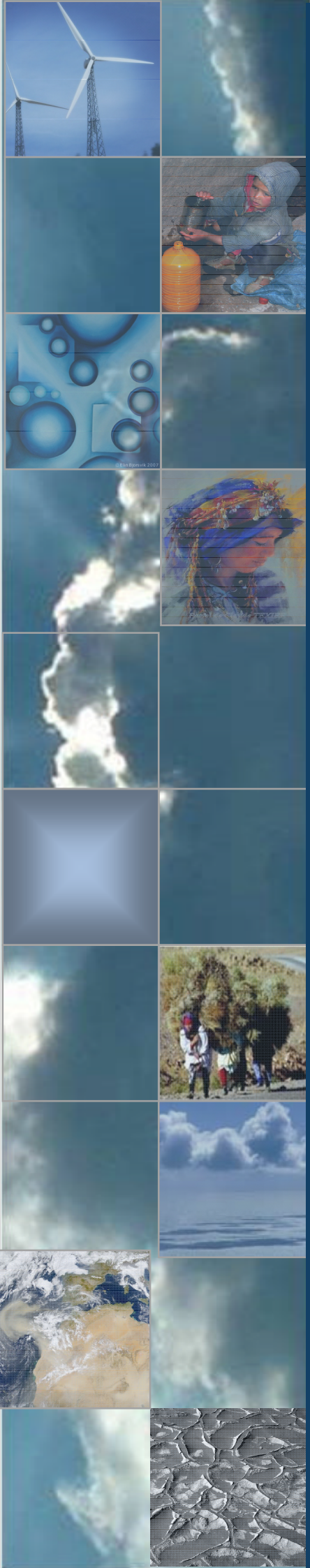

CLIMATE CHANGE IN THE MAGHREB: THRESHOLDS AND LIMITS TO ADAPTATION

In preparation for climate change: What appropriate and effective climate change adaptation strategies for the Maghreb?

Report of Workshop,
November 26– 27, 2008
Marrakech, Morocco

Climate change and Adaptation in the Maghreb:

Supported by the Climate Change and Adaptation in Africa program

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WORKSHOP COMMITTEES

Workshop Co-Chairs

Mohammed Messouli,
Diversitas Morocco, University Cadi Ayyad, Marrakech
Mohamed Yacoubi-khebiza,
CDRT, University Cadi Ayyad, Marrakech

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Lalla Bahia Ghallabi, FSS- UCAM
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Firdaous Hallam, FSS- UCAM

Ahmed Chehbouni, CDRT
Abdelkader Mokhlisse, CDRT

Mustapha Geanah, DMN
Abdalah Mokssit, DMN

International Organising Committee

Hassan Virji, START Secretariat (USA)
Clarck Seipt, START Secretariat (USA)
Youba. Sokona, OSS (Tunisia)

Technical Support:

Hanan CDRT, Marrakesh
Aziz CDRT, Marrakesh
Houda Benjelloun DMN (Morocco)

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We would also like to thank all chairpersons, eminent speakers and panelists for making valuable contributions, and would like to place on record the extremely enthusiastic response of the participants. Last, but not the least, we wishes to acknowledge the efforts of the workshop staff members, who worked towards making the workshop a success.

For further information: messouli@ucam.ac.ma
This report can be downloaded from http://www.ucam.ac.ma/ccam

Report Structure

Abbreviations

ACCMA	Adaptation au Changement Climatique au Maroc (project)
ARCE	Association de Recherche Climat Environnement (Algérie)
AUF	Agence Universitaire de la Francophonie
CCAA	Climate Change and Adaptation in Africa
CCAM	Climate Change and Adaptation in the Maghreb
CDRT	Centre de Développement de la Région de Tensift
ENA	Ecole Nationale d'Architecture, Rabat, Maroc
ENFI	Ecole Nationale Forestière d'Ingénieurs (Morocco)
GDP	Gross Domestic Product
GRAPHIC	Groundwater Resources Assessment under the Pressures of Humanity and Climate Changes)
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit GmbH
HCEFLCD	Haut Commissariat des Eaux et Forêts et de la Lutte Contre la Désertification
IMPETUS	Integratives Management-Projekt für einen Effizienten und Tragfähigen Umgang mit Süßwasser
INRA	Insitut National de la Recherches Agronomique
IGBP	Internationa Geosphere Biosphere Programme
IPCC	Intergovernmental Panel on Climate Change
IRScNB	Institut royal des Sciences naturelles de Belgique
OSS	Observatoire du Sahel et du Sahara
START	SysTem for Analysis, Research and Training
UNFCCC	United Nations Framework Convention on Climate Change
WEAP	Water Evaluation And Planning system

Executive Summary

The Climate change and Adaptation in the Maghreb (CCAM 2008), Regional Workshop on Adaptation was held at the CNSS *Village des vacances* in Marrakech, Morocco, 26 and 27 November 2008. The workshop aimed at highlighting African concerns related to climate change adaptation and vulnerability reduction, with a view to identifying specific adaptation needs to be considered under the UNFCCC. Seventy participants were in attendance, mainly from Africa, but also from developed countries. The meeting was conceived as a workshop to discuss emerging research agendas that inform development and policy. The focus was implementation of effective development in the Maghreb changing climate conditions, the role of stakeholders in focusing research design, and the application of mechanisms that incorporate climate change adaptation and mitigation into development programmes. The first session highlighted the significant physical and ecological changes as a result of a changing climate. This session was intended to evaluate the current state of understanding of thresholds and recommend possible actions to improve knowledge and adjust management priorities even with incomplete understanding of what drives thresholds of change and when they will occur. The second session placed research in context by addressing wider issues within the development agenda, including highlighting critical questions on policy frameworks and climate change response. The third session examined the institutional changes required to address climate change. Such questions pose profound challenge to contemporary forms of governance.

Participants identified the followings potential actions to better cope with the threat of transformative change:

- Develop Better Threshold Knowledge
- Monitor Multiple Driver
- Reduce Other Stressors
- Manage Threshold Shift
- Project Impacts to Water Supply, Biodiversity, and Resource Extraction
- Instigate Institutional Change to Increase Adaptive Capacity
- Identify Recommendations for Monitoring and Research

Participants noted that efforts to identify measures to improve adaptation planning, monitor progress, determine priorities, and assess the value of various adaptation actions have been limited in the Maghreb countries, despite the fact that the impacts of climate change are already serious and becoming worse.

- metrics must not be developed hastily;
- a more coherent framework for development of metrics is necessary, especially because of significant overlaps between development and adaptation projects;
- development of metrics should be context-specific and involve all relevant stakeholders;
- adaptation targets should be used wherever possible and such targets should be human development-oriented;
- metrics should evolve through an adaptive learning process
- Standard IPCC methodology does not solve all the problems!
- Need to have baseline data
- Need to develop methodological tools in the Maghreb countries (modeling, GIS, assessing the value of non-marketable assets)

- Objective limits of the V&A studies: they cannot quantify everything, nor predict everything!
- Need to have multi-disciplinary national teams
- Require major funding
- Importance of national leadership for impact assessment and for defining response strategies
- National technological context (e.g. the possibilities of processing satellite images)

CCAM Workshop Outputs and their Use

• Provide a stronger scientific basis for the vulnerability and adaptation assessments of the Maghreb countries' National Communications to the UNFCCC;
• Inform national delegations to the UNFCCC COPs about key issues;
• Raise the awareness of stakeholders and the general public about climate change vulnerability and adaptation;
• Advance scientific understanding and inform the 5th Assessment Report of the IPCC on these issues as they pertain to developing countries; and
• Inform the consideration and development of adaptation strategies at local and national scales.

Presentation of multiple climate change assessments during the CCAM Workshop produced substantial synergistic benefits. The CCAM provided numerous opportunities for the different teams to interact with each other through regional cooperation, synthesis activities, joint training activities, and electronic communications. It is imperative that we build on the experience and achievements of CCAM and develop the next phase of such work to help advance new knowledge for a possible Fifth Assessment Report of the IPCC.

Conclusions

The CCAM Workshop made important progress on the objectives of advancing knowledge, enhancing scientific capacity and improving links between science, policy and stakeholder communities.

Building Understanding and Adaptive Capacity

Decision makers need improved information, guides and tools which are tailored to their field and scope of operation to enable effective adaptation. Key components of adaptive capacity include the ability to generate, access and interpret information about climate change and its likely impacts; suitable methods for identifying and assessing potential adaptation strategies; appropriately skilled people; adequate financial and other resources; governance systems with sufficient flexibility and foresight to embrace adaptation planning; and willingness to adapt. Knowledge and methods will need to span a range of disciplines, including climate science, biophysical sciences, engineering, social sciences and economics, and planning. Inter-disciplinary studies will also be important.

Major gaps in knowledge include:

- Characterization of the range of future exposures to climate hazards at regional and finer spatial scales that are important for adaptation decisions;
- Identification and prioritization of climate hazards that are of highest concern for different sectors, systems, places and groups and investigation of how these hazards will change with human-caused climate change;

- Measurement of vulnerability of different groups, empirical validation of the measurements, and attribution of differences in vulnerability to proximate and underlying causes;
- Decision processes of different classes of actors for managing climate risks, the information needed to make good decisions, and how climate change information can be integrated into decision making processes;
- The role of institutions (rules, processes and organizations) in facilitating or limiting adaptation to climate hazards;
- Identification of effective strategies for enabling adaptation and lessons about how strategies that are successful in one context can be expanded in use or transferred to other contexts; and
- The benefits and costs of adaptation.

Towards a Network on Adaptation in the Maghreb

To keep the CCAM participants engaged in climate change assessment work, both the individuals and the institutions; discussion on the possibility of creation and implementing of a network on Adaptation in the Maghreb has been launched.

Preface

The Climate change and Adaptation in the Maghreb (CCAM 2008), Regional Workshop on Adaptation was held at the CNSS *Village des vacances* in Marrakech, Morocco, 26 and 27 November 2008. The workshop aimed at highlighting African concerns related to climate change adaptation and vulnerability reduction, with a view to identifying specific adaptation needs to be considered under the UNFCCC. Seventy participants were in attendance, mainly from Africa, but also from developed countries. A number of the participants are taking up leadership roles in the global change science community, including membership on the science committee of the CCAA program, the project management team for the ACCCA project, the IPCC Task Group on Data Scenario Support for Impact and Climate Analysis, the IPCC Working Group II on Impcats and Adaptation, Diversitas National Committee, IGBP, and observers from various organizations in Morocco and Germany participated.
The meeting was conceived as a workshop to discuss emerging research agendas that inform development and policy. The focus was implementation of effective development in the Maghreb changing climate conditions, the role of stakeholders in focusing research design, and the application of mechanisms that incorporate climate change adaptation and mitigation into development programmes. The sessions were structured by theme, with short 'thinkpiece' presentations to generate a debate between interdisciplinary participants, which included decision-makers, funders, practitioners and researchers.

The first session highlighted the significant physical and ecological changes as a result of a changing climate. This session was intended to evaluate the current state of understanding of thresholds and recommend possible actions to improve knowledge and adjust management priorities even with incomplete understanding of what drives thresholds of change and when they will occur. The focus was on the Maghreb ecosystem threshold changes and what they mean for human society. This session aimed to answer question such as: What barriers and limits exist to adapting to such changes? What thresholds are there in physical and ecological systems beyond which it is not feasible for societies to adapt? What might

adaptation mean in a system nearing a threshold? How is adaptation possible if the change occurring is irreversible? Which habitat ranges, ecosystem functions and threats of extinction of particular species have been identified to constitute thresholds?
The second session placed research in context by addressing wider issues within the development agenda, including highlighting critical questions on policy frameworks and climate change response.

The purpose of this component was to explore useful metrics needed for estimating the short- term and long-term impacts of climate change on different sectors, both in monetary and non monetary terms, helping decision–makers evaluate, at regional to national levels, which adaptation strategies and policy options potentially minimize risk and maximize benefits under changed climate regimes. Metrics can help stakeholders and policy-makers assess levels of risk and vulnerability of systems, by helping to quantify thresholds beyond which substantial changes in management practices and concerted action for planned adaptation strategies is necessary.

We have to understand if it is possible to distinguish between anthropic and climate change origins, and to what extent the human influence accelerated natural phenomena. We have to consider the irreversible processes linked to climate change. The theme will had four topics focusing on

(i) methodological issues,
(ii) indicators in the agriculture sector,
(iii) indicators in the water sector, and
(iv) policy implications of adaptation metrics.

The third session examined the institutional changes required to address climate change. Such questions pose profound challenge to contemporary forms of governance. At some level, this challenge has been recognized in the effort to create indicators of sustainable development, quantitative measures that enable decision makers to factor in elements of sustainability into decisions that might otherwise have relied solely on economic criteria. But the challenge to governance goes deeper than just creating new indicators. New governance processes are required that can facilitate the inclusion of new kinds of information, new values, and new voices into decision–making. This, in return, requires new institutional settings and, prior to that, adaptability of current institutions. New kinds of arrangements must be made to rebalance the relationship between formal and informal institutions, consequently between citizens and experts, acknowledging that citizens hold valuable knowledge that is key to creating sustainable communities at all levels of society from the village to the globe.
In addition, the CCAM 2008 Workshop focused on other thematic areas related to climate change particularly in the Maghreb. The theme is wide in scope as it broadly covers the main issues relating to impacts, vulnerability and adaptation to climate change in relation to Africa.

Workshop structure

The workshop sessions began with a keynote presentation that set the agenda and structure of the sessions. Subsequent oral and poster presentations occurred in sessions that contribute to each of the conference's 4 scientific themes. In each session, important time was dedicated to open discussion of the technical and policy-related issues that arise from oral and poster presentations. Session chairs and rapporteurs included experts in both technical and policy issues to distil minuted discussions. To aid in this process, presenters were asked to submit, where possible, two key policy and scientific recommendations emanating from their presentation. A synthesis of the technical and policy-related issues raised in each session will be presented and discussed on the end of each day during which key technical and policy-related recommendations has been debated and adopted. Finally, the conference featured a side event that includes an invitation for experts to join a global network of scientists in the UNESCO GRAPHIC Programme.

Theme 1:
Understanding Ecosystem Thresholds in climate change in the Maghreb

Keynote speaker: Mohammed MESSOULI (DIVERSITAS Morocco)
Assessing risks and managing resilience to avoid dangerous climate

M. Messouli stressed that in the past three decades, climate change has become a pronounced driver of ecosystem change. Changes in phenology, range shifts of species, and increases in disturbances such as wild land fires have all reflected ecosystem scale responses to a warming biosphere. There have also been abrupt, nonlinear changes in ecosystems where the levels of response to incremental increases in global temperature have suddenly changed trajectories. These thresholds of ecological change are not well understood but are potentially critical to adaptation strategies for managing natural resources in a rapidly changing world. Sudden, unanticipated shifts in ecosystem dynamics make planning and preparation by managers intensely difficult.
He covered aspects of risk management and risk assessment to address vulnerabilities in the context of the AR4. He presented seven criteria for defining and assessing key vulnerabilities: magnitude, distribution, timing, persistence and reversibility, likelihood and confidence, potential for adaptation, "importance" (perceived, objective) of the vulnerable system. In his view, climate change science should support risk assessments (consequence times probability) as a function of alternative policy choices

A.Chriyaa, (INRA, Morocco), illustrated lessons learned and good practice guidelines from Morocco, including: the involvement of all actors; holding workshops on practical skills; and including experts in policy development. He also identified gaps which need to be addressed, including difficulties in accessing data, as well as low quality and fragmentary data, both of which create difficulties for sectoral programme assessments of vulnerability and adaptation options. He suggested bilateral activities to undertake common research agendas and pool resources.

P. Martin (IRScNB, Belgium) showed that stygofauna exhibits high levels of endemism and many of the species appear to have restricted ranges, which seems to be a shared feature of subterranean animals in other well-studied parts of the world. In addition to being endemic, many species have considerable scientific importance and conservation significance because they appear to be important bio-indicators for a particular aquifer.

A. Ait lhaj (INRA, Agadir) explained the complexity of factors influencing the development and potential benefits associated to small dams in mountainous regions. In semi-arid areas, small dams contributes to rainwater harvesting, replenishment of the water table, flood control and, more importantly, improvement of water availability for rural communities.
He concludes that in dry mountainous areas, community based small dams' management may represent a good option to cope with climatic change and improve community resilience, health status and well-being. However, potential benefits must be considered in relation to potential health risks.
Nejraoui (Algeria) noted that the observations and measurements done in The ROSELT programme coordinated by the OSS, permitted to establish a list of 130 threatened species in the Maghreb, as a result of climate change

Discussion

Participants commented on: the difficulty of obtaining data, both nationally and regionally; issues of quality and the need for adequate training of data collectors; the lack of funding for observation systems and networks maintenance; and improving internal communication between governmental departments to access data. Speakers' responses highlighted the need to convince governments of the importance of these networks and for economic studies identifying funding priorities for governments.

Participants also stressed that assessing resilience in social-ecological systems requires engagement of a knowledgeable group, including, practitioners and all other stakeholder groups, to identify issues and problems. An assessment should determine what is important and integrate accumulated experience and knowledge.

Participants, noted that to better prepare for ecological threshold crossings, there is a need to increase resilience of ecosystems to slow or prevent the crossing of thresholds, identify early warning signals of impending threshold changes, and employ adaptive management strategies to deal with new successional trajectories and combinations of species. Better integration of existing monitoring information across great spatial scales will be needed to detect potential thresholds, and research will need to focus on ecosystems undergoing a threshold shift to better understand the underlying processes. Finally, natural resource managers will have to adjust their goals for desired states of resources away from historic benchmarks that are not likely to be achieved in a world being altered by climate change.

Participants also identified the followings potential actions to better cope with the threat of transformative change:

- Develop Better Threshold Knowledge: While conceptually robust and widely acknowledged as occurring already, thresholds have had relatively few empirical studies addressing them. Reliable identification of thresholds across different systems should be a national priority because of the potential for substantive surprises in the management of our natural resources.
- Monitor Multiple Driver: Consideration should be given to monitoring indicators of ecosystem stress rather than solely the resources and ecological services of management interest.
- Reduce Other Stressors: The trigger points for abrupt change in ecosystems that are responding to climate change are rarely known because human civilizations have not witnessed climate change of this magnitude. However, other stressors for which reliable information exists can be reduced.
- Manage Threshold Shifts: There may be constraints to reducing or reversing climate change-induced stresses to components of an ecosystem. If a threshold seems likely to occur but the uncertainties remain high as to when it will occur, contingency plans should be created. These can be implemented when the threshold shift begins to occur or can be carried out in advance if the threshold is clear.
- Project Impacts to Water Supply, Biodiversity, and Resource Extraction: There are many efforts to project climate change (*e.g.*, GCMs) and ecosystem responses to climate change (*e.g.*, mapped atmosphere-plant-soil systems) using simulation modeling and other tools. These models generally project ecosystem trends and shifts, but do not explicitly consider the possibility of thresholds. A concerted effort must be made to understand, model, and project ecosystem responses to climate change with explicit acknowledgment of thresholds.
- Instigate Institutional Change to Increase Adaptive Capacity: The current institutional structure promotes disciplinary and jurisdictional isolation by agencies and, therefore, does not lead to much synthesis across resources or issues. The capacity for

synthesis will be critical for identifying potential thresholds in ecosystem processes on multiple scales.

- Identify Recommendations for Monitoring and Research: The major research needs and priorities that will enhance the ability in the future to forecast and detect abrupt changes in ecosystems caused by climate change must be articulated.

Theme 2:
Adaptation catalyst metrics: indicators for measuring the effectiveness of adaptation

Keynote speaker: Eihab Fathelrahman Affiliated Faculty at Colorado State University, Fort Collins, Colorado, U.S.
Modeling Tradeoffs between Climate Change Adaptation and Economic Development - Computable General Equilibrium Approach

Eihab Fathelrahman proposed a holistic approach for the integration between climate change, water balance budget, and the economic computable general equilibrium CGE models. CGE components such as the input-output (I-O) matrices, social accounting matrices (SAMs) as well as model generated hydrological information were described to quantify economic and environmental impacts due to economic development plans in the Maghreb in one hand and strategies for climate change adaptation on the other. He explains that the tradeoff analysis utilizes a stochastic dominance (stochastic efficiency with respect to a function) approach with economic indicators (e.g. net present value of on-going and proposed development plans in the region) and environmental indicators (e.g. groundwater storage) to quantify impacts of climate change adaptation strategies in the Maghreb region. Finally, he describes the expected tradeoff results and provides discussion of possible implications for policy and the decision-making processes at regional and sub-regional levels, and concluded that:

- There is a need for expanding on databases building that include hydrology, climatic, and socio-economic data variables. We recommend more efforts on this.
- Groundwater studies and data on the regional and local levels are lacking behind compared to surface water studies and data paying attention to groundwater.
- Encouragement of climate change strategies that consider both the short term as well as the long-term needs.
- Successful strategies consider all stakeholders in the climate change policies and strategies. This means inclusion of farmers, business, NGOs, and decision makers at the local, regional, and national levels.

This session focused on the usefulness of different models that integrate not only climatic data but also other variables such as socio-economic, hydrological, agricultural or surface and groundwater parameters. Such models produce scenarios that can help stakeholders to anticipate climate change effects and adopt appropriate strategies in order to face future climate changes. The usefulness of these models was evaluated in taking into account specific features of the Maghreb countries such as the importance of the littoral, the aridity

of the climate, and so on. Examples of different approaches were given through the successive talks that each focused on specific, complementary aspects (climate change and economic development, sensitivity of agricultural systems, coastal hydrodynamics, water management, rising of sea levels).

Scherer (Germany) gave an overview on the Moroccan-German cooperation research project with special focus on 'Adaptation Catalyst Metrics'. The central objective was to develop strategies how agriculture in the Casablanca region that could be integrated in a sustainable urban development. In view of the challenges of climate change both adaptation and mitigation strategies have been examined with respect to their applicability and efficiency. He suggested that the effectiveness of an adaptation option may be measured by the extent it reduces vulnerability over time and that metrics should be related to the determinants of vulnerability.

The German IMPETUS approach in southern Morocco highlighted some pertinent research results and tools, but also stressed relevant lessons learned within the project.
Khattabi (Ecole Nationale Forestière d'Ingénieurs, Morocco) presented an overview of the ACCMA project, supported by the CCAA programme and focused on socio-economic aspect of the Moroccan western Mediterranean littoral. He highlighted the need for adaptation strategies in the coastal zone, where important population lives.

Participants, noted that efforts to identify measures to improve adaptation planning, monitor progress, determine priorities, and assess the value of various adaptation actions have been limited in the Maghreb countries, despite the fact that the impacts of climate change are already serious and becoming worse. The participants identified adaptation metrics as one of the most important knowledge gaps. E. Fathelrahmane suggested that the multi-dimensional, and time and scale-specific nature of adaptation must be fully considered in developing metrics that are policy relevant, simple, transparent, comparable and practical.
Participants agreed that adaptation metrics are forward looking and are essential for prioritizing adaptation actions. However, they stressed that there exist many barriers (e.g. information on climate risks at the local level) besides metrics to achieving effective adaptation in developing countries. They recognised many methodological challenges for adaptation metrics, which include choosing between deductive or inductive approaches, qualitative versus quantitative indicators, discrete or comprehensive measures, locally-specific or spatially-scalable measures, output or outcome-based measures, and measures derived from past experiences or those sensitive to future climate change. The diversity in perceptions of stakeholders on the meaning and utility of metrics is also considered a challenge to their development.

• The differences between adaptation and mitigation metrics were discussed. Some participants called for the development of "adaptation targets" and noted that metrics would have meaning only when there are associated actions supporting them.
• Participants recognised the need for different sets of agricultural adaptation metrics at the local and national levels, especially because metrics relevant for top-down national decision making may not be appropriate for the local level. However, some participants noted difficulties in developing sector-specific metrics at the community level. Retaining the sectoral is a challenge due to the difficulties of distinguishing between sectors at the local level. This challenge requires a specific approach based on the articulation between local

community need and national policies. In fact, a metric specific to agriculture sector may indeed be relevant to monitor the effectiveness of adaptation in other sectors.
• important points that came up during the meeting are:
(a) metrics must not be developed hastily;
(b) a more coherent framework for development of metrics is necessary, especially because of significant overlaps between development and adaptation projects;
(c) development of metrics should be context-specific and involve all relevant stakeholders;
(d) adaptation targets should be used wherever possible and such targets should be human development-oriented;
(e) metrics should evolve through an adaptive learning process

Participants discussed several methodological challenges in the development of adaptation metrics for the water sector. Metrics must account for multiple values and interests of stakeholders, frequent policy shifts and uncoordinated actions, and potentially hidden stakeholder agendas.
They agreed that (a) the development of adaptation metrics should consider trade-offs and multiple values and interests of stakeholders, (b) frequent policy shifts and uncoordinated actions in water management may be related to the lack of suitable metrics, and (c) bottom-up assessments of metrics should consider the hidden agendas of stakeholders.

Development of adaptation metrics in the water sector should consider physical and value flows of water, multiple system uses, and non-linear responses. National water accounting should be improved to strengthen the basis for adaptation metrics.
Metrics should be integrated into a planning context at all levels. They should be piloted as soon as possible on existing adaptation projects and integrated into the current monitoring and evaluation processes.
Adaptation metrics should be policy-relevant, scalable, transferable, context-specific, and comparable. Metrics should capture the multi-dimensional nature of climate change impacts and the diversity in perceptions of stakeholders on their utility in decision making.
Many methodological challenges remain in the development of metrics. They include whether approaches should be deductive or inductive, locally-specific or spatially-scalable, and based on past experiences or linked to future projections. Integration of inductive and deductive approaches is desirable, but it may be difficult. Further research is needed on this possible integration.

Theme 3:
How do we adapt institutions to address climate change?

Key questions to address during the theme include:

What are the barriers to adaptation within various governance structures? In what ways does the status of knowledge and embedded uncertainty about climate change act as a limit to adaptation? How do different ways of knowing influence adaptation? Are there limits to the opportunities that technology can provide for adaptation? How may different forms of governance, including democratic governance, act as barriers to adaptation?

Keynote speaker: Mohamed Senouci Review Editor IPCC (Algeria)

Quelles réformes au Maghreb pour répondre aux défis du changement climatique global ?

M Senouci presented a variety of current perspectives on adaptation, and summarizes the state of knowledge and thinking as reflected in recent researches in the Maghreb countries.
Whatever the early implication of the Maghreb countries in UNFCCC the search for adaptation needs and the development of priorities has received a little attention, he said. This stems from the fact that the need for adaptation is likely to be greater and the capacity in known to be less. On this basis he identifies the necessity of reforms.
He then presented a science perspective on the role of climate change for Africa, as well as current understanding and weaknesses in knowledge. He outlined how both climate variability and the impacts of climate change are large, yet people are vulnerable because they are mostly dependent on rain-fed agriculture and have limited adaptive capacity.
He stressed that adaptation cannot be seen in isolation from development issues, as vulnerability to climate change is compounded by existing stressors, and that indigenous strategies to adaptation must be incorporated in any action plans.
He noted that adaptation is a new policy area for the Maghreb and pointed out that their policy considerations could also be relevant to Africa. He addressed the availability of information, gaps in research, and integrating adaptation into existing policy. Highlighting the need to encourage the private sector to implement adaptation measures.

Guy Jobbins (CCAA): noted that adapting to climate change should be a dynamic process, as change will be continuous. The capacity of individuals, groups and institutions can be conceptualized as three broad categories that exist at both intentional and conditional levels. The traditional and scientific knowledge guiding adaptation is conditioned by methodologies and epistemology, the tools and interventions of adaptation are conditioned by financial and material resources, and the legitimacy of adaptive action is conditioned by societal and legal aspects of the governing system.
Jobbins explains the role of The Climate Change Adaptation in Africa (CCAA) Program in improving the capacity of African countries to adapt to climate change in ways that benefit the most vulnerable members of society. Key to this goal, he said, is the strengthening of adaptive capacity through Participatory Action Research (PAR) that engages research institutions with multiple stakeholders to ensure that research meets the needs of research end-users. CCAA's approach suggests that actively engaging multiple stakeholders in new processes to share both scientific and traditional knowledge, co-develop research methodologies and learning approaches, share resources, and build partnerships and alliances is key to strengthening adaptive capacity, as stakeholders combine their capacities to meet collective needs in the face of climate change.
In her presentation, N. Oumoussa (Ministry of Energy, Mines, Water and Environment, Morocco) shared some measures that may help to ensure the required synergy between the two processes, combating desertification and Climate Change to adapt to the negative impacts of Climate Change.
She highlighted that the African vulnerability is due to development difficulties. She then urged the importance to enhance capacities of our countries and communities to have a better quality of life. And in doing so, plan for the future, integrating Climate Change and Desertification issues in our policies and taking advantage of international efforts and opportunities.

Her recommendations were as follow:
With scarce financial and human resources, it essential to link adaptation to climate change and desertification measures rather than designing, implementing and managing policy separately
With combined Climate Change and Desertification, the bottom line is all have to adapt. So in that way, it requires means of cooperation between all countries and all Development institutions.
We should not disregard existing knowledge; we should build upon it.
We have to look back at the old techniques and try to revise them if necessary.
We need to use efficiently the available funding to adapt, and within the two processes, there are some means to support, to help those who are the most vulnerable to adapt. We need to build upon other's success.
We should create the right institutional framework. Those who are the most concerned by Climate Change and Desertification impacts must have their say in decision making.
Chehbouni, (CDRT) gave a case of successful pilot experience realized by the CDRT contributing to reduce the GHGs effect induced by Marrakesh's pottery village.

Key points raised from discussion are:

- Standard IPCC methodology does not solve all the problems!
- Need to have baseline data
- Need to develop methodological tools in the Maghreb countries (modelling, GIS, assessing the value of non-marketable assets)
- Objective limits of the V&A studies: they cannot quantify everything, nor predict everything!
- Need to have multi-disciplinary national teams
- Require major funding
- Importance of national leadership for impact assessment and for defining response strategies
- National technological context (e.g. the possibilities of processing satellite images)

Practical Action

- Need to question NGOs' vision of development and ask what different people mean by effective outcomes – the need to have a holistic approach, consider the impacts of globalisation, both rural and urban concerns, terminology and interpretation (language and clarity of outreach).
- Build on existing knowledge about resilient livelihoods, and consider the importance of 'bottom-up' research – African researchers should be leading on defining local priorities for research on climate change.
- NGOs have capacity to help develop skills at local levels and link with globalization issues – need to work better at different levels (e.g. cooperation and brokering role).
- Working with southern organisations to promote south-south learning for technologies and methods transfer (concerned about weakness in forecast science and the language of 'technology transfer').
- Need to frame project questions, especially at the community level, so need the right methodology (support from academics).

Participants agreed that there is a need to continue identifying the local priorities and help to generate space in national systems to address these priorities. However, he was unclear how

institutionally many governments could cope with a chain of priorities that are interlinked (e.g. Ministries deal with specific sectors).
A participant voiced concern about the lack of government support for development research. He felt that funding alone is not a solution and asked how it might be possible to make collaboration/communication be seen by government as more important. He was concerned this would have long-term consequences for policy and decision makers as limited research on practice and new ways of mainstreaming/adaptation.
Another participant was concerned that policy is asking the research community critical questions for development but in areas that are not being funded properly. This was perceived to be a particular weakness in the social sciences and may cause long-term problems for moving the research agenda on adaptation forward.
Institutions are found to play important roles for enabling adaptation. Local institutions, including community organizations, farmer associations, local government agencies, informal associations, kinship networks and traditional institutions, serve functions in communities that help to limit, hedge and spread risks. They do this by sharing knowledge, human and animal labor, equipment and food reserves; mobilizing local resources for community projects and public works; regulating use of land and water; and providing education, marketing, credit, insurance and other services. Provincial, national and international institutions aid by providing extension services, training, improved technologies, public health services, infrastructure to store and distribute water, credit, insurance, financial assistance, disaster relief, scientific information, market forecasts, weather forecasts and other goods and services.
Many developing countries have a good core of professional planners and managers operating in key sectors, but they are usually unaware of the potential impacts of climate change on their respective sector. Climate risk assessment needs to be incorporated into development activities by all of these professionals.

Theme 4:
free thematic areas

Keynote speaker: Abdalah Mokssit Lead Author IPCC – DMN (Morocco)
Les changements climatiques au Maroc : observations et projections

Mokssit, gave an overview of impact and adaptation assessments in Morocco, noting that the mean annual temperature has increased by 0.9°C since 1960, an average rate of 0.20°C per decade. This increasing trend varies with season, and is only statistically significant in AMJ season (April, May June) and SON season (September October November). The rate of increase is most rapid in the hot, dry season, AMJ, at 0.34°C per decade. He also stressed that the frequency of days that are classed as 'hot' has increased significantly since 1960 in all seasons except SON. The frequency of nights that are classed as 'hot', however, has increased significantly in all seasons.

Morocco's scientists have generated a base of information about how the climate is changing and the broad physical impacts these changes may have, he said. However decision makers require improved information about the projections of climate change, particularly of extreme events, social and economic trends that affect climate change vulnerability, and the social and economic impacts of climate change.

A. Bennouna (ISTICHAR sarl, Morocco) presented an exhaustive data collection, analysis and comments on 25 years of CO2 energy emissions in Morocco.
Karrouk (IGBP, Morocco) presented research foci and linkages of the IGBP programme with other global change programmes, such as those represented in the Earth System Science Partnership. He then posed a set of integrative questions that required collaboration between scientists from different programmes. He highlighted areas which have been characterized as "tipping points" in the climate system, since change in the physical and biogeochemical properties of these areas could occur on relatively short time scales ("abrupt climate change").
Major regions across the Maghreb face considerable risks from climate change impacts, and in many cases these risks will span a range of sectors. Effective decision-making will need to be supported by integrated, multi-disciplinary assessments of vulnerability to climate change. For example, understanding the implications of sea level rise for coastal planning will require insights from climate scientists, engineers, ecologists, economists and planners. Remote and Indigenous communities may have more limited capacity to adapt.
Labbene (GTZ, Tunisia) elaborated on a pilot project CCC/GTZ undertaken with German cooperation in his country.
Ben Salem (UCAM) presented the up-stream-downstream context in which downstream water pollution stems from upstream sources, or in which significant water diversion limits water availability and/or usability in the downstream areas of The Ziz valley (southern Morocco). H used the Water Evaluation and Planning (WEAP) model for the simulation and analysis of various water allocation scenarios and, above all, scenarios of users' behavior. There are many evidences concerning degradation, pollution and overexploitation of water resources, resulting from inappropriate groundwater management systems based on the administrative division. He proposed the ecohydrological approach as an adaptive management solution
In addition a large number of specific measures are proposed including

- Installing a displacement device, which reduces the water the toilet tank will hold
- Using low-flow faucets;
- Rehabilitation of watersheds
- Construction of deep wells

Khattabi: The coastal zone is vulnerable to sea level rise, increased sea surface temperature, increased storm intensity and frequency, ocean acidification and changes to rainfall, run-off, wave size and direction and ocean currents.
Climate-related problems include coastal erosion, siltation and sedimentation, storm surges and urban flooding, saltwater intrusion into water resources and degradation of water quality. Poor people, especially fishers and shellfish farmers, are affected most. Some autonomous adaptation has already occurred, including:
Accommodating sea level rise by building houses on stilts
Strengthening the physical structure of houses
Moving to safer places during calamities
Placing sandbags along the shorelines
Borrowing money from relatives or acquiring high interest loans from money lenders
Engaging in alternative income-generating activities locally or in other areas
Changing occupation.
Such strategies, however, are inadequate and not effectively integrated into local development plans.
The government has also instigated adaptation activities, including relief assistance, resettlement and shoreline protection. These have reduced the vulnerability of coastal households, but are inadequate and costly. Adaptation strategies proposed by local people

are mostly nonstructural measures such as policy and institutional reforms regarding coastal zone management, property, micro finance/insurance schemes disaster risk management, fisheries/aquatic resource management and community-based adaptation. Local capacity development was also deemed important, as was improving knowledge management.
Mezghani (Tunisia), described adaptation measures undertaken within the agricultural sector in his country, noting that the soils were eroded, fallow periods were no longer observed, and that slope erosion caused by run-off posed a serious problem. He elaborated on a pilot project undertaken with German cooperation in the eastern part of the country, aimed at enhancing capacity for the better management of catchments.

Discussion:

A participant highlighted the importance of systematic observation to ascertain vulnerability to climate variability and adaptation needs. Lamenting the absence of high density observing networks in his country, which restricts participation in GCOS, he added that many African countries are constrained by limited financial resources and lack of capacity to interpret and draw benefits from current observations. He noted that models used were originally designed for developed countries, and called on the UNFCCC to assist in coordination efforts amongst parties concerning capacity building, training and research.
Drawing attention to problems with instrument maintenance, he stressed the need for quality data and for collaboration.
He highlighted the mismatched scales of climate-related challenges and the resources available to address them, and said that data from the Maghreb is characterized by discontinuity and gaps, reiterating that systematic observations and meteorological data needs broader attention beyond the World Meteorological Organization (WMO) and its member countries.

Participants proposed evaluating capacities at the institutional and regional levels and making this information available to reinforce South-South cooperation, and proposed holding an annual African forum on vulnerability assessment. They also agreed on the usefulness of a website to exchange information and on the need to reinforce institutional capacities. On adaptation planning and implementation, participants highlighted the need for building capacity to formulate and prepare projects, possibly through workshops.

Increase awareness and knowledge. Nearly all of the case studies highlighted lack of knowledge as a critical constraint on adaptation and rank efforts to increase and communicate knowledge as a high priority. Stakeholders complain of limited to no access to information about historical climate and future climate change projections; estimates of climate impacts and risks; causes of vulnerability; and risk management technologies and practices. The study in Tunisia, for example, indicates that local farmers are reluctant to modify traditional agricultural practices because they lack the knowledge and education to evaluate and implement new methods.

Provide financial assistance. Participants commonly cite lack of financial resources as a major obstacle to adaptation. The constraint is particularly binding on the poor and very poor, who are typically among the most vulnerable to climate change. Poor households, small-holder farmers and small business owners often lack access to formal credit markets and insurance. They resort to community funds and informal networks for credit to recover from losses or make investments that reduce risks. Private sector innovations in micro-credit

and micro-insurance have increased access to financial resources and could play a role in financing adaptation.

International funding is acting as a catalyst for raising adaptation awareness, building capacity, improving understanding of risks and response options, engaging governments in prioritizing and assessing options and, to a limited extent, implementing selected adaptation measures. Nevertheless, the financial needs of adaptation are far greater than current funding. Additional financial resources are necessary. Ultimately, adaptation financing must come from multiple sources, including those internal to developing countries.

CCAM Workshop Outputs and their Use

Major outputs of the CCAM Workshop are as follow

Regional Climate Change Assessments

Many climate change assessments were presented during the CCAM2008 Workshop. The assessments are currently being used to:
• Provide a stronger scientific basis for the vulnerability and adaptation assessments of the Maghreb countries' National Communications to the UNFCCC;
• Inform national delegations to the UNFCCC COPs about key issues;
• Raise the awareness of stakeholders and the general public about climate change vulnerability and adaptation;
• Advance scientific understanding and inform the 5th Assessment Report of the IPCC on these issues as they pertain to developing countries; and
• Inform the consideration and development of adaptation strategies at local and national scales.

Substantial synergistic benefits

Presentation of multiple climate change assessments during the CCAM Workshop produced substantial synergistic benefits. The CCAM provided numerous opportunities for the different teams to interact with each other through regional cooperation (e.g. AUF, Morocco-Algeria, IMPETUS, GTZ…) synthesis activities, joint training activities, and electronic communications. These interactions will made important contributions to capacity building. Third, the success that CCAM 2008 has found in developing cross-institutional collaborations and engagement of participants with IPCC, OSS, IGBP, DIVERSITAS, START and GRAPHIC and the global change research programs has developed networks that will serve to keep the individuals and institutions that participated in CCAM engaged in climate assessment work. In view of this success, it is imperative that we build on the experience and achievements of CCAM and develop the next phase of such work to help advance new knowledge for a possible Fifth Assessment Report of the IPCC.

GRAPHIC

Call for Africa- GRAPHIC project case study participation and brainstorming on a proposal for the Maghreb GRAPHIC project thematic group
(see report)

Towards a Network on CC Adaptation in the Maghreb

To keep the CCAM participants engaged in climate change assessment and adaptation work, both the individuals and the institutions; discussion on the possibility of creation and implementing of a network on Adaptation in the Maghreb has been launched.
Its (network) form will be uniquely North African, reflecting the diverse and varied nature of expected climate change impacts in a region as big as the Maghreb, and enabling a flexible approach that can quickly respond to changing needs of governments, economic sectors (industry, agriculture, water…) and the community. The network would build on

existing capabilities by bringing coherence to the Maghreb adaptation research, focusing existing institutional capacity on agreed priorities, and providing a mechanism to foster new capacity where needed.
The network would have a key role in filling the information and knowledge gaps, identified in this Workshop. The network would synthesize knowledge, coordinate and commission research activities, broker research partnerships and provide information for decision makers in a form relevant to their sectoral or regional needs.
(see report)

Marrakesh statement
See report

Conclusions

The CCAM Workshop made important progress on the objectives of advancing knowledge, enhancing scientific capacity and improving links between science, policy and stakeholder communities, as documented in this report.

The CCAM workshop has demonstrated that a well designed project of relatively modest scale that invests in developing country science can yield substantial benefits (e.g. ACCMA project supported by the CCAA programme). More workshops of this type are needed. The remaining conclusions address lessons from CCAM for the design of effective projects for advancing knowledge, building scientific capacity and linking science, policy and stakeholder institutions.

More investment is needed in developing country science. While new programs like CCAA are encouraging, a great deal more still needs to be done in developing countries to advance scientific knowledge about climate change vulnerability and adaptation. Progress will require further enhancement of scientific capacity in the **developing** world, both of institutions and people. But this need tends to fall between the responsibilities of development and science funding agencies.

Building Understanding and Adaptive Capacity

There are substantial gaps in our knowledge and we need to improve the synthesis and dissemination of information for decision-makers. Decision makers need improved information, guides and tools which are tailored to their field and scope of operation to enable effective adaptation.
Key components of adaptive capacity include the ability to generate, access and interpret information about climate change and its likely impacts; suitable methods for identifying and assessing potential adaptation strategies; appropriately skilled people; adequate financial and other resources; governance systems with sufficient flexibility and foresight to embrace adaptation planning; and willingness to adapt. Knowledge and methods will need to span a range of disciplines, including climate science, biophysical sciences, engineering, social sciences and economics, and planning. Inter-disciplinary studies will also be important.
However, substantial gaps remain. Some of the important gaps in knowledge include:

- Characterization of the range of future exposures to climate hazards at regional and finer spatial scales that are important for adaptation decisions;

- Identification and prioritization of climate hazards that are of highest concern for different sectors, systems, places and groups and investigation of how these hazards will change with human-caused climate change;
- Measurement of vulnerability of different groups, empirical validation of the measurements, and attribution of differences in vulnerability to proximate and underlying causes;
- Decision processes of different classes of actors for managing climate risks, the information needed to make good decisions, and how climate change information can be integrated into decision making processes;
- The role of institutions (rules, processes and organizations) in facilitating or limiting adaptation to climate hazards;
- Identification of effective strategies for enabling adaptation and lessons about how strategies that are successful in one context can be expanded in use or transferred to other contexts; and
- The benefits and costs of adaptation.

UNESCO GRAPHIC: Call for Africa- GRAPHIC project case study participation

Reported by: Eihab Fathelrahmane

On the first day of the CCAM Dr. Eihab Fathelrahman on behalf of UNESCO GRAPHIC presented an overview about GRAPHIC's mission, objectives, and strategic goals. More than sixty participants attended the event and asked questions about GRAPHIC. The overview presentation was then followed by a discussion on GRAPHIC call for African case studies and the idea of creating a thematic group for the Maghreb scientists and practitioners who are concerned about the links between climate change adaptation and groundwater development projects and activities. Professor Mohammed Messouli considered the point of contact for future GRAPHIC activities. The event's participants mailing list was created, the GRAPHIC framework document was emailed to the participants, and the CCAM participants had the opportunity to discuss UNESCO GRAPHIC poster, As a result of the event, the Maghreb thematic group was created and the participants showed interest on the call for Africa case studies.

Towards a Network on Adaptation in the Maghreb

Reported by M. Senouci, Review Editor IPCC (Algeria)

During the Workshop on adaptation to climate change in the Maghreb (CCAM, Marrakech, 26-27 November 2008), an initial group of experts has organized an informal discussion on the possibility of creation and implementing of a network on Adaptation in the Maghreb. This document summarizes the findings of this informal discussion.

1 - Presentations and discussions held during the CCAM workshop clearly indicated an agreement between scientist and researchers about the sensitivity to the climate change impacts are extremely strong in the Maghreb.. However, in order to capitalize and expand efforts in this area, it seems necessary to structure the scientific community and define a framework for coordination.

2 - The question of whether to implement a highly structured network or define a flexible mechanism for coordination and exchange is not yet settled. In the first case, it will be necessary to mobilize sufficient resources to launch the network and ensure its sustainability. Commitments on a volunteer basis of the founding members of the network as well as clear objectives and platform of actions must be clearly specified. Taking into account the risk of the nature the volunteer work, the second option is to create an informal group (*task force*), which will analyze the conditions for implementing a network. This initial group will maintain an adequate level of coordination to initiate actions in this direction. This option seems realistic and can be implemented as follows:

3 - The CCAM workshop's recommendations constitute an initial objectives regarding adaptation to climate changes in the Maghreb. The workshop recommendations do not reflect all possible initiatives in climate change adaptations strategies. However, they are nevertheless useful starting points. The initial group of experts will reanalyze this document in order to identify strategic options for the future, gaps, obstacles, opportunities and available and/or potential resources. This refined document will attempt to catalyze the recommendations and suggestions emanating from the Workshop and will be enhanced by additional information and analysis coming from the working group. The document will be widely disseminated among more workshop participants and other networks, national or international institutions and individuals concerned about climate change adaptation strategies and implementation in the Maghreb.

4 -This action of synthesis and dissemination will define the contours of a real platform that foreshadows the foundation for a robust and dynamic network. The architecture of this network will be emerging to form to ideas, proposals and opinions which will be collected. This consultation period and interactions will also allow to estimate both the form and degree of commitment of partners and members of the future network on Adaptation in the Maghreb.

5 - The organizer of the Workshop (Prof. Messouli) suggested to circulate the initial recommendations for enrichment and approval by the participants within a period not exceeding one month (December 2008). We can consider that the reflection group will spend an additional month for the preparation of the refined second document (end of

January 2009). The dissemination may be made during the period February-March 2009. In April 2009, the working group could convene a meeting to develop a final document which will constitute a founding act of the network and platform for future actions.

Participants
Mohammed Messouli (Université de Marrakech)
Mohamed Yacoubi-Khebiza (Université de Marrakech)
Mohamed Senouci (ARCE, Algérie)
Abdallah Mokssit (DMN, Maroc)
Yadh Labbène (GTZ, Tunisie)
Mohamed Zmerli (Ministère de l'Environnement, Tunisie)
Guy Jobbins (ACCA, Cairo, Egypte)
Eihab Fathelrahman (Fort Collins, USA)

List of participants

List of participants

Mouna AAOUINE
Ecole nationale Forestière d'Ingénieurs de Salé, Maroc
Monmon-85@hotmail.fr

My Abdel aziz ABBAD
Faculté des Sciences Semlalia Département de Biologie, Marrakech, Maroc
abbad@ucam.ac.ma

Aicha ABBAD
Faculté des sciences de Kénitra, Maroc
aichaabbad@yahoo.fr

Abderrahmane AIT LHAJ
Institut Nationale de la Recherche Agronomique, (INRA) Agadir, Maroc
aitlhaj_ab@yahoo.fr

Jamal AIT LHAJ
Directeur local du projet IMPETUS, Ouarzazate Maroc
impetus.direction@menara .ma

Abdelkader ALLALI
Ministry of Agriculture and Fisheries Rabat, Morocco
allali05@yahoo.fr

Mohamed BAGHDADI
Ecole Nationale Forestière d'Ingénieurs de Salé, Maroc
Simo.enfi@hotmail.com

Ouarda BANAMAR
Ecole nationale Forestière d'Ingénieurs de Salé, Maroc
w-benmar@hotmail.fr

Ahmed BELKHEIRI
AGENCE DU Bassin Hydraulique du Sebou
belkheiri@abhsebou.ma

Amin BENNOUNA
ISTICHAR Consulting Marrakech, Maroc
istichar@menara.ma

Abdelkrim BEN SALEM
Faculté des Sciences Semlalia Département de Biologie, Marrakech, Maroc
bensalemk@gmail.com

Lahcen BOUARAB
Faculté des Sciences Semlalia Département de Biologie, Marrakech, Maroc
bouarab@ucam.ac.ma

Hamid BOUBEKRAOUI
Ecole Nationale Forestière d'Ingénieurs, Maroc
boubham@hotmail.com

Mourad BRIKI
Forest Conservation of Batna, Forest General Direction, Algeria
brikatmane@yahoo.fr

Rachid CHAKRIDI
Faculté des Sciences et Techniques Marrakech, Maroc
rchakiri@gmail.com

Nassima CHARAF
Université Hassan II, Ain Chock, Faculté des Sciences Casablanca, Maroc
nassimacharaf@yahoo.fr

Ahmed CHEHBOUNI
Centre de Développement de la Région de Tensift (CDRT), Marrakech, Maroc
chehbouni@ucam.ac.ma

Abderrahmane CHEMLAL
Président APROCIB, Berkane, Maroc
ciconiaberkane@yahoo.fr

Abdelouahid CHRIYAA
Institut Nationale de Recherche Agronomique, Settat, Maroc
chriyaaa@yahoo.fr

Fatima DRIOUCH
Direction de la Météorologie Nationale Casablanca, Maroc
driouechfatima@yahoo.fr

Ahmed EL HASSANI
Hassan II Academy of Sciences and Technology, Morocco
elhassani@israbat.ac.ma

My Ahmed EL ALAOUI EL FELS
Muséum d'Histoire Naturelle de Marrakech, Maroc
elalaoui_elfels@yahoo.com

El Houssine EL MZOURI
INRA Settat
elmzouri@yahoo.fr

Mustapha EZZAHIRI
Ecole nationale Forestière d'Ingénieurs de Salé, Maroc
enfi.ezzahiri@hotmail.com

Eihab FATHELRAHMAN
Affiliated Faculty at Colorado State University, Fort Collins, Colorado, U.S.
Eihab.Fathelrahman@ars.usda.gov

Naima FAOUZI
Ecole Nationale Forestière d'Ingénieurs, Salé, Maroc
faounaima@hotmail.com

Pedro Fernandez BAUTISTA
Policy Unit, EUCC
p.fernandez@eucc.net

Souad GHAZI
Ecole Nationale Forestière d'Ingénieurs, Salé, Maroc
souad_stipa@yahoo.fr

Lalla Bahia GHALLABI
Faculté des Sciences Semlalia
Département de Biologie, Marrakech, Maroc
bahia218@gmail.com

Mohamed GHAMIZI
Muséum d'Histoire Naturelle de Marrakech, Maroc
mghamizi@yahoo.fr

Jürgen GRÄBENER
German technical Cooperation (GTZ), Morocco
Martin.Tampe@gtz.de

Fatima Ezzahra HAMMADI
Faculté des Sciences Semlalia
Département de Biologie, Marrakech, Maroc
fati16@hotmail.com

Christian HOPFNER
Fachgebiet Klimatologie Institut für Ökologie
Technische Universität Berlin
Christian.Hoepfner@Klima.TU-Berlin.de

liorel JARLAN
Institut de Recherche pour le Développement
Marrakech, Maroc
lionel.jartan@ird.fr

Guy JOBBINS
Adaptation in Africa Program, Middle East and North Africa Regional Office, International Development Research Centre, 8 Ahmed Nessim St, Giza, Cairo, Egypt.
accagjobbins@idrc.org.eg

Mohammed-Saïd KARROUK
Université Hassan II, Casablanca
karrouksaid@yahoo.com

Abdellatif Khattabi
Ecole Nationale Forestière d'Ingénieurs de Salé, Maroc
abdellatif_khattabi@hotmail.com

Arnim KUHN
Institute for Food and Resource Economics, University of Bonn, Nussallee, Germany
arnim.kuhn@ilr.uni-bonn.de

Yadh LABBENE
German technical Cooperation (GTZ), Tunisia
labbene.gtz@gnet.tn

Ahmed LEGROURI
School of Science & Engineering
Al Akhawayn University, Maroc
Legrouri@aui.ma

Michel LE PAGE
Institut de Recherche pour le Développement
Marrakech, Maroc
michel.lepage@cesbio.cnes.fr

Mohamed LOUDIYI
Ecole nationale Forestière d'Ingénieurs de Salé
Lodi-84@hotmail.com

Mohammed LOUDIKI
Faculté des Sciences Semlalia
Département de Biologie, Marrakech, Maroc
loudiki@ucam.ac.ma

Patrick MARTIN
Royal Belgian Institute of Natural Sciences
patrick.martin@sciencesnaturelles.be

Melanie MATARESE
El Watan le quotidian indépendant, Algeria
melanimes@gmail.com

My Rchid MEKKAOUI ALAOUI
Association pour la protection de l'environnement et développement durable à Errachidia, Maroc
myrchid_mekkaoui@yahoo.fr

Mohammed MESSOULI
Faculté des Sciences Semlalia
Département de Biologie, Marrakech, Maroc
messouli@ucam.ac.ma

Sahla MEZEGHANI
Ministry of Agriculture and Hydraulic Tunisia
mezghanisahla@yahoo.fr

Noureddine MEZRIOUI
Faculté des Sciences Semlalia
Département de Biologie, Marrakech, Maroc
mezrioui@ucam.ac.ma

Abdelaziz MIMOUNI
Institut National de la Recherche Agronomique
mimouniabdelaziz@yahoo.fr

Hicham M'HARZI ALAOUI
Ecole Nationale Forestière d'Ingénieurs de Salé, Maroc
alaoui.net@hotmail.fr

Abdalah MOKSSIT
Division de la Météorologie Nationale
Casablanca, Maroc
mokssit.abdalah@yahoo.fr

Abdelkader MOKHLISSE
Centre de Développement de la Région de Tensift (CDRT), Marrakech, Maroc
mokhlisse@gmail.com

Bernard MOUGENOT
Institut de Recherche pour le Développement
Marrakech, Maroc
bernard.mougenot@ird.fr

Dalila NEDJRAOUI
Université des Sciences et de la Technologie d'Alger
Algérie
dnedjraoui@yahoo.com

Saida NIAZI
Université Mohamed V, Rabat, Maroc
saidaniazi@hotmail.com

Hanane OUAFIK
University of science Ben M'Sik
Casablanca, Marco
hananeouafik@gmail.com

Samir OUERGUEMMI
Ministry of Public Health Tunisia
mazouzirim@yahoo.fr

Khalid OUFDOU
Faculté des Sciences Semlalia
Département de Biologie, Marrakech, Maroc
oufdou@ucam.ac.ma

Ahmed OUHAMMOU
Faculté des Sciences Semlalia
Département de Biologie, Marrakech, Maroc
ouhammou03@yahoo.fr

Naïma OUMOUSSA
Ministry of Energy, Mines, Water and Environment , Rabat, Morocco
noumoussa@yahoo.com

Mohamed QARRO
Ecole nationale Forestière d'Ingénieurs de Salé, Maroc
qarro@wanadoopro.ma

Othmane RAJI
University Mohammed V-Agdal, Faculty of Sciences, Rabat, Morocco
saidaniazi@hotmail.com

Alexander REINHARD KASTL
German Technical Cooperation
Reinhard.Kastl@gtz.de

Nabil RIFAI
Ecole Nationale Forestière d'Ingénieurs de Salé, Maroc
nabilenfi@yahoo.fr

Saloua ROCHDANE
Faculté des Sciences Semlalia
Département de Biologie, Marrakech, Maroc
rochdane@yahoo.fr

Aicha SAADI
Faculté des Sciences Semlalia
Département de Biologie, Marrakech, Maroc
saadi_aicha@yahoo.fr

Hind SALAMA
Université Hassan II-Aïn Chock,
Casablanca, Maroc
salamahind@gmail.com

Bouchaib SALLAK
Ecole nationale Forestière d'Ingénieurs de Salé, Maroc
Sallak.bouchaib@gmail.com

Samira SAMOUDI
Faculté des Sciences Semlalia
Département de Biologie, Marrakech, Maroc
samoudisam@gmail.com

Dieter SCHERER
Institute of Ecology, Technische Universität Berlin
dieter.scherer@tu-berlin.de

Oliver SCHULZ
Department of Geography, University of Bonn; IMPETUS project
oschulz@uni-bonn.de

Mohamed SENOUCI
L'Institut Hydrométéorologique de Recherche d'Oran Algérie
msenouci@wissal.dz

Maria SNOUSSI
University Mohammed V-Agdal
Rabat, Maroc
ma.snoussi@gmail.com

Martin TAMPE German technical Cooperation (GTZ), Morocco Martin.Tampe@gtz.de Mohammed

Ouadia TAZI Université Hassan II Casablanca, Maroc ouadiaatazi@yahoo.fr

Mohammed YACOUBI-KHEBIZA Faculté des Sciences Semlalia Département de Biologie, Marrakech, Maroc yacoubi@ucam.ac.ma

Abdelaziz YAHYAOUI Département de Géographie FLSH Marrakech, Maroc ayahyaoui2006@yahoo.fr

Abdenbi ZINE EL ABIDINE Ecole nationale Forestière d'Ingénieurs de Salé, Maroc abdenbi_zine@hotmail.com

Mohammed ZMERLI Ministère de l'environnement, Tunisie zmerli2004@yahoo.fr

ZNAI Faculté des Sciences Semlalia Département de Biologie, Marrakech, Maroc, znari@ucam.ac.ma

MASTER STUDENTS (

16 Master students have been invited as hearers EdBio, Semlalia Faculty of Sciences , Marrakech

CLIMATE CHANGE IN THE MAGHREB: THRESHOLDS AND LIMITS TO ADAPTATION

Report of Workshop, November 26– 27, 2008 Marrakech, Morocco
www.ucam.ac.ma/ccam