

Climate Change Impacts on Water and Security

in Southern Europe and neighbouring regions

A cluster of collaborative research projects
under the 7th Framework Programme



EUROPEAN COMMISSION

Directorate-General for Research and Innovation
Directorate I – Environment
Unit I.4 – climate change and natural hazards

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Cataloguing data can be found at the end of this publication.
Luxembourg: Publications Office of the European Union, 2011

ISBN 978-92-79-20034-2
doi 10.2777/56413

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Printed in Luxembourg

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Climate Induced Changes on Water and Security – an EU thematic priority

The impacts of climate change on water resources are raising concerns over the possible implications for security. Decreasing access to water resources and other related factors could be a cause or a ‘multiplier’ of tensions within and between countries. Whether security threats arise from climate impacts – or options for cooperation evolve – does not depend only on the severity of the impacts themselves, but on social, economic institutional vulnerabilities or resilience and other factors that influence local, national and international relations.



Climate change impacts on the hydrological cycle have been linked to observed warming over several decades. Higher water temperatures and changes in extremes, including floods and droughts, are projected to affect water quality and exacerbate many forms of water pollution with possible negative impacts on ecosystems and human health, as well as water system reliability and operating costs. In addition, sea-level rise is projected to extend areas of salinisation of groundwater and estuaries, resulting in a decrease of freshwater availability for people and ecosystems in coastal areas. Besides this, changes in water quantity and quality due to climate change are expected to affect food availability, water access and utilisation of water infrastructure, especially in arid and semi-arid areas. Actions to combat climate change at global and EU scales are embedded into European Union policies, namely through the integrated energy and climate change policy adopted in December 2008, which includes ambitious emission reduction targets for 2020. Specific considerations about climate change impacts on the water cycle as well as on the reliability of current water management systems are also tackled by EU policies, namely through the

Water Framework Directive 2000/60/EC, which provide ambitious environmental targets with considerations of climate change adaptation needs for river basin management planning. This framework is complemented by parent legislation, such as the Flood Directive 2007/60/EC and drought action programmes.

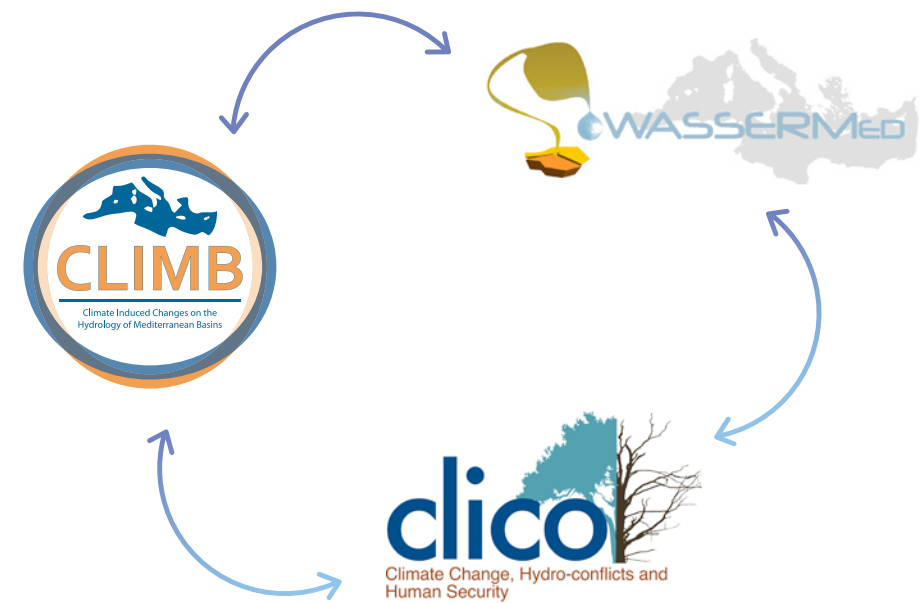
Research on climate change is needed to clarify the relations between climate change impacts and security also considering the policy attention to them, including in the 2008 paper of the EU High Representative and the European Commission dedicated climate and international security.

Scientific outputs are also contributing to international policies and debates, in particular through inputs to IPCC assessment reports and UNFCCC documents. The European Commission is funding research through its Framework Programme for Research and Technological Development. In this context, projects of the on-going 7th Framework Programme largely contribute to gathering knowledge relevant to climate change adaptation.

Angela Liberatore, Philippe Quevauviller

CLIWASEC – A research cluster on Climate Change Impacts on Water and Security in Southern Europe and neighboring countries

The Mediterranean region is experiencing a broad range of threats to water security. According to climate projections, the region is at risk due to its pronounced susceptibility to changes in the hydrological budget and extremes, which is expected to have strong impact on the management of water resources and on key strategic sectors of regional economies. Related developments have capacity to exacerbate tensions, and intra- and inter-state conflict among social, political, ecological and economic actors. Effective adaptation and prevention policy measures call for multi-disciplinary analysis and action.



■ The research cluster CLIWASEC

The European Commission actively prepares Europe and neighboring regions for climate induced ecological and socio-economic challenges that lie ahead and has placed related priority research topics in the Seventh Framework Program for Research and Technological Development (FP7). In order to better assess the consequences and uncertainties regarding climate impacts upon human-environment systems, a coordinated topic has been launched between Theme 6 ('Environment (incl. climate change)') and Theme 8 ('Socio-Economic Sciences and the Humanities') of the programmatic setup of FP7.

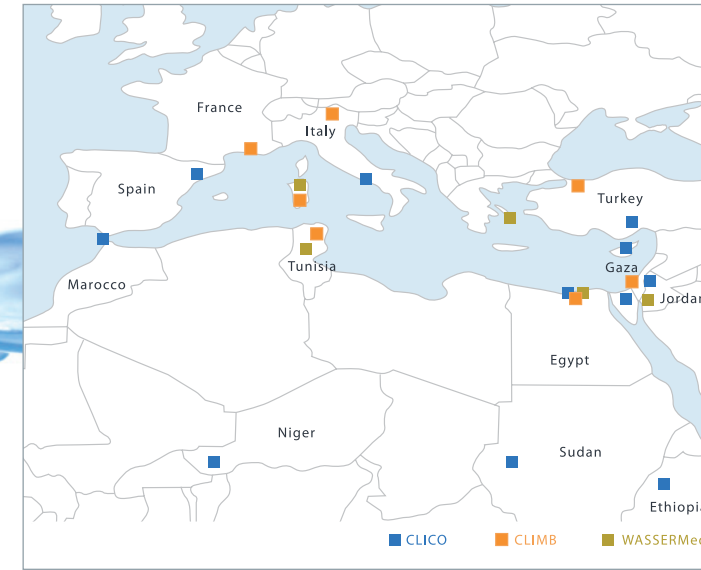
Three recently launched projects form the research cluster CLIWASEC (CLimate change Impacts on Water and SE-Curity, www.cliwasec.eu) for multi-disciplinary scientific synergy and improved policy outreach. The cluster comprises a critical mass of scientists from 44 partners (29 institutions from the EU, 5 institutions from S&T countries and 10 international institutions) to build relationships with relevant policy representatives and stakeholders at EU level and Mediterranean and neighbouring countries cover-

ed by the projects. It tackles most relevant research questions with regard to climate change impacts on water resources as a threat to security in an integrated way:

- **WASSERMed** – Water Availability and Security in Southern Europe and the Mediterranean (funded under FP7-ENV), co-ordinated by Prof. Roberto Roson (CMCC, Italy) www.wassermed.eu
- **CLICO** – Climate Change, Hydro-Conflicts and Human Security (funded under FP7-SSH), co-ordinated by Prof. Giorgos Kallis und Dr. Christos Zografos (UAB-ICTA, Spain) www.clico.org
- **CLIMB** – Climate Induced Changes on the Hydrology of Mediterranean Basins (funded under FP7-ENV), co-ordinated by Prof. Dr. Ralf Ludwig (LMU, Germany) www.climb-fp7.eu



Endangered: agricultural productivity, drinking water supply



1. Cyprus
2. Andalusia-Morocco Biosphere
3. Sarno – Italy
4. Niger – Niger
5. Alexandria – Egypt
6. Sudan
7. Seyhan – Turkey
8. Jordan River – Jordan
9. Sinai Desert – Egypt
10. Nile – Ethiopia
11. Ebro – Spain

1. Thau – France
2. Rio Mannu, Sardinia – Italy
3. Chiba, cap Bon – Tunisia
4. Noce, Trentino – Italy
5. Izmit Bay, Kocaeli – Turkey
6. Nile Delta – Egypt
7. Gaza – Palest.-admin. areas

1. Syros Island – Greece
2. Merguelli – Tunisia
3. Sardinia – Italy
4. Jordan River – Jordan
5. Rosetta area – Nile Delta – Egypt

Scientific Synergy and Policy Outreach

The three projects are joining forces to identify and foster scientific synergies and to establish a more focused and efficient policy outreach strategy. Major building blocks of this collaboration include scientific exchange and review, identify and utilize complementary monitoring and modeling methods, harmonize and share data and discuss dissemination strategies or elaborate and propose adaptation alternatives. The projects have agreed on joint annual general assemblies, a dissemination plan for presenting the results of the three projects in the scientific literature and the setting up a cluster project web-portal, which hosts and advertises further related projects. Policy briefs of the projects findings are prepared and posted on the cluster website on an event basis. At any time, regional, national and international stakeholders and policy bodies are invited to express their research needs and recommendations. To optimize benefits from the variety of cluster partners' competences, joint research must be devoted towards a better understanding and description of interfaces in such complex systems. Two main challenges lie ahead: i) bridging scales and ii) quantifying and reducing uncertain-

ty. Integrating different methods from natural and social sciences can contribute to better conceptualize each project's research findings and propose solutions for water resource management under climate change, especially when a variety of different situations can be covered in complementary case studies.

The case studies

The analysis of climate change impacts on available water resources and security is targeted on Southern Europe and neighbouring regions. The case studies, selected according to project specific criteria, are complementary in either scope, region or scale.

- **WASSERMed:** Syros Island (GR), Merguelli (TN), Sardinia (IT), Jordan River (JO), Nile (EG)
- **CLICO:** Cyprus, Andalusia-Morocco biosphere, Sarno (IT), Niger, Alexandria (EG), Sudan, Seyhan (TR), Jordan River, Sinai Desert (EG), Nile (ET), Ebro (ES)
- **CLIMB:** Noce (IT), Rio Mannu (Sardinia, IT), Thau (FR), Chiba (TN), Izmit Bay (TR), Gaza (Palest. Adm.), Nile Delta (EG)

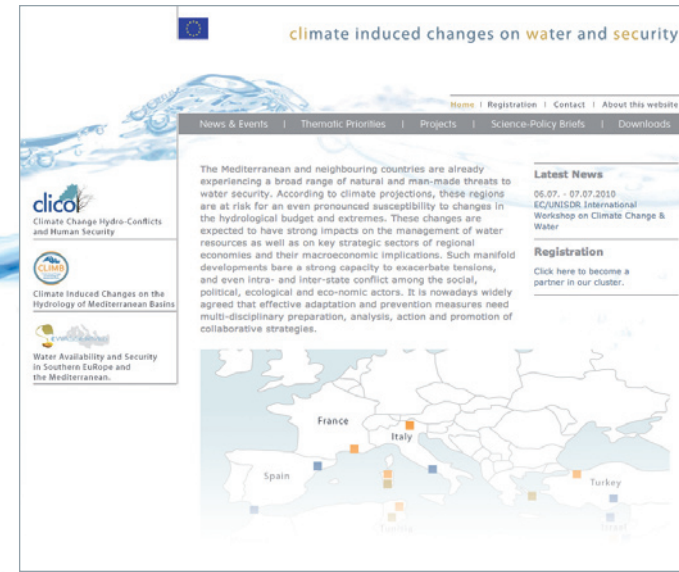
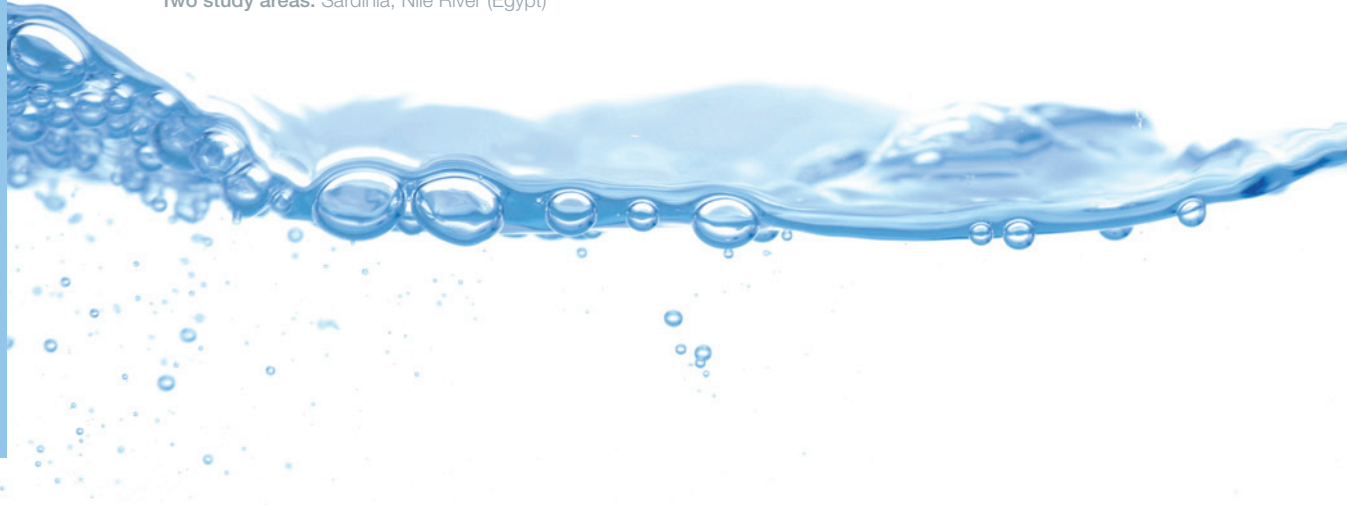
Bridging Scales

Besides the different perspectives on climate induced changes as a threat to water security, the CLIWASEC projects are considering different scales, as processes with a pronounced spatial character (e.g. precipitation, evapotranspiration) interact with linear processes (e.g. river runoff) as well as with processes without any direct connection to one specific spatial scale (e.g. economic, political or social decision making, where impacts are spatially disaggregated to various scales). Depending on selected process and scale, these processes can be described i) explicitly (microscale – field to small-sized catchments in the range of up to several 100 km²), ii) mechanistically (mesoscale – in the order of medium sized river catchments in the range of up to several 1.000 km²) or iii) effectively (macroscale – in the order of regions, possibly ranging up to over 100.000 km²). The transition from microscale to macroscale and back is always complex if the described processes are not linear and the case studies being investigated are heterogeneous, such as the ones proposed by the CLIWASEC projects. While maintaining project research focus, one great opportunity for

project collaboration comprises improved descriptions of scale interfaces. The spatially explicit results of distributed scale-crossing (environmental) models, such as the ones used in CLIMB (micro- to mesoscale) and WASSERMed (meso- to macroscale), can support and feed a yet largely unused interface to socio-economic sciences, which transfer the high-resolution signal of climate induced hydrological change into relevant socio-economic information at the appropriate scale. Decisions and courses of action which are consequently derived, such as any change in management practices, can in return be spatially disaggregated using the same interface to provide an additional external force for the hydrological/environmental models operating at the small scale. In this way, research groups can follow their sectoral expertise and joint efforts can focus on the definition of interfaces and their functionality to bridge scales.



Two study areas: Sardinia, Nile River (Egypt)



Cagliari 2011: At the joint General Assembly of CLIMB-CLICO-WASSERMed

■ Quantifying and Reducing Uncertainty

The current potential to develop appropriate regional adaptation measures towards climate change impacts suffers heavily from large uncertainties. These spread along a long chain of components, starting from the definition of emission scenarios to global and regional climate modelling to impact models and a subsequent variety of management options. The critical mass of research capacity obtained through clustering the projects will allow for quantifying uncertainties in climate change impact analysis for the Mediterranean and neighbouring regions to a yet unprecedented level, as most of the inherent contributors to uncertainty are being addressed. Again, a specified definition of interfaces, linked to an exchange of data, methods and model results, is the key prerequisite. Most projects dealing with climate change impact analysis are usually making vast use of available Global and Regional Climate Model data (GCM and RCM respectively) without ever exchanging the methods and reasons for making their climate data selections. The audits that lead to select the best regional performers as compared to observed values during the climatic reference period can be openly

discussed and exchanged and thus contribute substantially to the reduction of uncertainty. Conjointly evaluated procedures for downscaling RCM data will deliver the driving inputs for subsequent (hydrological) impact models, transferring a future climate signal into hydrological quantities at the catchment or landscape scale.

However, very limited quantitative knowledge is as yet available about the role of hydrological model complexity for climate change impact assessment, where predictive power becomes more and more important and raises the demand for process-based and spatially explicit model types. Hydrological model ensembles serve to analyse existing models and help to identify the appropriate level of model complexity, and thus to determine the data specifications required to provide robust results in a climate change context.

The joint research forces provided by clustering expands the possibilities for data mining and exchange. Data uncertainty can be reduced by creating a potent and multi-scale data repository that serves to parameterize integrated impact models and comprehensively describe the regions' vulnerability, associated risks and adaptive capa-

city. Further, the lack of awareness or understanding of the complex climate-resource-society dynamics often leads to take inappropriate or no measures at all. An inventory of international, national and regional policies dealing with responses to climate change, water resources management, responses to hazards and disasters, and security in the region, is essential for proposing a suitable policy framework to integrate security, climate change adaptation and water management issues and specific recommendations for policy streamlining at the UN, EU, national and regional levels.

■ Participation to CLIWASEC

The clustering of projects can help push forward current understanding of the interactions of climate change impacts on ecological, economic and social components of human-environment systems. The cliwasec cluster thus cordially invites other projects and initiatives active in these fields to cooperate under this common framework. Please register at <http://www.cliwasec.eu/registration/registration.php> to become a partner in our cluster and to optimize communications, share and exchange know-

ledge and information and to discuss individual and common experiences. This is essential for advancing towards optimized regional solutions for water resources management under climate change.

Become a partner in our cluster?

Please complete the information below:

*Required fields

Project details:

Project title: *

Description: *

Funding scheme: *

Budget:

Period: *

Partner:

Website: *

Logo: * Beginning with "http://"
 Keine Datei ausgewählt

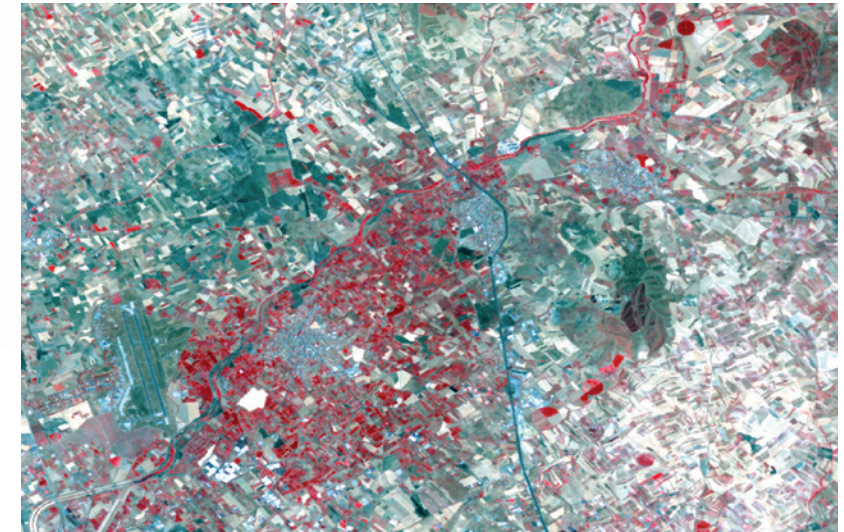
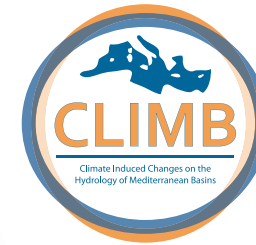
Data types: jpg, bmp, png, tiff, gif, doc, docx, pdf, eps, ai, ppt, pptx
 Max. memory size: 7.5 MB

Study site(s) description:

Including coordinates if to be included in overview map.

CLIMB – Climate Induced Changes on the Hydrology of Mediterranean Basins – Reducing Uncertainty and Quantifying Risk

CLIMB analyzes climate induced changes in hydrological budgets and extremes across the Mediterranean and neighbouring regions, targeted to selected river or aquifer catchments. A combination of novel field monitoring and remote sensing concepts, data assimilation, integrated hydrologic modelling and socioeconomic factor analyses is employed to reduce existing uncertainties in climate change impact analysis. Results of a multi-model ensemble feed a GIS-based Vulnerability and Risk Assessment Tool, serving as a platform for dissemination of project results, communication and planning for local and regional stakeholders.



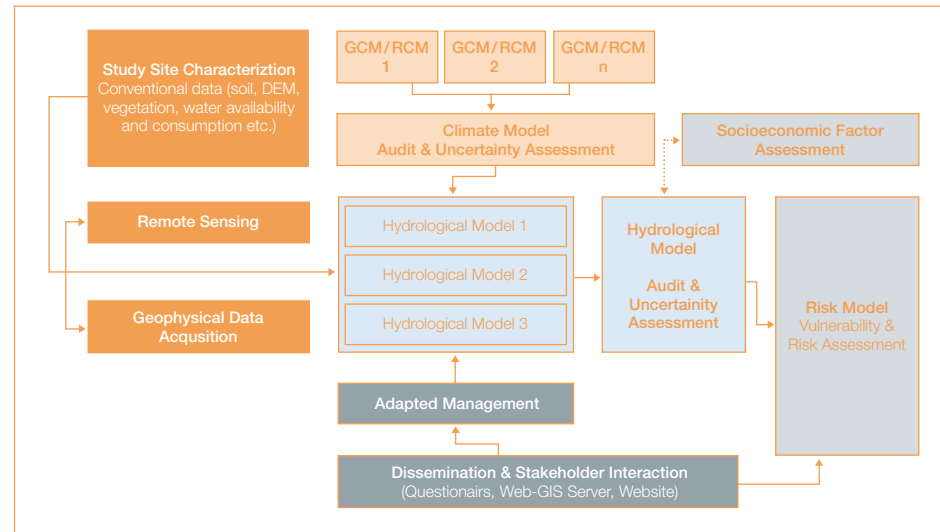
Sardinia, July 2010: Irrigated versus non-irrigated agriculture

■ Situation

There are a number of major obstacles to implementation of adaptation measures designed to achieve sustainable management of water resources in Southern Europe, North Africa and the Middle East. Effective adaptation measures need to be prepared in a multi-disciplinary approach. While there is scientific consensus that climate induced changes on the hydrology of Mediterranean regions are presently occurring and are projected to amplify in the future, very little knowledge is available about the quantification of these changes, which is hampered by a lack of suitable and cost effective hydrological monitoring and modeling systems. In particular, current projections of future hydrological change, based on regional climate model results and subsequent hydrological modeling schemes, are very uncertain and poorly validated. The conditions required to develop and implement appropriate adaptation strategies are lacking. To the extent that adaptation initiatives are being proposed and adopted, they are primarily by perceptions of individual stakeholders and are rarely based on a multi-disciplinary assessment covering both natural and associated social and economic changes.

■ The CLIMB approach

Modeling capabilities must be improved and appropriate tools developed to advance the capability to assess climate effects on water resources and uses. The project consortium employs a combination of novel field monitoring concepts, remote sensing techniques, integrated hydrologic modeling and socioeconomic factor analyses to reduce existing uncertainties in climate change impact analysis and creates an integrated quantitative risk and vulnerability assessment tool. Together, these provide the necessary information to design appropriate adaptive water resources management instruments and select suitable agricultural practices under climate change conditions. The risk and vulnerability analysis tool enables to assess risks for conflict-inducing actions, e.g. migration. The improved models, new assessment tools, and their results are evaluated against current methodologies. Improvements are communicated to stakeholders and decision makers in a transparent, easy-to-understand form, enabling them to utilize the new findings in regional water resource and agricultural management initiatives as well as in the design of mechanisms to reduce potential for conflict.



CLIMB: Research approach and workflow

■ The CLIMB way

An analysis of climate change impacts on available water resources is undertaken in study sites located in Sardinia, Northern Italy, Southern France, Tunisia, Turkey, Egypt and the Palestinian-administered area Gaza.

The work plan is targeted to selected river or aquifer catchments, with areas in the order of up to a few thousand square kilometers, representing water management units for regional water authorities. Selection criteria included an expected high susceptibility to climate induced changes in water availability and security: high agricultural productivity, irrigation, heavy multi-source nutrient loads and pollution, sea water intrusion or growing water use rivalries. The site specific analysis enables an improved assessment of region-specific vulnerability and risk factors for agricultural, drinking, residential and industrial water. Advanced climate scenario analysis techniques are employed and dynamical and statistical downscaling of regional climate model simulations is performed to provide the drivers for an ensemble of hydrological models with different degrees of complexity in process description and level of integration. The outputs of the climate-hydrological

modeling chain is focused to estimate changes in hydrological components such as timing and frequency of extreme precipitation, run-off, in-stream mean flow, soil moisture or groundwater balance.

Field monitoring and measurement strategies for surface and subsurface hydrological processes will be adjusted to the specific requirements in the study sites. Synergistic radar and optical remote sensing techniques are employed to retrieve and provide steady state and dynamic model parameters, to monitor process variables and to validate model results. Data assimilation is used to incorporate relevant data and process understanding into existing modeling concepts, helping to reduce uncertainty in predicted hydrological quantities.

The integration of hydrological model results and socioeconomic factor analysis supports the development of a GIS-based, modular Vulnerability and Risk Assessment Tool. This tool serves as a platform for the dissemination of project results, including communication with and planning for local and regional stakeholders as well as for the discussion and comparison of results with the scientific community.



June 2010: Chiba Dam, Tunisia

■ Quick facts

FP7-Topic: ENV.2009.1.1.5.2
 Funding period: 01/2010 – 12/2013
 Coordinator: Ludwig-Maximilians Universität München (LMU, Germany)
 Partners: 19
 Website: www.climb-fp7.eu
 Contact: Prof. Dr. Ralf Ludwig (project co-ordinator), ludwig@lmu.de
 Dr. Thomas Ammerl (project manager), ammerl@bayfor.org

■ The Partners

The CLIMB consortium comprises a total of 19 partners from four European Member States (Italy, Austria, Germany, and France), four SICA countries (Turkey, Tunisia, Egypt, Palestinian-administered areas) and one non EU member country (Canada).

- Ludwig-Maximilians-Universität München, Germany
- AGRIS Sardegna - Agenzia per la Ricerca de la Agricoltura, Italy
- Christian-Albrechts-Universität zu Kiel, Germany
- Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, France
- Centre de Recherche et des Technologies des Eaux, Tunisia
- Consorzio Interuniversitario Nazionale per la Fisica delle Atmosfere e delle Idrosfere, Italy
- Centro di Ricerca, Sviluppo e Studi Superiori in Sardegna, Italy
- Deutsches Zentrum für Luft- und Raumfahrt e.V., Germany
- Forschungszentrum Juelich GmbH, Germany
- Gebze Yuksek Teknoloji Enstitusu, Turkey
- Institut National de la Recherche Scientifique, Canada
- Joanneum Research Forschungsgesellschaft mbH, Austria
- Université d'Angers, France
- Islamic University of Gaza, Palestinian-administered areas
- Università degli Studi di Padova, Italy
- Università degli Studi di Trento, Italy
- Zagazig University, Egypt
- VISTA Geowissenschaftliche Fernerkundung GmbH, Germany
- Bayerische Forschungsallianz gemeinnützige GmbH, Germany
- Université François-Rabelais du Tours, France

CLICO – Climate Change, Hydro-conflicts and Human Security

Climate change poses threats to human security and hydro-climatic hazards can exacerbate social tensions, intra- and inter-state conflict. Still, there are few peer-reviewed studies examining links between climate change, hydrology, conflict and security. Focussing on the Mediterranean, Maghreb, Middle East and Sahel, CLICO fills this gap in knowledge over the social dimensions of climate change. It examines why some countries and communities are more vulnerable to droughts, floods and related conflict, and what policies and institutions are necessary to ensure adaptation and security under global and regional hydro-climatic change.



Tata in Southern Morocco: Flooded street

■ Situation

The pace of changes in the planet's climate has no precedent in the history of civilization. Potential links between natural hazards or scarcities and conflict have been publicly acknowledged by officials and made their way into international forums such as the European Security Strategy, and the UN High Level Panel on Threats, Challenges, and Change. The Mediterranean, Middle East and the Sahel are among the world's most exposed and vulnerable regions.

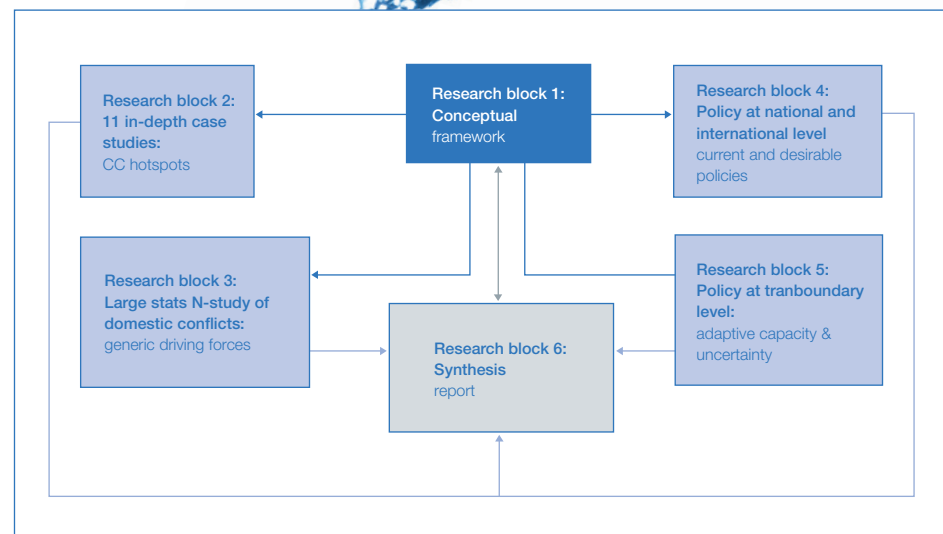
However claims about a causal relationship between water scarcity and conflict are often based on single case studies and have not been confirmed by large comparative studies. Moreover, the vulnerability, capacity to adapt, and resilience of different regions and communities to climate change differs a lot and so does the propensity for conflict. In some cases extreme climate events happened but the population remained resilient while in other cases the change in climate was moderate but caused tremendous impacts and conflicts. Whereas we are learning more about the drivers of vulnerability to climate change, we still know little about vulnerability to socio-economic stressors

acting in concert with climate change. The concept of security is under-specified and used differently in different contexts, and the links between security, vulnerability and conflict are poorly understood.

As a result, the capacity to forecast and avoid hydro-climatic threats to human security through monitoring and mediation remains low. Whereas in some places the lack of understanding of the complex climate-resource-society dynamics is used as an excuse for not taking measures, in other places inappropriate measures may be taken. The motivation for the CLICO project is to address this gap in basic knowledge and hence help design better policy responses.

To achieve this aim, the project pursues two objectives:

- Understand and model relationships between hydro-climatic hazards, climate change vulnerability, human security and conflict, on the basis of theoretically-informed, comparative empirical research.
- Map international and national policies for security and adaptation in water resources and hazard management, and develop a policy model for "hydro-security" in the region, applicable to the UN, EU and national states



CLICO: Research approach and workflow



Climate change: a threat to human security

Quick facts

FP7-Topic: SSH.2009.4.2.1
 Funding period: 01/2010 – 12/2012
 Coordinator: Universitat Autònoma de Barcelona (UAB-ICTA), Spain
 Partners: 14
 Website: www.clico.org
 Contact: Prof. Giorgos Kallis (project co-ordinator), giorgoskallis@gmail.com
 Dr. Christos Zografos (research co-ordinator), czografos@gmail.com

The CLICO approach

Much of the debate on climate change and hydrological impact focuses on national security and the potential for armed conflict. CLICO complements this with attention to regional and local scales and with a concern for climate change impacts on vulnerable livelihoods. It takes a critical look at the sources of vulnerabilities that undermine human security and the governance arrangements necessary to enhance adaptation. The project mobilizes 14 research teams from Europe, North Africa, Sahel and the Middle East and brings together leading researchers in water resource, vulnerability, and peace and security studies.

CLICO is structured around four empirical, one theoretical (1) and one synthesis (6) research block. The first unit develops the project's conceptual framework and is used to both guide empirical research and consider the place of the project and its foreseen contributions within current knowledge. Eleven cases of hydro-conflicts are studied (see pg. 10). Moreover, a large dataset – the first of its kind – of hydro-conflicts in the Mediterranean, Middle East and Sahel is regressed against climatic, hydrological and socio-

economic variables (research block 3). Despite calls by political actors for attention to climate change and security issues, concrete ideas concerning appropriate international and national policy responses and how these would differ from (or fit in with) existing ones are lacking. Various EU policies touch issues relevant to climate change, water resources and security but none addresses them directly. This policy deficit is associated to the lack of rigorous scientific conceptualization and understanding of the links between climate change, water, vulnerability, security and conflict. CLICO maps existing policies at the national and international level and envisages a better overarching framework with improved links between existing policies (research block 4). Policies to deal with transboundary water issues are studied in the fifth block, which investigates their adaptive capacity and the way they consider uncertainty (e.g. regarding future climatic conditions). Project results will be synthesised in a report that will identify potential security concerns in the studied regions and provide fresh policy ideas for promoting peace and security under changing hydro-climatic conditions (research block 6).

The Partners

CLICO mobilizes 14 research teams from Europe, North Africa, Sahel and the Middle East, bringing together some of the world's leading researchers in water resource, vulnerability, and peace and security studies.

- ICTA, Universitat Autònoma de Barcelona, (coordinator)
- United Nations University, Institute for Environment and Human Security
- Tyndall Centre for Climate Change Research, University of East Anglia
- Addis Abeba University
- Israeli-Palestinian Science Organization, Brussels
- Centre for the Study of Civil War (CSCW), International Peace Research Institute
- Israeli-Palestinian Science Organization, Brussels
- Department of Geography, The Hebrew University of Jerusalem
- Suez Canal University, Egypt
- Swiss Federal Institute of Technology
- Energy, Environment and Water Research Center, The Cyprus Institute, Cyprus
- School of Global Studies, University of Sussex
- Palestinian Hydrology Group For Water And Environmental Resources
- Centre de Recerca Ecològica i Aplicacions Forestals, Barcelona

WASSERMed – Water Availability and Security in Southern Europe and the Mediterranean

WASSERMed builds on existing climate projections in order to assess present and future uncertainties in hydrological budgets in the Mediterranean area, and to provide an improved assessment of climate effects on water resources and use sectors. Research expands to the quantification of socioeconomic factors that can affect future threats to water security, and to the evaluation of potential measures to mitigate adverse effects. Results, which concern sensitive sectors of the Mediterranean area and specific regions, are widely disseminated to stakeholders in order to facilitate long-term adaptive planning.



Tunisia: Informal pumping from the Wadi

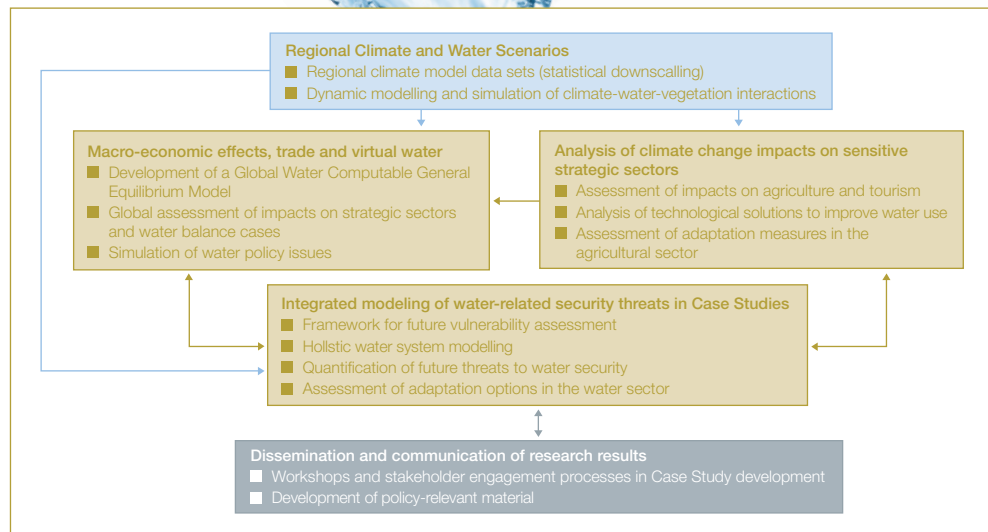
■ Challenges and research context

The conditions of increasing water stress faced in the Mediterranean regions of Southern Europe, North Africa and the Middle East already have adverse effects on two significant strategic sectors of the area, agriculture and tourism, as well as wider environmental and social implications at both the local and national scale. Such issues are expected to exacerbate as a result of climate change: the anticipated rise in temperatures, the potential decrease in rainfall and the increase in the frequency and magnitude of extreme events are bound to significantly affect human livelihoods and local economies. However, and despite concerns over climate change impacts, policy development is often hampered by the ambiguity and uncertainty of future projections at local scale, and the (often) high costs of adaptation measures.

The WASSERMed Project builds on existing climate projections in order to address present and future uncertainties in hydrological budgets in the Mediterranean area. Research starts from the assessment of changes in mean flows, frequency and magnitude of extreme events, streamflows and groundwater balance, to provide a coherent assessment of future to water security and the economy. Technological so-

lutions and integrated management practices are assessed in terms of risk reduction and trade-offs, and formulated into coherent strategies to address climate variability and change.

Research works on two distinct and interrelated geographical scales. A Mediterranean-wide analysis focuses on strategic sectors (agriculture and tourism) to better understand climate change impacts on the specific characteristics of water demand and explore the applicable range of technical solutions. Furthermore, the impacts of water availability changes on national economies, trade flows and implicit water trade (virtual water) are assessed through the development of a Global Computable General Equilibrium Model. This global assessment is used to identify the main mechanisms of propagation of water-related shocks throughout the economic system and potential changes in economic structure, as response to climate change. Case Study-level analyses are employed to explore potential security threats, infrastructure requirements and integrated adaptation strategies in 5 areas of the Mediterranean, also considering exogenous drivers of change and potential environmental and socio-economic implications.



WASSERMed: Research approach and workflow



Rosetta area: Nile Delta, Egypt

Quick facts

FP7-Topic: ENV.2009.1.1.5.2
 Funding period: 01/2010 – 12/2012
 Coordinator: Centro Euro-Mediterraneo per i Cambiamenti Climatici (CMCC, Italy)
 Partners: 12
 Website: www.wassersed.eu
 Contact: Prof. Roberto Roson (project co-ordinator), roson@unive.it
 Simone Mereu (project manager), simonemereu@gmail.com

The WASSERMed Case Studies

The 5 Case Studies of WASSERMed seek to address response strategies and adaptation to climate change, encompassing localised analyses of climate change impacts, and evaluation of adaptation measures in close collaboration with local stakeholders and decision-makers. Case Studies have been selected to reflect diverse problems and conditions within the Mediterranean region, differing in terms of scale, complexity, water use and potential water-related security threats. They comprise a small tourist island (Syros, Cycladic Complex, Greece), medium-sized regions experiencing conflicts among water use sectors (Sardinia, Italy and Merguellil catchment, Tunisia) and water systems which depend on interregional water allocation policies and transboundary agreements (Rosetta area, Nile Delta, Egypt and Jordan River Basin, Jordan). The assessment of climate-induced threats to water security involves multi-disciplinary research. The Project builds on up-to-date climate projections, which are integrated in a meta-analysis of ensembles, to produce high resolution gridded climate datasets, covering a large spectrum of climate data, and relevant uncertainties. Two-way coupling

of regional climate and eco-hydrological models is used to study hydrology, vegetation, erosion, nutrient dynamics and climate interactions, providing an improved simulation process at the watershed scale. In terms of water use, a detailed analysis of impacts on local agriculture is performed, considering changes in air temperature, precipitation and CO2 concentration on the duration of crop growing cycles, growing seasons, yield and water productivity. Impacts on tourism are assessed through localised models, considering changes in tourist comfort indices. The assessment of threats to water security is performed through holistic water balance modelling, embedding climate projections and sectoral water demand assessments. A systems' approach, based on System Dynamics and Hydro-Economic Modelling, is used to assess indicators for future water and environmental security. Potential adaptation measures, including infrastructure development, demand management and policy instruments, are simulated and evaluated in terms of their effectiveness in alleviating water-related security threats, costs, benefits and secondary impacts, in order to derive integrated strategies to reduce vulnerability and future risks.

The WASSERMed Consortium

WASSERMed is implemented through the collaboration of 12 partners, from six (6) European Member States (Italy, United Kingdom, Greece, Spain, Germany, France), three (3) SICA countries (Jordan, Tunisia, Egypt) and an international institution.

- Centro Euro-Mediterraneo per i Cambiamenti Climatici, Italy
- University of Exeter, UK
- Centro Internazionale di Alti Studi Agronomici Mediterranei - Istituto Agronomico Mediterraneo di Bari, International
- CLU srl, Italy
- National Technical University of Athens, Greece
- Universidad Politecnica de Madrid, Spain
- National Center for Agricultural Research and Extension, Jordan
- Potsdam Institute for Climate Impact Research, Germany
- Institut de Recherche pour le developpement, France
- Environment and Climate Research Institute, Egypt



- Institut National Agronomique de Tunisie, Tunisia
- Faculty of Agriculture, University of Jordan, Jordan



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EUROPEAN COMMISSION

EUR 11148 - Climate Change Impacts on Water and Security; A cluster of collaborative research projects under the 7th Framework Programm in Southern Europe and neighbouring regions

Luxembourg: Publications Office of the European Union

2011 - 26 pp - 17.6 cm x 25.0 cm

ISBN 978-92-79-20034-2

doi 10.2777/56413

The Mediterranean and neighbouring countries are already experiencing a broad range of natural and man-made threats to water security. According to climate projections, these regions are at risk for an even pronounced susceptibility to changes in the hydrological budget and extremes. These changes are expected to have strong impacts on the management of water resources as well as on key strategic sectors of regional economies and their macroeconomic implications. Such manifold developments bare a strong capacity to exacerbate tensions, and even intra- and inter-state conflict among the social, political, ecological and economic actors. The clustering of projects can help push forward current understanding of the interactions of climate change impacts on ecological, economic and social components of human-environment systems. A multi-disciplinary approach is essential for advancing towards optimized regional solutions for water resources management under climate change.

