

RICAMARE : DEFINING A REGIONAL RESEARCH AGENDA OF THE MAJOR GLOBAL CHANGE IMPACTS IN THE WHOLE MEDITERRANEAN BASIN AND LEADING IT WITH A CONSOLIDATED SCIENTIFIC COMMUNITY

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ABSTRACT:

The Mediterranean region is a very complex world, under pressure of both natural and anthropogenic factors that interact with much larger scale phenomena. Local geographical and socio-economic conditions make bring significant local changes to regional overall features, making assessments very difficult. So, taking into consideration the evolution of the Mediterranean basin under global change is a very hard task. Little scientific work has been done at such a scale, and results are far from being consolidated. These issues were first addressed by an international ENRICH/START Workshop on "Global Change and the Mediterranean Region" (Toledo, Spain, 25-28 October 1996). This workshop developed a set of regional priorities in the various scientific fields of relevance for global change research. As a result, the RICAMARE concerted action was developed (1999-2001), under sponsorship of EC/ENRICH, START and national sources. It included three major activities: (i) developing a regional research agenda, (ii) promoting training and capacity building, (iii) promoting diffusion of research and awareness of global change and its implications. The first activity was focussed on four main themes: (i) land-use, land-cover changes and water, (ii) global change and biodiversity, (iii) evaluating the costs of global change, (iv) development of a concerted data assessment, assimilation and validation for global change. It led to a very comprehensive research agenda. The second activity led to strengthen the scientific community, especially in Northern Africa. The third one aimed at advertising scientists about research to be undertaken and decision-makers about the regional consequences of global change and the need to develop targeted research. In order to lead the recommended activity, a flexible post-RICAMARE action plan, based upon a dedicated RICAMARE network and a close co-operation with START has been endorsed by the project Steering Committee and is now on its way.

1. THE MEDITERRANEAN BASIN FACING GLOBAL CHANGE: THE SCENERY

The Mediterranean region is under pressure of both natural and anthropogenic factors, which may strongly interact with much larger scale phenomena. These interactions have to be considered dynamically, under the evolving conditions of global change. The region contributes to the dynamics of the oceanic conveyor belt, is a source of aerosols and dust (including its influence on desert dust circulation) which affects a large area, and influences synoptic scale circulation systems due to its unique topography and to land-ocean-atmosphere interactions. The region is very sensitive to, and greatly influenced by, global climate changes, through effective coupling and teleconnections: amplified effects due to its sensitivity can easily be detected and studied in a laboratory-like enclosed environment.

The region is distinguished by its geographical position at the boundary between the descending branch of the Hadley circulation and the Westerlies and as well is influenced by the North Atlantic anomalies that cause large climate variability. Basically, Westerly winds from the Atlantic ocean determine the weather in winter and as the Hadley cell moves northward its sinking branch determines weather during the summer months. The interannual variability of these cycles primarily is controlled in the western part by large-scale steering mechanisms of the NAO – Northern Atlantic Oscillation -

(Hense et al., 1990) and in its eastern parts by the continental desert-like conditions and the influence of the monsoon from the Indian Ocean. Teleconnections to ENSO have also been investigated (Ricard, 2000).

The region is an area of high topographic complexity, in which processes interact at various scales, and features large gradients of land use intensity and water availability. It is also very sensitive to changes in land policy, world economy, and demography, which in combination have considerable control over sustainable development. The Mediterranean Sea links, as well as separates, different economic and political systems, which can induce quite different impacts for instance on land-use. Nevertheless, on both sides of the water, there is shared concern over many common environmental problems, which serves as a bridge for Euro-African scientific co-operation and consultation between decision and policy makers. Furthermore, there is considerable potential for research around the Basin. These outstanding features make the Mediterranean region an exemplary area for integrated research and policies into change-related impacts.

It may be useful to present the main features of the present Mediterranean climate under these influences in a more detailed manner (Bolle, 1998a, 1998b).

The position of the semi-permanent high and low-pressure systems over the North Atlantic determine the import of wet

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Atlantic air masses into the Mediterranean area. Their positions are determined by the general atmospheric circulation pattern of the Northern Hemisphere and by the spatial distribution of sea surface temperatures. The large-scale variability is transformed into the regional scale of the Mediterranean by topographic structures.

During winter vigorous synoptic scale weather systems imbedded in the westerlies are the main driving force. High mountain barriers such as Atlas, the Pyrenees and the Alps are necessary to modify or generate these systems which are developing in the middle troposphere and gain their own momentum by internal energy transfer processes. At this time the temperature gradients of the whole Mediterranean area including the North-western African coasts are small and to a large degree determined by the Mediterranean Sea surface temperature.

The picture changes completely during summer, when the Westerlies pass further north and only seldom affect the Mediterranean area. Topographic effects gain in importance and interact with the large-scale pressure systems in the Mediterranean area. The land-sea circulation becomes mainly responsible for the exchange of dry and humid air between land and sea. Already during spring large thermal contrasts build up during daytime between sea and land causing warm air to rise in coastal zones. This generates low surface pressures that entrain the cooler, wetter, and heavier air from the sea that warms up rapidly. The air over the 22 - 27° C warm sea can take up large amounts of water vapour but, because of the much higher temperatures over land, often needs additional lifts by near coastal mountains to be moved up to the condensation level.

In summer, in the northern part of the Mediterranean basin the sea surface temperatures are about five degrees lower than in its southern part. This situation is indicated already in spring, when the Black sea has the lowest temperatures in the region and the Peloponnese is usually cooler than e.g. the south of Spain. This locally leads to complex valley-mountain circulation systems or catabatic winds as known for the eastern Adriatic coast ("Bora"). Local circulation systems may develop into vigorous thunderstorms if the moisture is available which feeds these systems by its latent heat. In early autumn the situation may change insofar as now the sea remains relatively warm in comparison to the atmosphere and the land. At this time of the year convection may start already over sea and strong latent fluxes lead to thunderstorms that enter the land.

Such complex phenomena explain why setting up Regional Circulation Models (RCM) and impact studies at the Mediterranean regional scale climate proves to be extremely difficult. The conclusions of some concerted actions such as ACACIA (Parry, 2000) or ECLAT-2 (Palutikov and Goodess, 2001) clearly show that the impact of global change over the Mediterranean region may be considerable, both in physical and socio-economic terms. Nevertheless, it is quite difficult to reach consensus upon quantitative or even qualitative figures. It is noticeable that the issue of regional aspects of global climate change in the Mediterranean is quite poorly addressed in the third IPCC report (2001), an international authoritative source on these issues. Nevertheless, the following general trends seem to lead to reasonable consensus.

The region could be severely impacted by changes in climate, most notably by changes in the precipitation regime. Current model projections into the 21st "greenhouse gas" century tend to show quite contrasted evolution between the northern and

southern sides: intense warming and drying in the south; moderate warming and little variations, or even an increase of the precipitation in the north. Small alterations in water availability could have critical consequence at all natural and human levels in the region (Rambal and Debussche, 1995). This situation is quite critical when considering the strong demographic development in the Southern part of the basin, which implies a fast growing water resource demand for domestic and irrigation needs (Senouci, 2002).

Much of the population lives in coastal, low-lying areas subject to sea level rise. Additionally, the Mediterranean shores are a very important tourist resource, vital for many countries. Furthermore, the ecosystems are among the most sensitive in the world for the predicted changes in atmospheric composition and ensuing interactions with water availability (Oechel *et al.*, 1995). Recent and on-going changes in land use have contributed to part of the dramatic alterations in ecosystem functioning, leading to serious losses of soils (Puigdefàbregas, 1995) and susceptibility to forest fires (Moreno *et al.*, 1998).

Similarly, global warming, industrialisation and increased anthropogenic inputs of nutrients via rivers and the atmosphere threaten marine resources in the Mediterranean Sea. Semi-enclosed bodies of water such as the Mediterranean basin are much more sensitive to Global Change, compared to the other troubled waters of the World Ocean. Eutrophication can lead to considerable loss of habitats and decrease in biomass and species diversity in specific areas of the Mediterranean, if the present increase in deep water nutrient stocks continue the same trend (Béthoux, 1993). Migrations of foreign marine species appear linked with anthropogenic changes.

So, the socio-economic evolution of the different people living in the Mediterranean basin may no longer be compatible with the physical situation and resource availability. Presently developed scenarios show that such a natural trend might be exacerbated by the regional and local consequences of global change (Jeftic *et al.*, 1996; Parry, 2000). These threatening issues need to be addressed through dedicated research agendas, leading to action plans underpinned by the sustainable regional development of the communities living all around the Mediterranean basin.

2. FROM THE TOLEDO WORKSHOP (1996) TO RICAMARE (1999-2001)

An International ENRICH/START Workshop on "Global Change and the Mediterranean Region" was held in Toledo, Spain, 25-28 October 1996. This workshop developed a set of regional priorities in the various scientific fields of relevance for global change research. In several of those fields there already exists a high degree of collaboration at regional level. However, the workshop was instrumental in identifying a number of integrative issues that deserve special effort and preparation before new scientific ideas and projects emerge, and policies are enacted.

The workshop underlined a serious need to develop a regional network of activities with two main goals:

To review and stimulate progress in the development of *collaborative global change research at regional scale*, following the recommendations of the workshop, with special attention paid to the involvement of scientists from Southern and Eastern Mediterranean countries, and

To *focus on selected issues* requiring a dedicated effort to build up future projects and *which were identified as integrative, crosscutting themes* at the workshop.

This led to the RICAMARE concerted action funded by EC/ENRICH, START and several national sources, led from beginning of 1999 to end of 2001. This concerted action led in turn to set up and develop the associated RICAMARE network; which consists of individuals and institutions interested in such research in countries within the European Union and in other Mediterranean countries, particularly in the Maghreb and Eastern Mediterranean countries.

Three major activities were led under the RICAMARE project:

- 1) Development of a regional research agenda;
- 2) Promoting training and capacity building;
- 3) Promoting diffusion of research and awareness of global change and its implications.

Within activity I, four tasks were undertaken, concerning the assessment of the state of the art and further development in four topics, which were considered at the Toledo workshop as crosscutting issues and correspond to some of the critical issues underlined in Section 1:

- 1) land-use, land-cover changes and water;
- 2) global change and biodiversity;
- 3) evaluating the costs of global change;
- 4) development of a concerted data assessment, assimilation and validation for global change.

Each of these tasks were developed by a specific group, which concluded their work in a dedicated workshop, producing a review of the stage of knowledge, a proposal of a set of joint initiatives, and a strategy suggestion to develop them in connection with the main concerned actors.

Within activity II, promotion of training on global change issues will be pursued, aiming at celebrating five dedicated courses covering the physical, socio-economic, biological, and water resources components of the regional system:

- 1) Agriculture, environment and global change (IAMZ-CIHEAM, Zaragoza, September 25 - 29, 2000);
- 2) Conserving biodiversity under the threats of global change: challenges and consequences (UCLM, Toledo, Spain, 16-21 October 2000);
- 3) The water resource and global change in the Mediterranean (UCLM, Toledo, December 2-8, 2001),
- 4) The physical system (ICTP, Trieste, March 12-16, 2001);
- 5) The socio-economic system (ICTP, Trieste, November 12-16, 2001).

Within activity III, efforts were dedicated to ensure regional collaboration and awareness, and to improve the diffusion of research results. A directory of scientists and institutions, service providers and decision-makers was set up. A website delivering information about the project conclusions and recommendations was also set up. This website will be a key toll for the post-RICAMARE action plan (see below). National representatives within the Steering Committee committed themselves to disseminate information at their national levels. A plan for publications and conferences was also set up. Presenting RICAMARE at the ISPRS Dar Es Salaam symposium can be considered as a part of this plan implementation.

It should also be underlined that the RICAMARE objective was to identify the state of the art, the major gaps in global change research at the regional level, and set up a tentative research agenda. One major objective of Activity II was to widen and strengthen the scientific community addressing these issues. Such an effort would be meaningless if an implementation plan was not led. So, the RICAMARE Steering Committee decided to adopt the "RICAMARE Manifesto" and a flexible post-RICAMARE action plan, in order to have guidelines and a short-term starting plan paving the way to long-term actions. It was decided to consolidate the START secretariat in the Mediterranean (MEDCOM), to set up the RICAMARE network on the long run, and closely co-ordinate the two structures, in particular by sharing key common actors.

3. SOME KEY ISSUES FOR A MEDITERRANEAN RESEARCH AGENDA

As explained in Section 2, the four RICAMARE workshops aimed at drawing recommendations and conclusions about such key issues in some major domains. Summarising these conclusions is a quite challenging task. What follows is an attempt to present some main guidelines without losing significant key points.

3.1 Land Use, Land Cover and Water Resources

Pr. Puigdafabregas led the task. The workshop took place on April 18th and 19th, 2001 in IRA facilities, Medenine, Tunisia. It addressed land use and land cover changes and water resources in the Mediterranean, and was organised around reports produced before the meeting.

The main following trends were noted:

- There are contrasting trends between North (land abandonment) and South (combination of several factors, leading to numerous cases of degradation and overgrazing). The main driving force is socio-economic (such as sedentarisation in the South). Climate is not perceived as a driving factor, but acts in synergy with socio-economic drivers.
- Reports about water availability were studied. In the North, what is going on is not so clear. In the South, a degradation of resources (salinisation) and a strong demand growth are the most worrying factors.

The main following gaps were underlined, both in terms of knowledge and relevant structures:

- The effects of rangeland changes on water resources are poorly understood. It is necessary to focus to small to medium size areas and to network these studies.
- The water resources studies are poorly co-ordinated all around the basin. Networking is mandatory.
- There are several hot spots in the Mediterranean, a very sensitive system. In such places, intensive research can be led. There are strong interactions between factors occurring at different scale, which all need to be addressed.
- An important network has been built. It is necessary to co-ordinate and stimulate the network, a baseline to address these problems. Data needs have to be identified. An information system has to be set up and co-ordinated with existing systems, such as WAICENT, MEDHYCOS.

- A key point is to address socio-economic issues, bringing proper specialists within the network and identifying how to alleviate the observed pressures.
 - The network should be endorsed by Lucc (Puigdefabregas, 2001). It is also necessary to co-operate with related activities. The DIS-MED initiative is a proper example: the network should build on that basis to address desertification issues taking into account socio-economic drivers.
 - An objective could be to set up an observatory performing some basic tasks, including interacting with EO sources. Very few monitoring stations do exist in Southern and Eastern Europe. This is a real task, for which a lot of funds should be found. EUROFLUX is an example of such a dedicated network. The future network should keep in touch with such structures (including of course other initiatives emerging from RICAMARE itself).
 - Once this initiative firmly structured, it is necessary to look for funds. Synergies with the MERAN initiative have to be taken into proper account.
- The main processes of interest are CO₂ and vapour fluxes; flows of water, soil and nutrients; propagation of disturbances; biotic exchanges.
 - The main global change drivers of landscape change are considered to be land use and climate; far beyond are nitrogen deposition, biotic exchange and atmospheric CO₂.
 - In terms of patterns and trends, there is a great variety but the determinants are unknown. There are trends in change but how and why is also largely unknown. Studies should be carried out across the region to identify the main patterns and trends of change and to understand what factors play a role.

The main future research needs are:

- Fire and landscape interaction;
- Species patterns in the landscape as indicators of change;
- The importance of landscape features;
- The species movements across landscapes.

The integration needs are:

- Coupling field observations with remotely sensed data;
- Setting up robust techniques for interpolating in space;
- Identifying the appropriate scale for each studied process.

The key conservation issues are:

- All countries are taking measures, but structuring and co-ordination is needed.
- Conservation has improved, but on an ad hoc basis.
- NATURA 2000 is the main common legal framework for the next 20 years, but it is static
- National and regional strategies have been signed by 50 countries, including Mediterranean ones.
- A strategic selection procedure is needed (we may learn from other countries).
- A framework for viability of population and species is not ensured.
- In the short term, species remain but ecosystem change; so, how should conservation be addressed?
- There are active management needs to be pursued.
- Scenarios for conservation need to be made and used to project conservation measures.

3.2 Biodiversity Conservation

Pr. Andreas Troumbis and Dr. Helena Freitas led the task. The workshop took place in the University of the Aegean, Mytilini, Lesbos Island, Greece, November 27-29, 2000.

The main addressed issues were:

- Identification of current knowledge in the Mediterranean;
- Trends in Mediterranean diversity under global changes at species and landscape levels;
- Conservation priorities.

The Mediterranean countries differ in having well defined strategies and active communities on biodiversity research. In most cases, some individuals are active, but no central policy or co-ordination structure exists. In itself, Global Change is not a clearly defined field for research policy. The main issues to be studied are: flora, genetics, landscapes

In terms of species diversity, the following points were highlighted:

- The Mediterranean region is rich in hotspots, and is a hotspot in itself. Hotspots are flagships for research. Lucc and climate are the main factors of change, but varies with hotspots. Little knowledge is available on diversity-function relationships.
- Diversity function approaches should be based on meta-analysis of data, revisiting data, correlation studies at patterns level, removers experiment, composite communities, monitoring (no permanent plots exist).
- Monitoring should combine long term monitoring and ecological research, establish common protocols, study sites as composite places, from a multidisciplinary approach (from organisms to landscapes).

At the landscape level, the following points were highlighted:

- Landscapes are characterised by a fine grain, and a diverse, old history. There is a great diversity. A challenge in the science of landscape ecology is "empty world versus full world" (there is no such a thing as natural areas). Approaches can be pattern recognition, administrative units, property values (cadastral information).

3.3 Evaluating the Costs of Global Change

Prof. Mordechai Shechter, Prof. Marzio Galeotti and Dr. Manfred led the task. The workshop took place on February 9-10, 2001 in Milan, Italy, kindly hosted by FEEM.

The initial objectives of the workshop were defined by three items:

- Present on-going or planned research projects on the impacts of global climate change on social and economic systems in the Mediterranean basin, in relation to such areas as water resources, agriculture and forestry, desertification, biodiversity, extreme weather events, sea level rise and coastal areas, human health, tourism, and others.
- Set a research agenda for and create a network of social scientists from the Mediterranean basin. The scope is intended to be inter-disciplinary, with a primary focus on social science and related research.

- Exploit the meeting in order to set-up achieved through the presentations in order to advance an agenda for future research and collaboration.

The workshop addressed these issues from generic and thematic (agriculture, tourism) points of view, focussing on climate change impacts, but purely national aspects were not addressed. Vulnerability, then damages were considered, and assessed in economic terms. The adaptability issues and efforts were considered. Most of the results came from other consolidated projects. There were no co-ordinating efforts in terms of models.

A major issue is to develop the community of skilled scientists in Eastern and Southern parts of the Mediterranean, and sub-regional projects, since more local scientists address purely physical than socio-economic issues.

Some of the main questions raised were:

- Which are the major impacts? Which priorities should be adopted? The priority is depending upon the extent of damages, and how to mitigate them.
- It must be understood if it is possible to distinguish between anthropogenic and climate change origins, and to what extent, taking into proper account irreversible processes linked to climate change.
- From a socio-economic perspective, countries have to be saved from impacts of global change (adaptation), but action is possible only if there are anthropogenic origins.
- Climate change has a lot of synergies with other aspects. These synergies have to be taken into account to solve problems such as: how to face scarce water resources, threatened both by climate change and overexploitation? Declining precipitation has impacts on agriculture. For instance, in Israel, the country could adapt, which is not the case in Egypt.
- In terms of vulnerability and adaptation, with limited resources, what can be done to protect populations?
- Vulnerability includes the capacity to cope with specific stresses. Money, technology, etc... has to be taken into account. Vulnerability is a function of physical phenomena and socio-economic parameters.

The main conclusions of the workshop were summarised in seven major items, which should serve as guidelines for future actions and research projects:

- Integrated work should be organised.
- Data collection and distribution of knowledge should be facilitated.
- Network of scientists working in CC should be identified.
- A model or structure should be developed for the analysis, which would take into consideration: adaptation/vulnerability but also focuses on other changes i.e.; population, economy, natural resources, etc.
- The issue of aggregation and desegregation should be also taken into account for the analysis.
- The analysis should also have some policy orientation for better understanding and implementation. Stakeholders' opinion also should be taken into consideration.

3.4 Development of a Concerted Data Assessment, Assimilation and Validation for Global Change

Prof. H.J. Bolle and E. Ozsoy led the task – a very complex one since it addresses “horizontal” issues within a potentially unlimited scope. The workshop was held in Casablanca, February 21-24, 2001, with a strong support from Moroccan meteorological services, in parallel with a WMO/CLIVAR workshop, which aimed at defining regional climate change indicators over the Mediterranean. It was prepared by a series of questionnaires that paved the way to the MERAN concept – a network of national centres and “anchor stations”.

The workshop organised three subgroups (atmosphere, and sea) which focussed each on three purposes:

- availability of data,
- scientific goals (why these data are needed),
- merging conclusions and recommendations with WMO regional indicators workshop.

Understanding the climate changes over the Mediterranean is a quite complex task, requiring modelling and various kinds of homogeneous datasets. For instance, precipitation changes have been observed in the Mediterranean sea. Different models exhibit large discrepancies (MPI Hamburg).

The *atmosphere group* enhanced the following major facts and questions:

- The research strategy and the problem of anchor stations needs to be refined. Most of the climate variation information has to be updated periodically. The major issue to be taken into account is the water cycle, strongly linked between the carbon fluxes and the water cycle. In parallel (and synergy) with data collection, there is a strong need to improve mesoscale models (RCM). A typical question to be answered is: will global warming lead to acceleration of water cycle, bringing up some uneven results (flood, desertification)?
- The water provided by the vegetation is critical to evaluate precipitation and runoff up to the basin level. We need to understand the link between biophysics and biogeochemistry, the link between ecosystem and the atmosphere.
- GEWEX addresses the energy and water cycle and the hydrological cycle determination by global measurements. It requires modelling the hydrological cycle and its effects. Some updated GEWEX science questions have to be solved :
 - Are the Earth's energy budget and water cycle changing? Is the water cycle accelerating (1° temperature of water increase could mean 10% more water vapour)? Can it be predicted on inter-annual or seasonal basis? How does this impact on climate and water availability?
 - Will global warming lead to water cycle acceleration? Does it lead to extreme events? What is the role of the carbon cycle? Is air quality changing?
 - There are several experiments going on: BALTEX, GCIP, LBA, GAME, CATCH, but no experiment over the Mediterranean. How could a GEWEX-like experiment allow to better understanding the issue of water cycle in the Mediterranean? Such an experiment needs co-operation of modern NWP centres, to commit resources and personnel, to have regional co-operation, and a free exchange of data. In the region, no free exchange of meteorological data seems possible.

- The role of Remote Sensing data and techniques is essential in that domain.

The *land group* stressed that land is certainly the most complex issue to deal with, since land is very diverse in itself, with closely embedded human and natural processes. New developments have to be taken into account. The main issues to be addressed are the land use and land cover changes drivers (see § 3.1), the sustainability constraints and adaptive strategies (see § 3.3), the changes in the structure of ecosystems (see § 3.2), the water and carbon exchange processes. The anchor stations should target a full understanding of these processes at a given site.

The *marine group* enhanced the following major facts and questions:

- The sea has to be studied in itself, but is also a part of the physical Mediterranean system.
- Some examples of severe events in the Mediterranean have to be further investigated, in order to predict the effects of extreme events.
- Links with such phenomena as volcanic eruptions, teleconnections with areas like Central Asia, and the monsoon system have to be further investigated.
- Spaceborne altimeters such as TOPEX-POSEIDON (and now JASON-1) allow to "close the system" in terms of sea level rise.

As a synthesis, the main features of the *MERAN initiative* were tentatively described:

- MERAN should be developed as a non-hierarchical network, which may be used for mega-projects or smaller projects, and for North-South co-operation.
- There are already voluntary people interested in being involved, but more people need to be attracted in a further phase.
- There are a lot of existing projects related to issues to be addressed by MERAN (BIME, ICARUS, AECCE) New initiatives are developed to fill gaps. The role of RICAMARE is to identify projects filling such gaps. One of the gaps is the socio-economic evaluation associated to on-going projects.
- A coherent network of anchor stations has to be developed. One or two anchor stations in each country are a suitable target.
- Some issues such as carbon and water fluxes are a major concern for the land community (CARBOFLUX, EUROFLUX). Other main "land" issues such as ecosystem vulnerability needs representative areas. It may be one of the key roles of anchor stations.
- A CLIVAR-type of activity is needed, federating interdisciplinary research. MERAN is a key tool to develop such an initiative.
- A preliminary picture of a network of anchor stations can be drawn. Each anchor station should have a partner in an official institute. Sharing the experience is essential, as well as having a direct access to data flowing from networks. A scheme of development from raw data to corrections, validation, then combining data with secondary and third level datasets has to be developed.

4. CONCLUSION – TOWARDS THE POST-RICAMARE ACTION PLAN

The extent of Section 3 is a clear demonstration of the fact that understanding the behaviour of the Mediterranean basin under climate change conditions, even when focussing on specific items, is a very wide and complex task. This work needs to be done to lead policy makers to take decisions favouring the regional sustainable development.

As underlined at the end of Section 2, the RICAMARE objective was to identify the state of the art, the major gaps in global change research at the regional level, and set up a tentative research agenda. Such an effort would be meaningless if an implementation plan was not led. So, as already explained, the RICAMARE Steering Committee decided to adopt the "RICAMARE Manifesto" and a flexible post-RICAMARE action plan, in order to have guidelines and a short-term starting plan paving the way to long-term actions.

It was decided to consolidate the START secretariat in the Mediterranean (MEDCOM). The START Scientific Steering Committee recommended to consider the Mediterranean as one of the top priorities for START. It was also decided to set up the RICAMARE network on the long run, and closely coordinate this network and MEDCOM, in particular by sharing key common actors.

The flexible post-RICAMARE action plan began to be implemented. Several projects were defined in the socio-economic and biodiversity field. A proposal to develop MERAN was sent to the 5th FP of the EC DG RESEARCH, unfortunately without success. Considering how the post-RICAMARE action plan could be developed following the guidelines of the on-going 6th FP is under careful consideration. It is quite encouraging to conclude by positive words. One of the actions of the post-RICAMARE action plan in the Northern Africa was successfully led. A follow-on initiative was proposed by Pr. SENOUCI (ARCE, Algeria) and endorsed by the Steering Committee. The objective was to convene an international scientific forum on climate forecast and strategic management of water resources in Maghreb and its evolution under Mediterranean climate change conditions. These issues needed to be addressed in a prospective and international perspective, defining and developing a research agenda for the Maghreb and a mechanism for follow-up. The planned workshop took place in Adrar, Algeria, September 24-26, 2001. In order to develop the initiative, the participants endorsed the so-called "Adrar call" (Senouci, 2002).

It should be hoped that such a positive initiative is only the first step of a successful post-RICAMARE action plan. The ambition of its actors and co-ordinator is to bring interdisciplinary scientifically assessed answers to questions that have a major importance for the sustainable development of all the population living in the surroundings of the Mediterranean basin. Major efforts have to be devoted to contribute to such a challenging objective.

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ADDITIONAL INFORMATION SOURCES

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