Responsible: Lelieveld Jos (MPICH)

Total project description: This WP is dedicated to the study of regional impacts of radiation changes in warmer climate conditions and changed emissions of aerosols and precursor gases. The objective is to assess the changes of radiation levels and resources in possible future climate states, and study the associated feedbacks with clouds and aerosols

The impact assessment will involve: (i) Changes in radiation resources resulting from changes in aerosol and cloud distributions; (ii) Local radiative feedbacks. The latter includes to what extend the climate of the Mediterranean area reacts passively to radiation changes, or whether these radiation changes may further increase the modifications of the local climate. (iii) Links with other RLs to determine the importance of radiative changes on other components of the climate system.

Task 1: Emission scenarios (Raes, EC-DG-JRC)

Objective: Develop emission scenarios of aerosols and precursor gases.

The following set of emission scenarios for the years 2010, 2025 and 2050 will be developed for anthropogenic aerosols and precursor gases:

i) Business as usual scenario based on current developments in the world with no particular emphasis on the Mediterranean region

ii) Maximum feasible reduction scenario applied only to the Mediterranean countries to determine how the region itself can influence the radiation conditions (“own responsibility scenario”)

iii) Maximum feasible reduction scenario applied to those countries/regions in the world for which model studies have shown a relatively large impact on the Mediterranean region (“friendly neighbour scenario”)

The emission scenarios, including species such as SO_2, NO_x, NH_3, OC, BC, will be made available through the EDGAR database on a 0.5°x0.5° global grid.

Task 2: Clouds and dynamical regimes (Le Treut, CNRS/IPSL)

Objective: Analyse model predicted cloud fields from climate scenario simulations.

Within RL2 (WP 2.1 and WP 2.2) climate evolution scenarios will be performed to assess the potential future impacts on the Mediterranean region. The model simulations, carried out at relatively high spatial resolution, will provide new and detailed information on cloud distributions in a warmer climate. In this WP the simulated cloud fields will be analysed in detail, firstly to assess the consistency with other models and satellite data, and secondly to asses the impact of changing cloudiness on surface radiation. The analysis will particularly emphasize the links of Mediterranean cloudiness with dynamical regimes as controlled by weather regimes over the Atlantic Ocean and other possible teleconnections, e.g. with the South Asian monsoon.

Task 3: Evaluation of emission scenarios (Lelieveld, MPICH)

Objective: Apply emission scenarios to develop optimal control strategies to limit the radiative impact of aerosols.

The emission scenarios developed within task 1 of this WP will be applied in time slice simulations with a chemistry-general circulation model for the years 2000, 2010, 2025 and 2050. The climate change scenarios will be consistent with RL2, by assimilating predicted SSTs and meteorological fields into the model. The emission scenarios will be adopted from T3.3.1, in combination with the IPCC AR4 scenarios. By varying the emissions for a selection of countries and source categories for particular years, it will be investigated how the impact of aerosols on radiation can be minimized most efficiently. The aerosol impact assessment will include the effects of scattering and absorption of solar radiation on lower atmospheric heating, surface cooling, evaporation, clouds and precipitation. We will investigate the feedbacks between climate change caused by global greenhouse gas and regional aerosol forcings, accounting for both natural and anthropogenic emission sources.

Task 4: Evaluation of surface UV changes (Giorgetta, MPIM; Manzini, INGV)

Objectives: Assess the impact of future climate change and ozone changes on surface UV radiation.

Assessment of the impact of future climate change on the radiative surface fluxes, using available simulations that include changes in clouds, aerosols and ozone. Use the diagnostic strategy validated in WP3.2. The focus is on the Mediterranean region.

WP3.4: Coordination of RL 3
Responsible: Le Treut Herve (CNRS/IPSL)

Total project description: The RL3 coordinators and the WP leaders will provide management and coordination of the activities within RL3, and stimulate cooperations with other RLs, in particular RL2 and RL8. Integration across the RL will be achieved through a series of workshops, partly jointly with other RLs.

RL4 - Scale Interactions and Feedback processes

Millan Millan (CEAM), Zerefos Christos (NKUA)

Objectives: The objective of this RL is:

a) To determine how the Mediterranean System works, including its response to internal perturbations,
b) To establish how the perturbations propagate through the global system and back, i.e., how the Mediterranean system responds to external inputs.

Description: This RL4 is focused on the investigation of the meteorological processes, scale interactions and feedbacks mechanisms linked to climate change in the Mediterranean basin.

The determination of the main circulation modes of the atmospheric pathways, and its seasonal variability in the Mediterranean basin, is a relevant issue to integrate feedbacks driving climate change in terms of precipitation regimes, secondary pollutants production, ventilation conditions, etc.

This characterisation of the atmospheric flow regimes, its seasonality and statistical significance allows the assessment of the representativity of selected case studies to evaluate the impact of air quality on climate, as it will be done in RL8, and, besides, feedbacks between the different components involved in the climate change within the Mediterranean environment (water vapor budget, import-export pollutant pathways in the Mediterranean, land-use change), topics that are developed in this RL4. Both approaches will be closely connected through bilateral exchanges between the involved groups.

The figure esquema.gif (in files) shows the conceptual framework proposed for this Research Line. Some components and their links summarise experimental and modelling results obtained from EC Research Projects since 1975, and have been validated experimentally. Others should be considered at the working hypothesis level. The ultimate objective of this RL is to validate the proposed hypothetical framework including components and feedback links.

From approximately late April to early October the WMB coastal seabreezes, their return flows aloft and their compensatory subsidences over the sea, become self-organized in vertical recirculations that extend to the whole basin for periods of 3 to 10 days (Gangoiti et al, 2001). Thus, in contrast with regions dominated by advection, pollutants and water vapor accumulate over the sea in layers piled up to » 5000 m (Millán et al, 1997). And, without requiring the high evaporation rates of more tropical latitudes, this mechanism can generate a very large, polluted, moist, and potentially unstable airmass after a few days. This is the Mediterranean "Holding Tank Mode" (Millán et al, 2004).

Finally, this airmass can be uplifted by a transitory depression, or a trough of cold air aloft, allowing the cycle to start anew. The uplifted airmass can then feed onto a Vb depression track and contribute to intense summer precipitations in Central Europe (Ulbrich et al, 2003). Alternatively, it can be adverted along the Southern Atlas corridor and/or towards Central Africa, mixing with and modifying the physic-chemical characteristics of the Saharan dust transported across the Central Atlantic towards the Caribbean (Prospero et al, 2003 and Gangoiti et al, 2005).

The conditions that make this possible are: (a) a deep sea totally surrounded by high mountains in the sub-tropical latitudes, (b) anticyclonic conditions prevailing for approximately seven months of the year (April to October), and (c) current surface properties around the WMB. In this set-up, the seabreezes develop and grow in a stepwise fashion (Salvador et al, 1997) by successively

incorporating upslope wind cells into a circulation stronger than the sum of its components (Mahrer et al, 1977 and Miao et al, 2003). Additionally, deep convective-orographic injections develop at the breeze's leading edge with strong compensatory subsidence that limits the depth of the breeze along the rest of its path.

As the marine airmass moves inland, its water vapor content increases through evaporation and evapo-transpiration from the surface. If it accumulates enough moisture to reach its cloud condensation level (CCL), storms can develop at its leading edge. If, on the contrary, it does not accumulate enough moisture to compensate for the surface heating along its path, the CCL of the airmass will rise above the mountain ridges, and storms will either not develop or not reach maturity.

In the latter case, the convective-orographic injections at the breeze's leading edge keep the surface winds connected directly to their return flows aloft and these, under the effect of compensatory subsidence, sink and form layers over the sea (Millán et al, 1997). The breeze of the next day brings the lower layers inland while the injections at its leading edge replace the upper layers, to complete a vertical recirculatory loop. In this circulatory system, the CCL of the local breeze with respect to the height of the mountain ridges becomes a critical threshold which, if exceeded, tends to keep the circulations closed and the layers accumulating over the sea.

Thus, through their effects on the CCL, land-use changes appear as the main driving factor determining whether the local atmospheric circulations are open, i.e., with evening storms inland, or closed, i.e, with no precipitation and vertical recirculations over the coastal areas and the sea. While in this mode the WMB acts as a holding tank where the airmasses increase their residence times and acquire memory of previous interactions with the surface (potential temperature and moisture gains). Finally, the loss of summer storms inland results in: drier soil, increased surface heating, higher CCL and, thus, reinforcement of the first feedback loop towards desertification (Millán et al, 2005a,b).

This situation now prevails along the Mediterranean coasts of Northern Africa, the Iberian peninsula, southern France and southern Italy, from late spring to early autumn, under current land-use conditions that could, in turn, be the result of feedbacks accumulated during the last 2000 years (Bolle, 2003). Another recent factor is the increase in atmospheric emissions, adding aerosols, ozone (Bastrup-Birk et al, 1997, and Lelieveld et al, 2002) and other photo-oxidants to the returned water vapor, all with strong greenhouse properties.

The second feedback loop originates in the greenhouse effect of the components stacked over the sea, if they increase the cumulative heating of the sea during summer. Higher Sea Surface Temperatures (SSTs) increase torrential precipitations over the coastal areas in autumn-winter (Pastor et al, 2001). And because warm water pools move and evolve within the basin, they can feed torrential rains and flash floods anywhere in basin. Thus, this loop would tend to propagate the effects of land-use perturbations in one part of the basin to other parts of the basin with a three-to-six-month delay. An additional question is the possible increase in other extreme events (e.g., tornadoes) at the local-to-regional scale, associated with both the higher SST and the increased moisture content of the accumulated airmass, both of which increase the potential instability.

The third feedback loop originates when the (non-precipitated) moisture accumulated over the sea leaves the region. This alters the evaporation-precipitation equilibrium over the WMB and would tend to increase the saline content of the deep water flowing through Gibraltar to the Atlantic. How this saltier outflow could affect processes at the North Atlantic level, at what time scale it operates and what, if any, critical thresholds could be exceeded are additional questions.

Finally, how the pollutants in this airmass add to the sulfatation and nitrification of crystal aerosols over Africa; how, and if, they affect climatic processes over the Caribbean and the US; and how

they link the North Atlantic Oscillation to the dominating conditions over Europe, are questions related to the fourth feedback loop.

The Lagrangian approach used in the numerical methodology of this RL4 contrasts with the Eulerian approach followed in RL8. Use of both methodologies in the Mediterranean basin in this project gives a complementary approach to the simulation of the atmospheric transport on the Mediterranean basin.

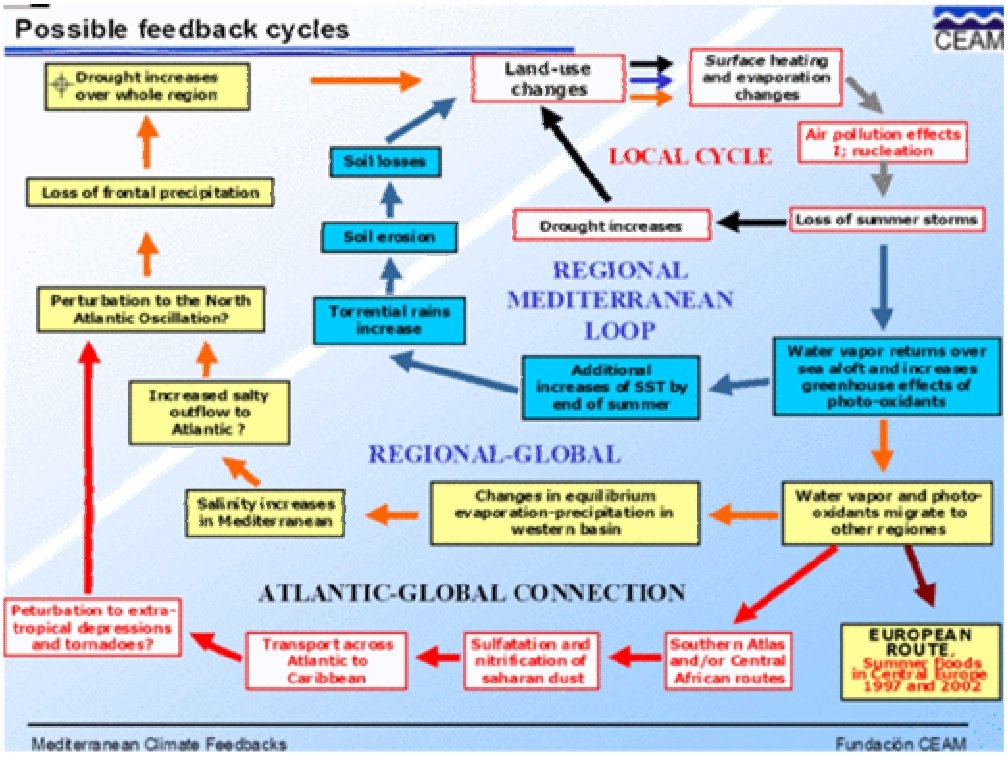
To answer these questions we have considered the following Working Packages:

WP 1. Atmospheric flow regimes in the Mediterranean Basin. Airmass pathways, inputs and outputs at all levels to establish continuity in relation to meteorological conditions and season. Determination of recirculation-accumulation modes (Holding Tank mode) vs. advection-transport modes, their characteristics and evolution.

WP 2. Rain regimes and precipitation components across the basin. Determination of meteorological disaggregation criteria for the available data (diurnal precipitation) series collected both in RL4 and RL1. Study of the typified series and correlation with major indices (NAO, ENSO) and with SST.

WP 3. Land-Atmosphere-Oceanic interactions/Integrated regional studies. In relation to precipitation and extreme events, with links to WP in other RL (i.e., extreme events studied on RL6), oceanic processes, land use, forest fires and desertification. Focused, integrated regional studies, including: the hydrological cycle, land use evolution and response, carbon cycle and air pollution effects on vegetation, assessment of possible feedbacks and modelling of their interactions for selected airsheds-watersheds within the basin.

WP 4. Feedbacks within the Global Cycle. System integration of results from previous WP and other RLs (RL2, RL6 and RL8), How do perturbations propagate to, within, and out of the Mediterranean Climatic System?



References

Bastrup-Birk, J. Brandt, Z. Zlatev, I. Uría, (1997). Studying cumulative ozone exposures in Europe during a 7-ycar period. J. Geophys. Res., 102, D20, 23,917- 23,935.

H.-J. Bolle, (Ed.) Mediterranean Climate. (2003). Springer-Verlag, Berlin, New York, 372 pp.

G. Gangoiti, L. Alonso, M. Navazo, J. A. García, M. M. Millán, (2005). North African soil dust and European pollution transport to America during the warm season: hidden links shown by a passive tracer simulation. J. Geophys. Res., In press.

G. Gangoiti, M. M. Millán, R. Salvador, E. Mantilla (2001). Long-range transport and re-circulation of pollutants in the western Mediterranean during the RECAPMA Project Atmos. Environ., 35, 6267-6276.

J. Lelieveld, H. Berresheim, S. Borrmann, P. J. Crutzen, & others, (2002). Global Air Pollution crossroads over the Mediterranean. Science, 298, 794-799.

Y. Mahrer, R. A. Pielke, (1977). The effects of topography on the sea and land breezes in a two-dimensional numerical model. Mon. Weather Rev. 105, 1151-1162.

J.-F. Miao, L.J.M. Kroon, J. Vilá-Guerau de Arellano, A. A. Holtslag, (2003). Impacts of topography and land degradation on the sea breeze over eastern Spain. Meteorol. Atmos. Phys. 84, 157-170 (2003).

M. Millán, M Estrela, J. Miró. Rainfall Components: Variability and Spatial Distribution in a Mediterranean Area(Valencia Region). Journal of Climate, 2682-2705, Volume 18, 2005a.

M. Millán, M. Estrela, M. Sanz, E. Mantilla, M. Martín, F. Pastor, R. Salvador, R. Vallejo, L. Alonso, G. Gangoiti, J. Ilardia, M. Navazo, A. Albizuri, B. Artíñano, P. Ciccioli, G. Kallos, R. Carvalho, D. Andrés, A. Hoff, J. Werhahn, G. Seufert, B. Versino: Climatic Feedbacks and Desertification: The Mediterranean Model. Journal of Climate, 684-701, Volume 18, 2005b.

M. M. Millán, R. Salvador, E. Mantilla, G. J. Kallos (1997). Photooxidant Dynamics in the Mediterranean Basin in Summer: results from European Research Projects J. Geophys. Res., 102, D7, 8811-8823 (1997).

Pastor, F, Estrela, MJ, Peñarrocha, D, Millán, M.:Torrential Rains on the Spanish Mediterranean Coast: Modeling the Effects of the Sea Surface Temperature. J. Appl. Meteor., 40, 1180-1195, 2001.

J. M. Prospero, P.J. Lamb (2003). African Droughts and Dust transport to the Caribbean: Climate Change Implications. Science, 302, 1024-1027.

R. Salvador, M. M. Millán, Mantilla, E., J. M. Baldasano (1997). Mesoscale Modelling of atmospheric processes over the western Mediterranean area during summer Int. J. Environment and Pollution. 8, 513-529.

U. Ulbrich, T. A. Brücher, A. H. Fink, G. C. Leckebusch, A. Krüger, G. Pinto (2003). The central European floods of August 2002: Part 1 –Rainfall periods and flood development-. Weather, 58, 371-377.

WP4.1: Atmospheric flow regimes in the Mediterranean Basin
Responsible: Millan Millan (CEAM)

Total project description: The outcomes of this workpackage will provide the seasonal variability of the atmospheric flow regimes in the Mediterranean basin and their continuity through the global system in relation to meteorological conditions and season. It covers the compilation, processing, quality control and interpretation of selected available data inside the basin and relevant fringe/border areas (e.g., Alps, Northern Sahara). Measurements of air pollutants-air quality cycles in existing monitoring networks will also be used as tracers of opportunity of the atmospheric pathways, in a complementary way, e.g., to determine the main residence times and venting cycles and statistical significance.

The recirculation-accumulation modes versus advection-transport modes, their characteristics and evolution will be determined by means of the combined use of measurements and mesoscale model simulations at different spatial scales. Proper configuration of current meteorological and Lagrangian Transport models will be established considering their capabilities and limitations in the simulation of the relevant observed phenomena. Two different modelling approaches will be considered focusing on case studies (high spatial resolution) and longer time periods (lower spatial resolution). Differences between both approaches will be analysed comparing key parameters (as residence time, ventilation index, orographic injection, etc) under different meteorological conditions.

Inputs and outputs from the Mediterranean basin will be analysed in relation to meteorological conditions and season. Besides, outlet tracking and circulation modes within the basin will be contrasted with satellite data for different seasons. The analysis of trace gases and water vapour satellite data will enable the identification of sources and transport patterns over the area of interest, and can be useful for validating simulations and for the characterisation of circulation modes.

WP4.2: Rain regimes and precipitation components across the basin

Responsible: Estrela Maria (CEAM)

Total project description: Climate change and variability have a profound effect on water resources. In the Mediterranean Basin, groundwater is the most important water resource. Changes in precipitation patterns will be translated into groundwater resource changes over time. The study of a long term series of synoptically disaggregated precipitation data in the Spanish Mediterranean coast showed that variations in precipitation totals could be related to changes in synoptical event type, in frequency and in precipitation intensity by type of event and/or in any combination of these. Thus, we asked the following questions:

1. Could the increases in interannual variability or the trends in precipitation totals, or both, mask changes in the partitioning of the precipitation totals with respect to the meteorological situations producing them?
2. Could these changes also include important regional variations and seasonal differences between the specific tendencies in each region?

To answer this questions, a novel procedure was developed to sinoptically disaggregate daily precipitation data into three main components: frontal rains, summer storms and Mediterranean cyclogenesis, and working hypotheses were derived on the likely processes involved. We have used homogeneous long daily precipitation database on the Spanish Mediterranean coast and disaggregated the precipitation series in the Valencia region on the basis of their meteorological origin and then study the trends and changes and also their correlations with NAO (Millán et al, 2005a). The database for this work included daily precipitation records (0700–0700 UTC) from 1950 to 2000 for 497 stations in the Valencia region and neighboring areas. The results indicate that

the precipitation regime in this Mediterranean region is very sensitive to variations in surface airmass temperature and moisture (Millán et al, 2005b). The causes we have found for the mentioned variations in the air mass may have been induced from the interactions between the air mass and the land-sea system. Variations in SST or in land use (man induced) can have changed the characteristics of the Mediterranean air-mass. Such environmental changes in the last 30 years may have induced changes from an open, monsoon-type regime with frequent summer storms over the mountains inland, to one dominated by closed vertical recirculations where feedback mechanisms favour the loss of storms over the coastal mountains and additional heating of the sea surface temperature during summer. This, in turn, favours Mediterranean cyclogenesis and torrential rains in autumn-winter (Pastor et al, 2001). Because these intense rains and floods can occur anywhere in the basin, perturbations to the hydrological cycle in any part of the basin can propagate to the whole basin and adjacent regions. Furthermore, present levels of air pollutants can produce greenhouse heating, amplifying the perturbations and pushing the system over critical threshold levels. The questions raised are relevant for the new EU water policies in Southern Europe, and for other regions dominated by monsoon-type weather systems. Now, we want to extend the precipitation synoptical disaggregation procedure for the whole Mediterranean basin, Atlantic interphase (France, Spain) and areas available from North Africa and Near East. So, we need to compile daily precipitation data across that areas, at the highest spatial resolution possible, then quality checks will be performed and data will be homogenized. The time scale for the data base will be greater than 50 years. Our database will consist in those raw data disaggregated by typical synoptic situations that will be complemented in later tasks with databases from RL1 or other RLs.

To work in this field, three main issues have to be addressed:

1. Meteorological (synoptical) interpretation of precipitation data from a regional point of view
2. Assessment of thresholds/critical levels for each region, trigger mechanisms and possible flip-flop processes for the precipitation in the Mediterranean system
3. Implications for the hydrological cycle. Development of scenarios to support possible mitigation actions.
4. Evaluation of the importance of the hydrological balance over continental parts of Mediterranean Europe with meteorological, chemical and hydrological models.

References:

M. Millán, M Estrela, J. Miró. Rainfall Components: Variability and Spatial Distribution in a Mediterranean Area(Valencia Region). Journal of Climate, 2682-2705, Volume 18, 2005a.

M. Millán, M. Estrela, M. Sanz, E. Mantilla, M. Martín, F. Pastor, R. Salvador, R. Vallejo, L. Alonso, G. Gangoiti, J. Ilardia, M. Navazo, A. Albizuri, B. Artíñano, P. Ciccioli, G. Kallos, R. Carvalho, D. Andrés, A. Hoff, J. Werhahn, G. Seufert, B. Versino: Climatic Feedbacks and Desertification: The Mediterranean Model. Journal of Climate, 684-701, Volume 18, 2005b.

Pastor, F, Estrela, MJ, Peñarrocha, D, Millán, M.:Torrential Rains on the Spanish Mediterranean Coast: Modeling the Effects of the Sea Surface Temperature. *J. Appl. Meteor.*, 40, 1180-1195, 2001.

WP4.3: Land-Atmosphere-Oceanic interactions. Integrated regional studies
Responsible: Dolman Han (VUA)

Total project description: We will consider for our analysis airsheds/watersheds in: the Atlantic interphase, one Western Mediterranean (Castellón-Valencia), one Northern Africa (Morrocco or Tunisia), one Central Mediterranean (Italy), one island, three Eastern Mediterranean sites (Greece,

Israel, Egypt). We will select a number of instrumented experimental air sheds for full modelling of precipitation (frontal, storms, and torrential events). We will first produce a database of moisture products such as atmospheric moisture, precipitation and evaporation from ERA 40. A key issue is the stability of the atmospheric water balance that includes import-export and recirculations. We will attempt to include this in the analysis by performing selected mesoscale modelling experiments. We will produce estimates of fog capture when required based on advanced models of fog capture. We will perform data analysis and modelling experiment to determine the trigger mechanisms of rainfall for selected airsheds. We will use the observed moisture balances for validation of our modelling attempts and validation of feedback processes. We will determine changes in the balance between evaporation-precipitation in each basin, connections and delays between basins, variations in saline output to the Atlantic, and the relation to indices such as NAO. We will acquire the satellite measurement of the sea-surface temperature evolution, water vapour exchanges and water vapour recharge for torrential events in each basin. To understand the interaction we will model the atmosphere-ocean interactions for selected extreme events (e.g., torrential rains in autumn-winter), and determinate the trigger mechanisms as a function of moisture content of the airmass (self, orographic, upper level troughs). We will investigate continental scale feedbacks between Mediterranean processes and Central European flooding

· To quantify the magnitude of these feedbacks, we will build a coupled regional Earth System modelling framework, enabling the simulation of 1) vegetation, carbon cycle and surface hydrology, 2) regional mesoscale meteorology, and 3) regional transport and production of pollutants, and their interactions. The integrated climate will then be studied by multi-year simulations of the coupled models and specific event studies. The integration will also allow to determine the impact of ozone on vegetation productivity and carbon fluxes. The model will be based on regional atmospheric models such MM-5 and RAMS and advanced land surface schemes that include a carbon cycle and O_3 effects, such as ORCHIDEE and Sib-2. We will make use of the eddy correlation and earth observation data obtained in RL 5

WP4.4: Feedbacks within the Global Cycle
Responsible: Ruiz de Elvira Antonio (UAH)

Total project description: The work in this package is connected with the simultaneous work in the other packages of the research line 4. Therefore we may expect to have at our disposal a more or less complete set of data concerning meteorological circulation data (WP4.1), precipitation data, extreme events and some hydrology (Wp 4.2). We need data on land use and land use change, vegetation and vegetation change, pollution generation and distribution over Europe, the Mediterranean and across the Atlantic.

We must distinguish between the feedbacks in the climate system connected directly with the climate evolution inside the Mediterranean region and the feedbacks at longer spatial scales. Drought in the Mediterranean lands, dust and pollutant emissions, salinity of the sea and some other effects of climate change have a direct impact on the regional climate, but also they have a longer impact (and feedback) on the general circulation of the atmosphere, as for instance the generation of disturbances in the Caribbean that may affect the low pressure trajectories over the Atlantic, the possible displacement of the mean path of the Polar Jet and the intensity of the thermohaline circulation.

To quantify these causes and effects, these feedbacks, is possible but to include them into GCM's goes over the possibilities of small groups of researchers. Therefore we propose to study these feedbacks by systematizing data on data-bases, by using traditional and Bayesian statistical

techniques, scale interaction using spectral analysis and Bayesian statistical modelling.

So the questions we must ask are the following:

1) How are pollutants from Europe transferred to the Mediterranean Basin?
2) How do pollutants and dust in the Mediterranean basin travel across the Atlantic?
3) Do pollutants over the Mediterranean affect the radiation budget?
4) Can we model the water vapour budget changes over the land due to the changes in the vegetation cover and type?
5) Does the changing water vapour budget changes the precipitation regimes around the Mediterranean?
6) What changes in hydrology may we expect due to changes in precipitation and land use?
7) Does a change in hydrology causes a change in the surface salinity of the Mediterranean?
8) Does a change in hydrology can cause a change in the formation of deep water?
9) Does a more saline Mediterranean outflow have an influx on the Atlantic thermohaline circulation?
10) Does a more saline Mediterranean outflow have an impact on the NAO?

WP4.5: Coordination
Responsible: Millan Millan (CEAM)

Total project description:

Management activities:

- Website, for exchange and communication
- Representation of research line at project management meetings
- Organisation of meetings and workshops within RL4
- Management and financial reports for the Commission
- Coordination with RL8 and RL2
- Relation with RL0 (CIRCE coordinator)
- Exchanges and meetings with stakeholders

RL5: Water Cycle

Alpert Pinhas (TAU), Vurro Michele (IRSA-CNR)

Objectives: This Research Line aims at producing an assessment of the expected variations of the water cycle in the Mediterranean Environment due to global climate changes. This Research Line is focused on main components of atmospheric, inland and oceanic water cycle that are expected to be highly impacted by climate evolution. This RL is made by four WPs.

Description: This Research Line aims at providing an assessment of the past variations and future projections of the water cycle in the Mediterranean environment due to global climate change. It is focused on the main components of atmospheric and inland and oceanic water cycle that are expected to be highly impacted by climate evolution, and is composed of four WPs as follows:

Analysis of changes in Atmospheric water budget: This WP aims at the analysis of interannual variations in the atmospheric water budget and coupling to hydrological components. The objectives are to analyse the impact of global warming on existing tendencies in the components of the atmospheric moisture budget equation, in order to achieve a full closure of this equation over the Mediterranean region and the surrounding regions, including the deserts, and to evaluate the likelihood of changes in atmospheric moisture components in future climate change scenarios.

Variations in the precipitation component of the water cycle: This WP aims at the evaluation of inter-annual rainfall variability in relation to river flow regimes and water availability in the whole Mediterranean basin. Special attention will be given to potential variations in orographic precipitation. The WP will analyse the impact of large-scale circulation patterns (NAO, EAWR, SCAN, ENSO) to drive variability and trends of the river flow regimes over the western Mediterranean.

Variations in the terrestrial component of water cycle: This WP aims at the analysis of major control factors of terrestrial water balance and their variation under climate changes. Among them vegetation, soil-vegetation interaction and various synoptic climate situations are considered to interpret past trends and predict future dynamics characterizing floods and droughts under changing climate scenarios. The whole activity will be carried out following a twofold line of investigation having several items of mutual cooperation. The first line will be focused on process characterization of terrestrial water cycle ranging from water balance controls across different space-time scales, and dynamics of natural reservoirs such as groundwater and lakes in the Mediterranean. The second line of investigation will aim at the detection of water stress sensitive areas under future climate change scenarios and will be undertaken on the typical regional scale covering the entire Mediterranean basin. In this framework the improvements of process knowledge will help in refining the predictions of water availability at suitable space-time scales. In details, the main processes characterizing the terrestrial water cycle will be investigated by way of five main research tasks that will be well integrated to improve the capability of existent SVAT (Soil Vegetation Atmosphere Transfer) models through typically Mediterranean dry-land and flood processes, as well as groundwater and lake dynamics. All these five tasks will help solving the apparent complexity of Mediterranean hydrology where both climatic and landscape features result in a limited runoff signal as a measurable component of terrestrial water cycle. The second line of investigation will be instead undertaken at a broader spatial scale in order to provide a picture of the water stress sensitive areas in the entire Mediterranean basin. The aim of this activity is therefore to obtain a likely evolution of the water stress sensitive areas under future climate change scenarios provided by other WPs and will benefit from the activities related to the first line of this WP.

Changes in the Mediterranean Sea water cycle and implications for water mass characteristics.

Water cycle changes in the Mediterranean Sea at basin and sub-basin scale will be documented and the impacts of the variations in freshwater and heat fluxes on Mediterranean sea water mass will be assessed. Changes in river discharge into the sea and the associated nutrient load will also be considered. We will also describe the expected changes in climatology and variability of the Mediterranean water cycle, and associated impacts on river discharge and Mediterranean water mass characteristics.

WP5.1: Analysis of changes in Atmospheric water budget
Responsible: Alpert Pinhas (TAU)

Total project description: This WP aims at the analysis of inter-annual variations in the atmospheric water budget and coupling to hydrological components. The work will be organised around two inter-linked tasks:

Task 5.1.1 Analysis of changes in the Atmospheric Moisture Budget in regional climate modelling (RCM) for the recent climate and for different future scenarios including the surface evaporation, precipitation and total moisture in the atmosphere (Pinhas Alpert, TAU)

Task 5.1.2 Large-scale interactions between atmospheric moisture and water availability - coupling of atmospheric and hydrological RCMs (D Hemming, Hadley UK)

Potential changes in surface evaporation, precipitation and total moisture in the atmosphere due to climate change are among the highest priorities in Earth science. The main concern is that a warmer climate, directly leading to increased evaporation, may well accelerate the hydrological cycle. This, in turn, could result in increase in the amount of moisture circulating in the atmosphere. Therefore, task 1.1 will focus on a critical evaluation of existing tendencies in the atmosphere moisture budget equation and its primary components, in order to achieve a full closure of this equation over the Mediterranean region. A special attention will be given to the assessment of vertically integrated cloud liquid water (CLW) over recent decades based on reanalysis data and satellite estimates of rainfall and water vapour. The CLW is a weak link in the atmospheric moisture budget.

Different future scenarios of the Mediterranean climate change modelling will be used in order to estimate the trends in the components of the atmospheric moisture budget equation, in particular in CLW.

We intend to evaluate in greater detail the phenomenon of a paradoxical winter net moisture sink over the Arabian-Iraqi desert based on the approaches developed by Shay-El et al. (JGR, 1999, 2000), Alpert and Shay-El (Ann. Geophys., 1993).

Task 5.1.2

Further to the activities outlined above, the second phase of this task will focus on future projections of WA utilising RCM output from runs forced by future socio-economic scenarios (from RLs 1 and 2). Projections of WA changes under the different scenarios will be quantified at two time horizons; 2020-40's and 2080s-2100. In order to determine future potential changes in WA, future projections of WA will be compared with current estimates examined during the first 18 months of the project. These WA changes will be assessed spatially, using GIS mapping techniques, and temporally, through monthly and inter-annual analyses of the data. Changes in the components of WA between the current and projected climates will also be quantified spatially and temporally. Uncertainties in future WA projections will be compared with those of current WA (assessed in the first 18 months).The influence of large-scale feedbacks between atmospheric and land surface components of the water cycle will be assessed with a coupled RCM which will have the latest land

surface and hydrological specifications. Various feedbacks between these systems, i.e. transpiration, soil evaporation, precipitation, will be quantified and compared between the current and future climate scenarios. The sensitivity of these feedbacks will be examined by forcing the RCM with changes in land surface characteristics, including vegetation and urban cover, and studying the responses. Reports of these changes and sensitivities will help inform stakeholders interested in water stress adaptation and mitigation policies. Suitable datasets of WA and its components, under current and future projected climates, will be provided for regional impacts assessments and case studies (links with RL5, RL6, RL10, RL11).

WP5.2: Variations in the precipitation component of the water cycle in the Mediterranean Region
Responsible: Krichak Simon (TAU)

Total project description: Weather processes of the Mediterranean region are in many ways forced by atmospheric developments over the other regions of the globe. In particular, intensity of regional mean monthly precipitation is affected by the space distribution and trends in such European teleconnection regimes as the NAO and EA/WR. The ENSO's role in controlling precipitation has also been demonstrated (Krichak and Alpert 2005a,b; Trigo 2004a,b). It must be noted however that intensity of individual precipitation events in the region is affected not only by space distribution of the acting in the area teleconnection regimes and weather patterns but also by such, on the average secondary, factors as orientation and intensity of the jet streams, formation of PV streamers, moist air mass convergence as well as natural and manmade variations in the cloud microphysics. These factors are sensitive to effects of topography. Role of jet streams in their interaction with topography of the Mediterranean region is important for several reasons. First, the jets influence the direction of synoptic scale features (also affected by topography). Second, jets contribute to formation of upper level divergence and convergence zones. Thirdly, they can influence moisture transport. Finally, the jets can influence stability and be responsible for the (usually affected by topography) gravity wave formation. It has been shown (Trigo et al. 2002) that Mediterranean cyclones developing over the three most active areas in winter - the Gulf of Genoa, the Aegean Sea, and the Black Sea are essentially sub-synoptic lows affected by local orography of the northern Mediterranean coast. Additional investigations are required for understanding effects of changes in wind direction and velocity (leading to those in the upslope component of wind) in formation of orographic precipitation in the region. Orography of the region also contributes to modifications in the distribution of aerosols, and, as a consequence, to those in formation of orographic clouds which are shallow and short living, so that aerosol induced changes in the rate of conversion of cloud droplets into precipitation affects the actual amount of rainfall that the clouds can produce over the hills. Recent findings (Givati and Rosenfeld, 2004, 2005) demonstrate that orographic precipitation is most vulnerable to changes in the atmospheric circulation and pollution aerosols. The mechanisms allowing to these factors to participate in determining trends of precipitation intensity over the region are not yet fully understood (and not fully taken into account in the contemporary climate modeling systems). This WP is devoted to the understanding the synoptic (physical) nature of the relations between the "secondary" factors, teleconnection regimes and the variations in the monthly mean precipitation over the region. Dependence of the relationships on the global warming effects will also be addressed. A comprehensive image of the dependence of the Mediterranean precipitation on the factors for both current and future climates will be provided.
Three main targets of the WP may be formulated as follows:
(1) identification and analysis of the factors influencing the western Mediterranean precipitation **(Task 5.2.1)**;
(2) identification and analysis of the factors influencing the eastern Mediterranean precipitation **(Task 5.2.2)**;
(3) evaluation of the role of the manmade microphysically induced factors in the natural changes in orographic precipitation and water resources (based on the data from the eastern Mediterranean region) **(Task 5.2.3)**.

In Tasks 5.2.1 and 5.2.2 we will analyse the orography effects in the precipitation over the region which may be dependent on the large-scale circulation patterns (NAO, EAWR, ENSO) over the western and eastern Mediterranean. In Task 5.2.3 the role of manmade factors in the precipitation will be analysed based on the detailed data from Israel. The role of microphysical contribution of aerosols will be explored.
This WP is also in strong interaction with other RLs of the CIRCE by using the data from global and regional climate modeling (links to RL1, RL2, RL4 and RL5).

References:

Givati A. and D. Rosenfeld, 2004: Quantifying precipitation suppression due to air Pollution. *Journal of Applied Meteorology* **43**, 1038-1056.
Givati A. and D. Rosenfeld. Separation between Cloud Seeding and Air Pollution Effects. (2006) In press, *Journal of Applied Meteorology*.
Krichak, S.O., P. Alpert (2005a) Decadal trends in the East Atlantic/West Russia pattern and the Mediterranean precipitation, Int. J. Climatol, 25: 183–192.
Krichak, S.O., P. Alpert (2005b) Signatures of the NAO in the atmospheric circulation during wet winter months over the Mediterranean region, Teor. Appl. Climatol. 82(1-2),27-39.
Trigo, I. F., G. R. Bigg, T. D. Davies (2001) Climatology of Cyclogenesis Mechanisms in the Mediterranean, Monthly Wea. Rev, 2002, 549-569
Trigo, R. M., Trigo, I. F., DaCamara, C., & Osborn, T. J. (2004). Climate impact of the European winter blocking episodes from the NCEP/NCAR reanalyses, Clim. Dyn., 23,17–28.
Trigo R.M., Pozo-Vazquez D., Osborn T.J, Castro-Diez Y., Gámis-Fortis S., Esteban-Parra M.J. (2004) "North Atlantic Oscillation influence on precipitation, river flow and water resources in the Iberian Peninsula". Int. J. of Climatology. 24, 925-944

WP5.3: Variations in the terrestrial component of water cycle
Responsible: Vurro Michele (IRSA-CNR)

Total project description: To simulate the impact of climate change on soil moisture and river run-off (Task 5.3.1) under Mediterranean climatic conditions a coupled surface energy and water balance model and a hydrological model will be suitably used. Hydrological predictions will have a suitable grid resolution for sub-regional investigation and such a model will be fed by a meteorological analysis system which uses meteorological models outputs combined with available observations This model coupling will be improved in the representation of evapotranspiration processes for the Mediterranean plants and soils. Other model improvements will be implemented also in the representation of groundwater and karsts, which are an important feature of the region. After these improvements, a reference simulation will be done over a 20 years period in a Mediterranean area. The activity for the coupled surface energy and water balance / hydrological model (Task 5.3.1) used for space-time dynamics of water runoff and soil moisture will be further developed to better assimilate spatial heterogeneities which are typical of the Mediterranean climate-soil-vegetation interactions. Dynamics of ground water storage and flow will be integrated and validated for the test site and the model will be used under the various climate scenarios available in the project. Then, the climate scenarios provided by other WP of CIRCE will be used to modify the meteorological input data. The modified soil liquid water content and simulated river flows will be compared to the reference run. It will also focus on soil wetness, especially in summer. It is foreseeable that consistent advances in the development of model components and parameterizations will result from the assimilation of space-time patterns of climate-soil-vegetation

interactions related to the peculiarities of the Mediterranean environments. In fact the role of climate-soil-vegetation interactions is expected to operate major controls in the dynamics of soil moisture variability (Task 5.3.2) across the Mediterranean. In particular the pattern interpretation of the climate-soil-vegetation-topographic catena will be used to detect similarities of the hydrological response to be adopted as a means to simplify the problem of spatial heterogeneity at larger scales (e.g. sub-grid heterogeneity) without affecting the model performances both as prediction and interpretation tool. It is planned therefore to test the hypothesis that the climate-soil-vegetation interaction can be adopted to interpret observed spatial patterns of vegetation and soils in the Mediterranean landscapes. It is argued that such functional interactions would have a good potential for the reduction of uncertainties in water balance predictions across scales, whatever the model tool adopted. The characterisation of conceptual models will be achieved following an increasing complexity procedure involving different phenomena with different space and time scales. Therefore the minimum model complexity will be evaluated according to the process/variable of interest and its suitable scale of parameterisation. In the first 18 months a simplified water balance model based on a bucket description of the water holding capacity of landscapes at the monthly timescale, will be adopted to evaluate the prediction accuracy in representative test catchments up to the regional scale. Model verification will be based both on traditional fitting to runoff statistics and distributed validation through eco-hydrological patterns. This modelling approach will be a test bed for effective parameterisation of landscape attributes aiming at the regional application of both simpler conceptual models and physically-based SVAT models. The role of time resolution of water balance calculation on the accuracy of prediction will be investigated (Task 5.3.2). The aim of this activity is to assess the suitable time resolution as a trade-off between prediction accuracy and computational burden (including climate records). Event, daily, monthly, annual and decadal scales, from a practical viewpoint involve different process descriptions and landscape parameterisations. It is therefore foreseen that for the particular climate-landscape features of the Mediterranean region specific space-time resolution will be recognised as suitable given some reasonable accuracy threshold in model predictions. Specifically the daily time resolution of water balance model will be adopted as a reference to compare simpler model structures based on coarser time resolution. Results of this activity will help both the development of the SVAT model and for the study of the water stress sensitive areas in the entire Mediterranean (in cooperation respectively with Task 5.1.2 and Task 5.3.6).

Another approach will be undertaken for the synoptic-hydrologic analysis of Mediterranean-dryland floods, as a regional control factor of climate change (Task 5.3.3). Such a descriptor of the surface runoff in the Mediterranean region is deemed fundamental for surface water resources and flood risk issues under the typical ephemeral or intermittent flow regimes. Floods will be statistically categorized to the synoptic oriented classes with due regard for seasons, spatial distribution, flood magnitude (peak and volume) and duration. This approach will be undertaken for the Negev, represented by a dry Mediterranean climate in the NW, and a semiarid to arid climate in its center, south and east, by pooling the vast digitised flood database of the Israel Hydrological Survey for this Eastern Mediterranean sub-region, together with the digitised database of daily synoptic systems over the Eastern Mediterranean (Alpert et al., 2004) covering a period of more than 50 years. It is therefore planned to develop a statistical season-regional model for flood events, including research into flood peak, volume, shape and duration, as well as relationships between flood peak and other flood characteristics. Here flood peak is a predictor which is commonly determined at gauging stations and can also be estimated at ungauged sites immediately after occurrence of a flood event based on identification and surveying of maximum flood levels; under certain conditions historical flood marks may also be used. The developed model will increase the potential of this methodology, thereby permitting not only estimation of flood peaks, but also determination of other flood characteristics, particularly flood volumes. One of the primary project results will be estimates of flood volumes based on peaks for any gauged or ungauged site in the study region, also suitable as a method for the wide-spread ungauged river basins. This stage (the

first 18 months) will also include data verification for the paired databases of floods and daily synoptic conditions; these will be used for the second part of the project. In this manner a unique opportunity will be realized to predict not only the Mediterranean-dryland flood characteristics, but also relationships between flood volume and peak based on synoptic conditions. The novel approach will enable the detection of the main features of flood events through the analysis of the synoptic weather conditions, thereby permitting prediction of future flood dynamics under changing climate scenarios. Thus, (i) Mediterranean to dry-land floods may serve as a control factor of climate change, beyond the spatial extent of the study region,, (ii) this research component into floods and meteorological conditions in a Mediterranean to arid environment are universally applicable; its results may be extended to other sub-regions in the Mediterranean and, for that matter, elsewhere.

The flood volume studies for Negev can be useful the to extension of the methodology to other situations. Simple flood volume-peak relations have been developed in the literature[1], but the methodology proposed hereby and initially shown to provide unsurpassed prediction ability allows robust evaluation of flood volumes also for basins where gaging is not available, particularly for large floods which commonly comprise the majority of surface water resources. The proposed approach incorporates the *entire* historic flood record for the southern half of Israel. The atmospheric input in this methodology is the unsurpassed *entire* historic synoptic record for the Eastern Mediterranean developed by Alpert et al. The essence of WP5.3 is to relate the novel flood volume-peak methodology to the interrelationships that will be developed by the exceptional flood and synoptic databases, each spanning half a century.

Once the approach relating the hydrological to the meteorological inventories has been developed and extended to the flood volume-flood peak interrelationships, it will provide a methodology which may be extended to any area within the Mediterranean and beyond. This is so because it will require (1) the availability of standard meteorological and hydrometric data, (2) the classification for the flood-inducing meteorological conditions, (3) application of flood volume-peak model relevant to any particular area and (4) running the model which relates the hydrometric database to the atmospheric database. As relevantly for CIRCE, predicted atmospheric conditions may be utilized to infer predicted runoff volumes, thus the surface water resources response of any area in the Mediterranean to a change in atmospheric conditions.

The research endeavour suggested within WP5.3 is very closely related to CIRCE applied to other Mediterranean locals.

The deeper comprehension and prediction of terrestrial water cycle in the Mediterranean will of course pass from a proper analysis of ground water dynamics under both climatic and anthropogenic trends during the past decades. The impact of climate change on ground water recharge and storage (Task 5.3.4) will be investigated in this WP.

For ground water, the following activities will be developed at selected case studies in the Mediterranean region:

a) Identification and analysis of ground water trends in the past decades

During the first 18 months the identification of case studies will be performed on the basis of i) available data; ii) representativeness as for hydrogeological features and quantitative pressures. Part of the effort will be devoted to the data collection (meteorological, hydrological, piezometric levels,

[1] Unlike flood volumes, which may be directly determined only for the very small minority of river basins in the Mediterranean (and other regions) where gaging is being deployed, flood peaks can be determined for every river after every flood based on slack water deposits and standard hydraulics. The dependence of flood volume on flood peak allows regionalization of the most pertinent hydrologic variable required for assessment and prediction of surface water resources – namely flood volumes.

etc). Ground water trends in the past will be analysed by means of statistical and mathematical models.

b) Application of selected climate scenario and forecast for the future decades.

Different climate scenarios assessed by other WPs will be considered and mathematical models will be run in order to forecast the future decades evolution of groundwater availability (discharge and storage) in relation to selected case studies.

Considering lakes as representing an other typology of large natural reservoir in the Mediterranean, the aim of this WP is also to build up a model-based tool for predicting long-term scenarios of variations in thermal structure and water storage in lakes and to infer about possible temperature related changes in the lake production/respiration budget (Task 5.3.5). In particular, modelling and experimental activities will be carried out in two sub-alpine lakes: Lake Pusiano (mid-shallow) and Lake Como (large-deep). The modelling tool will combine the results of hydrological and hydrodynamics models. Meteorological scenarios, required to drive the models, are expected to be the result of other RLs/tasks of the project. The in lake model will be focused on different scenarios during the thermal stratification induced by the changing in air temperature and energy budget. The work on sub-alpine lakes will be divided into two tasks (TS1 and TS2): modelling the effect of long-term meteorological changes on the hydrological and hydrodynamics regimes (TS1) and infer on the related temperature productivity/respiration processes variations (TS2). The TS1 data collection covers the first 6 months and is focused on meteorological, hydrological, lake level and temperature data acquisition. These data will be used for the meteorological, hydrological and hydrodynamics model calibration (within the first 24 months of the task activities). The calibrated meteorological model will be used for long term scenarios, which drive the hydrological and hydrodynamics simulations. The three scenarios should be completed within the first nine months of the third year. Within the TS2 the first 12 months will be dedicated to ecological calibration using results collected in the field. Lake water temperature scenarios will be used to infer on the effects on lake production/respiration rate. Four principal milestones can be identified within this task: data collection, models calibration and validation, scenarios (TS1), production respiration (TS2). The last three months will be dedicated in writing the final report (deliverable), which combines the results of the two sub-tasks. The second line of investigation will be instead undertaken at a broader spatial scale in order to provide a picture of the water stress sensitive areas in the entire Mediterranean basin (Task 5.3.6). The aim of this activity is therefore to obtain a likely evolution of the water stress sensitive areas under future climate change scenarios provided by other WPs. In fact, in the European shore of the Mediterranean an increasingly wealthy population requires more water per capita, while in North African and Middle East countries, the combined increase of wealth and population numbers also raises water demand (WD). Today, water resource policies are simply based on WD management, not in WD control. In order to cope with the increasing need for water, the common approach is to increase the water harvesting exploiting rivers and underground runoff as much as possible and increasing the water storage capacity of a region. Other even less desirable practices are the mobilization of non-renewable water resources (fossil aquifers) or the diversion of rivers from wetter areas to drier regions. Among the purposes of the this study is the assessment of WD defined as the water amount required by the population living in a region to cope with their activities in a period of time. WD will be considered as the water actually consumed by the population in domestic, industrial and agricultural activities, but not the use of water for other secondary purposes from the point of view of the society, like leisure or ecosystem maintenance. This will assure reliable estimations for present WD and its future evolution in most Mediterranean countries. On the other hand, water availability (WA) is defined as the water flux that can be actually used for human purposes. WA of course depends on human factors like the river water volume that can be actually diverted to the pipes, and the water storage facilities of a region. Nevertheless, WA fundamentally depends on natural factors as the total river and ground water runoff resulting from catchment water balance (including the role of vegetation

transpiration). Basically there is an upper limit to WA influenced both by technical and natural factors but ultimately dependent on climate dynamics and thus sensitive to climate change. Finally, as an overall measure of the water safety margin (WSM) the difference between WA and WD will be adopted. Therefore, when WSM is negative (WD larger than WA) a water stress situation is recognized. In conclusion, the aim of this second line of investigation is to detect water stress sensitive areas in the Mediterranean basin under future climate change conditions. Therefore, the resulting sensitive areas will be studied from both the predicted average conditions (climatology) and during low precipitation periods (extreme drought events). The study will be performed on a monthly basis as the WSM can change dramatically at this temporal resolution due to the seasonal evolution of both WA (rainfall is extremely seasonal in the Mediterranean area) and WD (irrigation as well as some tourist areas). The spatial resolution of the investigation will be at least that of the river basins. For the geographical recognition of the water stress prone areas and their future evolution under changing climate scenarios suitable mapping tools will be developed. Therefore analysis of the present situation of WD, WA and WSM in the different Mediterranean river basins will be performed in the first 18 months while the rest of the project will be dedicated to the forecast of future conditions of WD, WA and WSM.

The work will be organised around six inter-linked tasks:

Task 5.3.1 Impact of climate change on soil moisture and river run-off
Task 5.3.2 Role of climate-soil-vegetation interactions in the dynamics of soil moisture variability
Task 5.3.3. Synoptic-hydrologic evaluation of Mediterranean to dryland floods under climate change.
Task 5.3.4 Impact of climate change on ground water recharge and storage
Task 5.3.5 Effects of climate and hydrological changes on the thermal structure and water storage in sub-alpine lakes and temperature related production/respiration variations
Task 5.3.6 Analysis and detection of water stress sensitive areas in the Mediterranean Basin under future climate change.

WP5.4: Changes in Mediterranean Sea water cycle and implications for water mass characteristics
Responsible: Mariotti Annarita (ENEA)

Total project description: The air-sea interface freshwater flux is a major component of the Mediterranean Sea water cycle representing, together with inputs from river discharge, the major source of fresh water for the sea (Peixoto, 1982; Boukthir and Barnier, 2000; Mariotti et al., 2002; Struglia et al., 2004). River discharge is also an important source of nutrients, especially in the vicinity of major river mouths (Dowidar, 1984; Crise et al., 1999; Sempere et al., 2000; Penna et al., 2004). Being a semi-enclosed basin with a link to the open-ocean only through the narrow Gibraltar Strait, changes in both the atmospheric water flux and river discharge exert an important control on the physical and geochemical properties of the Mediterranean Sea especially at sub-basin scales (Harzallah et al., 1993; Bethoux and Gentili, 1999; Crispi et al., 2002; Skliris and Lascaratos, 2004; Rixen et al., 2005). On the other hand, the Mediterranean Sea represents a main source of moisture for the atmosphere in the Mediterranean region at large (over the sea net evaporation is generally positive; Peixoto, 1982; Mariotti et al., 2002). Sea surface conditions, in part due to oceanic dynamics, have an important influence on the air-sea interface freshwater flux and potentially on the overall Mediterranean water cycle. Hence, it is important to understand how Mediterranean Sea water cycle has functioned in recent climate and how it may change in the future. The main goal of this WP is to document changes in the Mediterranean Sea water cycle under the various climate change scenarios and investigate the effects on water mass characteristics. These effects will be assessed considering air-sea interface freshwater changes and changes in the water cycle of neighbouring land regions, specifically changes in river discharge and the associated nutrient load. WP activities will be organised in two inter-linked tasks:

Task 1: Diagnosing Mediterranean water cycle changes and implications for water mass characteristics
Task 2: River discharge into the Mediterranean Sea and estimation of the associated nutrient load.

References

Bethoux JP and Gentili B, 1999: Functioning of the Mediterranean Sea: past and present changes related to freshwater input and climatic changes. J. Mar. Sys., 20: 33-47.
Boukthir M and Barnier B, 2000: Seasonal and inter-annual variations in the surface freshwater flux in the Mediterranean Sea from the ECMWF re-analysis project. J. Mar. Sys, 24: 343-354.
Crise A, Allen JI, Baretta J, et al., 1999: The Mediterranean pelagic ecosystem response to physical forcing. Progress in Oceanography, 44 (1-3): 219-243.
Crispi G, Crise A, Solidoro C, 2002: Coupled Mediterranean ecomodel of the phosphorus and nitrogen cycles. J Mar Syst, 33: 497-521.
Dowidar NM, 1984: Phytoplankton biomass and primary productivity of the south-eastern Mediterranean. Deep-Sea Research. 31, 983-1000.
Harzallah, A., Cadet, D.L., Crepon, M., 1993: Possible forcing effects of net evaporation, atmospheric pressure and transients on water transports in the Mediterranean Sea. J. Geoph. Res., 98, C7: 12341-12350.
Mariotti A, Struglia MV, Zeng N, Lau K-M, 2002: The hydrological cycle in the Mediterranean region and implications for the water budget of the Mediterranean Sea. J Climate 15 (13): 1674-1690.
Peixoto JP, De Almeida M, Rosen RD, Salstein DA, 1982: Atmospheric moisture transport and the water balance of the Mediterranean Sea. Water Resources Res., 18, 1: 83-90.
Penna N, Capellacci S, Ricci F, 2004: The influence of the Po River discharge on phytoplankton bloom dynamics along the coastline of Pesaro (Italy) in the Adriatic Sea. Marine Pollution Bull 48 (3-4): 321-326.
Rixen M, Beckers JM, Levitus S, et al., 2005: The Western Mediterranean Deep Water: A proxy for climate change. Geoph Res Lett 32 (12): Art. No. L12608.
Sempere R, Charriere B, Van Wambeke F, et al., 2000: Carbon inputs of the Rhone River to the Mediterranean Sea: Biogeochemical implications. Global Biogeochemical Cycles, 14 (2): 669-681.
Skliris N, Lascaratos A, 2004: Impacts of the Nile River damming on the thermohaline circulation and water mass characteristics of the Mediterranean Sea. J Marine Systems 52 (1-4): 121-143.
Struglia MV, Mariotti A, Filograsso A, 2004: River discharge into the Mediterranean Sea: Climatology and aspects of the observed variability. J Climate 17 (24): 4740-4751.

Task 1

Activities in this task aim at understanding how Mediterranean Sea water cycle has functioned in recent climate and how it may change in the future. Initially, climatological water cycle components in various parts of Mediterranean Sea will be diagnosed for current climatic conditions based on observational data (mostly re-analyses and satellite derived data; links to RL1, WP5.1. and WP5.2). Climatological relationships establishing major controls on observed net evaporation will also be diagnosed. Estimates of regional river discharge from historical time-series will be used to close the climatological sea water cycle and derive oceanic currents at the Gibraltar Strait based on a "residual" approach (link to Task 2 of this WP).This approach will be complemented by results from the analysis of the regional climate models (RCMs) simulations performed in RL2. This will allow to estimate the uncertainties associated to the climatological estimates by intercomparison of various RCMs results and the observational estimates as well as allowing a better understanding of the processes. Recent interannual to decadal variability of the Mediterranean water cycle will be diagnosed based on observational data and RCMs control simulations. Specifically, the variability of the atmospheric component and of major river basins derived from observations will be compared to the model results. In turn, these will be used to extend the analysis and better investigate large scale atmospheric forcing and air-sea processes. Particularly anomalous periods for

the various Mediterranean sub-regions will be identified. Understanding will benefit from and complement activities of WP5.1 and WP5.2 as well as those from RL1 and RL2. Building on these results, the task will investigate how the Mediterranean water cycle may change in future climates. For this analysis, the outputs from selected RCM climate change scenario simulations (link to RL2) will be used to derive climatologies of Mediterranean water cycle components, as described above, for the "target" base periods of this project. Changes will be determined comparing components from the scenario simulations with those from the control runs. Uncertainties in these changes will be evaluated based on the various RCMs model outputs and the range of climate change scenarios. Major changes evidenced by this analysis will be related to changes in large-scale atmospheric circulation (links to results from RL1, RL2, WP5.1, WP5.2), sea surface conditions and interpreted in terms of potential implications for the oceanic water cycle component of the Mediterranean system.

Task 2

The activities of this task are aimed at giving a description of the climatology and interannual to decadal variability of river discharge into the Mediterranean Sea under current climatic conditions and to evaluate its impacts on the sea's nutrient loads. As information about the possible changes in river discharge or land use under climate change scenario will become available from others RL's during the final stage of this project, a "first order" description of the impact that such changes may have onto the Mediterranean Sea will be attempted. The effect of river discharge on the coastal waters results from the inter-play between freshwater input, ambient coastal waters and the modification of the trophic concentrations due to river loads. Beyond the physical impact of river discharge onto the Mediterranean Sea, mainly due to the local alterations of the physical parameters of the surface waters (salinity, temperature) at the outlet of the main rivers, the impact of river discharge variability onto the marine environment and ecosystem must also be considered. Total nutrient loads into the Mediterranean Sea can be estimated by the integration of instantaneous fluxes (i.e. the product of the nutrient concentration C and the river discharge Q), with the temporal variability of river discharge being the dominant factor in the determination of such fluxes. In this project, Mediterranean river discharge climatology and variability will be characterised analysing historical discharge time series, mainly monthly series, by means of standard data analysis techniques. A limited number of river basins, possibly representative of the response of the European and African coasts, will be selected as case studies, based on their relevance and on data availability (temporal resolution of discharge data, concentration measurements, land use information). An empirical model to estimate the nutrient load will be developed based on:

- land use information, in order to estimate the concentration of nutrients, also accounting for the organic bioavailable forms. Data, if already available, will include: land cover data, DEM, soil texture, soil surface surplus, point sources emissions from agriculture. Data from urban activities will be used to describe the inputs into the studied river basins via various point sources and diffuse sources;
  - a method for estimating the nutrient retention and loss (absorption/desorption, uptake form primary producers, nitrification/denitrification) within the river systems;
  - river discharge data, in order to evaluate the nutrients fluxes at the outlet and the consequent nutrient loads into the Sea.

Results from this model will be compared with available observed (satellite or in-situ) quantities linked to riverine nutrient load, thus providing initial guidance on further development and analyses. Nutrient load estimates from this task will be of relevance in the development of land-use management scenarios for Mediterranean coastal areas and related health and economic impacts (links to RL9, RL10 and RL12).

WP5.5: Coordination
Responsible: Vurro Michele (IRSA-CNR)

Total project description: The role of this WP is to ensure the achievement of the RL's objectives, as specified in the WPs.
The following tasks will be carried out by the co-ordinators:
1) Preparation of the annual reports of the RL.
2) Management of the RL including effective communication among the partners.
3) Organization of meetings at months 6, 18, 27, 36 coupled with the planned deadlines for the WPs.
4) Attendance to the meeting of the executive board

RL6: Extreme Events

Lionello Piero (UNILE), Garcia Ricardo (UCM)

Objectives: Many weather extremes are associated with hazardous situations and they have significant impacts on many socio-economic issues and activities in the Mediterranean area, namely: health, agriculture, forest management, energy production, offshore activities, coastal and port management, energy use, tourism, civil protection/insurance.

To understand changes in climate extremes is a difficult task because

a) high resolution (at least daily, often hourly data) data are often required
b) the causes of variations in extremes and their links to large scale patterns are not adequately known
c) current global (and also regional) models have limitations to simulate extreme events
d) extreme events intensity has a large intrinsic variability and it is therefore often difficult to identify statistically significant trends or changes

The purpose of the RL6 work packages is 1) to understand the current space-time distribution of extreme events over the Mediterranean 2) to analyse/implement sets of climate simulations with several models to understand how the intensity/distribution of extremes could change in the 21st century 3) to provide information for "focused" impacts analysis.

Within RL6, among others, mainly the following variables will be considered: precipitation, temperature, waves, sea level, upper troposphere height. Analysis will be based on the definition of extreme event indexes, the identification of thresholds, the analysis of links with large scale patterns. These outcomes will be used for the analysis of extremes in future climate scenarios. Specific sets of data will be built, using both observations and model simulations in order to analyse recent trends. Information will be provided for the analysis of phenomena such as fires, landslides, Saharan dust transport, and "other impacts" in cooperation with "impact" RLs. RL6 will use datasets from other CIRCE RLs, mainly RLs 1, 2 and 5 . On the other hand, RL6 will provide information to the rest of the CIRCE RLs, mostly, RLs 7 to 12. This implies that RL6 includes a specific WP6.5 to act as interface with the other RLs. This is expected to contribute to a better integration within CIRCE.

Description: The WP is organized in a sequential set of 3 WPs (from WP6.1 to WP6.3) with the subsequent WP6.4 and WP6.5 being based on their results, and WP6.6 reserved for coordination

- WP6.1: Mediterranean extreme characterization and indices:

(1-9 months) delivery of 6 sets of indices to describe variability and estimate changes in climate extremes for temperature, precipitation, hydrological cycle, cyclones, waves and surges, upper troposhere, across the whole basin

- WP6.2: Diagnosis of trends/variability in extremes during the 20th century

(10-18 months) Analysis of existing sets of data and their integration with new observations/data for the identification of characteristic variability and trends

- WP6.3: extremes: causes and links to large scale patterns

(19-27 months) Analysis of link between the occurrence of different types of extremes and large scale patterns and identification of causes for the variation of their intensity.

WP6.4: Extremes in future climate scenarios

(24-48 months) Assessment of changes in extreme events likely to occur in the next decades up to one century and their uncertainty, as derived from the specific scenarios produced in RL2 and former modelling projects, including global simulations, properly analysed, and specific regional simulations.

WP6.5: Database for future impacts of weather and climate extremes

(24-48 months) provide an estimate of specific impacts not covered by the other RL's such as Saharan dust transport. Additionally, data to evaluate other impacts with reference mainly to health, agriculture, biodiversity, insurance, tourism, water resources (droughts and floods) will be provided to the respective RLs.

WP6.6 is devoted to coordination.

WP6.1: Mediterranean extreme characterization and indices
Responsible: Gimeno Luis (UCM)

Total project description: The first step in the study of climate extremes consists of defining clearly when an event can be considered extreme. To do this we need to define indices to characterize the events and to establish threshold values of the indices to select the extremes. WP6.1 focuses on this activity, identifying the most appropriate set of indices to describe variability and estimate changes in climate extremes across the Mediterranean basin. The indices will not only be restricted to meteorological variables, such as the temperature, but also to other related extreme phenomena (non-necessarily meteorological), such as river flows (in coordination with RL5) as well as to features of the atmospheric circulation.

The WP6.1 is articulated in five tasks:

- WP6.1.1 Identification of extremes in precipitation and temperature values: Provide preliminary list of potential indices of extremes, drawing on the experience of earlier projects. Calculate these and examine their viability in terms of spatial distribution and "value" for further analysis. "Value" in this sense is a trade-off between how extreme a metric is and its statistical properties. Obtain daily RCM and ERA-40 data. Calculate indices for present and future analyses on native grids. This includes calculating spatially varying definition threshold for a rain-day using station data in temperate, semi-arid, and arid regions. Examine characteristics of indices. Decide on final "best" subset of indices

- WP6.1.2 Identification of extremes in cyclones: Dependent on the region of cyclogenesis (origin of the systems) catalogues of Mediterranean cyclones /cyclone tracks will be generated. The catalogues will include parameters describing their characteristics from both available atmosphere re-analysis data and from selected present day atmospheric GCM data.

- WP6.1.3 Identification of extremes in the hydrological cycle, droughts and wet periods: Definition of appropriate thresholds for hydrological and meteorological droughts and wet events, at the local and regional scales. Elaboration of catalogues of droughts and floods. Identification of extreme dry and wet seasons at regional scales. Comparison between winter and summer droughts for the eastern and western Mediterranean sectors.

- WP6.1.4 Identification of extremes in winds, waves and storm surges: Proper indexes will be defined to quantify marine storminess in relation to significant wave height (e.g. Lionello and Sanna 2005), mean wave period, storm surge level and negative surges, wind speed,

accounting also for the duration of the events and the superposition of dangerous factors (eg simultaneous extreme waves and surge levels).

- WP6.1.5 Identification of extremes in upper-troposphere features: a comprehensive set of reanalysis and radiosonde data and objective algorithms of detection will be used in the identification of extremes of relevant features of the upper troposphere, such as the tropopause height (Nieto et al, 2005, Gallego et al, 2005 and Añel et al, 2006).

WP6.2: Diagnosis of trends/variability in extremes during the 20th century
Responsible: Luterbacher Juerg (UNIBERN)

Total project description: The importance of assessing trends in extremes is often emphasized because major precipitation events, temperature fluctuations and intense storms can cause loss of life, damage to property and infrastructure, and large societal and economic impacts. Thus, it is crucial to analyse the occurrence of extremes in order to assess the significance of any apparent changes or shifts in extreme characteristics over the longest time frame available. Note that in general extremes can have trends different from those of the mean variables. One difficulty in assessing trends in extremes is the fact that extremes are rare events, sometimes even in the context of very long instrumental observational records. The detection probability decreases the rarer the event. Therefore, assessments of trends are often based on indices of rather 'moderate' extremes, such as those defined by the 90th or 95th percentiles in the distribution of daily observations.

The study of Mediterranean extremes trends and variability is divided in the following five tasks:

WP6.2.1. Temperature extreme events

Temporal and spatial variability, related trends of extreme temperatures will be examined. Comparison of indices of temperature extremes from ERA-40 with equivalent indices from Regional Climate Model data at 44 km resolution and 25 km resolution, over the period 1961-1990 will be performed. We aim at the identification of areas of spatial bias in the model extremes, correct the spatial bias and assess the added value of improved model resolution. Analyses of temperature extremes will be completed for homogenous station data at daily and monthly time scales. Experiments will be undertaken to aggregate this up to larger spatial scales within the Mediterranean area. Maps of return periods for specific extreme events will be developed. The estimation of return period values will be based on station data as well as on integrated area-values for specific regions.

Comparison of indices of temperature extremes from ERA-40 with equivalent indices from Regional Climate Model data will be performed. Areas of spatial bias in the model extremes will be identified correct the spatial bias and assess the added value of improved model resolution. Another objective is the assessment of the ability of the models to extrapolate reasonable return levels.

WP6.2.2. Precipitation extreme events

This task consists of selection of highly resolved, temporal and spatial precipitation data in order to investigate Mediterranean rainfall extremes, their variability and changes. A variety of datasets will be used, e.g. reanalysis data and long highly resolved instrumental data provided by RL1. Analyses of precipitation extremes will be completed for homogenous station data at daily and monthly time scales. Experiments will be undertaken to aggregate this up to larger spatial scales within the Mediterranean area. Maps of return periods for specific extreme events will be developed. The estimation of return period values will be based on station data as well as on integrated area-values

for specific regions.

Comparison of indices of precipitation extremes from ERA-40 with equivalent indices from Regional Climate Model data will be performed. We aim at the identification of areas of spatial bias in the model precipitation extremes, correct the spatial bias and assess the added value of improved model resolution.
Another objective is the assessment of the ability of the models to extrapolate reasonable return levels and the relative performance of the models and reanalysis in terms of rainfall over complex topography, i.e. are the models better than reanalysis due to their superior resolution. Further, the uncertainty in conclusions, by using a few models, with at least two ensemble members each, will be assessed.

WP6.2.3. Hydrological trends and extreme events.

This task will focus on the characterization of hydrological trends and extreme events (floods and droughts) throughout the last 100 years. This will be done using the set of objective indices defined in WP 6.1 and results from previous EU projects (MEDALUS and ARIDE). Sources of moisture and precipitation in the Mediterranean area and the most important Mediterranean river catchments will be identified. Using a lagrangian approach has shown to identify reasonably well strong precipitation events (Stohl and James, 2004) and the absence of trajectories providing moisture and precipitation during a long period. Using the set of objective indices defined in WP6.1, hydrological and meteorological droughts and flood extremes will be analysed. E-P budgets along droughts and floods and sounder analysis for those extreme events will be used (Stohl and James, 2005). The results will be applied in WP 6.3 to link occurrence of extremes with large-scale patterns.

WP6.2.4. Extreme events and cyclones

This task deals with the variability in terms of cyclones using reanalysis and GCM data (Ulbrich and Christoph, 1999; Ulbrich et al. 1999). This part of work will focus on the extremes in cyclone parameters, in particular relating to their genesis, tracks, positions and growth rates. The stepwise analysis includes: Determination of trends and variability in the cyclone tracks and –variables using reanalysis and GCM; Estimation of the role of cyclones for other key atmospheric variables such as wind and precipitation; Estimation of the influence of atmospheric and oceanic key variables (e.g. temperature, humidity, SST) on cyclone development (Ulbrich et al., 2001); Estimation of the role of cyclones versus other large scale features for trends in the key atmospheric and oceanic variables.

WP6.2.5. Sea level and wave height extremes

Sea level extremes from observations and models will be studied for the Mediterranean Sea and compared with those along the Atlantic coasts of Spain and Portugal. The model covers the period 1958-2001 while the data are from various periods. The data and the model extremes will be interpreted in relation to the mean sea level variability of the Mediterranean basin thus examining the link of any temporal changes to changes in storminess. The variability of the extremes in time will also be correlated with the variability of large scale meteorological patterns, like the NAO.

This task also includes collection and analysis of in situ, satellite and model reconstruction wave data. For waves, both satellite and in situ data do not provide longer time series than the last decade of the twentieth century. A model reconstruction based on meteorological re-analysis and a wave model are, therefore needed for obtaining multi-decadal time series. The combination of these data, with the analysis of cyclones (WP 6.2.4) will be used for a consistent evaluation of extremes of marine storminess.

WP6.2.6. Upper troposphere extremes

The research work on upper troposphere features is divided into two branches of activities: first, the identification of extremes in one relevant features of the upper troposphere: tropopause height, second the characterization of these extremes and studying their geographical distribution in the Mediterranean area and trends. This will be based on the previous experience in the analysis of cut-off lows and tropause (Nieto et al. 2005). More specifically: a)the tropopause height over the Mediterranean area will be estimated with different tropopause detection methods. The tropopause temperature and the lapse-rate of the troposphere will be calculated. Extremes based on height, location, temperature and lapse-rate will be identified. b) The interannual variability and long-term trends of the extremes extracted in b) will be studied.

WP6.3: extremes: causes and links to large scale patterns
Responsible: Lionello Piero (UNILE)

Total project description: This WP aims to identify causes and links of extremes to large scale patterns and indexes, and to analyse the conditions related to the genesis and development of extremes. The characterization of the relations between the occurrence of extremes and large-scale patterns and indexes is based of the simultaneous availability of high resolution regional sets of data and global data. The influence of planetary scale patterns on the climate of the Mediterranean region has been often discussed in the literature. The links are complex both in space and time because of the presence of strong regional features affecting them, such as orography and land-sea distribution. Particularly large-scale mid latitude atmospheric patterns such as NAO (North Atlantic Oscillation), but also the EA (East Atlantic) and the Scandinavian patterns play an important role on precipitation, temperature and affect the formation and evolution of cyclones ((Ulbrich and Christoph, 1999; Ulbrich et al. 1999, Trigo et al., 2004; Trigo et al., 2006, Lionello et al. 2006). Moreover influences of ENSO (El Niño Southern Oscillation) and of Asian and African Monsoons have been identified (Alpert et al. 2006). Warm summers have been found to be associated with blocking conditions, and generalized subsidence above the Mediterranean (Xoplaki et al. 2003). These links are very complicated themselves, and they have been generally considered in relation to mean seasonal variables such as temperature, precipitation, waves (e.g. Ulbrich et al.; 1999, Lionello and Sanna, 2005), etc. The purpose of this WP is to carry out this analysis considering extreme values (Lionello 2005, Della Marta et al. 2006) and the probability of occurrence of events above a fixed (and high) threshold.

The identification of patterns which favour the occurrence of extremes will be very important for deriving information on their values in future climate. Necessarily, future climate scenarios, because of relatively coarse resolution, have troubles to provide direct evidence for extremes in precipitation, cyclones, winds, sea level, wave heights. The knowledge of the links of extremes with large scale patterns can be an important tool for providing this information.

This WP is based on regional high time-space resolution datasets, where extreme weather events could be identified, produced in WP6.2 and RL1, and on the indexes defined in WP6.1. The time length covered by the datasets has to be sufficient to include periods with high and low relative frequency of events above the threshold used to define an extreme event. However, as these datasets will be used for extrapolating relationships and not for evaluating multidecadal trends, a length of 10 to 20 years could be sufficient. In this sense the sets of data could be different from those used in WP6.1 and WP6.2 and collecting them could be (partially) a specific task of this WP. Obviously, a longer (multidecadal) period would be helpful, if data are available. Different sources will be used for this sets of data: “in situ” and station observations, satellite observations, high resolution model simulations. Only for heat waves and for long wet/dry periods (hydrological cycle) the existence of such sets of data might be not necessary and model reanalysis might be sufficient.

The existence of "large scale" sets of data is needed for the identification of the large scale patterns. However, such sets of data are already provided by global reanalysis and they are freely available for this WP. They will be integrated with results from the high resolution reanalysis carried out in RL8 , for a better identification of their features in the Mediterranean region. The simultaneous availability of regional high time-space resolution and large scale sets of data will allow to identify relationships between the occurrence of extreme in the Mediterranean region and large scale patterns and indexes. This WP will also analyse the links between the occurrence of different types of extremes (e.g. to analyse those among extremes of precipitation, cyclones, waves or those between dry spells and heat waves). The output of WP6.3 will be extensively used in WP6.4 for the diagnosis of changes of extremes in future scenarios, compensating for lack of resolution in future climate simulations, and for increasing confidence in the projected changes. It would, moreover, be important for WP6.2, in order support the diagnosis of trends and to understand their causes on long time scales. The whole task is organized in 6 subtask, with a structure similar to that adopted by WP6.1.and 6.2

WP6.3.1 precipitation (UNIBERN)
WP6.3.2 temperature (UEA, IBIMET-CNR)
WP6.3.3 hydrological cycle, droughts and wet periods (ICAT-UL)
WP6.3.4 cyclones (FUBERLIN)
WP6.3.5 waves and storm surges (UNILE and NERC-NOCS)
WP6.3.6 upper troposphere extremes, tropopause height, cut-off low systems (UCM)

WP6.4: Extremes in future climate scenarios

Responsible: May Willi (DMI)

Total project description: Because of the adverse effects that weather and climate extremes often have potential future changes in the characteristics of such events due to anthropogenic climate change are of particular socio-economic interest. Therefore, WP6.4 investigates potential future changes in the characteristics of various kinds of extreme weather and climate events associated with potential anthropogenic climate changes. Such extremes are heat waves, heavy rainfall, droughts and floods, cyclones, storm surges, wave heights etc., and they are characterised by both the frequency, the intensity and in some cases the duration of the events. The changes in the characteristics of the selected extreme weather and climate events (based on indexes provided by WP6.1) will be done on the basis of numerous climate change scenarios from simulations with both global and regional climate models in RL2. Potential future changes in the frequency and intensity of heavy rainfall events are not only due to changes in the large-scale circulation but also associated with local changes in the atmospheric and land-surface conditions. In order to investigate the influence of the most important processes affecting the characteristics of heavy rainfall events, especially designed experiments with a regional climate model are performed. Such processes are related to the increased atmospheric moisture content, the increased moisture convergence, intensified vertical motions, or changes in the atmospheric stability. The assessment of future changes in wave heights and sea level extremes requires running specialized numerical models, driven by atmospheric boundary conditions from future climate scenarios from RL2 (e.g. Lionello et al. 2003).

Considering various kinds of weather and climate extremes, WP6.4 includes the following tasks assigned to different partners. Analysis will be carried out following the guidelines and exploiting the information provided by WP6.1 and WP6.3.

WP6.4.1 Temperature (UEA)

WP6.4.2 Precipitation (UNIBERN)
WP6.4.3 Hydrological cycle (ICAT-UL)
WP6.4.4 Cyclones (UBERLIN)
WP6.4.5 Sea level and wave heights (UNILE, NERC-NOCS)
WP6.4.6 Upper troposphere (UCM)
WP6.4.7 Processes of heavy rainfall in climate scenarios (DMI)

WP6.5: Data for the estimation of future impacts of weather and climate extremes

Responsible: Garcia Ricardo (UCM)

Total project description: To achieve Objective 1, we will produce a database containing indices on extreme events combining the data produced in WPs 6.1 to 6.4 and the requirements of the rest of the RL's most directly involved in the estimation of the impacts, viz. RL's 7 to 13. The database will contain information aggregated at different time and space scales according to the users demands on temperature, precipitation wind and storm extremes in the form of raw data and derived indices. Specific quality controls will be applied to ensure the accessibility of the data and the lack of errors. The database will be designed to allow for later additions and for easy abstraction of information/data blocks specified by the users. It will be supported by a substantial body of metadata to allow further post-processing after the formal end of CIRCE.
This database will be freely available for the whole scientific community once CIRCE has been completed. Since this activity depends mostly of the results obtained in the other WP's, its activity will be mostly developed after month 18th. The activities in the first part being mostly focused on meetings attendance and database design, while the bulk of the activity will be made along the year 3 of the project. A working database will be ready by month 24 and a final version by month 40 The Database will be accessible from the CIRCE website and from a CD-Rom freely distributed. Despite the large spectrum of extreme events covered by RL6 and others RLs in CIRCE as well as their associated human and socio-economic impacts there are still gaps. An important examples is

The activity of WP6.5 is organized in the following main subtasks:
WP6.5.1 construction of the data base.
WP6.5.2 definition of final database and CD-Rom.

WP6.6: Coordination
Responsible: Lionello Piero (UNILE)

Total project description: The objective of this WP is to ensure that the objectives of the RL are achieved in due time, as specified in the respective WPs 6.1 to 6.5. This will imply the following tasks for the co-ordinators:

1) The preparation of the annual reports of the RL.

2) Overall RL project management including effective communication between the RL6 partners and communication with the other RL coordinators.

3) Organization of meetings at months 9, 15 coupled with the planned deadlines for the WPs.

4) Attendance to the meetings of the executive board

References

Alpert P., Ben-Gai T., Baharad A., Benjamini Y., Yekutieli D., Colacino M., Diodato L., Ramis C., Homar V., Romero R., Michaelides S. and Manes, 2003: The paradoxical increase of Mediterranean extreme daily rainfall in spite of decrease in total values". Geophys. Res. Lett., 29, 11, 31-1 - 31-4.

Alpert, P. (2006) Relations between climate variability in the Mediterranean region and the tropics: ENSO, South Asian and African Monsoons, hurricanes, and Saharan dust. In: P. Lionello, P. Malanotte-Rizzoli & R. Boscolo (Eds), Mediterranean Climate Variability, Amsterdam: Elsevier, pp. 149—177.

Añel J.A., L. Gimeno, L. de la Torre and R. Nieto, 2006: Changes in the tropopause height for the Eurasian region from cards radiosonde data. Naturwissenschaften, (in press)

Della-Marta, P.M., Luterbacher, J., von Weissenfluh H., Xoplaki E., Brunet M., and Wanner H., 2006: Summer heat waves over western Europe 1880-2003, their change and relationship to large scale forcings, submitted.

Gallego, D., P. Ribera, R. García-Herrera and L. Gimeno, 2005: A new look for the Southern Hemisphere jet stream. Climate Dynamics, 24, 607-621

Leckebusch, G.C., B. Koffi, U. Ulbrich, J. Pinto, T. Spangehl, S. Zacharias, 2006: Analysis of frequency and intensity of winter storm events in Europe on synoptic and regional scales from a multi-model perspective. Accepted for Publication in Climate Research

Pinto, J. G., Spangehl, T., Ulbrich, U., Speth, P., 2005. Sensitivities of a cyclone detection and tracking algorithm: individual tracks and climatology. Meteorologische Zeitschrift, 14, 823-838.

Lionello P., E.Elvini, A.Nizzero (2003) Ocean waves and storm surges in the Adriatic Sea: intercomparison between the present and doubled CO2 climate scenarios Clim. Research., 23: 217-231

Lionello P. (2005) Extreme surges in the Gulf of Venice. Present and Future Climate in Fletcher C. and T.Spencer Eds., Venice and its lagoon, State of Knowledge Cambridge University Press, Cambridge UK, 59-65

Lionello P., Bhend J., Buzzi A., Della-Marta P.M., Krichak S., Jansà A., Maheras P., Sanna A., Trigo I.F., Trigo R. (2005). Cyclones in the Mediterranean region: climatology and effects on the environment. In P.Lionello, P.Malanotte-Rizzoli, R.Boscolo (eds) Mediterranean Climate Variability. Amsterdam: Elsevier (NETHERLANDS), pp. 324-372.

Nieto R., L. Gimeno, L. de la Torre, P. Ribera, D. Gallego, R. García-Herrera, J. Garcia, M. Nunez, A. Redaño, J. Lorente, 2005: Climatological Features of Cut-off Low Systems in the Northern Hemisphere. J. Climate 18, 3085-3108.

Pinto, J. G., Spangehl, T., Ulbrich, U., Speth, P., 2006. Assessment of winter cyclone activity in a transient ECHAM4-OPYC3 GHG experiment. Meteorologische Zeitschrift, accepted for publication.

Stohl, A. and P. James, 2004: A lagrangian analysis of the atmospheric branch of the global water cycle: Part I: Method description, validation and demonstration for the August 2002 flooding in the central Europe. J. Hydrometeor, 5, 656-678.

Stohl, A. and P. James, 2005: A lagrangian analysis of the atmospheric branch of the global water cycle: Part II: Moisture transports between Earth´s ocean basins and river catchments. J. Hydrometeor, 6, 961-984.

Trigo R.M., Pozo-Vazquez D., Osborn T.J, Castro-Diez Y., Gámis-Fortis S., Esteban-Parra M.J. (2004) "North Atlantic Oscillation influence on precipitation, river flow and water resources in the Iberian Peninsula". International Journal of Climatology. 24, 925-944

Trigo, R. and 21 collaborators (2006) "Relations between variability in the Mediterranean region and mid-latitude variability" In: P. Lionello, P. Malanotte-Rizzoli & R. Boscolo (Eds), Mediterranean Climate Variability, Amsterdam: Elsevier, pp. 179-226.

Ulbrich, U., M. Christoph , J.G. Pinto and J. Corte-Real, 1999: Dependence of Winter Precipitation over Portugal on NAO and Baroclinic Wave Activity. Int. J. Climatol., 19, 379-390.

Ulbrich, U., and M. Christoph, 1999: A Shift of the NAO and Increasing Storm Track Activity over Europe due to Anthropogenic Greenhouse Gas Forcing. Climate Dynamics, 15, 551-559.

Ulbrich, U., A.H. Fink, M. Klawa and J.G. Pinto , 2001: Three extreme storms over Europe in December 1999. Weather, 56, 70-80.

Xoplaki, E., Gonzalez-Rouco, F. J., Luterbacher, J., & Wanner, H. (2003). Mediterranean summer air temperature variability and its connection to thelarge-scale atmospheric circulation and SSTs. Clim. Dyn., 20, 723–739, doi: 10.1007/s00382-003–0304-x.

RL7 - Impacts of Global Change on Ecosystems and the services they provide

Valentini Riccardo (UNITUSCIA), Hoff Holger (PIK)

Objectives:

1) To evaluate the vulnerability of ecosystem services in the Mediterranean region to climate change and other forcings
2) To investigate feedbacks by ecosystems to biogeochemical and hydrological cycles.

Description: The objectives of this RL are: to evaluate the vulnerability of ecosystem services in the Mediterranean region to climate change and other forcings, and to investigate feedbacks by ecosystems to biogeochemical cycles.

The research focuses on the linkages between ecosystems and human well-being. Following the Millennium Ecosystem Assessment (MA), we use the well established concept of "ecosystem services" as a descriptor of the benefits people obtain from ecosystems. These include (i) Provisioning services such as food, water, timber, and fiber; (ii) Regulating services such as the regulation of climate, floods, disease, wastes and water quality; (iii) Cultural services such as recreational, aesthetic, and spiritual benefits; (iv) Supporting services such as soil formation, photosynthesis and nutrient cycling (Millennium Ecosystem Assessment 2005)

Our goal is to assess the indirect and direct drivers of change in ecosystems and their ecosystem services, the current condition of those services, and how changes in the services have affected or may affect human well-being. Ecosystem services in the Mediterranean region are particularly sensitive to the following conditions: (i) Extreme seasons, in particular exceptionally hot and dry summers and mild winters. (ii) Short-duration events such as windstorms and heavy rains. (iii) Slow, long term changes in climate leading to rising sea level ("coastal squeeze") or general aridification or desertification.

WPs address sectoral and process-based impacts, therefore they share topics and coordinate research from different perspectives. The main inputs to the RL7 workpackages are coming from RL2 for what concern climate scenario, RL6 for changes in water cycle impacting ecosystems. As output RL7 will provide information to RL10 (economy and social systems) and RL13 for policy implications. The research line is organized into 4 main activities:

<u>Climate change impacts on forests, agriculture, forest products and livestock production</u>

This workpackage will be based mostly on modelling and data about the impact of human management on Mediterranean forests, as well as on historical trends of forest products in the Mediterranean region, producing databases on forest management options and historical trends in forest products in the region. We will review the role of management for forest production under changing boundary conditions, the potential for mitigation by carbon sequestration in forest related activities, and scenarios of forest management and forest products in future conditions. (Calfapietra et al. 2001). Another aim is to assess crop production using state-of-the-art models and climate scenarios, including scenarios of the Common Agricultural Policy and management following from it. Impacts of climate change on yield of the following crop will be assessed: Wheat, maize, sunflower, potato, tomato, energy crops, grapevine, olive, peach, citrus (Miglietta et al. 2000) Where appropriate, mixed or rotational systems will be studied as well. The approach will normally encompass the entire Mediterranean region or be limited to selected study areas. The potential for mitigation by carbon sequestration in agricultural soils in the region will be explored. We will also study livestock production systems and animal products (quantity, quality and safety of meat, milk, eggs etc.). The scenarios will be based on historical trends and on deliverables from other RL 7

WPs (WP3) and also from RL1 and RL2. Validation will be based on agricultural statistics, remote sensing and other data sources (see WP1).

Fire and other disturbances. We will assess historical trends of the intensity and frequency of disturbance events, their relevance for ecosystem services and vulnerability, and the main driving processes involved. The key components and processes that make ecosystems vulnerable to major disturbances in the Mediterranean will be identified. Changes in fire regime (frequency, intensity and season) may have different consequences for different species; however, the persistence mechanisms of many species are poorly understood, especially in recurrent and changing disturbance conditions and also ecosystems that were not under fire pressure in the past (and where fire is becoming important) may have no strategy to deal with fire (Pausas et al. 1999).

Integration of ecosystem service at the regional scale. The aim is to provide (a) a vulnerability concept adapted to the Mediterranean region, focusing on ecosystem services and the impacts which are most critical for policy, (b) a set of consistent scenarios, based on climate scenarios from other components of CIRCE as well as land use change scenarios developed elsewhere, (c) a sector-by-sector synthesis of vulnerabilities from the studies in the other RL7 WPs, (d) a high-resolution model analysis of vulnerabilities in major ecosystem types. New process descriptions will be included in existing models. For biodiversity, using nested models at different scales, down to 1 km resolution, we will assess plant and bird distributions across the Mediterranean basin, allowing for scenario assessment for many species. This will be extended by a 'functional trait' concept in order to more broadly study the limitations for post-climate change colonisation of sites, the interactions between climate and land fragmentation and the changes in species assemblages. A further activity will address the risk for intensified plant invasions due to climate change, by investigating potential weeds in regions with climate similar to the Mediterranean, assess the likelihood of their arrival and study the potential consequences of them (in connection with the agricultural component). Human drivers and policy trends will be investigated. The end result will be a multi-scenario vulnerability analysis for the Mediterranean basin (Toth et al. 2000).

Climate impacts on biogeochemical cycles. For Mediterranean ecosystems one crucial climate change driver will be precipitation or more generally the water balance. Since carbon-water cycle and soil-vegetation interactions involve highly non-linear properties and processes, there is a strong risk of instability and run-away dynamics of ecosystems when a certain stress threshold is passed. In this context the distribution and timing of rain events and temperature changes in relation to vegetation phenology and soil carbon dynamics is of paramount importance. Current biogeochemical models do not sufficiently describe these critical interactions (Reichstein et al. 2002). The final deliverable is a biogeochemical modeling and mapping system that allows assessment of the effect of increasing frequency of extreme climatic events (e.g droughts) on biogeochemical cycles and ecosystem productivity (input and feedback to/from RL2, RL5) and the evaluation of adaptation strategies at the ecosystem level (e.g. thinning).

In addition RL7 will provide consolidated data sets on biosphere – atmosphere exchanges of carbon, water and energy in the Mediterranean region. The work will include as well as long term ecological stations data and the results of past and ongoing manipulation experiments on Mediterranean ecosystems. For atmosphere – biosphere exchanges the dense network of flux towers will be used. There are currently about 30 flux tower stations in the Mediterranean region which are measuring biosphere – atmosphere exchanges spanning a time period of 10 years with ancillary ecological data. In addition Terrestrial Ecosystem Monitoring Stations (TEMS, GTOS) are available on basic data such as phenology, biomass, soil properties etc. Manipulative experiments on Mediterranean ecosystems will also be considered and consolidated data sets will be used for model parameterisation. In particular. we have selected a number of manipulative experiments that are located in the Mediterranean region (EU project MIND - precipitation and VULCAN-temperature), where the expected changes in precipitation and temperature are likely to cause

significant changes in ecosystem services, such as net primary productivity and hydrological cycle. Consolidated results will be made available to RL7 to understand processes and therefore they are of great importance for validation of process models and to predict future trajectories of the interaction between the hydrological and the carbon cycles.

References

Millennium Ecosystem Assessment 2005. Living beyond our means. Statement of the Board

Miglietta F., Bindi M., Vaccari F.P., Schapendonk H.C.M., Wolf J., Butterfield R.E.,2000 "Crop ecosystem responses to Climate Change: root and tuberous crops". In: Climate Change and Global Crop Productivity (K.R. Reddy, H.F. Hodges eds.), chap. 9, 189-212 pp, CABI Publishing.

Pausas J.G.; Carbo E.; Caturla R.N.; Gil J.M.; Vallejo R. 1999. Post-fire regeneration patterns in the eastern Iberian Peninsula Acta OEcologica, 20 499-508

Toth F. L., Cramer W., Hizsnyik E. 2000 Climate Impact Response Functions: An Introduction, Climatic Change, 46:225-246

Reichstein, M, Tenhunen, JD, Roupsard, O, Ourcival, J, Rambal, S, Miglietta, F, Peressotti, A, Pecchiari, M, Tirone, G, Valentini, R 2002. Global Change Biology 8: 999-1017

WP7.1: Coordination of RL7, data distribution and network consolidation
Responsible: Valentini Riccardo (UNITUSCIA)

Total project description: This workpackage will focus on the coordination of the RL7 activities. The work will be conducted by workshops and meetings in order to ensure the exchange of information and the proper inputs to models and the discussion and analysis of the results. In addition the workpackage will provide consolidated data sets on biosphere – atmosphere exchanges of carbon, water and energy in the Mediterranean region. The work will include as well as long term ecological stations data and the results of past and ongoing manipulation experiments on Mediterranean ecosystems. For atmosphere – biosphere exchanges the dense network of flux towers will be used. There are currently about 30 flux tower stations in the Mediterranean region which are measuring biosphere – atmosphere exchanges spanning a time period of 10 years with ancillary ecological data. In addition Terrestrial Ecosystem Monitoring Stations (TEMS, GTOS) are available on basic data such as phenology, biomass, soil properties etc. Manipulative experiments on Mediterranean ecosystems will also be considered and consolidated data sets will be used for model parameterisation. In particular. we have selected a number of manipulative experiments that are located in the Mediterranean region (EU project MIND - precipitation and VULCAN-temperature), where the expected changes in precipitation are likely to cause significant changes in ecosystem services, such as net primary productivity and hydrological cycle. Consolidated results will be made available to RL7 to understand processes and therefore they are of great importance for validation of process models and to predict future trajectories of the interaction between the hydrological and the carbon cycles. All the data sets consolidated through the WP 7.1 will be made available to the model community of the RL7 and other components of CIRCE project for model validation and for improvement of processes representation in biogeochemistry models.

WP7.2: Climate change impacts on forests, agriculture, food products and livestock production
Responsible: Scarascia Giuseppe (IBAF-CNR)

Total project description: The workpackage will integrate information, data and modelling simulations from the different land-based sectors (forest, agriculture, livestock) to assess the impacts of climate change on production and land-management.

Forest sector: For this sector the WP activity will be based on a meta-analysis of available data about the impact of human management on Mediterranean forests, as well as on historical trends of forest products in the Mediterranean region, and on the application of simulation models for the prediction of the impact of Climate Change and of alternative management options. The WP will achieve this goal through an analysis of available experimental and literature data and their integration into process-based ecosystem and forest growth models. It is planned to deliver the following results: a) database on historical trends in forest products in the Mediterranean region; b) meta-database with description of the most important forest management options in the Mediterranean region; c) Modelling of historical trends in forest production in the Mediterranean and future impact of climate change.

Agriculture sector: Also the activity for this sector will be based on modelling. A crop model will be made available to the project to simulate the effect of changes in the climate on durum wheat production in the Mediterranean area. It will be a deterministic model capable of simulating canopy development (leaf area development and growth), photosynthetic carbon uptake and resource allocation. The model will be coupled with a soil module capable of simulating the dynamics of soil water availability, in response to changes in rainfall. The model will use up to date information on the most critical plant and canopy processes in response to environmental factors. Including a specific section dealing with nutrient balance in the soil-plant system and the proportional allocation of nitrogen and proteins in the grains. This will allow to simulate the effects of changes in the climate on both yield and grain quality (protein concentration). Special attention will be paid, on the simulation of the likely effects of rising atmospheric CO2 concentration on photosynthesis and stomatal conductance and, with that, on water use and water use efficiency. Another component of the activity will be related to scenario "experiments", based on output results obtained by general circulation experiments. For this, a specific activity will be made to interact with the specific RL and the modellers in order to adapt the model to the temporal and spatial resolution of scenario analyses.

Livestock sector: For the livestock sector, the impact of climate change will be assessed on the following issues: a) health and welfare, reproductive efficiency, productive parameters, and life expectancy in farm animals; b) numerousness of animals belonging to different species or breeds (cosmopolitan and local); c) evolution and sustainability of livestock farming systems; d) quantity and quality of food of animal origin. Furthermore, a part of the activity will be devoted to define strategies (housing, cooling and feeding strategies, genetic selection) to mitigate the impact of climate change in farm animals.

WP7.3: Fire and other disturbances

Responsible: Vallejo Ramon (CEAM)

Total project description: Fire is extremely linked to climate, and changes in climate are affecting fire regimes. Thus, we will focus on this disturbance (fire), although other disturbances that interact with fire are also considered, such as extreme drought and post-fire flooding. Thus, in this sense, this WP is linked to RL5 as well as to RL1 and RL2, that is, predictions obtained in these Research Lines will provide the spatial and temporal context of this WP.

For organisation purpose, this WP is structured in 5 Tasks.

Task 1. Fire regime and climate interactions

Although fire regimes change with climate, the direct link and the interactions are poorly understood. For instance, a decrease in plants water availability may increase flammability and fire hazard, but it may also reduce plant production and fuel loads. Thus changes in climate may have different fire effects in different climatic conditions depending on critical thresholds of combustibility. Understanding fire-climate patterns is essential; learning from the past not only will increase our understanding, but it will also facilitate future predictions for acquiring better adaptive strategies. In this task we aim to provide an accurate analysis of past fire regimes along a climate gradient (well-documented regions of different countries), and study the relation with weather data. Previous studies suggested that in some places fire increases in dry years, but the increase may be especially important if the previous year was a moist year. Alternated dry-wet years may have more impact on fire than consecutive dry years. However this pattern may be different between moist- and dry-Mediterranean systems. The results obtained will allow to produce accurate fire regime predictions from climatic predictions.

This task will use information from RL5 and will allow predictions on future fire regimes changes.

Methods:
- Selection of different regions in the Mediterranean basin with different climate
- Compilation of climatic and fire history data
- Analysis using methodologies based on Temporal Series.

Task 2. Fire impact protocols and database

Fire has occurred in the past and will occur in the future, although fire regimes may change. In few places the impact of fires in the landscape are systematically recorded, and in the few places that this is done, it is performed using different methodologies and systems, precluding any comparison. Thus we aim to elaborate a standardised protocol for evaluating fire impacts and test its use by the different Administrations and to compile the information in databases. These databases will include valuable historical (spatially explicit) information at landscape scale, and thus it will be valuable tool both for scientist and land managers.

Methods:
- Design of protocols for gathering field data
- Design a database to include the information
- Test the protocols and database in several regions
- Correct protocols and database
- Disseminate the methodology (with close collaboration with Forest Services)

Task 3. Plant response to disturbance

Some plants do not persist after fire (local extinction post-fire). Others have different mechanisms to persist and regenerate after fire (e.g., mechanisms at individual, population or landscape level). Different persistence mechanisms (plant strategies, plant responses) have been selected for different disturbance regimes (in evolutionary terms) such as different fire frequencies, intensity and season. Some of the mechanisms are very weak and may support occasional fires only. Thus, changes in fire regime may have different consequences for different species; however, the persistence mechanisms of many species are poorly understood, especially in recurrent and changing disturbance conditions (e.g. to what extent a resprouting species will keep resprouting in a high fire recurrent scenario?). Furthermore, ecosystems that were not under fire pressure in the past (and

where fire is becoming important) may have no strategy to deal with fire. All this processes have strong implications to biodiversity.

Thus experimental evidence is needed for an accurate and unambiguous knowledge of the species response and to different fire regimes. Furthermore, changes in species composition may have consequences on the landscape combustibility and flammability and thus it may feedback to the fire regime. However, flammability information for Mediterranean species and communities is very scarce. Knowledge of response traits and flammability would permit to scale up impacts from species to landscapes.

Methods:
- Compiling existing information and databases in different countries/environments of species response, flammability and chemical composition, for as many species as possible. Making use of the existing databases from previous EU projects (LEDA, EUFireLab, etc...).
- Finding gaps in the knowledge, especially for important species. Species may be important for their high abundance (common species with unknown information), but also for their rarity and biodiversity value (endemics, threatened species, etc.).
- Performing experiments of selected species to quantify resprouting and post-fire germination capacity under different fire severities, and the flammability characteristics. Resprouting ability will be determined after subjecting the plants to disturbance (clipping or burning) at individual basis. Monitoring will be continued during the second phase of the project. Germination capacity will be evaluated after a set of heat treatments (varying temperature and time) in the laboratory. Flammability will be evaluated by standard protocols.

- All information for all species and countries will be centralised in a database for further use, and will be analysed considering environmental and historical effects.
- Prediction on expected plant changes based on climatic and fire predictions will be performed.

This task will also contribute to the WP on Biodiversity.

Task 4. Ecosystem vulnerability

Fire may have direct consequences to plants (see Task 3). However, there are other impacts and responses that are at the ecosystem level, and these are determined by plant communities as well as soil characteristics (e.g. erodibility) and post-fire events (e.g., heavy post-fire rains). In this task we aim to determine the ecosystem characteristics that makes ecosystems vulnerable to fire and their landscape level consequences. Predictions will include potential post-fire erosion, potential flooding for a range of climate, fire, and post-fire weather combined scenarios.

Methods:
- Selection of several study regions all over the Mediterranean Basin
- Compile information on plant communities and soil characteristics
- Combine the information on a GIS
- Develop a conceptual model based on the experience on previous projects and in the Task 3.
- Compile information on projected climatic changes from RL2 and RL5
- Generate scenarios of post-fire weather conditions
- Predictions in GIS format

Links: with RL2 and RL5.

Task 5. Mitigation and adaptation

Previous task will provide the spatial and temporal conditions for important fire impacts. In this task we propose mitigation techniques for reducing fire impact and adaptation methods to the new fire regimes. This techniques and tools will be based on previous European research (e.g., SPREAD, GEORANGE projects). The focus will be on strategies for fuel and vegetation management to reduce fire impact and increase ecosystems resilience, specially in high vulnerable areas.

WP7.4: Integration of ecosystem services at the regional scale
Responsible: Hoff Holger (PIK)

Total project description: Ecosystem scenarios for the Mediterranean region will be developed by simulating bidirectional vegetation-water-climate interactions, using the LPJ dynamic global vegetation and water balance model.

For given climate and land use scenarios, LPJ provides vegetation responses (and hydro-meteorological feedbacks) for different plant and crop functional types for typical Mediterranean natural and agricultural ecosystems. Required ecosystem and flux data will largely be provided by the flux tower network and other data distributed through WP7.1.

This task will also draw upon previous LPJ experience with fire disturbance in the Mediterranean. This task will closely collaborate with the eastern Mediterranean case studies i) Judean Foothills, ii) Tel Hadya and iii) Beirut, using ongoing collaborations, e.g. in the GLOWA Jordan River project. These case studies in semi-arid climates address i) afforestations and their interactions with the hydrological cycle and water resources, ii) the integration of green and blue water in agricultural and natural ecosystems through supplementary irrigation and other adaptations practices, and iii) increasing ecosystem-urban competition for land and water. The adaptation and water and land use practices from these case studies (and manipulative experiment results from WP7.1) will be introduced into LPJ for upscaling of potential effects in ecosystem-climate interactions.

LPJ also yields water productivities and virtual water contents of different crop types for the respective climatic conditions under which they are grown. With that, there is also a link to WP 13.3, by providing a basis for calculating virtual water fluxes under different agricultural trade regimes and scenarios.

The simulation of vegetation-water interactions with LPJ in WP7.4 will also embed these Mediterranean ecosystem scenarios in the new Green-Blue Water Initiative of SEI and partners, which aims at a better understanding of interactions between ecosystem and human water needs and adaptive land and water management.

WP7.5: Climate impacts on biogeochemical cycling
Responsible: Reichstein Markus (MPIBGC)

Total project description:

For Mediterranean ecosystems is it clear that one crucial climate change driver will be precipitation or more generally the water balance. Since carbon-water cycle and soil-vegetation interactions involve highly non-linear properties and processes, there is a strong risk of instability and run-away dynamics of ecosystems when a certain stress threshold is passed. In this context the distribution

and timing of rain events in relation to vegetation phenology and soil carbon dynamics is of paramount importance. Also interactions with temperature changes will play an important role, where a warmer winter-spring can lead to earlier vegetation activity and higher evapotranspiration and nutrient mobilization. Current biogeochemical models do not sufficiently describe these critical interactions. During recent years Mediterranean ecosystems already have experienced extreme climate conditions (heat and drought 2003, drought 2005 over the Iberian Peninsula) which may serve as proxies and help to understand the reaction of ecosystems to climate extremes. Hence, the aim of this Task is to provide

- a synthesis of existing and ongoing carbon and water cycle observations in relation to climate extremes
- improved general biogeochemical process model descriptions with particular emphasis on interactions of carbon, water and nutrient cycles that are validated against data from the other tasks
- model-based experiments about the non-linearities and emergent properties of ecosystem processes that differently affect the different sectors (agriculture, forestry etc.
- ecosystem-model based maps of expected rates of change of ecosystem carbon and water balances in the Mediterranean based on climate scenarios from within CIRCE and soil information

The final deliverable is a biogeochemical modeling and mapping system that allows to asses the effect of increasing frequency of extreme climatic events (e.g droughts) on biogeochemical cycles and ecosystem productivity and the evaluation of adaptation strategies at the ecosystem level (e.g. thinning).

References

Batchelor C., Cain J. (1999): Application of Belief Networks to Water Management Studies, Agricultural Water Management, 40, 51-57

Falkenmark M., Rockström J. (2004): Balancing Water for Humans and Nature, Earth Scan, London, UK

Gerten D., Hoff H., Bondeau A., Lucht W., Smith P., Zähle S. (2005): Contemporary "green" water flows and plant water limitation: simulations with a dynamic global vegetation and water balance model, Physics & Chemistry of the Earth, 30, 6-7, 334-338

Hoff H. Küchmeister H., Tielbörger K. 2006: The GLOWA Jordan River Project - Integrated Research for Sustainable Water Management, IWA Water Environment Management Series No 10

RL8 - Air Quality and Climate

Kallos George (IASA), Levin Zev (TAU)

Objectives:

• Study links and feedbacks between the air pollution transport and transformation processes, the air quality and the regional climate change in the Mediterranean region (Determine impacts)
• Study links and feedbacks between regional (Mediterranean basin) and global air quality with respect to climate change scenarios.
• Study links and feedbacks between air quality, climate change, local circulations, severe weather and water budget in the Mediterranean Region.
• Develop an optimal control strategy that will lead to the improvement of air quality in the region (by limiting the violation of air quality standards) and mitigate climate change.

Description: Rationale: The Mediterranean Region has some unique characteristics concerning the regional atmospheric circulation, regional climate and therefore air quality. The general pattern of the atmospheric circulation in the Mediterranean region is from North or Northwest to South or Southeast. This is due to differential heating between the land of North Africa and Southern Europe and the Mediterranean waters in between. This results in transport of air pollutants from Europe towards the Mediterranean Region, Northern Africa and the Middle East (Kallos et al. 1997, 1999, Millan et al., 1997). Large scale subsidence over Mediterranean waters has as a result the dominance of dry conditions during the warm period of the year. During the cold period of the year the cyclogenetic activity dominates. The characteristic scales of air pollution transport are ranging from 2 to 4 days depending on the synoptic and mesoscale conditions in the region as well as the strength of pressure gradient between the Atlantic anticyclone and the monsoonic low activity over the Middle East and the Indian Ocean (Kallos et al., 1993; 1997; 1999; Millan et al., 1997). Due to the dominance of the clear sky conditions for long periods in the Mediterranean region photochemical activity is considerable at all scales (Kallos et al., 1997, Balis et al., 2002; Zerefos et al., 2002; Kouvarakis et al., 2002).

O3 and PM formation and transport are key issues in the region (Luria et al. 1996). In addition to this air pollution transport and transformation activity the uptake, transport and deposition of Saharan dust towards the Mediterranean region and Europe is an important factor that contributes significantly in air quality degradation, ecosystems and water management (Rodriguez et al., 2001; Oszoy et al, 2001; Levin et al., 1996; Givati and Rosenfeld, 2004, Kallos et al., 2006). This is a major factor that affects air quality in the region to such extend that many areas and cities cannot meet the imposed EU regulations (Rodriguez et al., 2001; WHO, 2003). The water budget in the Mediterranean region is in a critical balance and is a critical issue because it affects hundreds of millions of people and a fragile ecosystem.

The impacts of the PM and mineral dust on the water budget and radiative transfer are very complicated and can affect them in various ways (Nickovic et al., 2001, Oszoy et al., 2001, Kallos et al., 2006). It can lead to the warming of mid tropospheric layers and cooling of the surface and therefore suppress precipitation, it can reduce precipitation due the high amounts of CCNs (Rosenfeld, 2000; Levin et al., 2005) but it can lead to the appearance of heavy rainfall due to the formation of giant CCNs (Levin et al., 2005). Such giant CCNs can be formed in wet environment due to the coexistence and interactions of anthropogenically-produced pollution particles and natural particles such as sea salt and mineral dust.

Current status of knowledge: The current status of knowledge concerning the air pollution scales and paths of transport in the Mediterranean region is at relatively high level. Despite this fact the links to critical details described above and especially these with the climate and its variability need

further analysis and a multi-scale and interdisciplinary approach.

The existing records of air quality and climatic data are considered as sparse and mainly collected during past experimental campaigns.

The existing modelling tools that can be used for studying air pollution – climatic interactions and impacts are capable to analyse regional climatic and air pollution conditions of the Mediterranean region but they lack an integrated approach and feedback with the global scale climatic and air pollution changes.

Methodology followed: In order to achieve the imposed objectives an interdisciplinary approach is adopted. The proposed methodology includes the creation of a database containing current and future emission scenarios, past and future observations of air pollutants (surface, upper air, radiation, remote sensing etc), the development of a new generation integrated modelling system that will contain the necessary links between the various physico-chemical processes taking place and finally, perform limited area case studies analysis and climatic-type model simulations that will test the control strategies.

WP8.1: Emission inventories and scenarios
Responsible: Raes Frank (EC-DG-JRC)

Total project description: The development of an inventory of historical emissions will support the understanding of present air quality and climate forcing in the Mediterranean region. Application of the emission data for the period up to 2050 will support the understanding of potential future air quality and climate forcing in the Mediterranean region. For this purpose the emission scenarios developed under RL3.3 for the period 2005-2050 will be specialized for the Euro-Mediterranean Region in limited area modeling exercises. The work package on present day emissions and emission scenarios of air pollutants and greenhouse gases will facilitate the atmospheric and climate modeling studies in CIRCE by providing a consistent dataset of monthly anthropogenic historical emissions (1990-2005) on a 0.1° x 0.1° grid (for each year). The appropriate emission inventories for the selected case studies in WP8.4 will be provided with all the necessary parameters and details. By application of the historical and future emissions data in RL3 and RL8, the links between regional and global air quality can be studied. Application of the same emission inventory data by the different models and comparison with measurement data will allow proper evaluation of discrepancies between the model results and atmospheric observations.

WP8.1.1: Historical emissions (1990-2005) on 0.1x0.1degree lat-lon: The Emission Database for Global Atmospheric Research we be used to calculate anthropogenic emissions of air pollutants (gases and PMs) and greenhouse gases by sector and country with a temporal resolution of a month and spatial resoltion of 0.1x0.1 degree lat-lon. The work performed for RL8 is (i) the definition of allocations functions to allow for a spatial resolution of 0.1° x 0.1° grid suitable for the regional models applied in the project (based on location of large industrial facilities, highway maps, population) and (ii) the definition of allocation functions to calculate monthly emission fields. The spatial and temporal allocation functions will also be applied to the emission scenario studies as developed under RL3. Biogenic emissions will be calculated from the partner CEPEMPS, by utilizing existing work. The necessary assistance will be provided to make the parameterisations in the different atmospheric chemistry models. Future scenarios emissions inventories will be provided according to the needs of RL8.3-5 (existing work with no new development). (EC-DG-JRC, CETEMPS)

WP8.1.2: Verification study of historical direct and indirect aerosol emissions: Discrepancies

between satellite derived aerosol optical depths and those calculated by the models could be attributed to uncertainties in the models, observation and/or the applied emission inventories. DG-EC-DG-JRC will apply the TM5 model with a high resolution zoom over the Euro-Mediterranean (1°x1° and possibly 0.5°x0.5°) to link the current discrepancies between satellite derived aerosol optical depths and those calculated by models to assess inaccuracies in the emission inventories. (EC-DG-JRC, CETEMPS)

WP8.2: Observational data base and trend analyses
Responsible: Mihalopoulos Nikos (UOC)

Total project description: Collect and homogenize the existing observational data sets from various sources. The data collected will be from surface, airborne and remote sensing systems. Emphasis will be on the collection of specific data sets from large experimental campaigns that are focusing on specific processes and key species (e.g. airborne measurements related to radiative transfer, cloud microphysics, mid-tropospheric chemical transformations).

WP8.2.1: Complement the available observational data base of satellite products of tropospheric interest by the NO_2, SO_2, formaldehyde, CO and water vapor data products (tropospheric column densities), with capabilities in measuring the local, but vertically resolved, partitioning between water vapour and cloud liquid water in coincidence with aerosol and cloud particle observations, and from Thessaloniki and Athens columnar SO2 amounts since 1982 (UOC, CSIC, IASA/NKUA, CEAM, TAU, HUJI).

WP8.2.2: Compile the geographical distribution of PM10 and PM2.5 mass levels as well as of chemical species (dust, sulphate, nitrate, ammonia, marine aerosol, carbonaceous material and metals) across the Western and Eastern Mediterranean. Collect and compare available data on chemical composition of PM10 and PM2.5. Most of the series are already available (by the proposing groups) but new data will be obtained for specific locations of interest. In addition to these observational data sets the EARLINET data will be utilized for past cases and EARLINET-ASOS for recent and future profiles. (UOC, CSIC, HUJI, CETEMPS, IASA/NKUA, CEAM, HUJI, TAU).

WP8.2.3: Search, compile and validate additional data series of atmospheric pollutants for both basins, with special interest in O3, NOx, CO, PAN, HCHO, HCs, PM and atmospheric deposition (UOC, CSIC, CETEMPS, HUJI, TAU).

WP8.2.4: Make use of the J's measured during PAUR I and PAUR II campaigns both by aircraft flying over the Aegean Sea at various altitudes from sea level up to the tropopause and ground based measurements again at sea level and at a high mountain in Crete, in the presence of urban, Saharan, and natural aerosols (Zerefos et al., 2002, Balis et al., 2002). (IASA/NKUA).

WP8.2.5: Evaluate possible trends with special interest in ozone, PM and atmospheric deposition using statistical analysis of observational data, trajectory analysis and modelling results. (UOC, CSIC, IASA/NKUA).

WP8.3: Integrated Limited Area Modeling System
Responsible: Kallos George (IASA)

Total project description: The integrated modelling system will be based on the existing

atmospheric modelling systems RAMS and SKIRON/Eta with the dust cycle capabilities and the photochemical models CAMx and CMAQ. It will have basic capabilities like chemistry transport and transformation, mineral dust, sea salt spraying, cloud processes and radiative transfer algorithms that take into account the aerosol effects on cloud formation and precipitation. Emphasis will be given to develop the best parameterization of the ice nucleating (IN) processes considering the available data on the ability of mineral dust or of combination of mineral dust with sea salt and particulate of anthropogenic origin (formation of giant CCN and effective IN). This will be applied and tested to the model and compared with the well known formulation of Mayer et al. (1992). This latter parameterisation, which is presently extensively used in modelling, is known to have several deficiencies and must be replaced by a state of the art formulation. A series of test events and case studies will be organized in this WP in order to explore the capabilities of the new system. Additional case studies will be organized in WP8.4. The case studies will address selected events and periods, primarily to test the models and the emission inventories. The integrated modeling system that will be developed will use results from global chemistry-climate models for boundary conditions (RL3 and cooperation with University of Oslo, Prof. Ivar Isaksen). It will be applied in both modes hindcasting and forecasting for various spatiotemporal scales. Its capability to accurately predict weather and air quality in various spatiotemporal scales over the Mediterranean Region will be tested with operational weather and air quality data. This work is divided in the following tasks:

WP8.3.1: Develop the post-processing module of the general circulation atmospheric and chemical model that will provide the necessary initial and lateral boundary conditions for the integrated limited area modelling system (IASA).

WP8.3.2: Couple atmospheric chemistry and aerosol modules into limited area meteorological models. Compare the results from the algorithms that calculate the photochemical reaction rates (J values) in the chemistry module with the experimental data from past campaigns - make necessary adjustments. The atmospheric and chemistry modules of the models RAMS, SKIRON/Eta, CAMx, CMAQ will be integrated in order to be used for scenario and downscaling simulations. The community limited area system that will be developed will be optimized for the best computer performance (utilization of parallel computer platforms). (IASA).

WP8.3.3: Include mineral dust cycle into the integrated modelling system. The mineral dust cycle module developed and coupled with the SKIRON/Eta model system will be improved and coupled with the integrated system for extreme events, scenario and downscaling simulations. The SKIRON/Eta model with the dust module has been developed from the AM&WFG of NKUA and IASA at the framework of SKIRON, MEDUSE and ADIOS projects. The surface parameterisation and especially the incorporation of soil characterization that is appropriate for the Mediterranean and Saharan soils (rocky and sandy soils) will be further developed. Consideration of the rocky soil thermo-physical and hydraulic properties will be included. As it was found in preliminary testing this consideration of rocky soil is considered as very important for climate studies and especially in arid and semi-arid mid and low latitude areas like the Mediterranean Region. It is expected to reduce RMSE of the model parameters like temperature energy fluxes and wind speed near the surface according to recently finished (but not published yet) work at the AM&WFG. (IASA).

WP8.3.4: Include parameterisation of aerosol and dust effects on cloud microphysics into the integrated limited area modelling system. The RAMS model has a detailed cloud microphysical parameterisation that takes in to the account CCN concentrations. This scheme has to be improved by considering variable CCN concentrations as well as CCNs and Ice Nucleus (IN) with different hygroscopic properties. This is expected to improve model accuracy and especially in applications related to extreme events. Both groups (IASA and TAU) have long experience in such model development and applications. They will cooperate in module development and integration in the new modeling system. (TAU, IASA)

WP8.3.5: Evaluation of the integrated modelling system. The improved limited area modeling system will be evaluated for each of its components by comparing model results with observations available from extensive experimental campaigns like MEIDEX (TAU) and CARL (IASA). Study influences of aerosol effects on cloud microphysics and precipitation. The integrated modelling system that will be developed will be used to analyse cases of interest. Scenario simulations will be performed with and without the aerosol impacts on clouds and precipitation. Evaluation will be performed with existing data from past experimental campaigns like CARL and MEIDEX. (TAU, IASA).

WP8.4: Air Quality and Climate: Case Studies
Responsible: Levin Zev (TAU)

Total project description: The limited area community modeling system that will be developed and tested in WP3 will be tested for its accuracy to simulate air quality processes. This testing will be based on available emissions, weather air quality data. The system will utilize gridded meteorological and air quality fields from global systems (from RL3 and University of Oslo in cooperation with Invar Isaksen who will act as external scientific collaborator). The model simulations, together with measurement data, will be used to evaluate the influences of local air pollution as compared to long-distance transport for selected meteorological conditions to assess to what degree the "own responsibility" and "friendly neighbour" scenarios need to be pursued. A preliminary selection of case studies includes the strong biomass burning events in the summers of 2000 and 2001, as well as a major dust event in April 2005. Due to the long time series of available satellite data (from RL3 and RL4), these are well suited for case studies on particular regions and/or time intervals. Near Real Time satellite data could be provided to help planning promising campaigns in the future. The case studies will address links and feedbacks between atmospheric chemistry and meteorological processes relevant for climate simulations, with a focus on links with the regional atmospheric energy budget and the water cycle. This includes the scattering and absorption of solar radiation by PM, and the influences of aerosol particles on evaporation, clouds and precipitation. Downscaling techniques, i.e. from the global model results to local effects, will be tested and improved through the application of a range of model resolutions. A preliminary selection of case studies involves the anomalously wet winter of 2002 and the extremely warm summer of 2003.

WP8.4.1: Select the case studies that will be analysed and collect the emission data and measurements (meteorological and air quality) that are needed for model simulations (TAU, IASA, UOC, CSIC, CETEMPS, EC-DG-JRC).

WP8.4.2: Study regional recirculation systems of air pollution as influenced by local flow features (e.g. orographic, sea breezes, convergence zones) and microphysics and radiative transfer new model parameterisations. Emphasis will be given in the East Mediterranean part of Mediterranean. (IASA, TAU, CETEMPS).

WP8.4.3: Select and analyse cases in order to assess the influence of various European sources on regional air quality. As it was found in previous studies (e.g. T-TRAPEM, SECAP projects and reported in publications like Kallos et al. 1995, 1997, 2006, Millan et al., 1997, 2005) some areas in Europe and Mediterranean act as local pools of air pollutants where chemistry transformations take place and then they are transported to other locations (e.g. Black Sea and East Mediterranean, Kallos et al. 1998). Similar typical patterns have been reported in Central and Western Mediterranean. Simulations with the integrated modeling system will be performed for selected periods over specific locations with multi nesting model configurations (IASA, CETEMPS). Observational data from previous campaigns will be utilized for model validation (UOC, TAU,

CSIC, CETEMPS, IASA, NKUA).

WP8.4.4: Select and analyse cases in order to assess the importance of long-range transport of air pollution and mineral dust. In this task the long range transport paths and scales will be identified (to/from Mediterranean Region) with modeling activities that will be supported with observational data sets from previous experimental campaigns (e.g. MINOS). Transport and transformation of air pollutants from Europe towards Africa and Atlantic Ocean will be analysed. In addition, the possibility of transport from other remote locations like sub Sahel Region and Indian Ocean towards Mediterranean will be explored and impacts on Mediterranean climate will be discussed. Such transport patterns have been identified in the past (Kallos et al., 1993, 1997, 1999, 2006) but they still need further investigation by applying advanced tools like the integrated limited area modelling system and new data sets. (IASA, TAU, UOC, CSIC).

WP8.4.5: Perform downscaling studies for specific periods from the climate scenario simulations and especially for the period 1990-2050. In these studies the global circulation model and emissions scenarios will be utilized as initial and boundary conditions in the limited area integrated system (IASA, EC-DG-JRC, RL3 partners and University of Oslo with Ivar Isaksen).

WP8.5: High Resolution Reanalysis data set for the Mediterranean Region and the surrounding Areas
Responsible: Kallos George (IASA)

Total project description: The existing ECMWF reanalysis (ERA40) is considered as inappropriate for the proposed regional climatic analysis and especially the modeling exercises because of its coarse resolution. In order to construct time series of various climatic parameters and minimize the initialisation errors in modeling a high temporal and spatial resolution reanalysis will be prepared for a large area around the Mediterranean. The basic product of this activity will be the construction of a high resolution data base as a result of the compilation of all the existing surface and upper-air observations together with the existing ECMWF reanalysis. The produced fields will be with smaller temporal intervals while the horizontal resolution of around 0.15 - 0.10 degree will allow the description of the higher frequency disturbances that are absent in the current reanalysis (inclusion of mesoscale features in the analysis fields). The existing reanalysis fields have been prepared for global scale studies and applications and are not considered as appropriate for mesoscale type of analysis and modeling (Katsafados et al., 2005). The proposed reanalysis will be of regional type that will cover Europe and Mediterranean together with a large area of Africa, Asia and Atlantic Ocean. The technique that will be used is based on a 3-D limited area assimilation package. Initialising a limited area modeling with such a resolution data set is absolutely necessary for modeling exercises related to cloud structure analysis, heterogeneous chemistry and radiative forcing. The produced reanalysis fields will be utilized also from the other WP-ges and especially WP2, WP3 and WP4 as well as from other CIRCE RLs (e.g. RL4, RL5, RL6) and other projects currently funded from EU or national sources. This reanalysis effort is considered as very complicated and resource demanding. Professors Eugenia Kalnay and Fedor Mesinger from University of Maryland and NOAA/NCEP will be in close cooperation because she has a valuable experience in this subject from her previous work at NOAA/NCEP. They will act as external scientific collaborators of this task and will be invited to cooperate with IASA group (expenses covered by CIRCE). The proposed work is divided in the following tasks:

WP8.5.1. Development of the high resolution reanalysis package. The system under development will be based on the limited area assimilation system LAPS and SKIRON/Eta that is used for mesoscale operational forecasting.

WP8.5.2. Collection of the existing meteorological observations from various sources (surface, upper air, ships, aircrafts, special events). Quality control, System validation and readjustments are some tasks that will be carried out in this WP.

WP8.5.3. Preparation of the high resolution reanalysis fields for the period 1986-2005.

WP8.6: Coordination and Communication
Responsible: Kallos George (IASA)

Total project description:

Management activities:

1. Website, for exchange and communication
2. Representation of research line at project management meetings
3. Organisation of meetings and workshops within RL8
4. Management and financial reports for the Commission
5. Coordination with RL2, RL3, RL4, RL5 and RL6
6. Cooperation with the project coordinator and in general with RL0
7. Cooperation with related and running projects
8. Dissemination of the RL8 results

References

Balis, D.S., C.S. Zerefos, K. Kourtidis, A.F. Bais, A. Hofzumahaus, A. Kraus, R. Schmitt, M. Blumthaler, G.P. Gobbi, “Measurements and modeling of photolysis rates during the PAUR II campaign”, J. Geophys. Res., 107, D18, 10.1029/2000JD000136, 2002.

Givati, A. and D. Rosenfeld, 2004: Quantifying precipitation suppression due to air pollution. J. Appl. Meteorol., 43, 1038-1056.

Kallos G., Kotroni V., Lagouvardos K., Varinou M., Uliasz M., Papadopoulos A., Luria M., Peleg M., Sharf G., Matveev V., Alper-SimanTov D., Vanger A., Tuncel G., Tuncel S., Aras N., Gullu G., and Al-Momani I., 1997: "Transport and Transformation of Air Pollutants from Europe to the East Mediterranean Region (T-TRAPEM)" Environmental Research Program AVICENNE. ISBN960-8468-07-8.

Kallos, G., V. Kotroni, K. Lagouvardos, and A. Papadopoulos, 1999: On the transport of air pollutants from Europe to North Africa. Geophysical Research Letters. 25, No 5, 619-622.

Kallos, G., P. Katsafados, A. Papadopoulos and S. Nickovic, 2006: Trans-Atlantic Saharan dust transport. Model simulation and results, J. Geophys. Res., In press

Katsafados, P. A. Papadopoulos, and G. Kallos: Regional atmospheric response to tropical Pacific SST perturbations. Geophysical Research Letters, Vol. 32, No. 4, L0480610.1029/ 2004GL021828, 2005.

Kouvarakis, G., M. Vrekoussis, N. Mihalopoulos, K. Kourtidis, B. Rappengluck, E. Gerasopoulos, C. Zerefos, "Spatial and temporal variability of tropospheric ozone (O3) in the boundary layer above the Aegean Sea (Eastern Mediterranean)", J. Geophys. Res., 107, D18, 10.1029/2000JD00081, 2002.

Levin, Z., E. Ganor, and V. Gladstein, 1996: The effects of desert particles coated with sulphate on rain formation in the eastern Mediterranean. J. Appl. Meteorol., 35, 1511-1523.

Levin, Z., A. Teller, E. Ganor, and Y. Yin, 2005: On the interactions of mineral dust, sea salt particles and clouds – measurements and modeling study from the MEIDEX campaign. In press J. Geophys. Res.

Luria, M., M. Peleg, G. Sharf, D. Siman Tov-Alper, N. Spitz, Y. Ben Ami, Z. Gawii, B. Lifschitz, A. Yitzchaki, and I. Seter. 1996: Atmospheric sulfur over the Mediterranean region. J. Geophys. Res., 101, 25917-25930.

Mayers, M.P., P.J. DeMott, and W.R. Cotton, 1992: New primary ice-nucleation parameterisations in an explicit cloud model. J. Appl.Meteor., 31, 708-721.

Millan M.M., Salvador R. Mantilla E. and Kallos G., 1997: "Photooxidant Dynamics in the Mediterranean Basin in Summer: Results from European Research Projects" J. of Geophysical Research -Atmospheres., 102, D7, 8811-8823.

Nickovic, S., G.Kallos, A. Papadopoulos and O. Kakaliagou, 2001: A model for prediction of desert dust cycle in the atmosphere. J. Geophysical Res., Vol. 106, D16, 18113-18129.

Ozsoy, E., N. Kubilay, S. Nickovic, and C. Moulin (2001), A hemisphere dust storm affecting the Atlantic and Mediterranean in April 1994: Analyses, modeling, ground-based measurements and satellite observations, J. Geophys. Res., 106, 18439-18460.

Rodriguez, S., X. Querol, A. Alastuey, G. Kallos and O. Kakaliagou, 2001. Saharan dust contributions to PM10 and TSP levels in Southern and Eastern Spain. Atmos. Environ. 35, 2433-2447.

Rosenfeld, D., 2000: Suppression of rain and snow by urban and industrial air pollution, Science, 287 (5459), 1793-1796.

WHO (2003). Health aspects of air pollution with particulate matter, ozone and nitrogen dioxide. World Health Organization, 95 p.

Zerefos, Zerefos, K. Kourtidis, D. Melas, D.S. Balis, P. Zanis, H. T. Mantis, C. Repapis, I. Isaksen, J. Sundet, J. Herman, P.K. Bhartia, B. Calpini, "Photochemical Activity and Solar Ultraviolet Radiation Modulation Factors (PAUR): An overview of the project", J. Geophys. Res., 107, D18, 10.1029/2000JD000134, 2002.

RL9 - Human Health

Menne Bettina (WHO-Europe), Bensalah Afif (IPT)

Objectives: The overall objectives of this research line are

• To identify and assess selected health impacts of climate change in the Mediterranean
• To contribute to the Regional Climate Change assessment (RACCM) by estimating the potential health impacts of climate change in selected Mediterranean countries
• To train epidemiologists and health workers in assessing the health impacts of climate change
• To discuss with stakeholders meetings potential strategies in reducing health impacts.

Description: The IPCC Third Assessment Report (McMichael and Githeko 2001). stated that climate change is affecting health in various ways like an increase in the frequency or intensity of heat waves will increase the risk of mortality and morbidity; regional increases in climate extremes (storms, floods, cyclones, etc.) are associated with physical damage, population displacement, and have adverse effects on food production, freshwater availability and quality, and would increase the risks of infectious disease epidemics; and changes in climate, including changes in climate variability, would affect many vector-borne infections, through ecosystem and other changes and might in particular affect populations at the margins of current distribution of diseases. Since the publication of the TAR, more information is available at national level and at local levels on population vulnerability to climate change. Several countries have undertaken health impact assessments, either as part of a multi-sectoral study, such as the United States, Canada, India, and Portugal (National Assessment Synthesis Team 2001; Calheiros and Casimiro 2002; Shukla, Sharma et al. 2003; Canada 2004) or a stand alone project, such as the United Kingdom (Department of Health 2002) and Australia (McMichael, Woodruff et al. 2003).

With the exception of Portugal and Spain, and some threat or disease specific assessments (heat and air pollution in 8 Mediterranean cities, as well as the impact of temperature increases on salmonella) little has been assessed in Mediterranean countries. The assessment of future impacts is to be seen in the context of multiple exposures on certain population groups. These can be addressed through integrated assessments that take into consideration other important determinants of ill health, and health inequalities. Assessments of environmental health exposures require robust evidence of causal effects from a variety of populations and settings to reach the expected high standards of evidence. Certain populations (urban, rural, coastal) are likely to face a range of environmental health problems that may be exacerbated by climate change. Quantitative estimates of future scenario-based health impacts have problems with validity, uncertainty, and contextual reality.

Over the last five years substantial efforts have been made to better understand these complexities at national level, as well as global estimates of attributable burden of disease have been generated (Patz, Campbell-Lendrum et al. 2005). The WHO has developed methodological guidance material (Kovats, Ebi et al. 2003) on how to better assess and quantify the health impacts of climate change. The project proposes both to use the guidance material to assess the health impacts of climate change at national level in selected countries as well as using the knowledge on specific health outcomes to generate specific Mediterranean estimates.

Climate change is now an issue of concern for health policy. Some climate-specific adaptation measures have started to be developed and implemented both within the health sector and beyond, mostly in relation to preparedness for extreme events and infectious diseases.

Integration: The success of this research line will be very much dependent on the data and information provided by the research lines dealing with the climate systems and in particular extreme events as well as by information on determinants of health like water, air pollution, economics and societal systems. On the other end the organization of this research line can be contributing to the case studies in research line 12 and generate information on social dynamics and adaptation processes, in particular through the stakeholders involved.

Coordinators: Menne Bettina (WHO-Europe), Bensalah Afif (IPT)

Participants: Klea Katsouyanni (NKUA), Paola Michelozzi (ASLRME.DE), Xavier Rodo (PCB-LRC), Elsa Casimiro (ICAT-UL)

Objectives:

The goal of human health research line of the project is to

identify and assess the observed impacts of climatic changes on human health

estimate the present and future risks of climate change for human health in the Mediterranean

discuss strategies of reducing impacts and explore adaptation needs

Description of work:

The work is divided in four basic steps:

1. Preparatory phase
2. Meeting
3. Data collection and analysis
4. Communication and outreach of results

1. Preparatory phase (Month 1-8)

a) Teleconference, website (Months 1-2, all partners)

A first meeting (teleconference) will be organized between the project partners to discuss the detailed development and workplan of the project. An internal website will be set up to facilitate and coordinate better communication. Development of the detailed implementation plan (WHO)

b) Literature review (Months 3-8, all partners)

A systematic literature review (in Arabic, English, French and other languages) will be achieved including scientific work on health impacts of climate change in Mediterranean countries. In particular the impacts of heat and air pollution on health and the impacts of climate change on infectious diseases (with a special consideration to water scarcity) will be focused.

c) Training material (Month 3-8, ICAT-UL)

The WHO and UNDP had developed different training modules on "assessing the health impacts of climate change and advice on adaptation measures" which need to be screened, updated, adjusted, systematized and adapted to the needs of the Mediterranean countries. In addition, guidelines on carrying out epidemiological and statistical analysis need to be developed and incorporated into the training manual. Further the material needs to be translated into local languages.

d) Protocol for assessing heat related health impacts and infectious diseases (Month 3-8, NKUA, ASLRME.DE, PCB-LRC, IPT)

In order to assess the health impacts of extreme temperatures and air pollution in 6 Mediterranean cities (Palermo, Lisbon, Istanbul, Tel Aviv, Tunis and Cairo), time series approaches will be used. In order to carry out this work the following is needed: to identify the contact persons from the city health institutions in the selected cities; actively collect all available data on meteorology, air pollution and mortality from the selected cities; develop the assessment protocol and apply an already standardized methodology (PHEWE/EuroHeat) to evaluate the impacts of weather and air pollution on mortality in the selected cities. Data and information are already available from some Mediterranean cities, like Athens, Rome, Barcelona, as elaborated in the EuroHEAT and PHEWE project.

For assessing the climate change impact on infectious diseases present in the Mediterranean Area, current patterns of distribution of certain diseases will be identified and risks under the changing climate will be estimated. Therefore, a protocol on information collection, data collection and

analysis needs to be developed. Data on specific infectious diseases, like leishmania, malaria, diarrhoeal diseases will be collected and experts will be consulted to estimate current and future risk of these diseases in the Mediterranean Region under different developmental and climate scenarios.

2. Meeting of health professional from Mediterranean countries (Months 11, all partners)

A one-week meeting will be organized in Tunis, with the aims:

a) To inform health officials about the health impacts of climate change;

b) To train them to carry out health impact assessment (examples of in depth health impact assessment including elaboration of adaptation strategies will be developed for Turkey and Tunisia);

c) To provide them with epidemiological and statistical methods in carrying out the basic data collection and analysis;

d) To discuss future information and communication needs;

e) To discuss adaptation needs and formulate policy recommendations.

3. Data collection and analysis (Months 12-23, all partners)

In the third phase, the assessment of the health impacts of extreme temperatures and air pollution in 6 Mediterranean cities and the assessment of the climate change impact on infectious diseases will be achieved by doing time series analysis, comparative risk assessment and mapping of results.

The risk assessment (time series and episode analysis) in the selected cities will focus on heat and air pollution in urban areas using PHEWE/EuroHEAT methods basing on daily mortality and meteorological indicators. The results will allow understanding the relative risks for deaths in summer and winter time, the risks during heatwaves, population groups at risk and the role of air pollution. Further it will allow evaluating the differences between the included cities in terms of effect modifiers, namely demographic, socio-economic and environmental characteristics.

The risk assessment on infectious disease will be achieved through an intensive and systematic literature review, the collection of data on specific climate-sensitive infectious diseases through questionnaires and an expert meeting to discuss the collected information and to estimate future risks for different diseases and for different public health policies and adaptation responses.

In two selected countries, namely Turkey and Tunis, a health impact assessment will be carried out

4. Communication and outreach of results (Months 24, all partners)

Results will be compared in a combined Mediterranean health impact assessment with adaptation strategies. Results will take into account the past and present health impacts, future estimates under different scenarios as well as conditions of multiple stresses and exposures.

Activities in first 18 month:

- Organize an internal meeting (teleconference) to develop the detailed implementation plan (WHO Europe, IPT);
- Set up an internal communication mechanism (web site) (WHO Europe);
- Achieve a systematic and comprehensive literature review on the health impacts of climate change in the Mediterranean (all partners);

- Identify the contact persons from the health institutions in the Mediterranean countries (all partners);
- Develop the assessment protocols and data collection protocols (questionnaire for infectious diseases) (NKUA, ASLRME.DE, PCB-LRC, IPT);
- Develop a training module on Health impact assessment, epidemiological and statistical analysis, observed and predicted climatic changes and risks for human health to be held during the workshop in Tunis (ICAT-UL);
- Organize a week of workshop in the Mediterranean Region (Tunis) to identify the climate change impacts and risks to be considered for a health impact assessment and to elaborate methods taking into account the global/regional models and scenarios (all partners), including training of epidemiologists and statistician from the selected countries to use the methodology and assist in the analysis and interpretation of the data (ICAT-UL)
- Collect the data and information and carry out the analysis (NKUA, ASLRME.DE, PCB-LRC, IPT);
- Assist in undertaking in-depth health impact assessment for Turkey and Tunisia (WHO, IPT);
- Evaluate the results and compile report (all partners);
- Formulate adaptation strategies (all partners);
- Facilitate exchange within the health RL, integrate, map and graphically visualize the outcome of RL 9 (WHO Europe);
- Disseminate information (e.g. relevant data, protocols, guidelines for good practice, etc) inside and outside the health and environment sectors (WHO Europe, IPT).

WP9.1: Methods, policy development and integration
Responsible: Menne Bettina (WHO-Europe)

Total project description: The Methods and policy development WP has the goal to identify and formulate the climate change health impact assessment needs, by involving stakeholders from Mediterranean countries; to train epidemiologists from Mediterranean countries to carry out a climate change health impact assessment (quantitatively and qualitatively) based on the WHO methodological guidance; and to carry out climate change health impact assessments in 2 selected countries. In order to do this a workshop in the Mediterranean Region (Tunis) will be organized to identify the key climate change impacts and risks to be considered for a health impact assessment and to elaborate methods taking into account the global/regional models and scenarios; and the results will be elaborated through country and topic specific reports.

WP 9.1 will further coordinate the workline and make the information available both to the project as well as through the WHO website.

WP9.2: Assessment of Health impact of extreme temperature and air pollution in the MedRegion
Responsible: Katsouyanni Klea (NKUA)

Total project description: The goal of this workpakage is to assess the health impacts of extreme temperatures and air pollution in 6 Mediterranean cities (Palermo, Lisbon, Istanbul, Tel Aviv, Tunis and Cairo), by using time series approaches. Data and information are already available from Mediterranean cities, like Athens, Rome, Barcelona, as elaborated in the EuroHEAT and PHEWE project. Results will be compared in a combined Mediterranean assessment. In order to carry out this work cities need to be selected and contacted, data availability assessed, a data analysis and collection protocol developed, statisticians to be trained to carry out the assessment. The final deliverable will be the estimation of the attributable deaths of summer and winter climates in the Mediterranean, and if possible this can be plaid in the scenarios by estimating increase of attributable deaths under different climate scenarios.

WP9.3: Risk assessment on infectious diseases
Responsible: Bensalah Afif (IPT)

Total project description:

The goal of this workpakage is to assess the health impacts of climate sensitivit infectious disease in the Mediterranean region. For assessing the climate change impact on infectious diseases in the Mediterranean Area, the relationship between climate and disease should be understood in order to identify the key factors (epidemiological, climatic o social) that allow climate variability to drive some infectious disease dynamics. This information will be combined with the distribution patterns (current and potential under different scenarios) of certain diseases in order to estimate risks under the changing climate. Therefore, besides achieving a comprehensive literature review, also a protocol on information collection and data analysis needs to be developed. This will then be used to compile information and data on specific infectious diseases, like leishmania, malaria, diarrhoeal diseases. In order to carry out this work, the follwing steps have to be done: contact countries in the Mediterranean, assess data availability, develop a data analysis and collection protocol and train statistitians to carry out the assessment. Finally, experts will be consulted to estimate current and future risk of these diseases in the Mediterranean Region under different developmental and climate scenarios. The final deliverable will be the estimation of the attributable deaths from climate sensitivie infectious disease in the Mediterranean, and if possible this can be modelled in the scenarios by estimating increase of attributable deaths under different climate scenarios. Results will be included in the combined Mediterranean assessment.

.

Activities in first 18 month:

- Organize an internal meeting (teleconference) to develop the detailed implementation plan (WHO Europe, IPT);
- Set up an internal communication mechanism (web site) (WHO Europe);
- Achieve a systematic and comprehensive literature review on the health impacts of climate change in the Mediterranean (all partners);
- Identify the contact persons from the health institutions in the Mediterranean countries (all partners);
- Develop the assessment protocols and data collection protocols (questionnaire for infectious diseases) (NKUA, ASLRME.DE, PCB-LRC);
- Develop a training module on Health impact assessment, epidemiological and statistical

analysis, observed and predicted climatic changes and risks for human health to be held during the workshop in Tunis (ICAT-UL);

- Organize a week of workshop in the Mediterranean Region (Tunis) to identify the climate change impacts and risks to be considered for a health impact assessment and to elaborate methods taking into account the global/regional models and scenarios (all partners), including training of epidemiologists and statistician from the selected countries to use the methodology and assist in the analysis and interpretation of the data (ICAT-UL)
- Collect the data and information and carry out the analysis (NKUA, ASLRME.DE, PCB-LRC);
- Assist in undertaking in-depth health impact assessment for Turkey and Tunisia (WHO);
- Evaluate the results and compile report (all partners);
- Formulate adaptation strategies (all partners);
- Facilitate exchange within the health RL, integrate, map and graphically visualize the outcome of RL 9 (WHO Europe);
- Disseminate information (e.g. relevant data, protocols, guidelines for good practice, etc) inside and outside the health and environment sectors (WHO Europe, IPT).

WP9.4: Management of RL
Responsible: Menne Bettina (WHO-Europe)

Total project description:

- management and coordination
- reporting
- communication
- dissemination

References

Calheiros, J. M. and E. Casimiro (2002). Human Health. Climate Change in Portugal: Scenarios, Impacts, and Adaptation Measures - SIAM project. F. D. Santos, K. Forbes and R. Moita. Lisbon, Gradiva: 241-300.

Canada, E. (2004). Climate change impacts and adaptation: a Canadian perspective. Ottowa, Natural Resources Canada.

Department of Health (2002). Health Effects of Climate Change in the UK. London, Department of Health.

Kovats, R. S., K. L. Ebi, et al. (2003). Methods of assessing human health vulnerability and public health adaptation to climate change. Copenhagen, WHO/WMO/Health Canada.

McMichael, A., R. Woodruff, et al. (2003). Human Health and Climate Change in Oceania: Risk Assessment 2002. Canberra, Commonwealth of Australia.

McMichael, A. J. and A. K. Githeko (2001). Human Population Health. Climate Change 2001. Impacts, Adaptations and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. J. J. McCarthy, O. F. Canziani, N. Leary, D. J. Dokken and K. S. White. New York, Cambridge University Press: 453-485.

National Assessment Synthesis Team (2001). Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change. Cambridge, Cambridge University Press.

Patz, J. A., D. Campbell-Lendrum, et al. (2005). "Impact of regional climate change on human health." Nature 438(7066): 310.

Shukla, P. R., S. K. Sharma, et al. (2003). Climate change and India: vulnerability and adaptation assessment.

RL10 - Economic Impacts of Climate Change

Roson Roberto (FEEM), Shechter Moti (HU)

Objectives:

- To study the impacts of climate change on
  (i) tourism, with a particular focus on temporal shifts and indirect effects
  (ii) labour and retirement migration
  (iii) extreme weather, with a particular focus on cities, water and insurance
  (iv) energy consumption
  in the Mediterranean.
- To provide an economic dimension to the assessment of physical impacts of climate change in the Mediterenean
- To evaluate the systemic effects on relative competitiveness, value of resources and trade flows, induced by climatic events

Description: Most impacts of climate change are on the natural system (RLs 5, 7 and 8), some of which may be transmitted to the human system (RL10). Other impacts are directly on humans, for example health (RL9). This RL focuses on direct economic impacts of climate change in the Mediterranean, particularly on the impacts of climate change on tourism, migration, extreme weather events, and energy consumption.

The literature on the impacts of climate change on tourism is growing fast, but most studies have focused on spatial shifts. For the Mediterranean, current models project that tourists would increasingly prefer to spend their holidays in Northwestern Europe. These models, however, do not allow for temporal shifts. While beach holidays in July and August may indeed become uncomfortably hot, spring, autumn and even winter holidays in the Mediterranean become increasingly attractive. We will study the importance of temporal shifts versus spatial shifts. In this, we will study not only the mean weather, but also weather extremes such as heat waves.

In addition, the spatial resolution of the analysis will be increased, so that we can also study the potential of shift towards the cooler mountainous areas of the Mediterranean.

As a further contribution, the tourism work package will study the indirect impacts of climate change, through air quality, water quality, landscapes, and coastal protection. We will estimate the

effects of these factors on current and past tourism demand, and use the results to project the future impacts of climate change, building on the scenarios developed elsewhere in the proposed integrated project.

The impacts of climate change on migration have hardly been studied. Labour migration is important in the Mediterranean. Both push and pull factors may be affected by climate change. Income gaps are a strong pull factor, and it is widely believed that climate change will disproportionally hurt the poor. This would increase the income disparities between the north and the south shores of the Mediterranean and increase migration. Push factors may further enhance this, for instance through increased drought.

The Mediterranean is also host to another set of migrants, namely retirees from Northwestern Europe. Their numbers may well increase substantial as the baby-boomers retire, but this trend may be reversed if the risks of forest fires and heatwaves become too large in the Mediterranean while the climate of England and Germany becomes more pleasant. Based on similar research in the USA, we will estimate the determinants of retirement migration, and use the results to project future decisions.

The impacts of climate change on extreme weather are the subject of RL6. Here, we will focus on the impacts on the economy, in three areas. First, the impact of climate change on urban infrastructure will be estimated, with a particular focus on transport infrastructure. The second emphasis will be on water management, including urban water management in the face of flash floods, and cooling water for power plants. Third, the impact of climate change on insurance will be studied -- including the potential shift from commercial to mutual and informal insurance.

The impact of climate change on energy consumption are the fourth topic of this research line. Climate change would reduce the demand for heating in winter, and increase the demand for cooling in summer. Previous studies have focussed on OECD countries and used annual average conditions. We will expand the analysis to all countries in the Mediterranean, and include seasonal temperatures. Obviously, we will control for other factors, such as the price of energy and capacity constraints. The results will be used to project the impact of climate change future energy use in the Mediterranean.

Moreover this RL will assess the economic impact of physical effects, like sea level rise, or changes in precipitations in the Mediterranean area. Emphasis will be given to a general equilibrium analysis, in which the Mediterranean and the world economy are conceived as a complex system of interrelated markets. This is needed, as the economic consequences of physical impacts will not be confined to the region where they occur.

This RL will have a horizontal, cross-cutting structure, since it will be interfaced with other RLs, providing input data about physical impacts of climate change in the Mediterranean. This information will be subsequently translated into economically meaningful variables like: changes in capital and infrastructure stocks, labour and total productivity variations, and so on.

In parallel, specific analyses will be conducted, also at the micro level, to better understand how economic agents and systems will adapt and react to the changing natural environment.

A specific workpackage is also devoted to the economic valuation of biodiversity in the Mediterranean.

WP10.1: Coordination
Responsible: Roson Roberto (FEEM)

Total project description: The coordination workpackage for this RL will consist of activities similar to other coordination workpackages of other RLs: organization of regular meetings among RL members, technical workshops within specific workpackages, participation to management board and general meetings, contribution to the development and maintenance of a web site. In addition, this RL will develop a common CGE modelling platform, to be used for different workpackages within this RL, as well as in other RLs. Also, the model will need critical information produced by other RLs. This means that additional coordination activities will be undertaken, due to the cross-cutting nature of this research line.

WP10.2: Tourism
Responsible: Tol Richard (UNIHH)

Total project description: Tourism is an important industry in many Mediterranean countries. Tourism is susceptible to climate change. Warming may induce tourists to travel to more northerly destinations instead, or travel in spring and fall rather than in winter. Climate change may also change the landscape (e.g., through water shortages), and may affect air and water quality. This could further deteriorate the competitive position of the Mediterranean tourism industry. Furthermore, adaptation to climate change could affect tourism; coastal protection, for instance, could negatively affect the attractiveness of beaches, a major asset to the tourism industry. In this work package, we will extend previous climate change and tourism research, with a major focus on the Mediterranean. Work package 10.2.1. Heatwaves and seasonal shifts Data will be collected (from published statistics and tourist organisations) on the temporal distribution of tourists in selected Mediterranean resorts, if possible by country of origin and age/life stage. This data will be combined with data on climate, weather, beaches, tourists facilities and attractions, prices, and so on. This activity will be done in collaboration with WP10.2.2.

The data will be used to estimate economic models of tourist behaviour. Such models necessarily include as many determinants as possible of destination choice, but the analysis will focus on the question, under a scenario of warming, what fraction of summer tourists would continue to visit Mediterranean resorts, what fraction would choose a cooler location, and what fraction would shift to spring and fall. We will use a similar model to study the impact on winter tourism, which may be positive (as it would get more pleasant in the Mediterranean, that is, more pull) as well as negative (as it gets more pleasant in Germany and the UK too, that is, less push). The above analysis is mainly constructed in terms of shifts in the average temperature. In a next step, we will study the effect of (the risk of) heatwaves and flash floods on tourist behaviour. The 2003 heatwave saw many tourists going home. For the tourist industry, a more important question is whether tourists returned later, or whether a substantial fraction of tourists is turned off for good by a single, bad experience. This analysis requires time series of visitor numbers, and will therefore be spatially more confined than the above analyses. Work package 10.2.2. Environmental quality We will develop our current database on tourist numbers to have a comparable spatial resolution in the Southern and Eastern Mediterranean as it does in the European Union (NUTS2). The data base will be combined with data on climate, air quality, water quality, landscape, coast type, and, if possible, coastal protection schemes. Tourist attractions and facilities as well as prices will be added too. This activity will be done in collaboration with Work Package 10.2.1. Based on this data, we will estimate destination choice and hedonic price models of tourist behaviour. The destination choide models will be used for scenario analysis of shifts in tourist flows should it get warmer, should eutrophication get worse, should prices fall, and so on. The hedonic price models are better suited to study the intensity of tourists' dislike of the changed situation; more specifically, these models can be used to estimate how much tourists should be offered in compensation (say, by reduced room rates) in order to keep them coming. (Alternatively, if the situation improves, hedonic price models

would indicate by how much prices could be raised.) Combined, destination choice and hedonic price models can be used to estimate shifts in tourists flows including the adaptive responsive by tourist suppliers; and to estimate changes in profits and welfare. Work package 10.2.3. Simulation models WP 10.2.1 and 10.2.2 estimate empirical relationships between tourist flows and indicators of weather, climate, and the environment. In WP 10.2.3, these statistical relationships will be implemented in a geographical information system (GIS) and used for exploring a wide variety of scenarios. The aim of using the GIS is to get finer spatial detail that the large administrative units at which socio-economic statistics are collected. An important component of this work package is therefore to develop, test and apply downscaling techniques for such data. Of course, GIS layers for all the variables in the model need to be constructed. Furthermore, these layers need to tied to the scenarios of climate change and socio-economic development used in other parts of the proposed integrated project. The analysis will include a variety of stresses, and will allow tourists to shift both in time and in space. The resulting spatially explicit model will be used to analyse scenarios of a variety of changes, so as to gain insight into the relative strength of threats and opportunities to the tourism industry in the Mediterranean.

WP10.3: Migration
Responsible: Maddison David (UBIRM)

Total project description:

WP10.3.1. Labour migration

The broad aim of this work package is to explore the impacts of climate change on labour migration within the Mediterranean, focussing in particular on migration from South to North. Climate change affects socio-economic systems through impacts on key vulnerable sectors, including water (floods and droughts), agriculture, health, fires, and sea level rise.

Migration induced by climate change is evident for extreme weather events, particularly floods. But also the gradual degradation of natural resources, impacts on production and consumption, and diminished productivity may induce the mobility of labour.

In the South Mediterranean, climate change is likely to have severe impacts on the regional economy, particularly through drought. This may exacerbate political and institutional conflicts, due to increase resource scarcity and poorly defined entitlements. This may force people to abandon unproductive lands and seek higher incomes and more secure livelihoods elsewhere. Previous studies of desert communities show that they are highly responsive to small changes in the climate, and particularly to extreme events. In the North Mediterranean, sea level rise and impacts on economic sectors may induce labour mobility.

The focus of this research will be on the socio-economic and environmental factors pushing and pulling migration.

Standard theory acknowledges the role of expected earning gaps as the primary determinant of migration, arguing that the higher expected earnings in the destination region would induce people to migrate. The new economics of migration views migration rather as part of a household's risk-diversification strategy, whereby the gains from remittances would compensate for shortcomings in the sending region. Based on these theories, a few hypotheses about the impact of climate change can be formulated:

- Climate change impacts on the economy would increase poverty and widen the expected earning gap, increasing migration.

- Uncertainty about climate change, exacerbated by institutional failures, and increases in weather variability would increase the need to diversity risks, increasing migration.

To test these hypotheses for the Mediterranean, we will collect data on climate and migration and use econometric methods to analyse this data. In addition, a case study will be developed in more detail.

WP10.3.2. Retirement migration

With the free movement of people in the European Union, a new phenomenon has emerged: People from northern Europe retire in increasing numbers in the Mediterranean, particularly in Southern France, the Balearic Islands, and Portugal. As the baby-boomers are about to retire, the numbers may well increase substantially. An influx of retirees and their pensions stimulates demand in the host regions, but also drives up prices and skews the economy towards the particular needs of the elderly. The pleasant climate is probably a major factor in the decision to retire in the Mediterranean, although other factors such as cost of living, culture, and landscape also play a role. We will collect data on the location decisions of retirees. We will regress the chosen, presumably preferred location on a range of characteristics of the retiree, including income, age, health, marital status, and education, and on a range of characteristics of the location, including climate, landscape, culture, medical care, and living costs. As a pilot study, we will do this for British retirees. If data and time permit, we will repeat the study for German and Dutch retirees. Based on the empirical analysis, we will construct scenarios of future retirement migration, using variations in economic growth, aging, pensions, and of course climate change.

WP10.4: Extreme weather

Responsible: Hourcade Jean Charles (CNRS/IPSL)

Total project description: The overall objective of the WP is to assess the economic and social impacts of changes in extreme weather conditions in the Western Mediterranean area, including unprecedented temperatures, large periods of droughts, storms and sudden rainfalls. This assessment will take into account a) the uncertainty of the magnitude and direction of these changes, their volatility b) the various possible adaptation patterns as a product of the technico-economic inertia and of the quality of private and collective foresight. The key considered channel of these impacts will be changes in the water cycle.

Over the first eighteen months, this WP will first use the outcome of climate models from RL5, from previous projects (e.g. Prudence, Mice, Stardex) to build maps figuring the move of general climate conditions (temperature and rainfall) following the method of analogues as used in Hallagette et al (2006). These maps, calibrated on several models will help to capture uncertainty in climate change prediction.

Second, spatial information on existing land-use, present irrigation potential, water requirements for electricity generation (hydropower and cooling requirements for thermoelectricity) and concentrations of water requirements for sanitisation and drinking (large cities) in the Mediterranean regions will be used to construct generic ” dependence functions" linking climate conditions, water availability and human activities. These dependence functions will be discussed with the Water Scarcity Group near the European Commission. They will allow first to write various “vulnerability maps” detecting three main sources of climate change damages *in a no adaptation scenario*:

- tensions on water use (agriculture, electricity, sanitisation, drinking)

- productivity changes of existing land-use patterns
- risks of forests fires and its implications in terms of value of assets and real estate

Over the four years program, sets of scenarios will be generated, using the analogue technique to compute new distributions of land-use and water management patterns, in function of the new climatic condition and accounting for various adaptation patterns. One key point to assess the vulnerability of societies will be the specifics of behavioural routines in individual behaviours, agriculture, energy generation, land and urban planning and the political constraints impinging upon the deployment of adaptation strategies. Resulting tensions and related propagation effects will be analysed using Nexus-agri and Nexus-elec, two sector models which are connected in the same macro-economic framework, Imaclim-R, a multisector general equilibrium with disequilibrium. The analysis of these tensions will include various prospects of existing tensions in agricultural markets and try and have a rough estimate of consequences of various adaptation schemes on tensions within the EU, within the maghrebian countries and the resulting impact on migration flows.

Over the following eighteen months, we will concentrate on supply- side measures on the water management (water storage, long distance transmission, reduction of leakages) and on electricity (changes in the structure of electricity supply, transmission networks) as a way of alleviating the tensions on water. The objective is to scrutinise the viability of such supply-side responses and the risks of sunk costs and ill-adaptation it entails in a context of volatility of climate signals, imperfect foresight (with various assumptions of progressive acquisition of knowledge) and institutional constraints leading to coordination failures when faced to controversial risks. One critical point will be to highlight the sources of coordination failures and their economic costs in a context of changing climate.

WP10.5: Energy

Responsible: Francesco Bosello (FEEM)

Total project description: The main objective of this work package is to assess the effects of climate change on energy consumption in the Mediterranean. The research will commence with a survey and a descriptive paper highlighting the main features of energy markets of energy market in the Mediterranean as a whole, with country details where possible. The main outcomes will be a set of quantitative economic indicators (e.g., energy production, consumption, imports/exports, environmental impact; per country, per sector) and a qualitative description (e.g., degree of competitiveness of markets, privatisation, taxation). An essential part will be to introduce key vulnerabilities of the energy sector to climate change to likely future macroeconomic developments.

This WP aims to estimate the elasticity of the demand for energy with respect to climate change, particularly warming. More precisely, the responsiveness to temperature of the demand by the residential, services and industrial sectors for main energy inputs (coal, oil, natural gas, oil products and electricity) will be estimated using standard panel-data econometric techniques. A particular effort will be put on capturing seasonal variability and regional specificities. Naturally, the level of geographical disaggregation will depend on the availability of time series on energy prices and energy consumption for all energy vectors for all Mediterranean countries. At the moment, the coverage of energy data is rather incomplete. An effort will be made to fill the gaps by resorting to national sources for as many Mediterranean countries as possible. An alternative strategy would be to estimate an aggregate elasticity of energy demand to temperature for the whole Mediterranean economic system. Disaggregation to country level would be obtained using Bayesian post-processing techniques. It is highly likely that this indirect approach will be needed at least to a certain extent. However, this task will make sure that it will be based on the maximum amount of

direct information available. If time and data permit, disaggregation to the subnational level (NUTS2) will be attempted for the countries of the European Union.

The econometric information will be used as the starting point for the economic evaluation of climate-change impacts on energy uses which will be based, among other, also on information provided by a conveniently updated and tailored version of the Computable General Equilibrium model developed in WP10.7. Some simulation exercises can be also performed.

The final step of the research is policy-oriented. Having assessed the social-economic impacts, it aims specifically to suggest possible mitigation and adaptation options to contrast it. Policy cost and effectiveness, impact on energy sectors will be discussed. This exercise offers valuable information to policy decision makers, by providing a clearer picture of economic consequences triggered by different policies together with a quantitative assessment that, albeit indicative, can provide at least an order of magnitude for costs and effectiveness of alternative policy options.

WP10.6: Sea Level Rise
Responsible: Vafeidis Nassos (UNIAEGEAN)

Total project description: The impact and especially the adaptation algorithms would also be developed to resolve more impacts and more details of possible responses. As part of this work, we will draw on the coastal case studies and use them to obtain detailed data on issues such as adaptation to sea-level rise, and also use them to explore the consistency of the DIVA-Med results (while being aware of the need to avoid circular reasoning).

These coastal results would interact with many of the other work packages, including:

- Tourism
- Migration
- Agriculture, Water and Land Use
- Ecosystems Change and Valuation
- CGE Development and Interface

In particular, estimates of land loss and expenditure on protective infrastructure investment will be used as an input for a CGE simulation analysis of the general equilibrium effects, triggered by changes in resources and demand patterns.

WP10.7: CGE Development and Interface

Responsible: Roson Roberto (FEEM)

Total project description: This workpackage will be devoted to the realization and development of a Computable General Equilibrium of the world economy, having a special focus on the Mediterranean economies. Starting from existing data-bases and model frameworks (e.g., GTAP), a model will be designed, in which Mediterranean countries appear disaggregated, as distinct economic entities, whereas the rest of the world will be aggregated in a few major trading blocks. Within each region/country, different industries will also be considered. To be made operational, the model needs to be calibrated, through estimation of structural parameters, consistently with the most updated information about regional economies, as it appears in official national accounts and other statistical sources. The CGE model will then be used to encompass a variety of different

impacts, analysed in details in other workpackages of this RL, as well as in other RLs. The idea is to use a sort of "common denominator" for the analysis of socio-economic impacts of climate change, allowing a comparison of the different effects and an evaluation of their importance and criticality. To this end, a first model version will be made operational and released within 12 months from the start of the project. Meetings will be organized with representatives of other WPs and RLs, to explain how the model can be linked and interfaced with other models, which input data is needed, in which format, how simulation output can be analysed, etc. In parallel with this action of information diffusion and interfacing, the model will be further developed, considering: (a) higher levels of disaggregation by region and industry, (b) recalibration of model parameters whenever more updated data will be made available, (c) expansion of the model data-base with satellite accounts, possibly including non-economic variables (e.g., emissions, population), (d) reformulation of market equilibrium conditions for key markets, like international capital markets. The development phase of the model will be kept relatively flexible, as priorities for model development will be identified during the diffusion phase, and according to the experience of interfacing the model for the various impact analyses.

WP10.8: Valuation of Ecosystems
Responsible: Nunes Paulo (FEEM)

Total project description:

1. Identification of ecosystem services (=externalities)

--- Task performed by economists with assistance of the natural scientists from the IP

Task 1.1 Inventory of ecosystem services (=externalities)

List of the socio-economic values of ecological and biodiversity benefits provided by terrestrial and marine ecosystems. For this purpose, it is important to discuss concepts relevant to the analysis and review models with the Panel of experts. The underlying idea for the creation of the Panel is that the economic valuation exercise is not an isolated application; it is necessary to establish ex ante an operational framework to allow interpretation of the valuation results. Such a discussion will help to better understand the relationships between the marine ecosystem under consideration, marine biodiversity, economic activity and human welfare. To fulfil this task, the organization of an interdisciplinary scientific Panel is required so as to identify, describe and conceptually model the complex network of human-ecological relationships present in the ecosystems under consideration (we plan link the valuation work to pilot sites). The Panel members are scientists with solid working experience in the study of the marine ecosystem under consideration.

Task 1.2 Selection of the relevant externalities

Since not all externalities are equally relevant to society, and since they differ from one marine ecosystem type to another, the first task will be to identify those more important. This process, that in a way presents some similarities to the screening in environmental impact assessment exercises, will also involve the use of a number of additional sources: a literature review, some short written questionnaires to key players, and a series of quick interview with end-users or stakeholders. The result of the screening will then go through a scoping process, following the environmental impact assessment analogy. The main ones will be kept for welfare impact valuation and policy analysis. The scoping process will be taken by all the partners of this WP in consultation with external advice of end-users and stakeholders, based on the importance of the externalities.

2. Formulation of site-specific scenarios regarding the provision of ecosystems services

--- Task performed by economists with assistance of the natural scientists from the IP

Task 2.1 Literature review of data climate change impacts

This task reviews the knowledge about the effects of climate change on the biophysical/ecological variables that are used to translate the selected externalities as identified in Main Task 1. Besides published data, outputs from other CIRCE participants will be utilized.

Task 2.2 Development of climate change scenarios for the Mediterranean region

The CIRCE models will be applied to project climate change impacts on quantity and quality aspects of terrestrial and marine ecosystems. For the selected case-study, this existing modelling knowledge will be applied to quantify the biophysical/ecological variables defined in Task 2.1 for the range of the different externalities under consideration

3. Valuation of the main externalities

--- Task performed by economists

Task 3.1 Set-up of the guidelines to organize the valuation process

Various economic methods are available for valuation of the socio-economic benefits provided by terrestrial and marine ecosystems, in term of ecological and biodiversity services. The aim is to combine and adapt state of the art economic valuation tools, in particular contingent valuation and travel cost method, bearing in mind the available scientific information and the pros and cons of each method. The choice of the valuation method will be motivated in terms of its originality and suitability to the ecosystem and biodiversity values under consideration or in terms of qualitative methodological and econometric developments In addition, the proposed project also proposes to address the discussion of the economic valuation to different stakeholders, such as fishery industry and environmental conservation groups, have different concerns and will value the same marine management option differently. An economic valuation exercise is viewed as a means for dialogue between different stakeholders and policymakers. Special attention will be given to the fields identified as “crucial” in the environmental policy agenda for the marine ecosystem under consideration, namely the evaluation of the effects of different fishing practices and associated regulations. The primary motivation for the execution of a stakeholder valuation study is to help defining priorities and to clarify conflicts of interest, so as to assist in the design of an effective and robust long-term development strategy for the marine ecosystem under consideration.

Task 3.2 Execution of an economic valuation exercise

The main objective here is to apply the guidelines as defined in Task 3.1 and design a questionnaire, survey the population, and obtain the values of the different externalities considered (in reference the selected case-study). A number of attributes (or physical changes leading to externalities) will be valued. This implies the definition of the level of each attribute that constitutes the status quo situation. Once those levels are defined, the changes to be considered are translated into changes in the level of each attributes. A number of level changes will be considered in order to have enough variation. A monetary attribute is also needed to reflect the payment cost of the different level changes. For this payment cost a policy that justifies how the different levels of each attribute will be designed. Using the different attributes and levels a (computer-based) questionnaire for applying a choice experiment valuation method will be drafted. Once the draft questionnaire is completed, it will be tested and discussed in different focus groups. The computerized questionnaire allows the use of good graphical simulations. The corrected version will then be tested in a pilot phase. If a need for considerable changes is detected at this stage, the questionnaire will be redesigned and go over the focus group and pilot stages again.

The Italian regions will be selected and their inhabitants of 18 years of age or more will be the considered survey population. A sample of this population will be selected randomly using telephone directories, and controlling by socio-demographic representative quotas. The sample size is estimated in 600. The selected individuals will be invited to go to a public place to answer the prepared questionnaire, and receive a monetary compensation for their time. The final version of the computer-based questionnaire will be self-administered to the sampled individuals. A person will be present during the interview time in case the respondent needs some technical help.

Task 3.3. Estimation procedures

Innovative estimation techniques will be employed in order to account for the heterogeneous preferences towards biodiversity conservation of the different stakeholders and interest groups. Studying how preferences towards conversation vary is important for environmental researchers, so that net welfare estimates of a particular policy option can be derived, considering that a policy classified as most preferred by a group may be disliked by another affected group. A number of recent studies are contributing to the study of these latent (non-directly revealed) preferences. Among the most recent techniques to incorporating heterogeneous preferences, random parameter models (including mixed logit models) have become a popular method to model preference heterogeneity. Applications of such models include Train (1998), Revelt and Train (1998), and Layton and Brown (2000), among others. However, multiple shortcomings arise when modelling choices in the estimation stage, so that empirical specifications are oftentimes limited by convergence difficulties and other empirical problems. In this context, recent contributions to the literature are those related to finite-mixture distributions (or latent class models), which are based on endogenous segmentations of individuals. The finite-mixture approach endogenously assigns individuals to classes with identical preferences and estimates the probability of membership to each class along with their respective class-specific preference parameters. Recent applications in the field of finite-mixing/latent class models include those by Boxall and Adamovicz (2002), Morey, Thacher and Breffle (2004) and Scarpa and Thieme (2005). We expect that the current research project will contribute to the literature on latent class models applied to environmental valuation.

Task 3.4 Evaluation of policy scenarios

After survey answers will be processed and analysed using the appropriate statistical techniques. Monetary estimates will be interpreted in terms of an evaluation of the alternative policy scenarios under consideration, searching for reasonable policy recommendations that can assist in the formulation of effective and broadly accepted marine management policies. In addition to the main result, which is the marginal value of each externality considered, a number of tests will be undertaken to check for the consistency of the results and benefit transferability, so to be able to aggregate values from regional to national and European levels.

Cited References:

Boxall, P.C. and V. L. Adamowicz. (2002). “Understanding Heterogeneous Preferences in Random Utility Models: The Use of Latent Class Analysis.” Environmental and Resource Economics, 23(4):421-446.

Morey, E., J. Thacher, and W. Breffle. (2005). “Using Angler Characteristics and Attitudinal Data to Identify Environmental Preference Classes: A Latent-Class Model.” Forthcoming in Environmental and Resource Economics.

Revelt, D. and K. Train. (1998). “Mixed Logit with Repeated Choices: Household’s Choices if Appliance -Efficiency Level.” Review of Economics and Statistics, 80(4):647-657.

Scarpa, R. and M. Thiene. (2005). "Destination Choice Models for Rock Climbing in the Northeastern Alps: A Latent-Class Approach Based on Intensity of Preferences." Land Economics, 81(3):426-444.

Train, K. (1998). "Recreation Demand Models and Taste Differences over People". Land Economics, 74(2):230-239.

Layton, D.F. and G. Brown (2000). "Heterogeneous Preferences Regarding Global Climate Change." The Review of Economics and Statistics, 82(4):616-624.

WP10.9: Agriculture
Responsible: Shechter Moti (HU)

Total project description: The proposed activities, Economic Assessment of Climate Change Impacts on Agricultural Land and Water Use, will be based on an extension of a regional scale economic model that is constructed for analysing climate-change impacts on agriculture (Yehoshua and Shechter 2003, Kadishi et al. 2005). This is a mathematical programming model which incorporates non-linear production functions describing yield responses to land allocation, water application and water salinity,. The responses to water quantity and quality are estimated by the use of scientific-based models simulating equilibrium in the root zone among plant's water uptake, soil salinity and soil's water content (Kan et al. 2002). The resultant production function is specific for the type of crop, soil, irrigation system and climate factors characterizing the potential evapotranspiration; the latter element enables accounting for yield changes as a response to variations in the temperature. Internalisation of land allocation among crops as an endogenous variable is based on Howitt's PMP calibration approach (1995). The model, therefore, enables assessment of climate-change impacts on optimal agricultural management, where adaptation is considered endogenously with respect to both the extensive (land allocation) and intensive (water application) margins; the latter incorporates impacts of water quantity, quality, and irrigation technology. All these factors play a major role in arid zones like the south Mediterranean area, where brackish water and treated wastewater sources are extensively used for agricultural production. The model is now being developed for the case of Israel. It is calibrated for a base year, and then run under various projected scenarios with respect to annual precipitations and temperatures to simulate the associated impact on optimal agricultural management. Optimality is considered as maximization of regional net returns from agricultural production subject to land constraint and availability of water sources for irrigation. Precipitations contribute directly to crops' water availability in the fields through rain falling during the growing season, and also indirectly influence the constrained amount of different types of irrigation-water sources. Base year regional aggregated data are readily available from statistical and economic reports open to the public. We currently have data on 45 crops (field crops and plantations) for the 21 ecological regions of Israel.

The model constitutes a convenient framework for sensitivity analyses with respect to changes in output and production factor prices, variations in the demands for competing water usages, regional water and land constraints, etc. Moreover, it can account for external benefits associated with agriculture; e.g., preservation of open spaces and aesthetic landscapes.

References:

Howitt, R.E. 1995. "Positive Mathematical Programming," American Journal of Agricultural Economics 77(2): 329-342.

Kadishi, N., Kan. I., Shechter, M. and Zeitouni, N. "Changes in Rainfall-Distribution Patterns: The

Impact on Agriculture in Israel," ICCAP WS, February 17-18 2005, Kyoto, Japan.

Kan, I., Schwabe, K.A., Knapp, K.C. 2002. “Microeconomics of Irrigation with Saline Water,” Journal of Agricultural and Resource Economics 27(1):16-39.

Yehoshua, N. and Shechter, M. 2003. “Climate Change and Agriculture: an Israeli Perspective,” in: Giupponi, C. and Shechter, M. (eds.), Climate Change in the Mediterranean, Cheltenham, UK: Edward Elgar.

RL11 - Integrating case studies

Goodess Clare (UEA), Giannakopoulos Christos (NOA)

Objectives:

- To integrate state-of-the-art climate and impacts modelling studies focused on the Mediterranean
- To use a rigorous common framework, including a set of quantitative environmental, vulnerability and sustainability indicators developed specifically for the Mediterranean environment
- To use a risk-based bottom-up, iterative approach (based on regional stakeholder workshops), as well as a top-down approach, to identify and explore potential adaptation and mitigation measures
- To consider North African (Algeria, Tunisia, Egypt), Middle Eastern (Israel, Lebanon, Syria) and European (Spain, Italy, Greece) case-study locations.

Description: The sectoral approach to climate change impacts followed in 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 and its impacts to be undertaken, making the most of specialised knowledge, data and modelling. However, the relative importance of changes and impacts in the different sectors also needs to be considered, together with their combined effects and cross-sector feedbacks.

Such questions can be effectively addressed through a set of carefully-chosen regional case studies. These eleven case studies will provide valuable opportunities for stakeholder involvement and will allow mitigation and adaptation issues to be addressed using both bottom-up and top-down approaches. They may also provide an ideal opportunity for testing the adaptation toolkit to be developed in RL13 in the real world.

Thus the CIRCE RL11 case studies will provide a common framework for integrated assessment of the cross-sectoral impacts of climate change in the Mediterranean. They will exploit the specialised and high-spatial resolution information about climate change and its impacts obtained from the other CIRCE RLs. They will also feed into and benefit from the policy and adaptation work undertaken in RLs 12 and 13 respectively. Stakeholder involvement (focusing on local and regional decision and policy makers), together with the broader dissemination of RL11 outputs, will benefit from a close working relationship with RL0. RL11 will also allow inter-comparisons and contrasts to be drawn in terms of the different climate regimes of the Mediterranean, together with the different political and socio-economic settings. At the same time, the range and scope of the case studies will allow common lessons and messages for the whole Mediterranean to be identified.

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

The issues which are likely to be important will vary between these case-study types. For rural areas, agriculture, water resources, biodiversity and tourism are crucial issues, for example. Whilst energy use, air quality and thermal comfort, together with the related health issues, are major concerns for urban areas, as is water supply and demand. The extreme weather events of greatest concern are also likely to vary between the case-study types.

While all case-study locations have sufficient data to allow meaningful assessments to be undertaken, the level of detailed climate and impacts information available will inevitably vary. In the case of coastal deltas, for example, the scale of physical processes is finer than the spatial resolution of climate models which distinguish simply between land and sea boxes. For urban areas, climate models do not yet incorporate the physics of the urban heat island (although some modelling work on this issue will be undertaken as part of RL11). Such limitations in the current generation of climate models do not, however, negate the need for stakeholders and policy makers to plan for climate change and to identify practical adaptation and mitigation strategies. It is important that any risk-based approach to the development of climate adaptation strategies explicitly recognises the existence of uncertainty in the decision-making process.

RLs 3-11 will address adaptation and mitigation issues on a sector-by-sector basis. RL11, however, provides a unique opportunity to identify and explore specific measures using both top-down (based on literature review and the modelling expertise of the academic research teams) and bottom-up (based on the real-life experiences and expertise of regional stakeholders) approaches. Strong stakeholder involvement from the early stages will allow identification of any adaptation and mitigation measures already in place and construction of an 'adaptation database', together with the non-climatic factors that may act as a constraint to, or facilitate, successful adaptation and mitigation. Adaptation measures will encompass both planned adaptation to climate change projections and responsive adaptation to experienced weather events. Where appropriate, regional stakeholder involvement will be enhanced by holding workshops and producing focused material in languages other than English.

This specific case-study work will complement the broader strategic and policy-orientated approaches to adaptation taken in RLs 12and 13 and may also provide an opportunity for testing the adaptation tool kit to be developed in RL13. It should make a major contribution to building adaptive capacity in the case-study regions and other parts of the Mediterranean, and hence facilitate delivering actual adaptation. These are the two critical components identified in the recently-published UK DEFRA (Department for Environment Food and Rural Affairs) Adaptation Policy Framework.

An integrated framework methodology for RL11 will be provided by using the following approaches:

· a common set of environmental, vulnerability and sustainability indicators constructed for the present and scenario periods;

· a web portal, incorporating targeted data, documentation and information on the case studies for end users, stakeholders and the general public, together with high-quality visualisation facilities; and,

· a probabilistic approach to address the uncertainties in climate scenarios and their impacts (based on the methodologies developed in the FP6 ENSEMBLES project).

The RL11 objectives will be implemented through the following six WPs:

WP11.1: RL11 co-ordination

WP11.2: Common tools and central datasets

WP11.3: Urban case studies

WP11.4: Rural case studies

WP11.5: Coastal case studies

WP11.6: Synthesis and wider implications of the case-study work

RL11 deliverables will include: a web portal aimed at end users, stakeholders and the general public; a case-study database, including environmental, sustainability and vulnerability indicators; information sheets and briefing notes suitable for technical and non-technical audiences (translated into non-English languages as appropriate); and, recommendations on adaptation and mitigation strategies. The case-study work will form the basis of the second part of the RACCM (see RL0), which will also describe the common lessons and messages learnt from the case-study work for the Mediterranean as a whole.

WP11.1: RL11 co-ordination
Responsible: Goodess Clare (UEA)

Total project description: The key tasks of WP11.0 will be:

- To foster scientific collaboration between RL11 partners
- To foster links, data exchange and discussion with other CIRCE RLs in order to ensure that RL11 makes best use of all relevant work undertaken in CIRCE and successfully integrates this expertise in the regional case studies
- To ensure that RL11 management reports, deliverables and milestones are provided on time
- To review and assess RL11 work on an ongoing basis
- To represent RL11 at CIRCE management meetings and to organise internal RL11 meetings as required.
- To create and maintain an RL11 web site

WP11.2: Common tools and central datasets

Responsible: Goodess Clare (UEA)

Total project description: One of the first tasks of WP11.2 will be to agree a definitive list of environmental, vulnerability and sustainability indicators appropriate for the Mediterranean. This will be done in consultation with all CIRCE partners and with stakeholder involvement (e.g., a draft list of indicators will be discussed during the CIRCE kickoff meeting and the first round of RL11 stakeholder meetings – the latter will be held during months 6-12).

The starting point for drawing up this common set of indicators will be the experience of the European Environment Agency 2004 report 'Impacts of Europe's changing climate: An indicator-based assessment', the EU-funded WISE project and the World Tourism Organisation. Categories covered by the indices will include: atmosphere and climate; marine systems; terrestrial ecosystems

and biodiversity; water; agriculture and forestry; economy and infrastructure, including tourism; and, human health. In the case of marine systems, for example, one environmental indicator is likely to be sea level rise, with population at risk from coastal flooding and erosion as a vulnerability indicator. For agriculture, crop yield and suitability are examples of environmental indicators, while percentage of population employed in agriculture is an appropriate vulnerability indicator. For human health, heatwave duration and intensity is relevant, as are vulnerability indices based on past events, such as the 2003 heatwave.

The common set of indicators must be:

· Appropriate to the Mediterranean (in terms of climate variability and change, and vulnerability)
· Able to be constructed relatively easily using reliable and appropriate data sets for the present-day and the future, focusing on outputs from other CIRCE RLs

It is anticipated that the atmosphere and climate indices will be provided by RL1 (for present climate) and RL2 (for future climate), together with indicators of extremes, such as heatwaves and fire, from RL6. Indicators for the other categories will be drawn from RL3-RL10 output, e.g., water indicators from RL5, agricultural indicators from RL7 and tourism indicators from WP10.2. The constructed indicators, together with other relevant datasets, will be made available via the RL11 case-study web portal. This will incorporate targeted data, documentation and information for end users, stakeholders and the general public, together with high-quality visualisation facilities. The portal will be hosted by UEA, and will be maintained for at least two years beyond the end of CIRCE.

Another key aspect of WP11.2 is to determine the way in which CIRCE partners will work with stakeholders to identify and evaluate potential adaptation and mitigation measures (the focus of the stakeholder workshops to be held during months 36-42). This will be done by collaborating with RL13 on the development, and, if possible, eventual testing in the workshops, of the open source toolkit for the identification and evaluation of adaptation options.

This toolkit will draw on existing tools and best practice. One such tool is the risk-based iterative approach to the development of climate adaptation proposed by Willows and Connell (2003) – see Figure RL11.1, along with the UK Climate Impacts Programme Adaptation Wizard (http://www.ukcip.org.uk/resources/tools/adapt.asp). This approach explicitly recognises the existence of uncertainties and the need to consider both climate and non-climate factors. It proposes a tiered risk assessment, with the focus on the identification of no-regret, low-regret, win-win and flexible options. The recent consultation exercise on the UK DEFRA Adaptation Policy Framework is also likely to be relevant to this aspect of CIRCE.

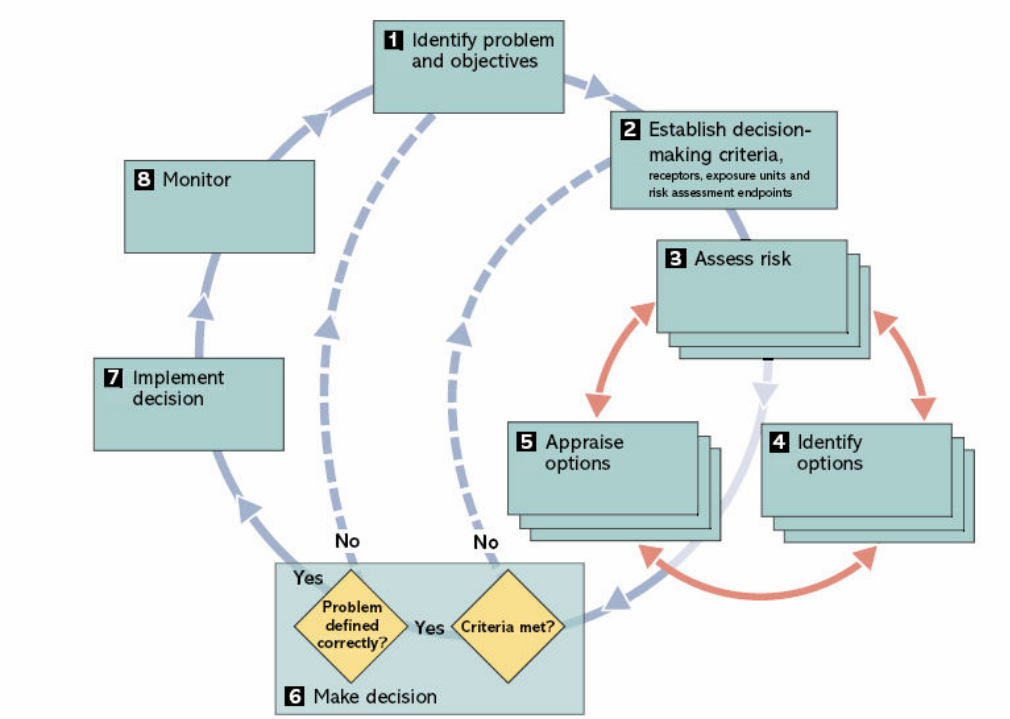


Figure RL11.1: Decision making framework for climate adaptation strategies. Source: Willows and Connell, 2003.

Beyond month 18, WP11.2 has the following major milestones:

- Construction of a common set of environmental, sustainability and vulnerability indicators appropriate for the Mediterranean, for the present and scenario time periods (month 36)
- Final version of the case-study web portal - public (month 48)
- Finalisation and archiving of the case-study datasets - public unless subject to third party restrictions (month 48)

References:

Adger, W.N., Brooks, N., Bentham, G., Agnew, M. and Eriksen, S., 2004: New indicators of vulnerability and adaptive capacity. Tyndall Centre for Climate Change Research, Technical Report 7. http://www.tyndall.ac.uk/research/theme3/final_reports/it1_11.pdf

European Environment Agency (2004) Impacts of Europe's changing climate: An indicator-based assessment. http://reports.eea.eu.int/climate_report_2_2004/en

Willows, R. and Connell, R. (eds), 2003: Climate adaptation: Risk, uncertainty and decision-making. UKCIP Technical Report, http://www.ukcip.org.uk/risk_uncert/risk_uncert.html.

WISE: Weather Impacts on natural Social and Economic systems.
http://www.cru.uea.ac.uk/cru/projects/wise/

World Toursim Organisation (2004) Indicators of sustainable development for tourism destinations.

http://www.world-tourism.org/cgi-bin/infoshop.storefront/EN/hotdeals

WP11.3: Urban case studies
Responsible: Giannakopoulos Christos (NOA)

Total project description: Three urban case study areas will be investigated: Athens (Greece), Alexandria (Egypt) and Beirut (Lebanon). As these cities are all located in the Eastern Mediterranean basin, their detailed study will allow several useful comparisons, for example, as to levels of pollution, heat stress and mortality, and energy usage. Thus efforts will be made to collect as much data as possible in the same impact sectors so as to enable these useful inter-comparisons. In addition, the cities' individual characteristics and vulnerabilities to climate change will also be examined:

Alexandria is more vulnerable to sea level rise due to its location in the low-lying Nile delta region (see WP2.5 for information about this coastal case-study region). It is an area undergoing tourism development, along with the building of a new international road which offers many new opportunities for economic development. Health issues are also a concern, particularly during severe warm Sirocco wind episodes in summer.

Athens is plagued by high ozone levels due to its geographical location surrounded by hills. Its four million inhabitants live in a densely-populated urban region with few open green spaces. It is prone to summer heatwaves (with high hospital admissions and mortality) and flooding during heavy rainfall events. Increasing energy demand for air conditioning is also a major concern.

Beirut is the largest urbanized area in the Lebanon. It currently suffers the most acute water deficit problems in the country, with only an intermittent supply in most areas (10 hours of supply every other day), coupled with a lack of piped water supply for a large number of people in poor urban areas. Pumping from private wells is increasing salt water intrusion. These problems are expected to be exacerbated due to climate change.

WP11.3 will use the common methodologies and indicator datasets from WP11.2 and will also use techniques such as statistical modelling, GIS analysis, and analysis of satellite data. In addition, a limited number of tailored RCM simulations will be undertaken to consider urban effects. These effects are not considered in current “state-of-the-art” GCMs and RCMs. However, preliminary work with a GCM for the BETWIXT project (http://www.cru.uea.ac.uk/cru/projects/betwixt/) suggests that these urban effects may exert a significant influence on climate, particularly temperatures. Crucially, it appears that it is not possible to use statistics of the current urban heat island to reliably estimate how standard climate change projections should be adjusted to account for changes in the urban heat island. WP11.3 will run a more advanced version of the Hadley Centre RCM (at 50 km resolution) which will explicitly include a representation of urban areas and their effects on climate (temperature – max and min, humidity). This model will be used to examine current and future projected heat island effects for the urban case study locations. Critically, this fully-integrated approach will allow the complex interactions between urban areas and the overlying climate to be accounted for. Future climates in urban areas will depend on:

- greenhouse-forced climate change
- intensification of urban heat island due to greenhouse-forced climate change
- intensification of urban heat island due to changes in the physical character of the landscape
- intensification of urban heat island due to increases in the release of heat from energy consumption

Such projections of changes due to (2), (3) and (4) have not previously been made. They will require the construction of new datasets of the physical properties of the Mediterranean land surface representing the growth of case-study urban areas. Simulations will be performed for the 2040s and 2080s and downscaling tools will be used to translate the RCM output to the specific urban case-study locations and scales.

Findings from each of the WP11.3 urban case studies will be used to provide policy relevant information for interested stakeholders and end users and to identify and evaluate possible adaptation and mitigation measures, including policy measures, during local workshops. In this way, interested stakeholders will be able to develop strategies in order to cope with potentially adverse effects of climate change on their activity sector. In Beirut, for example, the WP11.3 work is likely to be relevant to water allocation policy between various water demand sectors and to the development of regulatory standards for water quality vending. In Athens, it will help the National Health Service to assess the effects of extreme weather events on the population and from this develop a system to cope with increasing demand for hospital beds/intensive care during such events. It will also help the Ministry of the Environment to develop strategies, such as banning cars from the city centre, for pollution control during severe events.

The following CIRCE RLs and WPs are particularly relevant to WP11.3:
- WP5.3: Variations in the terrestrial component of the water cycle
- RL8: Air quality and climate
- RL9: Human health (particularly WP9.2 on health impacts of extreme temperature and air pollution)
- WP10.5: Direct economic impacts of climate change on the energy sector
- WP12.3: Energy policy, challenges and cooperations

Beyond month 18, WP11.3 has the following major milestones:
- Briefing notes outlining the climate scenarios and projected impacts for the urban case studies (month 36)
- Completion of the urban case-study workshops which will focus on the identification of practical and specific adaptation and mitigation measures (month 42)
- Recommendations on adaptation and mitigation measures for the urban case studies (month 48)

References:

Betts, R. and Best, M., 2004: Relative Impacts of Radiative Forcing, Landscape Effects and Local Heat Sources on Simulated Climate Change in Urban Areas. BETWIXT Technical Briefing Note 6, available from http://www.cru.uea.ac.uk/cru/projects/betwixt/.

Giannakopoulos, C., Bindi, M., Moriondo, M., LeSager, P. and Tin, T., 2005: Climate Change Impacts in the Mediterranean Resulting from a 2°C Global Temperature Rise, Report published by WWF, the global conservation organization, Gland, Switzerland, available from http://assets.panda.org/downloads/medreportfinal8july05.pdf

Giannakopoulos, C. and Psiloglou, B.E., 2006: Trends in energy load demand for Athens, Greece: Weather and non-weather related factors. *Climate Research,* MICE special issue, submitted.

Yamout, G. and El-Fadel, M., 2005: An optimisation approach for multi-sectoral water supply management in the Greater Beirut Area. *Water Resources Management*, 19, 6, 791-812.

WP11.4: Rural case studies

Responsible: Bindi Marco (IBIMET-CNR)

Total project description: The four rural case-study regions are characterized by a range of features and issues which are likely to make them particularly vulnerable to climate change:

Tuscany Region, Italy: Rural areas of Tuscany are characterized by agricultural and tourist activities that may be very vulnerable to climate change. In particular, grapevine and olive are two of the main agricultural crops in Tuscany. The former is very important for the economic role that wine producers play at national and international levels; whilst the latter is important not only for the income that it generates but also for its landscape role. Both crops are perennial crops, so the selection of the most appropriate crop management techniques is fundamental and may be strongly affected by changes in climate. On the other hand in the last 15 years rural tourism has increased exponentially in Tuscany, so that now it represents the main income for many farmers. The expected changes in temperature and precipitation may have negative effects determining increases in cost management (water supply, electricity for air conditioning, etc.) and lower production of typical local crops and animals.

Puglia Region, Italy: As in many other Mediterranean regions, mild orographic features and high population density have led to intensification of agricultural farming in Puglia, accompanied by replacement of existing natural vegetation with agricultural. In Puglia, which has an agricultural area of about 14,700 km^2, this has led to the adoption of typical 'naturally' selected crops and a low degree of crop diversity: 43% of the region is cultivated with wheat, 32% with olive groves, 9% with grapes, 3% with citrus and 2% with vegetables. The progressive increase of irrigation (with consequent improvement of productivity) has extended it from vegetables to tree crops, with intensive irrigation now being used to grow table grapes and citrus, and emergency irrigation to grow olive crops, by a spontaneous process with little concern for the long-term sustainability of water resources. The understanding of water resources variability and decline, in the context of human impacts and human and vegetation adaptations, are of paramount importance for the future sustainable management of water resources, with economic implications for the population, effects on the working force characterization at regional scale and regular availability of water to the population. Tourism in the Puglia region is a growing economic resource, whose growth could be affected by climate change and by management of coastal protections and many small harbours.

Judean Foothills, Israel: The steep moisture gradient makes the region susceptible to climate and vulnerable to climate-change impacts. Since water availability is the main limiting factor for organisms in drylands, biological activity varies with moisture at all levels, from leaf-scale photosynthesis to plant growth to landscape-scale vegetation composition and carbon sequestration. It has been shown, for example that El Niño events positively affect precipitation in the region, with subsequently increased growth of the dominant planted tree Pinus halepensis. In addition, the temperature impact on pine phenology proves to be moisture dependent. Previous work on precipitation trends showed increasing annual amounts of rainfall on the western slopes of the Judean Mountains, including the Judean Foothills between 1960 and 1990. However, general predictions for the Eastern Mediterranean Basin are for a warmer and drier climate. The Judean Foothills are in preparation to be accepted as candidate for the Biosphere Reserve of UNESCO's Man and the Biosphere Programme .

Tel Hadya, Syria: This area of northern Syria has a typical Mediterranean climate, with annual rainfall of 300 to 1000 mm. Agricultural systems are manly rain fed with cereals and legumes occupying most of the land. Supplemental irrigation is practiced in winter to overcome dry spells and stabilize yields. Summer crops include cotton, maize and vegetables and are fully irrigated. Ground water and Euphrates water are the main sources of irrigation. Rural areas are undeveloped - communities are poor and vulnerable to drought.

The complexities and vulnerabilities of these regions make them the ideal focus of cross-sectoral

study and integrated assessment, as proposed here. This cross-sectoral focus is reflected in the list of stakeholders with which WP11.4 hopes to work (see the first 18 month description of work). A broad range of data is known to be available for all four regions (as indicated in the first 18 month description of work). Thus they amply meet the three criteria used for case-study selection.

Alongside the common methodologies from WP11.2, WP11.4 will employ a range of additional approaches including crop modeling and downscaling of climate change information.

The WP11.4 work will be relevant to policy development in a number of areas, including: water resource management and pricing; agronomic and agricultural management strategies at the farm and regional level; and, management practices for nature reserves.

The following CIRCE RLs and WPs are particularly relevant to WP11.4:
- WP2.4: Coordination on production of scenarios and distribution of datasets
- WP4.2: Rain regimes and precipitation components across the basin
- WP6.4: Extremes in future climate scenarios
- WP7.2: Climate change impacts on forests, agriculture, food products and livestock production
- WP7.4: Integration of ecosystem services at the regional scale
- RL10: Economic Impacts of Climate Change (Tourism, Energy, Agriculture, Ecosystems etc.)
- WP13.3: Integrated management of vulnerability in agriculture and health

Beyond month 18, WP11.4 has the following major milestones:
- Briefing notes outlining the climate scenarios and projected impacts for the rural case studies (month 36)
- Completion of the rural case-study workshops which will focus on the identification of practical and specific adaptation and mitigation measures (month 42)
- Recommendations on adaptation and mitigation measures for the rural case studies (month 48)

References:

Bindi, M., Fibbi, L., Maselli, F., Miglietta, F. 2000: Modelling climate change impacts on grapevine in Tuscany. In: Downing TE, Harrison PA, Butterfield RE and Lonsdale KG (eds.), Climate Change, Climatic Variability and Agriculture in Europe. An Integrated Assessment, Research Report No. 21, Brussels, Belgium: Commission of the European Union, Contract ENV4-CT95-0154, pp. 191-216.

Portoghese, I., Uricchio, V.F. and Vurro, M., 2005: A GIS tool for hydrogeological balance evaluation at regional scale in semi-arid environments. *Computer and Geosciences*, 31, 15-27.

Steinberger, E. H. and Gazit-Yaari, N., 1996: Recent changes in the spatial distribution of annual precipitation in Israel. *Journal of Climate,* 9, 3328-3336.

WP11.5: Coastal case studies
Responsible: Sanchez-Arcilla Agustin (UPC)

Total project description: The four coastal case-study regions are characterised by a range of features and issues which are likely to make them particularly vulnerable to climate change:

Gulf of Valencia, Spain – key features and issues:

- Flat, low-lying region between the Ebro Delta to the north, and the Nao cape to the south
- Contains five RAMSAR wetland sites of international importance

- Affected by subsistence
- Also suffers from coastal regression due to reduction of riverine sediment inputs and changes in storminess
- Progressive salinisation of the River Ebro
- High pressure of use from tourism, agriculture and aquaculture
- Specific areas of concern include Cullera Bay, which is suffering particularly from high freshwater inputs of fertilizers and pesticides and untreated effluent from a shallow marine outfall

Gulf of Oran, Algeria – key features and issues:

- A complex morphological zone in western Algeria constituting a buffer zone with the Atlantic
- Existence of three important harbours (Oran, Arzew and Mostaganem)
- Increasing population and almost complete absence of treatment of domestic and industrial effluent
- Existence in Arzew of the biggest petrochemical complex in Africa constituting a major risk of marine and atmospheric pollution
- Phytoplankton growth restricted by large quantities of nutrients transported by the Cheliff and Mactaâ rivers

Gulf of Gabes, Tunisia – key features and issues:

- A very shallow and extended continental shelf with the most pronounced annual cycle of water temperature in the Mediterranean, along with the highest tidal range (1.8m)
- Recent indications of ecosystem changes, e.g., appearance of new species of shrimps and successive Sirocco episodes in recent summers causing red coloured waters
- Toxic industrial discharges, although phosphate discharges from the chemical industry are decreasing
- Economically valuable ‘nursery’ and fishing area, e.g., for Crevette Royale
- Particularly vulnerable areas include several fragile salt lakes or Sebkhats, the lagoon of Boughrara and a number of very low-lying islands, including the tourist destination of Djerba

Western Nile Delta, Egypt – key features and issues:

- A large and low-lying (many areas 3-5 meters below sea level) delta region hosting a large proportion of the Egyptian population and many important economic centres, including the city of Alexandria (one of the urban case studies – see WP11.3)
- Recent large-scale unplanned developments and poor awareness of environmental issues
- Direct inundation due to sea level rise, salt water intrusion, and waterlogging
- Coastal erosion rates currently exceeding 50 meters per year in some areas
- Concerns over water resources, agricultural resources, health and economic effects of

pollution

The complexities and vulnerabilities of these regions make them the ideal focus of cross-sectoral study and integrated assessment, as proposed here. This cross-sectoral focus is reflected in the list of stakeholders with whom WP11.5 hopes to work (see the first 18 month description of work). A broad range of data is known to be available for all four regions (as indicated in the first 18 month description of work). Thus they amply meet the three criteria used for case-study selection. Alongside the common methodologies from WP11.2, WP11.5 will employ a range of additional approaches, including: measurement campaigns; analysis of data from past field campaigns; visits and ground assessments; analysis of satellite data; construction of GIS datasets; and, development of a conceptual idealized coastal zone integrated model.

The following CIRCE RLs and WPs are particularly relevant to WP11.5:
- WP2.1: Detailed representation of the Mediterranean Sea in climate models
- WP2.3: INSTM will run a model with zooming in the Gulf of Gabes (500 m resolution)
- RL4: Scale interactions and feedbacks, in particular the airshed/watershed regional studies to be undertaken in WP4.3 for the Western, Central and Eastern Mediterranean
- WP5.4: Changes in Mediterranean Sea water cycle and implications for water mass characteristics
- WP10.6: Economic valuation of sea level rise
- WP13.4: Integrated management of the vulnerability to climate change in touristic coastal zones

Beyond month 18, WP11.5 has the following major milestones:
- Briefing notes outlining the climate scenarios and projected impacts for the coastal case studies (month 36)
- Completion of the coastal case-study workshops which will focus on the identification of practical and specific adaptation and mitigation measures (month 42)
- Recommendations on adaptation and mitigation measures for the coastal case studies (month 48)

References:

Brandhorst W., 1977: Les conditions du milieu au large de la côte tunisienne. *Bull. Inst. Nat. Scient. Tech. Océanogr. Pêche Salammbô,* 4, 129-220.

El-Raey, M., Nasr; S., Frihy, O., El-Desouki, S. and Dewidar; Kh., 1995: Potential impacts of accelerated sea level rise on Alexandria Governorate, Egypt. *Journal of Coastal Research*, Special issue#14, p(190).

El Raey, M., Fouda, Y. and Gal., 2000: GIS for environmental assessment of impacts of urban encroachment of Rosetta Region, Egypt. *Journal of Environmental Monitoring and Assessment*, 60, 217-233.

Falco, S., Hermosilla, Z., Romero, I., Martínez, R., Sierra, J.P., Mosso, C. and Mestres, M., 2006: Spatial and temporal pattern of water quality in Cullera Bay, *J. Coastal Research* (in press).

Sierra, J.P., Sánchez-Arcilla, A., González del Río, J., Flos J., Movellán E., Mösso, C., Martínez R., Rodilla, M., Falco, S. and Romero, I., 2002: Spatial distribution of nutrients in the Ebro estuary and plume, *Cont. Shelf Res*., 22, 361-378.

WP11.6: Synthesis and wider implications of the case-study work

Responsible: Goodess Clare (UEA)

Total project description: Two key tasks of WP11.6 will be to produce the following two deliverables at the end of the project:

1. A case-study synthesis report aimed at stakeholders both internal and external to the CIRCE community.

2. A journal paper suitable for peer-reviewed publication focusing on the methodologies used in RL11, together with recommendations on how future integrated assessments could be undertaken.

The synthesis report will benefit from collaboration with RL0 and the RLs focusing on socio-economic (RL10) and strategic/policy (RL12 and RL13) issues, while the methodological journal paper will benefit from collaboration with RL13 (i.e., it may provide an opportunity for practical evaluation of the RL13 adaptation toolkit).

WP11.6 will also provide the basis for the second part of the CIRCE Regional Assessment of Climate Change in the Mediterranean report (the RACCM Final Report). See WP0.1 for details and timetable.

RL12 - Relevant Societal Dynamics

Jaeger Carlo (PIK), Iglesias Ana (UPM)

Objectives: The research line will provide the basis of realistic climate impact functions, representing key climate impacts as combined results of patterns of climate dynamics and patterns of societal dynamics. It will do so by relating the effects of critical climate trends to ideal types of societal dynamics involving economic growth, development policies, employment disparities, and insurance practices. It will enable climate policy to operate in synergy with relevant societal dynamics both in the public and the private domain.

Description: So far, climate impact research has proceeded mainly by trying to follow a causal chain from climate dynamics via various intermediate steps to some measure of climate damage. While this was an indispensable first step, it is necessary to develop a more sophisticated analysis of climate risks (Jaeger et al, 1998, O'Brien and Leichenko, 2000): Climate impacts must be represented as functions of both climate dynamics and societal dynamics. For example, the impacts of increasing variability in temperature on agriculture will depend strongly on the market for crop insurance and various kinds of political regulation. As a result, an analysis of current trends in insurance markets can help to better identify the risks and opportunities engendered by climate change.

RL12 will provide the basis of realistic climate impact functions, representing key climate impacts as combined results of patterns of climate dynamics and patterns of societal dynamics. It will do so by relating the effects of critical climate trends to ideal types of societal dynamics involving economic growth, development policies, employment disparities, and insurance practices. It will enable climate policy to operate in synergy with relevant societal dynamics both in the public and the private domain.

RL 12 will focus on four societal dynamics of clear relevance for climate impact assessment: economic growth, development policies, changing patterns of unemployment disparities, and evolving practices of risk management. Each of these themes will be analysed in one work package. Together, they shall identify at least two ideal types of relevant societal dynamics:

Low growth, bureaucratic development policies, persistent unemployment disparities, high inertia in risk management practices;

High growth, sustainable development policies, decreasing unemployment disparities, low inertia in risk management practices.

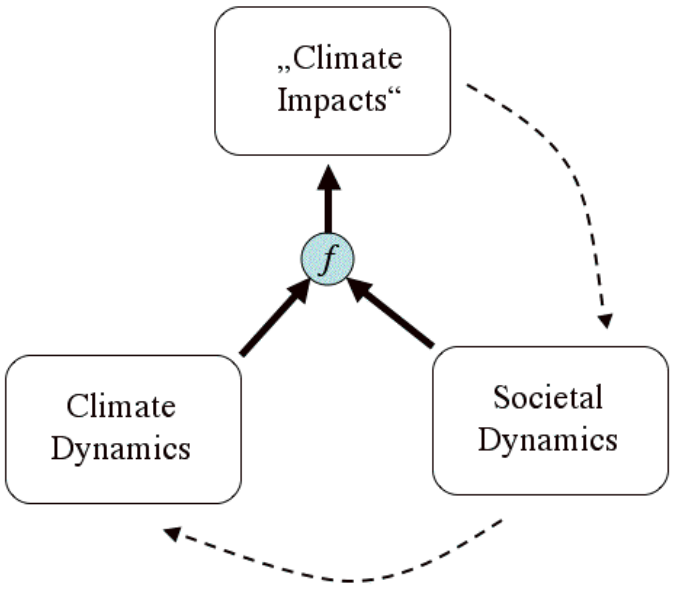
One work package will ensure the necessary coordination among the different work packages, another one will provide training opportunities for practitioners.

RL 12 will work in close contact with other research lines. E.g., researchers working on climate dynamics may become interested in identifying key variables that could enter meaningful climate impact functions. For the different phenomena to be studied – economic growth, development policies, unemployment disparities, and risk management – a synthetic report identifying at least two ideal types will be produced. For example, existing patterns of insurance may persist in a low-growth environment or in a high-growth environment; in the latter, they may also give way to more innovative forms of risk management.

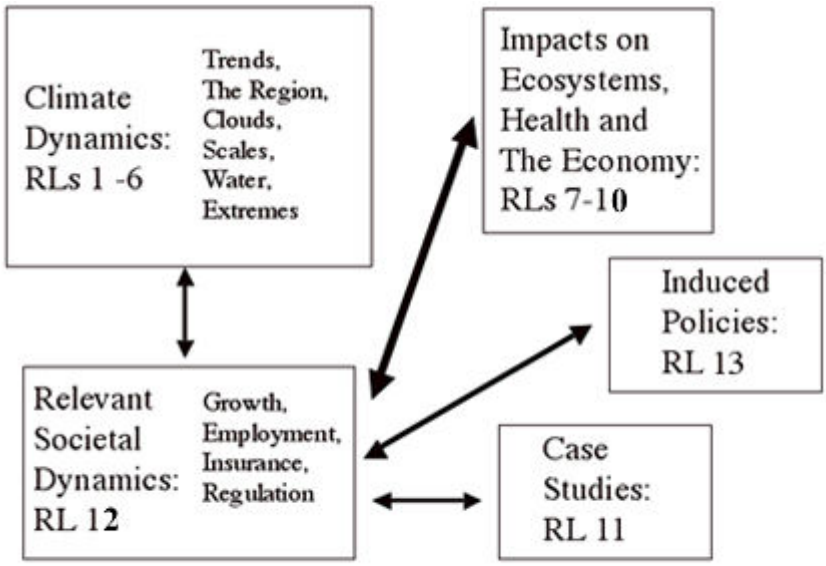
The report will specify linkages to other domains of Circe research. In addition, a report on the general methodology used in the research line will be produced, drawing on advanced tools of decision theory. Advanced training opportunities for practitioners will be provided during the course of the project.

With this internal structure, RL 12 will of course work in close contact with other research lines. E.g., researchers working on climate dynamics may become interested in identifying key variables that could enter meaningful climate impact functions.

With these insights, the policies induced by climate change may become much more effective by operating in synergy with some of the societal dynamics that take place regardless of such policies.



The Structure of Climate Impact Functions



Interactions with other Circe Research Lines

References:

Jaeger, C.C., Renn, O., et al.: Decision Analysis and Rational Action. p.141-215 in: Rayner, S., Malone, E. (eds) Human Choice and Climate Change. Vol. 3. Battelle Press, Columbus, OH, 1998.

O'Brien, K. L. Leichenko, R. M.: Double exposure: assessing the impacts of climate change within the context of economic globalisation. Global Environmental Change, p.221-232, 2000.

WP12.1: Coordination
Responsible: Iglesias Ana (UPM)

Total project description:
· Ensure a consistent and concise information flow, selecting and synthesising the information produced.

· Coordination with the RL leaders that provide input data.

· Maintain the dialogue between scientists and stakeholders.

· Feed back, revision and review of the Workplan after 18 months with participation of the stakeholders.

· Synthesise the results to provide inputs to National Adaptation Programmes of Action (NAPAs) and other national entry points such as the respective ministries (water and environment, economics, etc.).

WP12.2: Patterns of economic growth

Responsible: Jaeger Carlo (PIK)

Total project description: In the recent past, economic growth in Europe has been considered insufficient by many analysts and decision-makers (Hein and Truger, 2005). However, the countries

of the south-eastern Mediterranean shore face even greater economic challenges than Europe (Alonso-Garno et al., 1997, Meijer, 1993). Clearly, these are not ideal conditions to tackle the additional challenge of climate change. Nevertheless, Europe is a de-facto leader in global climate policy (Jaeger, et al., 1997), and its neighbourhood with the Arab world is a defining property of Europe's historical and geo-political situation. Before this background, the relation between climate policy and economic growth in Europe and the Mediterranean needs and deserves careful consideration. Regardless from climate change, higher growth is desirable in order to reduce unemployment and increase general welfare. Although there is no simple recipe for accelerating economic growth, it is well known that institutional factors play a key role in shaping rates of economic growth. From a climate policy point of view, however, it is not trivial to achieve higher growth without accelerating climate change. Moreover, in Mediterranean countries higher growth can exacerbate climate risks, in particular because without appropriate measures high growth is likely to increase water stress. On the other hand, the institutional factors leading to higher growth may also increase the innovative potential of societies in ways that help tackling climate risks. For these reasons, growth patterns and their key institutional determinants must be included in meaningful climate impact functions. This is the core task of the present WP.

References:

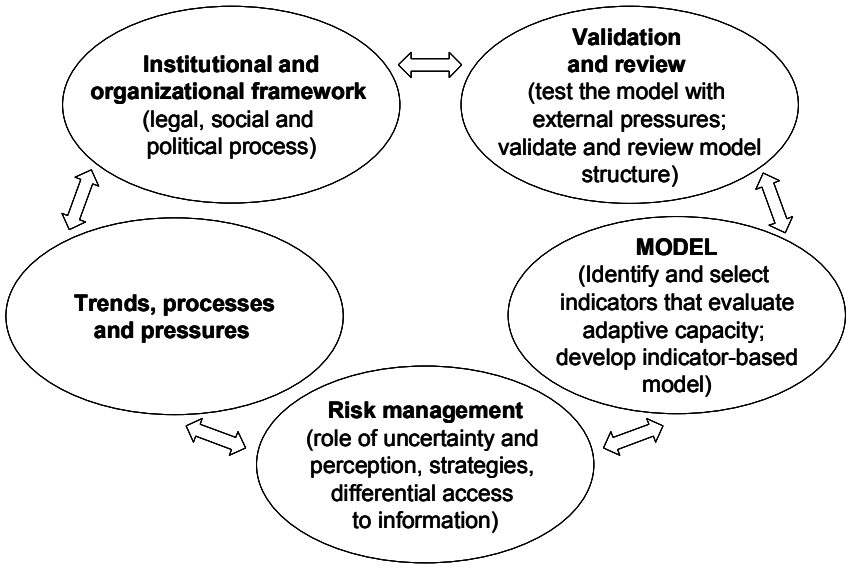
Alonso-Gamo, P., Fedelino, A., and S.P. Horvitz, Globalization and Growth Prospects in Arab Countries, IMF, Washington D.C., 1997. Hein, E., Truger, A., European Monetary Union: nominal convergence, real divergence and slow growth?," Structural Change and Economic Dynamics, 16, p. 7-33, 2005. Jaeger, C.C., Barker, T. et al., Procedural Leadership in Climate Policy: A European Task. Global Environmental Change 7, p.195-203, 1997. Meijer, M., Growth and Decline of European Cities: Changing Positions of Cities in Europe. Urban Studies, 30, p.981 – 990, 1993

WP12.3: Development policies
Responsible: Iglesias Ana (UPM)

Total project description: Different patterns of development policy profoundly affect the possible impacts of climate change. In particular, a wide array of public policies and private sector initiatives are essential to maintain a stable water supply to growing cities and part of the most efficient farming areas of the region (Iglesias et al., 2006a; Rijsberman, 2003; Varela-Ortega et al., 1998; Salam and Al-Karablieh, 2004). Climate change is likely to affect water availability via increased evapotranspiration and shifting precipitation patterns. Before this background, the WP evaluates the dynamics of Mediterranean development policies focusing on the regional, socio-economic, and technological dimensions, and on their role in managing climatic risks for agricultural production and water resources (Rijsberman, 2003; Varela-Ortega et al., 2002; Yang and Zehnder, 2002). The region is undergoing rapid social and environmental changes, and recent changes in policies stress water resources with recurrent and increased frequency (Iglesias and Moneo, 2005; Iglesias et al., 2002). Pressures and impacts of water scarcity often result in conflicts, with an apparent lack of policy response towards sustainable management, due to the inertia of a complex institutional organization. While there is wide recognition in the region of the threats of climate change, the economic forces push for further use intensification of land and water. More open agricultural trade, rather than easing the pressure, will exacerbate it because of the opportunities opened to produce more Mediterranean products and market them to Europe.

The current pattern of relatively low economic growth and high social inertia in various fields

exacerbates the risks from climate change. But high economic growth could fail to reduce these risks if it is not accompanied by major shifts in development policies. The WP will analyse these possibilities in close co-operation with researchers from RL 13 as well as from other Rls. (the biophysical and socio-economic impacts that define the pressures analysed are defined in RL5 to 12, and the development policies derived are then used to explore the induced responses in RL13).



Components of the development policies methodology

The components of the research are outlined in Figure RL12.1.

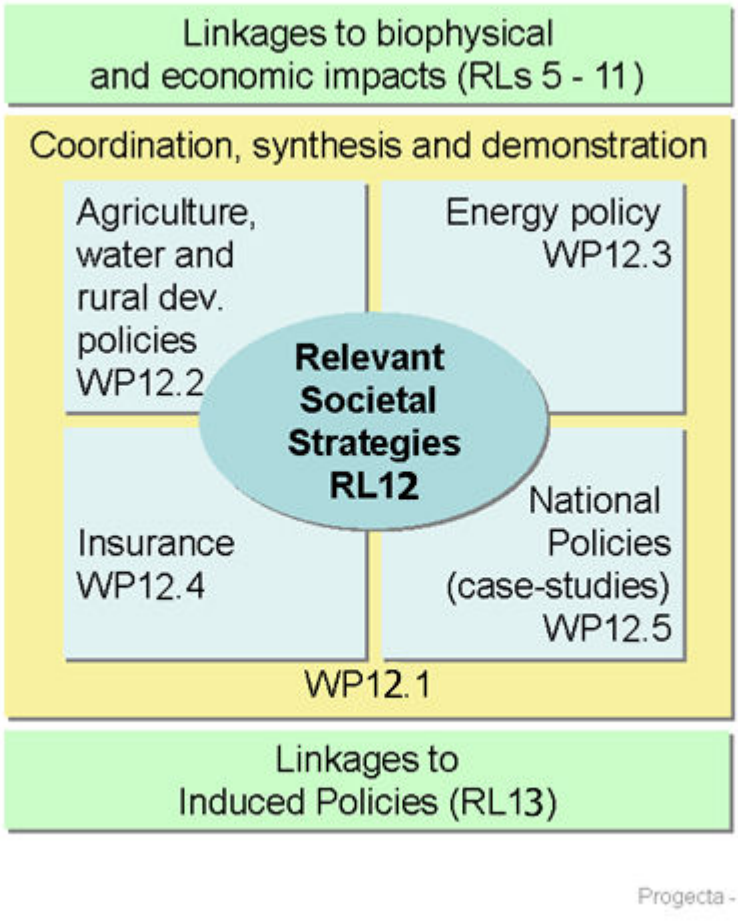


Figure RL12.1. Components of the agriculture, water and rural development policies research.

References

Iglesias, A. and M. Moneo (eds). 2005. Drought preparedness and mitigation in the Mediterranean: Analysis of the Organizations and Institutions. Options Méditerranéenness, CIHEAM, Centre international de Hautes Etudes Agronomiques Méditerranéennes, Paris. 2005.

Iglesias, A., M.N. Ward, M. Menendez, and C. Rosenzweig. 2002. Water Availability for Agriculture Under Climate Change: Understanding Adaptation Strategies in the Mediterranean. In: Giupponi, C. and M. Shechter (eds.). Climate Change and the Mediterranean: Socioeconomic Perspectives of Impacts, Vulnerability and Adaptation. Edward Elgar Publishers.

Rijsberman, F. 2003. Can development of water resources reduce poverty? Water Policy, 5(5-6): 399-412.

Varela-Ortega, C.; Sumpsi, J.M.; Garrido, A.; Blanco, M.; and Iglesias, E. 1998. Water Pricing Policies, Public Decision Making and Farmers' Response: Implications for Water Policy. Agricultural Economics, 19: 193-202.

Yang and Zehnder. 2002. Water Scarcity and Food Import: A Case Study for Southern Mediterranean Countries. World Development Vol. 30, No. 8, pp. 1413–1430.

WP12.4: Unemployment disparities
Responsible: Jaeger Carlo (PIK)

Total project description: The WP will study the dynamics of unemployment disparities under different trade regimes for energy, agricultural products, and services (Abed, 1998; Edenhofer and Jaeger, 1998) by means of a computable general equilibrium model with non-clearing labour markets. With such a model it is possible to take into account not only the direct cost of policies designed to induce large scale changes in trade direction, international specialisation and environmental policies, but also the gains/losses from revenue recycling and from changes in terms of trade, both at the national/regional level and at the international level.

The WP will develop a model that will be capable of simulating the impact of different trade regimes on industrial competitiveness and activity, either in terms of potential dislocation of activities or of new markets for technologies more compatible with the global challenge of climate change (Capros, 1999). The model will represent labour demand and supply on labour markets specified by regions and sectors, and it will allow for unemployment on these markets. The proposed analytical tool will take the form of a multi-regional multi-sector computable general equilibrium model with a specification close to the GEM-E3 model that has been widely used for the evaluation of energy, environmental and trade policies for the EU.

Once the model has been constructed and tested, a Baseline scenario will be elaborated to serve as a reference against which alternative scenarios will be compared and evaluated.

The main aim of the alternative scenario analysis will be the quantitative exploration of the employment implications of policies aimed at a radically higher degree of economic integration within the Mediterranean basin. A special point of focus will be the energy sector and its role in the economic development of the region (TREC, 2003).

The policies considered will be enhanced liberalisation and other measures designed to encourage exchanges among the diverse economies involved, eventually leading to a massive re-direction of energy trade. Such policies will be examined in the context of an increasing intensity of Climate policy and of a widening of its geographical scope providing opportunities for an extension of emission permit markets and the use of Joint Implementation and Clean Development mechanisms.

Abed, G.T., Trade Liberalization and Tax Reform in the Southern Mediterranean Region, IMF, Washington, 1998.

Capros, P., L. Mantzos, et al.: Climate Technology Strategies 1: Controlling Greenhouse Gases. Policy and Technology Options, Physica, Heidelberg, Germany, 1999.

Edenhofer, O., Jaeger, C.C.: Power Shifts. The Dynamics of Energy Efficiency. Energy Economics, 20, p.513-538, 1998.

The TREC development group, Trans-Mediterranean energy cooperation, "TREC", for development, climate stabilisation and good neighbourhood. A paper for the Arab Thought Forum and the Club of Rome, Amman, 2003.

WP12.5: Risk Management Practices
Responsible: Welp Martin (ECF)

Total project description: Today's world economy would be impossible without a solid structure of risk sharing, including markets for insurance and re-insurance as well as public insurance schemes for retirement, unemployment, and a plethore of regulations for risk management. This structure, however, is by no means static; rather, new forms of risk sharing are in the making in view of new challenges in risk management (Shiller, 2003). Relevant instances range from catastrophe bonds to

public-private partnerships, from large alliances between insurers and banks to schemes of micro-insurance. Moreover, new – often contradictory - ways of thinking about security issues are emerging: in view of national independence, energy provision, and of environmental issues (Welp, Hamidovic, et al., 2002). The WP will analyse these developments in view of their implications for climate risks (Mills, 2003). It will do so first by running and analysing stakeholder dialogues and by collecting and analysing relevant documents and data. In the second project phase, on this basis an economic model of climate risks with incomplete markets will be developed and used to provide the other RIs and the project as a whole with robust findings on the potential and limitations of various strategies of climate risk insurance.

References

Mills, E., Climate change, insurance and the buildings sector: technological synergisms between adaptation and mitigation. Building Research and Information, 31, p.257-277, 2003.

Shiller, R.J., The New Financial Order: Risk in the 21st Century. Princeton and Oxford: Princeton University Press, 2003.

Welp, M., Hamidovic, D., et al., The uncertain role of biodiversity management in emerging democracies. In: Stoll-Kleemann, S and O'Riordan, T. (eds.) Biodiversity, Sustainability and Human Communities. C.U.P., Cambridge, 2002.

WP12.6: Training
Responsible: Welp Martin (ECF)

Total project description: The WP will approach practitioners in a spirit of dialogue, building on the rich experience of the European Climate Forum in running science based stakeholder dialogues (Kasemir et al., 2003, Welp et al., 2005). The WP will help practitioners to improve their personal judgement about factual claims and methodical tools in dealing with climate change. In practice, climate risks rarely appear in isolation, but rather in conjunction with other, often even more pressing problems. The training courses will address this situation by discussing the "double exposure" of the Mediterranean region to the risks of climate change and the risks arising in a highly competitive global economy.

Before T18 Bayesian methods will be used as a didactical focus, because they are well suited to analyse multiple risk factors with limited information. In the subsequent project phase, simulation methods will form a second focus for training courses.

References:

Kasemir, B., Jäger, J., Jaeger, C.C., Gardner, M. (eds). Public Participation in Sustainability Science. C.U.P., Cambridge, 2003

Welp, M., de la Vega-Leinert, A., Stoll-Kleemann, S, and Jaeger, C.C., Science-based stakeholder dialogues: tools and theories. Global Environmental Change (accepted), 2005.

RL 12	Content and geographical scope	Key outputs and linkages to other RL
WP12.2: Patterns of economic growth	• Relates possible effects of critical climate trends to possible patterns of economic growth. • Defines climate impact functions (climate impacts as function of patterns of societal dynamics)	• Economic growth that influences greenhouse gas emission and therefore climate forcings • Input: RL 2, 3 • Feed-back: RL 1-3 • Output: RL 11, 13
WP12.3: Development and environmental policies	• Evaluates dynamics of development and environmental policies focusing on their role for managing climatic risks in agriculture and water resources. • Development of an indicator-based model	• Development and environmental policies • Input: RL 2, 5, 6, 7, 8, 10 • Feed-back: RL 2, 3, 5, 7 • Output: RL 11, 13
WP12.4: Unemployment disparities	• Use of a General Equilibrium Model to evaluate future trade and employment	• Trade, employment • Input: RL 2, 5, 6, 7, 10 • Feed-back: RL 2, 3, 5, 7, 10 • Output: RL 11, 13
WP12.5: Risk Management Practices	• New tools for risk sharing and new thinking about security • Explicit link between CIRCE and key players in the risk arena (Munich Insurance Initiative)	• Risk management practices • Input: RL 2, 6, 9 • Feed-back: RL 7, 10 • Output: RL 11, 13
WP12.6: Training	• Training in cooperation with the European Climate Forum and other public and private organisations	• Training courses • Input: RL 2, 5, 6, 11, 13

RL13 - Induced Responses and Policies

Kieken Hubert (IDDRI), Downing Tom (SEI-YO)

Objectives: The objective of RL13 are:

(a) to identify how the threats and opportunities related to climate change might affect planning for existing or future development policies in the Mediterranean region

(b) to provide actor oriented and practical methods, synthesis and policy recommendations of the results developed in the CIRCE project.

Description: The objectives of Research Line 13 are: (a) to identify how the threats and opportunities related to climate change might affect planning for existing or future development policies and dynamics in the Mediterranean region and, (b), to provide actor-oriented and practical methods, synthesis and policy recommendations of the results developed in the CIRCE project.

RL13 research will provide the conceptual underpinning for a consistent approach to adaptation and the core toolkit and training for application in the Circe case studies, linking closely with stakeholders and expert in RL11 (WP13.2).

RL13 will explore integrated approaches that emphasise the use of information on climate risks and opportunities in stakeholder decision making. The integrated, decision-orientation acknowledges that future socio-economic dynamics and development may act in synergy or challenge climate change-driven policies. Accordingly, part of the research of this RL will integrate from the outset socio-economic dynamics with the scenario of climate change for vulnerability assessment and management. Recommendations for action will be based on the "adaptive capacity" of public and private actors--taken as a process of social learning and risk management--encompassing the simultaneous assessment of: (1) the resilience to climate changes of fundamental trends shaping development, (2) the impact of development dynamics for reducing or increasing the vulnerability to climate changes, and, (3) the implementation of necessary ad hoc adaptation measures (where climate change impacts can not be smoothed and vulnerability can not be reduced). Induced recommendations will in particular be drawn for policies related to the management of coastal areas with existing tourism industry or foreseen high touristic potential (WP13.4). Further recommendations will be developed for policies related the agriculture sector, urban development, water resources and natural ecosystems management (WP13.5). This approach will build on the relevant socio-economic strategies developed in RL12.

This research will be conducted in parallel with stakeholder dialogues involving researchers and relevant stakeholders and decision-makers from the whole Mediterranean area to improve the relevance of outcomes for decision making processes.

WP13.1: Coordination

Responsible: Kieken Hubert (IDDRI)

Total project description: The coordination workpackage will gather all the management and liaison activities of the research line. Specific tasks include:

- Creation and maintenance of research line website, for internal and external communication

- Creation of a mailing list, for exchange and communication
- Periodical NewsLetter (3 / year) for information sharing within RL13
- Representation of research line at project management meetings
- Relation with RL0 (CIRCE coordinator)
- Organisation of coordination meetings and workshops within RL4
- Coordination with other RL, especially RL2
- Management and financial reports for the Commission
- Coordination of workshop & stakeholders meetings organised by WP

WP13.2: Identification and screening of adaptation options
Responsible: Downing Tom (SEI-YO)

Total project description: Adaptation options in response to climate change should extend existing stakeholder decision frameworks, using robust tools appropriate to the demands for information in the context of risk management. The first 18 months will complete the first objective:

Objective13.2.1 Provide a foundation paper on climate adaptation to be used by the project team and in discussion with stakeholders. The second objective will get underway in the first 18 months, and be largely complete by month 36:

Objective13.2.2 Develop an open source core toolkit for identifying and evaluating adaptation options

This will draw upon existing tools and projects to identify good practice in:
* Identifying and first-order screening of adaptation options (e.g., policy exercises, role playing, elimination by aspect)

* Climate risk assessment (e.g., sensitivity testing, Bayesian networks, multi-criteria assessment)

Implementation of the toolkit will be undertaken in the third objective:

Objective13.2.3 Assist case study teams and stakeholders to screen and prioritise adaptation options using the core toolkit and other resources

Training courses, demonstration activities and technical assistance to the case study teams will be carried out. The service orientation of the WP will build upon the expertise of the project partners and requirements for decision making in priority sectors and vulnerable regions.

WP13.3: Integrated management of vulnerability in agriculture and health
Responsible. Tran Annelise (CIRAD)

Total project description:

Objectives	Activities
1. Modelling Vector dispersal	- Retrospectives studies (1999-2005) to determine climatic events linked to the local and regional vector expansions (local within Corsica ; regional scale: between Corsica and France mainland), - Establish dispersal models at local and regional scale based on wind and climatic data obtained from Meteo-France, - Validate the models on actual and future spreading of *C. imicola* (2006-…).
2. Characterization of *Culicoides* habitat (environmental features required for breeding) and biological parameters (larval and adult space-time dynamics)	- Selection of study sites with settled population of *C. imicola* on mainland France (Var Department), - Characterization of *Culicoides* fauna, livestock and environmental features in study sites. - Sampling of potential breeding site and determination of *Culicoides* species at larval stage using specific molecular tools, - Characterization of physico-chemical parameters (soil, humidity, depth, …) influencing *C. imicola* larval development, - Determination of seasonal trends *for C. imicola* larval and adult populations, - Study of adult's active dispersal at a local scale around breeding sites.
3. Characterization of landscape parameters that underpin distribution of *Culicoides* using satellite imagery (Remote sensing, GIS)	- Selection of remote sensing images of study areas throughout study period, - Image analysis and creation of land use maps, - Landscape analysis, - Trapping of *Culicoides* to determine *Culicoides imicola* presence and abundance, - Statistical analysis and determination of the major parameters influencing *C. imicola* distribution, - Built-up and validation of a distribution model at a local scale.
4. Develop spatially and temporally varying models of the R0 to predict occurrence of BT	- Determination of adult biological parameters influencing the vector capacity: abundance, longevity, biting rates, host preferences (field studies),

	- Evaluation of vector competence of local populations of *C. imicola* using different serotypes of BT virus (experimental infections in laboratory), - Studies of spatio-temporal variations of R0 for BT
5. Develop prediction maps of areas at risk (dispersal and settlement of the vector, disease occurrence)	- Prospective modelling of areas at risk for the vector and the disease at local and larger scale taking into account climate change scenarios.
6. Evaluate the socio-economic impact of climate changes on livestock husbandry in relation with RL12 "Relevant Societal Strategies".	- To carry out stakeholders meetings to discuss socio-economic impact.
7. Derive generic conclusions from the analysis of the BT model disease in close relationship with the EDEN project (http://www.eden-fp6project.net/).	- To carry out meetings with EDEN consortium

WP13.4: Integrated management of the vulnerability to climate change in touristic coastal zones
Responsible: Chabason Lucien (IDDRI)

Total project description: Tourism is one of the fastest growing activity in Mediterranean coastal zones, both in terms of volume and number of destination. Coastal tourism offer many opportunities for Mediterranean countries both also several threats for the development of coastal area. In particular, the magnitude of development of coastal tourism creates competitions and, eventually, tensions on diverse natural resources: ecosystem, water resources, natural and agricultural land, etc. Like other human activities, tourism industry is also thought to be a contributing factor of an accelerated trend which threatens coastal habitat and ecosystems. Coastal tourism is susceptible to climate change in several ways. Tourism depends on resources that are foreseen to be affected by climate change impacts: forest fires, landscapes changes, water availability and quality, coastal erosion... Tourism infrastructures can be directly affected by climate changes. But tourism development might also contribute to reinforce climate change impacts, trough the increased consumption of natural resources (water, land availability...), the development of coastal infrastructures reinforcing climate change impacts, etc. These tensions are reinforced by the dynamic nature of the sector taking place in an environment lacking policies, legislations and coordination to support the management of these resources; as well as jurisdictional complexities combined with the fragmentation and lack of clear definition of tourism industry.

This WP will develop an integrated assessment of the climate change vulnerability of touristic coastal area based on the « Tourism Carrying Capacity » (TCC) of these area. TCC provide an integrated concept encompassing three basic components or dimensions: physical-ecological, sociodemographic and political-economic. Changes in tourism carrying capacity will be assessed taking into account: the natural and physical impact of climate change on touristic area, as studied in RL 5 to 9 and their economic valuation (RL10); the direct economical impact of climate change on the tourism industry (RL10); the scenarios of development for relevant socio-economic sectors (RL12).

Three categories of touristic coastal area will be considered: mature touristic area, where tourism

industry is massive both in terms of revenue and number of visitors (France, Spain, Italy, Greece, Malta...); emergent touristic area, where tourism industry is already significative but expected to grow significantly in the short term future (Marocco, Cyprus, Turkey, Tunisia, Croatia, Israel, Montenegro); potential touristic area, benefiting from natural or cultural resources favourable to the development of tourism activities in a mid-term future (Albania, Algeria, Libia...), when present obstacles to their development will be removed.

For each of these regions, contrasted scenarios of TCC evolution will be developed and considered for the mid-term future, taking into account both the natural impacts of climate change and their economical valuation, as well as sociodemographic and political-economic scenarios for the regions.

The integrated assessment framework will enable the WP to identify and propose a wide range of responses and policies induced by climate change, from pure adaptations measures to mainstreamed inflexions of development policies that are necessary to prevent collapse of Mediterranean coastal areas tourism carrying capacity. These induced responses will be formulated in a perspective of Integrated Coastal Zone Management (ICZM): balanced tourism development and other resource-based activities in the coastal zone, strengthen capacity of coastal communities to participate in tourism opportunities, supportive regulatory environment for both tourism development and preservation of natural resources and ecosystems in the coastal zone, etc.

These recommendations will be discussed and disseminated in a series of carefully designed workshops, for both improving their relevance for decision making and identify potential implementation constraints and barriers.

References

Agnew M. and Viner D. 2001 Potential impacts of climate change on international tourism Surrey Quarterly Review 3 37-60

Becken S. and Simmons D.G, 2002 Understanding energy consumption patterns of tourist attractions and activities in New Zealand, Tourism Management 23 343-354

Chabason L., 1999. The Concept of Sustainable Development in the Mediterranean: Emergence and Recurrence, Geographica Helvetica.

Dragicevic M, 1990: Methodological framework for assessing tourism carrying capacity in Mediterranean coastal zones. UNEP/MAP/PAP

Ewert A.W 1991 Outdoor recreation and global climate change: resource management implications for behaviour, planning and management Society and Naural resources 4 365-377

Perry A.H. 2003 Impacts of climate change on tourism in the Mediterranean: Adaptive responses In Climate change and the Mediterranean ed C Giupponi FEEM (In the Press)

Wall G. 1998 Implications of global climate change for tourism and recreation in wetland areas. Climatic Change 40, 371-389.

WP13.5: Sustainable strategies for the Mediterranean Region

Responsible: Kieken Hubert (IDDRI)

Total project description: The objectives of this Work Package are to provide actor-oriented

synthesis of CIRCE results and outcomes; and policy recommendations on the threats and opportunities related to climate change in the Mediterranean region. This WP will explore integrated approaches that emphasise the use of information on climate risks and opportunities in decision making. This integrated approach acknowledges that future socio-economic dynamics and development may act in synergy or challenge climate change-driven policies. Accordingly, the vulnerability assessment and management developed in this WP will integrate from the outset the relevant socio-economic dynamics studied in RL12 with the *scenario* of climate change impacts developed in other CIRCE research lines. Recommendations for action will be based on the "adaptive capacity" of public and private actors encompassing the simultaneous assessment of:

1. the resilience to climate changes of fundamental trends shaping development;

2. the impact of development dynamics for reducing or increasing the vulnerability to climate changes;

3. the implementation of necessary additional adaptation measures where climate change impacts can not be smoothed and vulnerability can not be reduced.

The combination of the 3 above dimensions of the integrated assessment provide the framework for developing sustainability criteria related to climate change. This approach is a generalization of the one developed in WP13.4 for touristic coastal areas through the adaptation of Tourism Carrying Capacity to climate change issues. Specific attention will be brought to irreversibility thresholds for ecosystems or activities which can be affected by climate impacts .

This WP will provide the conceptual framework for implementing this "sustainability criteria". This framework will provide concepts and approaches to:

1. to identify how the threats and opportunities related to climate change might affect planning for existing or future development policies and dynamics in the Mediterranean region;

2. build up actor-oriented integrated responses addressing threats and harnessing opportunities.

This framework approach will be implemented in a 3 steps process to:

· treat on a hierarchical basis the sustainability issues related to climate change identified by the CIRCE project for different region, sectors and land-use;

· develop strategies and development *scenario* addressing the highest priority issues;

· discuss, improve and disseminate these strategies with relevant stakeholders and decision makers to improve their relevance for decision making.

Induced recommendations will in particular be drawn for policies related to agriculture sector, health, urban development and management of natural ecosystems. They will be developed in parallel with stakeholder dialogues involving researchers and relevant stakeholders and decision-makers from the whole Mediterranean area.

6.2 Demonstration activities:
There are no demonstration activities foreseen.

6.3 Training activities

CIRCE results will be used in the training programme developed by the WWF Mediterranean

Programme Office, including exchanges, project grants, training courses. This training programme is active in Croatia, Bosnia-Herzegovina, Serbia-Montenegro, Libya, Tunisia, Algeria, Morocco, Portugal, Spain, Italy, France, Greece and Turkey. It will include a course on climate change, aimed at increasing Mediterranean NGOs awareness, knowledge and capacity to engage in climate policies, and addressing climate change in nature and natural resource conservation projects. WWF will make use of CIRCE generated information and knowledge in the following ways: (i) disseminate the scientific information through its own network, its partner NGOs and its extended outreach to media in the Mediterranean region, (ii) capacity building and training programmes, in particular organising at least three annual climate change training modules for Mediterranean NGOs and relevant institutions;

6.4 Management of the Consortium activities

RL0 - Coordination and Communication

Masina Simona (INGV), Tola Elisabetta (ZADIGROMA)

Objectives:

- Establish and maintain the governance of CIRCE.
- Facilitate communications inside and outside the project.
- Draft, edit and review the Regional Assessment for Climate Change in the Mediterranean (RACCM).
- Engage, inform and learn from stakeholders needs.
- Communication and outreach.

Description: This RL describes the task of the coordinator and the activity of the Project Office. A Project Office will be established, with a Project Director and a Project Secretary. Their role will be to assist the Coordinator in the preparation of meetings, in the collation of reports and financial statements, and to maintain communication with the Commission. A common electronic working area for the researchers involved in all the other RLs will be set up, making it easier for them to communicate and avoiding overload with mailing lists and newsletters, together with a Metadata Catalog to collect and display data from the different RLs. Dossiers and multimedia products, exploitable by journalists, teachers, science centers, and readable by the general public will be prepared.

Based on previous EU studies with large user participation, key end-users and stakeholders are already known and will be targeted. They include EU and national decision-makers in all the main policy areas (climate, economy, environment, health, industry, energy, water, waste, agriculture); teachers and researchers in the climate, economic, environmental, health, geography, engineering and planning; NGOs (e.g. WWF International); industry groups (e.g. in transport, agriculture, energy); environmental, medical and financial (e.g. insurance) services and the media. To access and involve these communities, networks will be set up, initially through individuals and organisations representing specific user communities. These will be expanded as the project develops to help disseminate and evaluate the results. Steering groups will also be established, both for the project as a whole and for each RL, comprising advisors from the main user communities. These will be invited to contribute directly to the work of the study. The principle of dissemination will be to ensure an active dialogue, and to provide opportunities for exchange of expertise and technology and for training. Contact will be maintained with science centers and science museums throughout Europe, and specific events will be organised where stakeholders can meet and discuss,

using a range of communication techniques (focus groups, consensus conferences, scientific forums, workshops). Key approaches will include:

· An active Web site, the "CIRCE Window", set up in the early phase of the project, targeted at the general public and professionals, and providing information on the project, updates on progress and results, a gateway to other relevant research, and a forum for discussion and comment.

· Publications in leading, international, peer-reviewed journals and presentations at major national and international conferences and symposia (in all the relevant disciplines), in order to disseminate results to the scientific community.

· Organisation of workshops and seminars, at key stages in the study, focusing on:

1. User needs and profiling.

2. Information and knowledge gaps and inadequacies.

3. Preliminary results and solutions from CIRCE.

· Development of learning materials for professionals and students including: fact-packs, study guides, computer demonstration materials and simulations (e.g. 'games' devised to compare and assess the health effects of policy decision; and short courses for professionals and students, giving training in specific methods/techniques).

· Publication of materials (e.g. book, TV programme) for the non-specialist audience.

· Promote encounter between the CIRCE scientific community and the large public in different science museums.

· Co-produce series of radio programmes to be broadcast in different European radio station and on web/podcasting.

At the start of the project, the kick-off meeting will be the first moment of interchange between the scientific groups, the stakeholders, and end-users. The objectives and methodologies of CIRCE will be discussed and further tuned to the demands and issues raised by the stakeholder. A main aim of this RL will be to profile the different stakeholders and decision/policy makers for whom the project may be relevant and to collate a stream of feedback opinions and ideas from the stakeholders and the general public about science and the scientific community.

CIRCE results will be disseminated and proposed to NGOs involved in climate research and campaigns to be used in their local and international actions. In particular, efforts will be made to include CIRCE results in the training programme developed by the WWF Mediterranean Programme Office, including exchanges, project grants, training courses. This training programme is active in Croatia, Bosnia-Herzegovina, Serbia-Montenegro, Libya, Tunisia, Algeria, Morocco, Portugal, Spain, Italy, France, Greece and Turkey. ZadigRoma will actively seek WWF involvement in order to include a course on climate change, aimed at increasing Mediterranean NGOs awareness, knowledge and capacity to engage in climate policies, and addressing climate change in nature and natural resource conservation projects. Besides that, WWF and similar organisations will be offered CIRCE generated information and knowledge in order to: (i) disseminate the scientific information through their own network and partner NGOs; (ii) to extend outreach to media in the Mediterranean region; (iii) to promote capacity building and training programmes on climate change.

A second major conference will be held at end of the second year. Scientific groups and stakeholders will discuss the structure of the Regional Assessment for Climate Change in the Mediterranean (RACCM), so that it best represents the emerging scientific results, and the evolution of their questions and needs. The stakeholder community will then be involved in the process of reviewing and editing the RACCM. The Final Version of the AR will be accepted at the last meeting of stakeholders in the fourth year.

WP0.1: Coordination, Management and Assessment Report
Responsible: Antonio Navarra (INGV)

Total project description: The complexity of an integrated project requires considerable attention to the management structure and fulltime human resources are needed to facilitating communication, organizing meetings, managing the reporting of scientific activities and financial matters to the Commission. CIRCE will establish a Project Office, composed of a Project Director and a Project Secretary.

The Project Office will monitor the progress of the project, the timely preparation of scientific reports, financial statement, and deliverables. It will facilitate communication between Research Lines and organize the project-wide meetings and conferences. The Project Director will communicate regularly with the Commission about the development of the project.

CIRCE will be managed by the CIRCE Executive Board (CEB) composed of the Leaders of each RL and chaired by two co-chairs:

CIRCE Executive Board

Antonio Navarra, INGV, Co-chair
Laurence Tubiana, IDDRI, Co-chair

Coordination and Communication
Simona Masina (INGV), Elisabetta Tola (ZadigRoma)

Identification and attribution of present climate trends
Von Storch Hans (GKSS), Xoplaki Elena (UNIBERN)

The Mediterranean Region and the Global Climate System
Li Laurent (CNRS/IPSL), Silvio Gualdi (INGV)

Radiation, clouds, aerosols and climate change
Le Treut Herve (CNRS/IPSL), Lelieveld Jos (MPICH)

Scale Interaction and Feedback processes
Millan Millan (CEAM), Christos Zerefos (NKUA)

Water Cycle
Alpert Pinhas (TAU), Vurro Michele (IRSA-CNR)

Extreme Events
Lionello Piero (UNILE), Garcia Ricardo (UNIMA)

Impacts of Global Change on Ecosystems and the services they provide

Valentini Riccardo (UNITUSCIA), Hoff Holger (PIK)

Air Quality and Climate
Kallos George (IASA), Levin Zev (TAU)

Human Health
Menne Bettina (WHO-Europe), Bensalah Afif (IPT)

Economic Impacts of Climate Change
Roson Roberto (FEEM), Schechter Moti (HU)

Integrating case studies
Goodess Clare (UEA), Giannakopoulos Cristos (NOA)

Relevant Societal Strategies
Jaeger Carlo (PIK), Iglesias Ana, (UPM)

Induced Policies
Hubert Kieken Hubert (IDDRI), Downing Tom (SEI-YO)

To simplify the functioning of the CEB and minimize travel expenditures, it will be required the presence at the CEB of only one of the two RL Leaders.

An EC nominated representative (the Project Officer) shall be entitled to attend meetings of the Management Board in an advisory role.

The CEB will correspond through a group e-mail address and will meet as often as the interests of the CIRCE Consortium require, probably once or twice a year. The CEB will have responsibility for drawing up the 18 month implementation plan on a rolling basis.

Research Line Steering Group

The RL Leaders and the WP Leaders of each RL will form the RL Steering Group that will be charged with coordinating the development of the work inside the RL. Meetings will be kept at a minimum and e-mail, web communication and phone conferences will be used extensively.

CIRCE Assembly

The CIRCE Assembly consists of one representative of each partner institution, and its purpose is to discuss progress and plans, normally once a year. It will meet at the project kick-off meeting, along with the RT and WP leaders.

Any Partner may, provided it has the written support of at least 50% of the Consortium Members for the time being, require the Project Coordinator to convene a CIRCE Assembly. The CIRCE Assembly shall be convened as soon as reasonably practicable to debate any single issue/motion as identified in the notice given to the Project Coordinator requiring the CIRCE Assembly to be convened. The decision of the CIRCE Assembly shall only be effective in overriding any previous inconsistent decision of the CEB and will only be given effect to by the CEB on condition that it is supported by a minimum of 66% of the Consortium Members for the time being. Consortium Members may attend and vote in person, may appoint a proxy to attend and vote on their behalf or may register their vote in writing prior to the meeting if they do not attend in person.

Meetings

The following suggested schedule of meetings is envisaged, although meetings will only be held if needed:

· There will be a project kick-off meeting as close to the start of the project as possible. This will include a meeting of the CIRCE Assembly, a meeting of the CEB and a meeting of the RT and WP leaders. The meeting will be designed as the First CIRCE Conference and it will be the opportunity to discuss and further tune the objectives and methodologies of CIRCE on the basis of the demands and issues raised by stakeholders and decision/policy makers.

· The CEB will meet as often as the interests of the project require, probably once or twice a year. The CEB will also communicate on a regular basis via email and phone.

· The CIRCE Assembly will normally meet once a year. The Coordinator will communicate with all the partner institutions throughout the project as and when necessary.

· There will be regular project meetings involving the RT and WP leaders and scientists from all partners. The meetings will discuss progress, the science achievements of the project and future plans. Project meetings may usefully be arranged around the CIRCE Assembly meetings. There will be regular communication within RTs and WPs by email and phone, as well as at international scientific meetings.

· A Second CIRCE Conference will be organised at the end of the second year. Scientific groups and stakeholders will discuss the structure of the Regional Assessment of Climate Change in the Mediterranean report (RACCM), so that it best represents the emerging scientific results, and the evolution of their questions and needs. The stakeholder community will then be involved in the process of reviewing and editing the RACCM. Before the Second Conference the CEB will appoint a Drafting Group which will carry out the design of the RACCM. The detailed structure of the RACCM will be defined by the Drafting Group at the Second Conference at the end of the last year, and it will contain three parts. The First part will be a synthesis report of the entire RACCM. The second part will describe the results of the thematic assessments of the RL, whereas the third part will contain the results of the integrating case studies. The Final Version of the RACCM will be endorsed at the last meeting of CIRCE in the fourth year.

Reports

The guidelines for reporting are laid out in the Commission's documents but we summarize them below for ease of reference.

In addition to the following formal project reporting, the project will produce an overall report showcasing the outcomes and findings of the project.

Every twelve months, the consortium will submit to the Commission the following four reports for the previous 12-month period, as well as a plan for the forthcoming 18-month period.

1) An activity report for the previous twelve months, containing:

- a management-level overview of the activities carried out by the project during the period;

- a description of progress toward its scientific and technological objectives and associated innovation-related activities;

- a description of progress toward the milestones and deliverables foreseen;

- a description of training activities, if any;

- identification of problems encountered and corrective action taken.

2) A management report for the period, containing:

a) a management-level justification of the resources deployed by each participant, linking them to activities implemented and justifying their necessity;

b) a financial part, consisting of:

- a financial statement prepared by each participant, showing the total eligible costs incurred broken down by type of activity;

- an audit certificate per participant as required by the commission, furnished by an independent external auditor or, in the case of a public body or international organisation, by a competent public official, certifying the overall total of eligible costs incurred by that participant;

- a summary financial report prepared by the co-ordinator, consolidating the incurred costs of the consortium and the requested Community contribution, broken down by type of activity;

- a report on the allocation of the Community financial contribution to each participant made during that period.

3)An updated implementation plan, including a detailed description of the implementation plan for the eighteen months following the twelve-month period covered by the reports above, and a revision of the overall implementation plan if needed.

4)An associated financial plan, containing an estimate of the costs to be incurred by each participant during the coming eighteen-month period, broken down by type of activity.

WP0.2: Web Based Reporting and Management
Responsible: Claudia Cesarini (CLU)

Total project description: To support the management and the reporting of CIRCE project, a web-based tool (PROGECTA) will be implemented and tailored on project necessity. It has been developed to manage large projects with a high number of partners and activities. PROGECTA will support project management in:
· schedule activities;
· optimise resources respecting time and budget;
· check the state of advancement of all the project activities;
· control and evaluate delay between the real and scheduled activities deadlines;
· allow excellent communication among component leaders, WP leaders and Project Manager;
· use analytic tools (GANTT, Key Performance Indicators);
· point out critical situations to be readily corrected (or taken into account);
· automatically generate management reports;
· gather documents, data and scientific files;
· help financial administration, keeping track of budgets; and
· inform partner about due date, activities changes, state of the play (activity reports).
Different contributions, like those for the Management and Technical Reports, will be collected through this system and then minimally re-processed to be submitted to the Commission.

WP0.3: External and internal communication office
Responsible: Tola Elisabetta (ZADIGROMA)

Total project description:

- Promotion of the project on print journals and magazines, radio and TV. Production of news, audio and video clips to be published in English on Circe web site and to be distributed to mass media, web radios and TV networks, public communication organisation and associations through a newsletter and with downloading facilities on the website.

- Organisation of one workshop focused on communication strategies, involving RL leaders, journalists and stakeholders (representatives of local communities chosen for case studies, politicians, social workers, professionals, representatives of consumer associations and NGOs.). Dialogue will be facilitated through use of participative communication strategies. Electronic reports will be produced.

- In collaboration with Medias France, design and development of a conceptual architecture for management of the data and metadata systems. Development of a 'google-like' search system, so each individual partners can discover and access data using thematic, temporal, and geographic criteria.

- Evaluation and editing of the existing audio and video material produced by the research institutes involved in Circe and production of new ones to be published on the public section of the web site and disseminated through the science communication networks and mass media (main scientific journals, Eurekalert, Alphagalileo and Athenaweb, international portals of science communication).

- Design and publication of editorial and scientific products, on paper and multimedia, to disseminate contents for the identified stakeholders (leaflets and short easy-to-read description to distribute in public occasions, Faq for the general public; didactic tools for teachers; strategies for a campaign for local institutions).

- Publication of online intermediate and final reports, organised in modules for different stakeholders: policy makers, environmental organisations, medical associations, schools and educational organisations, general public (on the model of those produced by the UN agencies and the Who, downloadable and printable by each interested organisation).

- Organisation of an audio/video upload and download facility on Circe website, to circulate material produced in the different countries, either by the communication office and/or single journalists and researchers. Audio and video material will be archived to facilitate a proper search and retrieval and to foster their usage by other communication professionals.

- Promotion of a proactive collaboration of CIRCE with the WWF International ongoing campaign on climate change. ZadigRoma will disseminate scientific data and case studies developed in RL11 to feed WWF campaign contents and spread them at a local, regional and international level through the WWF network, its partner NGOs and its extended outreach to media in the Mediterranean region with the aim of increasing public, institutional and civil society awareness of climate change impacts and need to integrate climate change in natural resource management. Furthermore, the capacity building programme of WWF Mediterranean programme will be offered support and scientific contents generated within CIRCE to organise one climate change training module for Mediterranean NGOs and relevant institutions (full immersion training school with participants from diverse local institutions and NGOs in different Mediterranean countries). WWF will then be encouraged to use this module enriched

with CIRCE data in other courses for which outside funding will be sought.

- Organisation of 4 citizen/local communities participative consensus conferences to discuss implication and to produce feedback for local and national regulators with regards to impacts described within Circe. The 4 consensus conferences will be organised in collaboration with RL11 choosing 4 representative areas within the ones where a case study has been performed.

- Production of a series of 10 radio programmes, in collaboration with Scirab (Science in radio broadcasting) members throughout Europe. Radio programmes will be inspired by case studies comprised in RL11, and will be produced by interviewing scientists from different RL and different countries participating to Circe. The finished products will be in English, available for any wilful European radio station to broadcast. Moreover, they will be published on the Circe website, freely downloadable from any radio willing to recirculate it. They will also uploaded onto Athena web, the European audiovisual portal, diffused to the network of journalists contacted through the communication office, distributed through the existing communication portals (community radio network, OneWorld Radio, Creative commons) and via podcasting.

WP0.4: Network of museums and science centers
Responsible: Tola Elisabetta (ZADIGROMA)

Total project description: In the framework of this workpackage, ZadigRoma in collaboration with at least 3 science centres will organise a "Circe day event" for the large public in three Mediterranean cities: Naples, Jerusalem and Marseille. A programme of various events will be implemented such as exhibitions, science demonstrations and debates about scientific topics and related issues developed in the CIRCE project.

The objective is to create an encounter between the scientific community of CIRCE and the large public in order to disseminate main results, to discuss social issues related to the project and to bring closer the global issues of the project with the local specificities. For these reasons, scientists and experts working in CIRCE will be involved in local events with the public.

6.B - Plans

6.5 Plan focusing and disseminating knowledge:

CIRCE has a large effort devoted to the dissemination of the knowledge produced during the project. These activities involve a connection through a network of science museums, the establishment of a project communication office, production of radio and printed material and other activities. They are described in detail in Work Packages 0.3 and 0.4.

The report produced at the end of CIRCE, the Regional Assessment of Climate Change impact in the Mediterranean, will also be a powerful contribution to the global and regional IPCC effort.

6.6 Gender Action Plan

Institutional Gender Action Plan

Many of the partners in CIRCE have gender action plans at the institutional level as part of their commitment to gender equality. These include programmes to raise awareness of the issues involved in gender equality, commitments to family friendly work practices and career breaks, and provision of child-care facilities. Organisational initiatives to encourage gender equality enjoy high level backing within partner institutes. Several organisations have an incentive policy to make

young female researchers take responsibility in science management, have an ongoing equality training programme, and have committees in charge monitoring gender issues.

a) ***Additional Gender Action Plan as a Component of the Integrated Project***

The project will constitute a project gender committee to encourage specific activities. Generally the proposed IP has women's in charge at all level of responsibility : general coordination, responsibility of research lines and responsibility of work packages. Nevertheless a plan of action to ensure promotion of women participation in all aspects of the project will be developed.

Project Gender Committee

The gender committee will actively promote the role of women at all levels within the Integrated Project. It will be responsible for ensuring that the gender plan is applied across the spectrum of research themes in the project, both in terms of internal communication of developments and progress via the project web-site, and communicating progress externally, via the annual gender action report. The committee will also be responsible for ensuring that the training and dissemination aspects of the project are female-friendly. The committee will consist of 3 members elected by all female project participants on an annual basis, with the possibility of re-election.

Annual Gender Action Report

The report will document the extent to which actions promoting gender equality have been performed at the Integrated Project level, and will chart the rates of female participation at all levels of the project.

Recruitment of Female Researchers

Recruitment of young, talented female researchers will be encouraged in CIRCE. Job advertisements will state the project's commitment to equality and to a family-friendly working environment and will explicitly encourage women to apply. The gender committee will liaise with national programmes in the production of suitable information material for schools, and will encourage participation of young female researchers in the workshops symposiums and academic meetings to present their works

Project Steering Committee

In the CIRCE project committee, women are represented at the highest organisational levels of the project and consists of 30 people, 8 of whom (26 %) are women. Whilst not approaching equality, this percentage is higher than that of women in senior positions in climate science generally, and gives women a significant say in how the project is organised and run.

Gender issues.

The Commission report "Gender In Research" on the 5th Framework Programme (Environment and Sustainable Development sub-programme, Annex 1, Page 18) concluded that "the natural science oriented climate research turns out to be more or less gender neutral". Nevertheless the importance of socio economic aspects in CIRCE will induce that a number of issues, population migration, socio impacts will belooked at integrating the gender dimension in all these research lines (RL 10, RL 11, RL 12 and RL13)

6.7 Raising public participation and awareness

A series of activities will be devoted to engage the public and raise public awareness. The Communication Office will promote the project on print journals and magazines, radio and TV. Production of news, audio and video clips to be published in English on Circe web site and distributed to mass media, web radios and TV networks, public communication organisation

and associations through a newsletter and with downloading facilities on the website. A close cooperation with WWF will allow the dissemination of scientific data and lessons learned from the case studies through the WWF network and partner NGO. Dissemination materials will be produced suitable for radio broadcasting, podcasting and usage in Science fairs and museums. These activities are described in detail in WP0.3 and WP0.4

6.C - Milestones

6.8 Major Milestones over full project duration:

Major Milestone 1: (Month 3), Project kick-off meeting as close to the start of the project as possible, not after Month 3. This will include a meeting of the CIRCE Assembly, a meeting of the CEB and a meeting of the RT and WP leaders. The meeting will be designed as the First CIRCE Conference and it will be the opportunity to discuss and further tune the objectives and methodologies of CIRCE on the basis of the demands and issues raised by stakeholders and decision/policy makers.

Major Milestone 2: Month(18), Appointment of the Drafting Group to carry out the design of the Regional Assessment of Climate Change in the Mediterranean report (RACCM)

Major Milestone 3· (Month 24), Second CIRCE Conference. Scientific groups and stakeholders will discuss the structure of the RACCM, so that it best represents the emerging scientific results, and the evolution of their questions and needs. The stakeholder community will then be involved in the process of reviewing and editing the RACCM.

Major Milestone 4· (Month 30), First Draft of the RACCM available and Review Process start. Experts and stakeholders will be chosen within and outside the CIRCE community for feedback and criticism of the RACCM.

Major Milestone 5· (Month 42), Final Draft of the RACCM approved by the Circe Executive Board (CEB).

Major Milestone 6 (Month 48) The Final Version of the RACCM will be presented and the endorsement of the wide CIRCE Assembly will be sought at the at the closing CIRCE Conference in the fourth year.

7. Project management

CIRCE Executive Board

CIRCE will be managed by the CIRCE Executive Board (CEB) composed of the Leaders of each RL and chaired by two co-chairs:

CIRCE Executive Board

Antonio Navarra, INGV, Co-chair and Laurence Tubiana, IDDRI, Co-chair

Coordination and Communication
Simona Masina (INGV), Elisabetta Tola (ZadigRoma)

Identification and attribution of present climate trends
Hans Von Storch (GKSS), Elena Xoplaki (UNIBERN)

The Mediterranean Region and the Global Climate System
Laurent Li (CNRS/IPSL), Silvio Gualdi (INGV)

Radiation, clouds, aerosols and climate change
Herve Le Treut (CNRS/IPSL), Jos Lelieveld (MPICH)

Scale Interaction and Feedback processes
Millan Millan (CEAM), Christos Zerefos (NKUA)

Water Cycle
Alpert Pinhas (TAU), Michele Vurro (IRSA-CNR)

Extreme Events
Piero Lionello (UNILE), Ricardo Garcia (UCM)

Impacts of Global Change on Ecosystems and the services they provide
Riccardo Valentini (UNITUSCIA), Holger Hoff (PIK)

Air Quality and Climate
George Kallos (IASA), Zev Levin (TAU)

Human Health
Bettina Menne (WHO-Europe), Bensalah Afif (IPT)

Economic Impacts of Climate Change
Roberto Roson (FEEM), Mordechai Schechter (HU)

Integrating case studies
Clare Goodess (UEA), Cristos Giannakopoulos (NOA)

Relevant Societal Strategies
Carlo Jaeger (PIK), Ana Iglesias, (UPM)

Induced Policies
Hubert Kieken (IDDRI), Tom Downing (SEI-YO)

To simplify the functioning of the CEB and minimize travel expenditures, it will be required the presence at the CEB of only one of the two RL Leaders. An EC nominated representative (the Project Officer) shall be entitled to attend meetings of the Management Board in an advisory role. The CEB will correspond through a group e-mail address and will meet as often as the interests of the CIRCE Consortium require, probably once or twice a year. The CEB will have responsibility for drawing up the 18 month implementation plan on a rolling basis. In case of resignation of a member, the CEB will appoint a provisional member subject to ratification in the following General Assembly.

CIRCE Assembly

The CIRCE Assembly consists of one representative of each partner institution, and its purpose is to discuss progress and plans, normally once a year. It will meet at the project kick-off meeting, along with the RT and WP leaders.

Any Partner may, provided it has the written support of at least 50% of the Consortium Members for the time being, require the Project Coordinator to convene a CIRCE Assembly. The CIRCE Assembly shall be convened as soon as reasonably practicable to debate any single issue/motion as identified in the notice given to the Project Coordinator requiring the CIRCE Assembly to be convened. The decision of the CIRCE Assembly shall only be effective in overriding any previous inconsistent decision of the CEB and will only be given effect to by the CEB on condition that it is supported by a minimum of 66% of the Consortium Members for the time being. Consortium Members may attend and vote in person, may appoint a proxy to attend and vote on their behalf or may register their vote in writing prior to the meeting if they do not attend in person.

Research Line Steering Group

The RL Leaders and the WP Leaders of each RL will form the RL Steering Group that will be charged with coordinating the development of the work inside the RL. Meetings will be kept at a minimum and e-mail, web communication and phone conferences will be used extensively. Modification in the WP leadership will be appointed by the RL leaders and ratified by the CEB.

Advisory Board

At the kick off meeting the CEB will propose to the General Assembly the nomination of an Advisory Board. The Board will be composed by five experts in the scientific fields relevant to CIRCE and by five members chosen among the coordinators of the EU Projects that are more closely linked to CIRCE. The Advisory Board will be chaired by the co-chairs of the CEB.

Project Office

CIRCE will establish a Project Office, composed of a Project Director and a Project Secretary. The Project Office will monitor the progress of the project, the timely preparation of scientific reports, financial statement, and deliverables. It will facilitate communication between Research Lines and organize the project-wide meetings and conferences. The Project Director will communicate regularly with the Commission about the development of the project. The PO will use extensively web-based tools and techniques to facilitate communication, assure the timely delivery of products and results, monitor the information flow.

Communication Office

The CO will have of course extensive responsibilities to communicate and disseminate results at the outside of CIRCE, but it will also play an important role in facilitating dissemination of results inside the project. CIRCE is complex and the management of the information flow also inside the project require dedicated resources and specific professional skill. The CO will supervise the publication of online intermediate and final reports, organised in modules for different stakeholders,

and facilitate the communication between RL and WP

Meetings

The following suggested schedule of meetings is envisaged, although meetings will only be held if needed:

- There will be a project kick-off meeting as close to the start of the project as possible. This will include a meeting of the CIRCE Assembly, a meeting of the CEB and a meeting of the RT and WP leaders. The meeting will be designed as the First CIRCE Conference and it will be the opportunity to discuss and further tune the objectives and methodologies of CIRCE on the basis of the demands and issues raised by stakeholders and decision/policy makers.

- The CEB will meet as often as the interests of the project require, probably once or twice a year. The CEB will also communicate on a regular basis via email and phone.

- The CIRCE Assembly will normally meet once a year. The Coordinator will communicate with all the partner institutions throughout the project as and when necessary.

- There will be regular project meetings involving the RT and WP leaders and scientists from all partners. The meetings will discuss progress, the science achievements of the project and future plans. Project meetings may usefully be arranged around the CIRCE Assembly meetings. There will be regular communication within RTs and WPs by email and phone, as well as at international scientific meetings.

- A Second CIRCE Conference will be organised at the end of the second year. Before the Second Conference the CEB will appoint a Drafting Group which will propose a structure of the Regional Assessment of Climate Change in the Mediterranean report (RACCM) and then scientific groups and stakeholders will discuss and approve the structure of the RACCM at the Second Conference, so that it best represents the emerging scientific results, and the evolution of their questions and needs. The stakeholder community will then be also involved in the process of reviewing and editing the RACCM. In general terms the RACCM will contain three parts. The First part will be a synthesis report of the entire RACCM. The second part will describe the results of the thematic assessments of the RL, whereas the third part will contain the results of the integrating case studies. The Final Version of the RACCM will be endorsed at the last meeting of CIRCE in the fourth year.

Reports

The guidelines for reporting are laid out in the Commission's documents but we summarize them below for ease of reference. In addition to the following formal project reporting, the project will produce an overall report showcasing the outcomes and findings of the project. Every twelve months, the consortium will submit to the Commission the following four reports for the previous 12-month period, as well as a plan for the forthcoming 18-month period.

1) An activity report for the previous twelve months, containing:

- a management-level overview of the activities carried out by the project during the period;

- a description of progress toward its scientific and technological objectives and associated innovation-related activities;

- a description of progress toward the milestones and deliverables foreseen;

- a description of training activities, if any;

- identification of problems encountered and corrective action taken.

2) A management report for the period, containing:

a) a management-level justification of the resources deployed by each participant, linking them to activities implemented and justifying their necessity;

b) a financial part, consisting of:

- a financial statement prepared by each participant, showing the total eligible costs incurred broken down by type of activity;

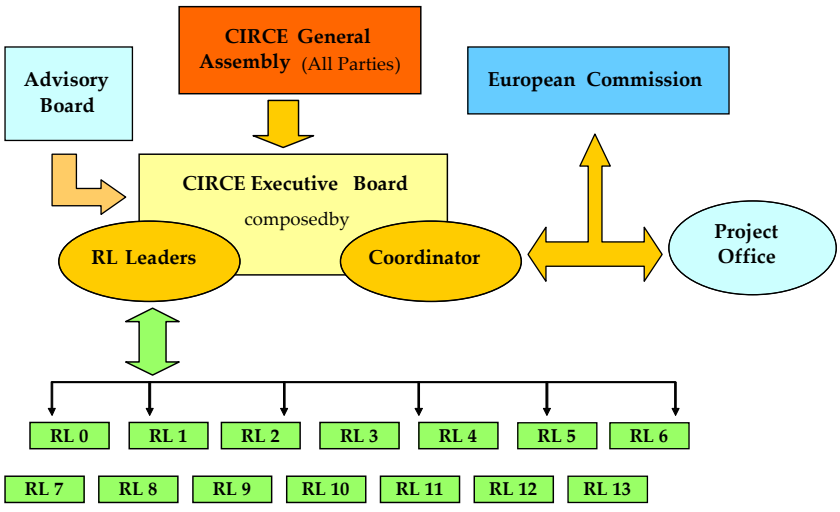
- an audit certificate per participant as required by the commission, furnished by an independent external auditor or, in the case of a public body or international organisation, by a competent public official, certifying the overall total of eligible costs incurred by that participant;

- a summary financial report prepared by the co-ordinator, consolidating the incurred costs of the consortium and the requested Community contribution, broken down by type of activity;

- a report on the allocation of the Community financial contribution to each participant made during that period.

3) An updated implementation plan, including a detailed description of the implementation plan for the eighteen months following the twelve-month period covered by the reports above, and a revision of the overall implementation plan if needed.

An associated financial plan, containing an estimate of the costs to be incurred by each participant during the coming eighteen-month period, broken down by type of activity.



Organization of the activities in WorkPackages

Appendix A – Consortium Description

A.1 Partecipants and Consortium:

1 : INGV (INGV)

Istituto Nazionale di Geofisica e Vulcanologia

The Istituto Nazionale di Geofisica e Vulcanologia (INGV) is a public research organization working under the supervision of the Italian Ministry of Education, University and Research (MIUR). Its area of activity ranges from geophysics environmental studies to seismology and volcanology. The institution is composed by 7 departments and a laboratory located in seven main sites (Roma, Milano, Catania, Palermo, Napoli, Bologna, Pisa). The Dynamic Climatology division takes part to several European and international projects with different dimension and partnerships, both as Partner and Coordinator. It collaborates with all the main climate research centres in Europe and in the rest of the world.

Scientists involved in the work will be **Antonio Navarra, Silvio Gualdi, Elisa Manzini** and **Simona Masina**, all of them with extensive experience in the field of climate change.

2 : CSIC

Consejo Superior de Investigaciones Cientificas

The group includes researchers from the Institute of Earth Sciences at Barcelona (CSIC-IES, 90 staff from which 26 are scientific staff) which belongs to the Spanish Research Council (CSIC) which in turn belongs to the Spanish Ministry of Science and Education.

The research team is formed by Xavier **Querol, Andrés Alastuey** and **A. Lopez Soler.**

3 : CEAM

FUNDACION CENTRO DE ESTUDIOS AMBIENTALES DEL MEDITERRANEO

The Centro de Estudios Ambientales del Mediterráneo, (Mediterranean Centre for Environmental Studies) - CEAM -, was created in 1991 to address specific environmental research areas in the Mediterranean Basin; it operates the EUropean PHOto REactor (EUPHORE), the largest simulation chamber facility in the world for studying atmospheric chemistry. CEAM scientists also led some of the initial EC projects to document atmospheric physico-chemical processes in Southern Europe and the Mediterranean area. The scientists involved will be **Millán M. Millán** and **V. Ramon**

4 : CLU (CLU)

CLU srl

CLU srl is a company composed by a team of young people with both scientific and organizational background. CLU was involved in several European projects as MATER, MFSPP and MEDNET;

CLU personnel involved in the project will be **Luisella Bianco** and **Claudia Cesarini**.

5 : DMI (DMI)

Danish Meteorological Institute

DMI has a very long expertise in global and regional climate modelling, and there is considerable experience in running multicentury and high-resolution simulations and handling the resulting large amounts of data. The contact person for DMI will be **Dr. Wilhelm May**

6 : UOC (UOC)

University of Crete, Environmental Chemistry Processes laboratory

UoC-ECPL belongs to the Dept. of Chemistry of the University of Crete. ECPL has four Faculty members: **N. Mihalopoulos, M. Kanakidou**, E. G. Stephanou, and S. Pergantis, with more than 20 years of expertise in environmental science research, three Technical Staff members and forty graduate and Ph.D. students.

7 : ENEA

Ente per le Nuove tecnologie, l'Energia e l'Ambiente

ENEA is the Italian government agency responsible for the areas of new technology, energy and the environment. Its two fundamental tasks are to conduct research in these areas and to diffuse the

results nationallyand it has been involved in several EU projects (TEMPO, MERMAIDS, Clivamp, MTP II MATER, TRACMASS, SCOUT, AMMA).ENEA personnel involved will include **Vincenzo Artale, Paolo M Ruti, Annarita Mariotti**.

8 : FEEM (FEEM)

Fondazione Eni Enrico Mattei

The Fondazione Eni Enrico Mattei (FEEM) is a no-profit, no-partisan research institution established to carry out research in the field of sustainable development and it will be represented by Prof. **Roberto Roson**

9 : UCM (UCM)

Universidad Complutense de Madrid

Universidad Complutense de Madrid (UCM)- Department of Earth Sciences II
Spain. UCM is the biggest University in Spain, with 6000 teachers, 100000 students and 195 departments. The group participating is mostly based on the Departamento de FÌsica de la Tierra II. UCM Personnel involved will be **Ricardo Garcia Herrera, Luis Gimeno Presa, J. Fidel Gonzalez Rouco**

10 : GKSS (GKSS)

Institute for Coastal Research, GKSS Research Center

The Institute for Coastal Research (ICR) is art of the GKSS Research Center, which is a member of the Helmholtz Association of National Research Centres in Germany. The ICR deals with problems related to monitoring the state of the coastal environment and with analyzing the past and ongoing change of the coastal environment as well as envisaging possible plausible futures (scenarios**). Dr. Hans von Storch** will be the senior presonnel involved in CIRCE

12 : IASA (IASA)

Institute of Accelerating Systems and Applications

The Atmospheric Modeling and Weather Forecasting Group (AM&WFG) is part of the Institute of Accelerating Systems and Applications (IASA). IASA is associated with the National and Kapodistrian University of Athens (NKUA) and the National Technical University of Athens (NTUA). It is hosted at the NKUA Campus. IASA has more than 20 faculty members and a number of Post Doctorate Researchers and PhD students. Members of the Group: **Prof. George Kallos**, Dr. G. Galanis, Dr. J. Pytharoulis, Dr. P. Louka, S. Sofianos, Dr. E. Mavromatidis, Dr. P. Katsafados, Dr. A. Voudouri, MSc M. Astitha, MSc G. Emmanouil, MSc E. Katirtzoglou, MSc C. Spyrou, J. Exidaridis

13 : CNR (ISAC-CNR, IBIMET-CNR, IRSA-CNR, IBAF-CNR)

Consiglio Nazionale delle Ricerche- Istituto di Scienze dell'Atmosfera e del Clima

The Institute of Atmospheric Sciences and Climate (ISAC) is part of the National Research Council (CNR). Over 200 staff members, postdoctoral researchers, and students conduct pure and applied research on atmospheric sciences and the climate system. Specific mission objectives are represented by the four divisions of the Institute that are oriented towards exerting a possibly unified research effort on the atmosphere and climate: Dynamic Meteorology, Climate Change, Earth Observations, Atmospheric Processes and a technical service structure: Field Facilities and Instrumentation.. ISAC personnel involved will be **Dr.Sandro Fuzzi, Dr. Susanna Corti, Dr. Alberto Maurizi**

Istituto di Biometeorologia

The Institute of Biometeorology (IBIMET) of the National Research Council
(CNR), Italy, is engaged in a wide spectrum of research activities in basic and applied meteorology, climatology, ecosystem analysis, crop yield forecasting systems, socio-economic development in agriculture and forestry at different scales and over several distinct geographical areas, including cooperation with developing countries. Scientists invloved will be **Marina Baldi, Franco Miglietta, Marco Bindi**

Istituto di Ricerca Sulle Acque

The Water Research Institute (IRSA) is an Institute of the Italian National Research Council (CNR),

operating by a multidisciplinary approach on strategic national and international problems, whose solution requires a critical mass of experts. IRSA conducts research on the main aspects concerning water (quality, management, treatment) and acts as consultant for Ministries and central public bodies. Chief Scientists will be **Michele Vurro**, **Costantino Masciopinto, Elisabetta Preziosi**

Institute of Agroenvironmental and Forest Biology - National Research Council

CNR-IBAF employs 50 persons of which 26 are researchers. IBAF engages in basic and applied research in the field of plant biology for increasing productivity of crop and forest species and improving the environment. Scientists involved will be **Giuseppe Scarascia Mugnozza, Francesco Loreto, Giorgio Matteucci**

14 : PIK (PIK)

Potsdam Institute for Climate Impact Research

PIK was founded in 1992 and now has a staff of about 140 people. The historic buildings of the Institute as well as the high-performance computer are located on Potsdamís Telegrafenberg campus. PIK research projects are interdisciplinary and undertaken by scientists from the following five departments: Integrated Systems Analysis, Climate System, Natural Systems, Social Systems and Data & Computation. Senior Scientist for CIRCE will be **Carlo Jaeger.**

15 : CIRAD (CIRAD)

Centre de coopération Internationale en Recherche Agronomique pour le Développement

Center for International Cooperation for Research on Agriculture for Development (CIRAD) has a long and proved experience on agricultural research and epidemiology of animal diseases. CIRAD conducts research on the impact of environmental changes on emerging diseases such as Bluetongue, for which CIRAD is the national reference laboratory. Scientists involved will be **Thierry Baldet** (entomology), **Jean-François Renard** (socio-economy) and **Annelise Tran** (geography).

16 : CNRS (CNRS/IPSL)

Centre National de la Recherche Scientifique

CNRS brings its contribution to the CIRCE project through the participation of its two research units: IPSL (in particular LMD - Laboratoire de MÈtÈorologie Dynamique) and CIRED.

The IPSL (Institut Pierre-Simon Laplace) is a federation of five research laboratories in the Paris area, all of them working in the field of terrestrial and planetary environments. The CIRED (Centre International de recherches sur líEnvironnement et le DÈveloppement) was founded in 1973 to harmonize environmental economic research, natural resource management and economic development, an issue which today known as sustainable development. Senior Sacientists involved will be **Jean-Charles Hourcade, Herve' Le Treut, Laurent Li**

17 : UPM (UPM)

Universidad Politecnica de Madrid

The Universidad PolitÈcnica de Madrid (UPM) is one of the leading universities in Spain in teaching and research activities that covers all fields of engineering and architecture and is carrying out the largest number of EU funded project in Spain and one of the largest in the EU. Senior personnel involved will be **Ana Iglesias, Luis Garrote**, **Consuelo Varela**

18 : WHO-Europe (WHO-Europe)

WHO European Centre for Health and Environment

The World Health Organization is a technical agency of the United Nations and the leading public health agency in the world. It is the main provider of technical advice and guidance on health matters for governments, local authorities and other stakeholders, monitoring of health trends, strategic analysis and research of health-related issues in its broadest sense. The WHO Europe has a special programme on health and environment with an office in Rome, where the unit on Global Change and Health is situated. Senior personnel involved will be **Dr.Bettina Menne**

19 : IDDRI (IDDRI)

Institut du DÈveloppement Durable et des Relations Internationales
Iddri was established in 2001 to respond to the challenges of a world characterized by the globalization of environmental and health issues and by a multiplication of risks. Initially taking the form of a scientific consortium, Iddri was transformed in 2003 into an association completed with a Foundation created in December 2004. Director of the IDDRI is **Laurence Tubiana** and other personnle involved will be **Lucien Chabason** and **Hubert Kieken**

20: NERC- NOCS (NERC-NOCS)

Natural Environment research Council
The National Oceanography Centre Southampton (NOCS) is unique among Britainís oceanographic establishments with its combination of research, teaching and national research support services on a purpose-built campus.The work proposed will be undertaken within the James Rennell Division for Ocean Circulation and Climate. Senior personnel involved will be **Dr. Michael N. Tsimplis**

21 : MPG (MPIBGC, MPIMET, MPICH)

Max-Planck Institut fur Biogeochemie
The Max-Planck-Institute for Biogeochemistry (MPI-BGC) is a new research institute of the German Max-Planck Society, founded in 1997. Its research mission is the investigation of the global biogeochemical cycles and their interaction with the climate system. Researcher at MPIBGC will be **Markus Reichstein** and **Christian Beer**.
MPGMET represented by the Max Planck Institute for Meteorology
The Max Planck Institute for Meteorology (MPI-M) (http://www.mpimet.mpg.de/) was founded as an institute dedicated to fundamental climate research personnel involved will be **Dr. Marco A. Giorgetta and Dr. Daniela Jacob**
MPICH Max Planck Institute for Chemistry
The Max Planck Institute for Chemistry is the oldest institute of the Max Planck Society, founded in 1912. While classical chemistry was practised in the beginning, the focus has later been mainly put on radiochemistry, nuclear physics and mass spectrometry. Senior personnel will be Dr. **Jos Lelieveld**

22 : NOA (NOA)

National Observatory of Athens
The main areas, in which the Institute has been active, are:Collection and Processing of Meteorological and climate Data, Participation in Environmental Research Programmes, Provision of Training and Consultancy Services to Third Parties, Communication of research results to the media and stakeholders. Senior staff involved will be **Dr. Christos Giannakopoulos** and **Dr. Basil Psiloglou**

23 : INSTM (INSTM)

Institut National des Sciences et Technologies de la Mer
INSTM is the National Institute of Marine Science and Technology (Tunisia). INSTM conducts research activity related to the sea and its resources : fishing, agriculture, marine environment, sea technologies, oceanography and climate. Senior scientists involved will be **Ali Harzallah** and **Cherif Sammari**

24 : HU (HU)

University of Haifa-Natural Resource & Environmemntal Research Center (NRERC)
NRERC operates under the auspices of the Research Authority of the University of Haifa. It conducts theoretical, applied and policy studies in the areas of: Environmental resource management (water and air quality, solid waste, noise pollution, preservation of natural areas and open spaces), and Natural resource management (water, energy, non-fuel minerals). Involvement in CIRCE will be made by **Prof. Mordechai Shechter** and **Dr. Iddo Kan.**

25 : BOKU (BOKU)

University of Natural Resources and Applied Life Sciences (BOKU), Dept. W-A-U, Institute of Meteorology

Research at the Institute deals with climate and climate change, agro-meteorology, boundary layer and environmental meteorology and radiation and is based on field experiments, model development and theoretical studies. The Institute has participated in and coordinates national and international research programmes, such as the Austrian climate research programme StartClim, and the EU projects SCOUT, STACCATO or VOTALP. BOKU personnel involved will be **Helga Kromp-Kolb, Petra Seibert, Bernd C. Kreger.**

26 : EC-DG-JRC (EC-DG-JRC)

European Commission DG Joint Research Centre, Institute for Environment and Sustainability

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of commercial or national interests Senior Staff will be **Dr. John A. van Aardenne**

27 : PCB- LRC (PCB- LRC)

Parc Cientific de Barcelona

The "Laboratori de Recerca del Clima" (LRC, Climate Research Laboratory) of the "Parc CientÌfic de Barcelona" (PCB, Science Park of Barcelona), was founded by Dr. X. RodÛ at the Department of Ecology of the University of Barcelona in 1998. The LRC-PCB has a remarkable experience on the modelling and analysis of climate variability from global to regional scale. Research leader will be **Xavier Rodo Lopez.**

28 : (ASLRME.DE)

Azienda Unità Sanitaria Locale Roma E

The Department of Epidemiology (ASLRME.DE) in Rome is a 25 year old public health and a research institution that has the responsibility for epidemiologic monitoring of the regional population (about five million inhabitants). The Department runs the local information system of mortality. Key Staff will be **Dr.Paola Michelozzi**,

29 : METEO-FRANCE (METEO-FRANCE)

METEO-FRANCE

The ´ Centre National de Recherches MÈtÈorologiques ª (CNRM) of the French meteorological service (MÈtÈo-France) is the department responsible for conducting the largest part of the meteorological research activities, and for coordinating research/development undertakings conducted within other departments. Key staff will be **Serge Planton, Michel Deque, Eric Martin**

30 : METOFFICE (METOFFICE)

Met Office (Hadley Centre)

The Met Office is the UK national meteorological service, with large computing facilities and extensive activities in weather and ocean forecasting and in climate research and prediction. Detailed information on the activities of the Met Office are available via the internet at http://www.metoffice.com/. Senior staff for the project will be **Richard Betts**

31 : UNITUSCIA (UNITUSCIA)

UNiversity of Tuscia - DISAFRI

The Department of Forest Science and Environment (DISAFRI) of University of Tuscia is composed by 10 full time permanent scientists working in the field of forest research with a major aim in understanding the biological processes and interactions from the scale of plants to the ecosystem and regional problems. Senior staff involved will be Prof. **Riccardo Valentini, Nicola Lacetera** and **Dario Papale**

32 : SEI-YO (SEI)

University of York, Stockholm Environment Institute (SEI-York)

The SEI is an independent, international research institute specializing in sustainable development and environment issues. It works at local, national, regional and global policy levels. The SEI research programmes aim to clarify the requirements, strategies and policies for a transition to sustainability. Key staff for this project will be **Dr Thomas E. Downing**

33 : UBIRM (UBIRM)

University of Birmingham

Since its foundation in 1900 the University of Birmingham has led the way in research and education, making ground-breaking progress in areas that span industries such as gene-structure, medicine, space research, communications and energy production. Key staff involved will be **Dr. David J. Maddison**

34 : UPV-EHU (UPV-EHU)

Universidad del PaÌs Vasco / Euskal Herriko Unibertsitatea (UPV/EHU)

University of the Basque Country (Plublic University)

The Atmospheric Research Group at the Faculty of Engineering in Bilbao, is the research group involved in this project. Senior staff involved will be **Lucio Alonso Alonso**, **Marino Navazo Munoz**, **Gotzon Gangoiti Bengoa.**

35 : UPC (UPC)

Universitat Politecnica de Catalunya

Laboratorio de IngenierÌa MarÌtima, Universidad PolitÈcnica de Catalunya (LIM/UPC). The Laboratori d'Enginyeria MarÌtima (LIM/UPC) is a Research Group within the Department Hydraulic, Maritime and Environmental Engineering of the Universitat PolitËcnica de Catalunya (UPC) in Barcelona. Key staff involved will be **Prof. AgustÌn Sanchez-Arcilla** and **Prof. Joan Pau Sierra**

36 : NKUA (NKUA)

National and Kapodistrian University of Athens

The Department of Hygiene and Epidemiology of the University of Athens Medical School was established in 1936. It's educational role at the undergraduate level includes teaching of Biostatistics, Epidemiology, Preventive Medicine and Occupational Medicine to Medical, Dental and Pharmaceutical School students. Senior Scientist leader for the project will be **Prof. Klea Katsouyanni**

The Laboratory of Climatology and Atmospheric Environment (**LACAE**) of the National and Kapodistrian University of Athens (NKUA) has been established recently in 2002, as an extension of the historical Laboratory of Climatology, founded at the University of Athens in late 19th century. It specialises in climatology and atmospheric environmental research, including studies on the climate variability on various time and space scales, measurements of ultraviolet and visible radiation as well as meteorological parameters and air quality, stratosphere-troposphere exchange and climatic effects from aircraft emissions. Senior personnel will include Professor C. Zerefos that has more than 30 years of experience in basic and applied research on atmospheric physics and global change.

37 : TAU (TAU)

Tel Aviv University

Tel-Aviv University is presented by Tel Aviv University Weather Research Center (TAU WeRC) and by Israel Space Agency- Middle-East Interactive Data Archive (ISA-MEIDA). Key staff will be **Prof. Pinhas Alpert, Dr. Simon Krichak, Prof. Zev Levin** and researchers: Dr. Pavel Kishcha, and K. Bassat.

38 : UAH (UAH)

Universidad de Alcala

Universidad de Alcala: The second oldest university in Spain, it dates from 1498. It has 22.000 students, with specialities ranging from literature to positive sciences to medicine and engineering.

It encompasses both teaching and research. The section of Physics of Climate is chaired by one of the participant, **Dr. Maria Jose Ortiz**. **Dr. Antonio Ruiz de Elvira** is full professor of physics specializing in fluids and statistical physics. He has been coordinator of 7 EU projects in the range of climate, climate change and wave modeling.

39 : Zadigroma (ZADIGROMA)

Zadigroma srl

Zadigroma srl is a private company, born in 1999 and specialised in science writing and editing and in designing communication strategies to enhance science diffusion and promotion within society. We are specialised in dealing with general science, medicine and health care, environment, energy, education, and human development. Based in Rome, Italy, Zadigroma, has over 40 collaborators who work as journalists, publishers and trainers. One of our thriving activity is the planning and implementation of science communication projects, magazines, newsletters, websites, brochures for Ministries and public or private bodies as well as editorial consultancy services. Key staff will be **Elisabetta Tola**, **Stefano Menna** and **Christoph Stein**

40 : UEA (UEA)

University of East Anglia

The Climatic Research Unit (CRU) is a research centre in the School of Environmental Sciences at the University of East Anglia in Norwich. The school was graded 5* during the last Research Assessment Exercise (the highest grading). At present, CRU is composed of around 20 research staff, and 14 postgraduate students. Senior personnel wil be **Dr Clare Goodess** and **Dr Tom Holt**

41 : UIB (UIB)

Universitat de les Illes Balears - Centre de Recerca EconÚmica - Departament d'Economia Aplicada

The Group of Tourism and Environmental Economics of UIB is a research group of economists with expertise in tourism demand, economic environmental policies, and environmental valuation. Group members are **Jaume Rossello Nadal, Antoni Riera Font** and **Andreu Sanso Rossello**

42 : ICAT-UL (ICAT-UL)

Instituto de CiÍncia Aplicada e Tecnologia da Faculdade de CiÍncias da Universidade de Lisboa

The Instituto de CiÍncia Aplicada e Tecnologia (ICAT) is a non-profit, public benefit institution founded in 1989. Its mission is to improve scientific development activities, by encouraging cooperation programs with other research and production organizations, and interchange of knowledge and technology, contributing to Portugalís economical and social development. Leading staff will be **Ricardo Machado Trigo, Filipe Duarte** and **Elsa Casimiro**

43 : UniHH (UNIHH)

Universitaet Hamburg

The Research unit Sustainability and Global Change (FNU) was founded in 2000 at the Department of GeoSciences and the Department of Economics at Hamburg University. FNU is devoted to multi-disciplinary research and education on human-induced environmental change that is either global in nature or pervasive across the world. Its research aims to further the understanding of sustainable development and its constituents environmental quality, economic efficiency and social equity. Activities in CIRCE will be led by **Prof. Richard S.J. Tol**

44 : UNIAEGEAN (UNIAEGEAN)

University of the Aegean

The Department of Geography, University of the Aegean, has a strong research core in Geographic Information Systems and remote sensing and substantial experience in the compilation and management of environmental geodatabases and in the monitoring and modelling of coastal land-

use change. Investigators will be **Dr Athanasios** and **Dr Sotiris Koukoulas** .

45 : CEDARE (CEDARE)

Center For Environment and Development for Arab Region and Europe

CEDARE, led by its Executive Director, Dr. Nadia Makram Ebeid, Egypt's former Minister of the Environment, has crafted and sharpened a new vision for the future of CEDARE. Four key areas of priority have been identified: (i) water resources management; (ii) land resources management; (iii) dissemination of knowledge and the use of information and communication technologies; and (iv) addressing issues related to trade, investment, and the environment. Senior staff involved in CIRCE will be **Prof. Mohamed El-Raey** and **Dr. Hesham El-Askary**

46 : UNIBERN (UNIBERN)

Institute of Geography

The Institute of Geography, founded in 1881, is one of the five departments of the Faculty of Sciences. The Climatology and Meteorology Research Group (KLIMET) is composed of 7 research staff, 4 support staff and 12 graduate students. Key staff involved will be **Dr.Elena Xoplaki**, **PD Dr. Juerg Luterbacher** and **Paul Della Marta**

47 : CETEMPS (CETEMPS)

Integration of Remote Sensing Techniques and numerical modelling to forecast severe weather

CETEMPS is organized in four main research lines atmospheric Modelling, hydological modellig, remote sensing from the surface, remote sensing from space. CETEMPS employs about 15 people and is configured as an indipendent resarch center of the University of L'Aquila. Key staff will be **Guido Visconti**, **Piero Di Carlo**

48 : FUBERLIN (FU Berlin)

Freie Universitaet Berlin

Research at the Institute of Meteorology of Freie Universitaet Berlin, Germany is concerned with the simulation and diagnosis of atmospheric conditions on time scales from hours/weeks (diagnosis of weather events, weather-forecasting) to months/millennia. Staff will be **Prof. Uwe Ulbrich** and **Dr. Gregor C. Leckebusch**

49 : UNILE (UNILE)

Università del Salento

The Università del Salento was established in 1955. It presently includes 703 faculty members, a total of 519 employees in the technical and administrative personnel and 27.000 students. It has expertise in wave and storm surge modelling, air-sea interaction, regional coupled atmosphere ocean models, modelling of turbulence and dispersion in the urban environment. analysis of synoptic variability and cyclone tracking algorithms. Key staff invovled will **Prof. Piero Lionello**.

50 : ECF (ECF)

European Climate Forum

The European Climate Forum is a platform for joint studies and science-based stakeholder dialogues on climatic change. ECF brings together representatives of different parties concerned with the climate problem: energy industries, companies engaged in renewables, major energy users, insurance and finance, policy-makers, environmental NGOs, and scientists. Key staff involved will be **Dr. Martin Welp**

51 : VUA (VUA)

Vereniging voor Christelijk Hoger Onderwijs Wetenschappelijk Onderzoek en Patientenzorg, Department of Hydrology and Geo-environmental Science

The Vrije Universiteit Amsterdam (VUA) was established in 1880. The environmental research includes research on physical processes related to the impact of land use change on our climate, water resources, ecological systems, geomorphology, biodiversity, carbon and nutrient cycling, as well as research on the social and economic issues and drivers leading to such land use change. Key staff: **Prof. Dr. A.J. Dolman**

52 : HUJI (HUJI)

The Hebrew University of Jerusalem

The Institute of Earth Sciences is part of the Faculty of Natural Sciences of the Hebrew University of Jerusalem. It was founded in 1978, encompasses working units in Geology, Atmospheric Sciences and Oceanography and is responsible for teaching and research of the entire spectrum of earth sciences studies. The atmospheric sciences curriculum includes physics and chemistry of the atmosphere, cloud physics, ocean-atmosphere interaction, chemistry of atmospheric pollution, meteorology, and remote sensing. Principal Investigators: **Prof. Daniel Rosenfeld** and **Dr. Jose Gruenzweig**

53 : USC (USC)

Universidad de Santiago de Compostela (Universidade de Santiago de Compostela)

The University has experience participating in many similar international projects as the one here presented. Consequently, there is personal available who can help at this end with the management of the tasks related to University of Santiago.Principal Investigator: **Maria L. Loureiro.**

54 : CMCC

Centro Euro-Mediterraneo per i Cambiamenti Climatici

The (CMCC) is a scientific research structure that is determined to improve the knowledge in the field of climatic variability, its causes and its consequences through the development of numerical simulations with Earth System global models and with regional models.

The Centre produces models, simulations, middleware, software and high qualification staff both in the specific field of climate dynamics and in the computer science technologies.

55 : IPT (IPT)

Institut Pasteur of Tunis

The Institut Pasteur of Tunis is a public health institution established in 1893 in Tunis (Tunisia) to improve the knowledge regarding endemic diseases for a better surveillance and control. It serves Tunisia in training students in medicine and biology, developing serum and vaccines and strengthening the surveillance of emerging infectious diseases. Key staff is **Prof. Ben Salah**

56 : ARCE (ARCE)

Association for Research on Climate and Environment

Created in Oran (Algeria) in 1993, the Association for Research on Climate and Environment (ARCE) materialised the will of a group of scientists from different backgrounds to advocate an integrated pluridisciplinary approach of the environmental research. Principal Investigator is **Mohamed Senouci**

57: ICARDA (ICARDA)

International Center for Agricultural Research in the Dry Areas

The International Center for Agricultural Research in the Dry Areas (ICARDA) was established in 1977 and is one of the 15 centers strategically located all over the world and supported by the Consultative Group on International Agricultural Research (CGIAR). With its main research station and offices based in Aleppo, Syria, ICARDA works through a network of partnerships with national, regional and international institutions, universities, non-governmental organizations and ministries in the developing world; and with advanced research institutes in industrialized countries.Principal investigator will be Prof. **Theib Oweis**.

58 : HCMR (HCMR)

Hellenic Centre for Marine Research

The Hellenic Centre for Marine Research (HCMR) is a large Governmental Research Centre that belongs to the Ministry of Development, General Secretariat for Research and Technology.

Key staff involved will be **Alexander Theocharis** and **Athanasia Iona.**

59 : UNI-SOTON (UNI-SOTON)

University of Southampton

University of Southampton is one of Europe's leading universities with strong expertise across the

natural, engineering and social sciences, and including the largest concentrations of oceanographers at the National Oceanography Centre. Key staff involved will be **Dr. Robert J Nicholls** and **Dr. Mustafa Mokrech**

60 : BGU (BGU)

Ben-Gurion University of the Negev

Israel 's youngest research university, **Ben-Gurion University of the Negev** was founded in 1969. Its purpose: to act as a driving force in the development of the Negev , a desert area comprising more than sixty percent of the country. The University was inspired by the vision of lsrael's first prime minister, David Ben-Gurion, who believed that the country's scientific future lay in this region. Principal Investigator is **Prof. Jonathan Laronne.**

61 : PSI (PSI)

Paul Scherrer Institut

The Paul Scherrer Institut is a centre for multi-disciplinary research and one of the world's leading user laboratories. With its 1200 employees it belongs as an autonomous institution to the Swiss ETH domain and concentrates its activities on solid-state research and material sciences, elementary particle and astrophysics, energy and environmental research as well as on biology and medicine. Key staff involved will be **Dr. André Prevot**

62 : ICCS (ICCS)

Institute of Communication and Computer Systems

E3M-Lab operating within the ICCS is a laboratory specialised in the construction and use of large scale computerised models covering the areas of Energy, Economy and Environment. Such models are used to make projections and analyse complex issues requiring system-wide consideration. Special emphasis is given to policy analysis and support. Principal Investigator is **Prof. Capros Pantelis**

63 : OGS (OGS)

Istituto Nazionale di Oceanografia e Geofisica Sperimentale - OGS

OGS is the Italian National Institute for Oceanography and Experimental Geophysics. Research activities include physical and biological oceanography as well as numerical modelling of estuarine and marine systems. Principal Investigator is **Dr. Alessandro Crise.**

64 : UNIBO (UNIBO)

Alma Mater Studiorum – Università di Bologna – Dipartimento di Colture Arboree

The Dipartimento di Colture Arboree, DCA, has substantial expertise in the development and application of ecosystem models, which has resulted in our involvement in several EU DGXII projects (LTEEF, LTEEF2, CarboEurope/ Carbo-Age, MIND) and more recently in a project by the European Space Agency (ESTEC 17169 /03/NL/GS). A good experience in sensitivity and uncertainty analysis has already been gained in these projects. Principal Investigator is **Prof. Federico Magnani.**

65 : Medias

Medias-France

The Medias-France structure was created in 1994 as a non-profit public organisation. Its objective is to bring services to scientists, service providers and policy makers addressing environment change and sustainable development issues, origins and impacts in a sustainable development perspective. Mediterranean and Subtropical Africa are top priority regions. Key staff will be **Dr. Michel Hoepffner**