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WATER AND ADAPTATION TO CLIMATE CHANGE IN TRANSBOUNDARY BASINS: CHALLENGES, PROGRESS AND LESSONS LEARNED

Report of the workshop held in Geneva, 12-13 April 2011

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Background and objectives

Water resources are vulnerable and can be strongly affected by climate change, with wide-ranging consequences for human societies and ecosystems. Nevertheless, few countries have developed adaptation strategies so far. The fact that many water bodies cross boundaries, especially in the UNECE region, implies that risks and challenges are shared between countries and that solutions need to be coordinated. Adaptation measures in one country, especially structural measures such as dams, reservoirs or dykes can have significant negative effects on other riparian countries. Cooperation on adaptation can help to find better and more cost-effective solutions, by considering a larger geographical area in planning measures, by broadening the information base and by combining efforts.

This is the main message of the UNECE Guidance on Water and Adaptation to Climate Change, developed under the Water Convention which explains step-by-step how to develop an adaptation strategy in transboundary basins. When adopting the Guidance at its fifth session in November 2009, the Meeting of the Parties decided to promote its implementation on the ground through the establishment of a programme of pilot projects on climate change adaptation in transboundary basins. To support the programme, the MoP decided to establish a platform for exchanging experience between the pilot projects through regular meetings, a web-based platform, and other activities.

The programme of pilot projects was launched at the first workshop organized in the framework of the platform wich was entitled "Water and climate change- how to develop an adaptation strategy in transboundary basins" and was held on 10-12 May 2010 in Geneva.

The 2011 workshop thus constituted the second workshop organized within the platform for exchanging experience on adaptation in a transboundary context and the programme of pilot projects on adaptation to climate change in transboundary basins under the UNECE Water Convention. It brought together countries and other stakeholders engaged in activities on water and adaptation to climate change, in particular in transboundary basins, with the aim to:

- Exchange practical experience and share lessons-learned on the technical and strategic aspects of adapting to climate change;
- Analyse the specific challenges of adapting water management to climate change in the transboundary context, identify best practices, success factors and lessons learnt; considering the different steps of developing an adaptation strategy: from the assessment of impacts and vulnerability to the selection of measures;
- Exchange experience between the pilot projects on adaptation to climate change in transboundary basins under the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) as well as other similar initiatives;
- Support governments, organizations and joint bodies engaged in the process of preparing national or regional adaptation strategies;
- Promote and discuss the implementation of the UNECE Guidance on Water and Adaptation to Climate Change.

This report provides information about the workshop and its main conclusions and includes summaries or abstracts of the presentations given during the workshop, as provided by their authors. All material related to the workshop is available at: http://www.unece.org/env/water/meetings/transboundary_climate_adaptation_workshop.html

Attendance

The workshop *Water and adaptation to climate change in transboundary basins: challenges, progress and lessons learned* was held on 12-13 of April 2011 in Geneva back-to-back with the fourth meeting of the Task Force on Water and Climate under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) on 14 April 2011.

The workshop was attended by more than 150 participants. The wide representation of countries and organizations that were present at this workshop shows that apparently there is a need for discussing water and climate change in the transboundary context. Experts and official representatives from Afghanistan, Algeria, Armenia, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Czech Republic, Egypt, Estonia. Finland, France, Georgia, Germany, Hungary, Jordan, Kazakhstan, Kyrgyzstan, Mexico, Morocco, The Netherlands, Poland, the Republic of Moldova, Russian Federation, Spain, Sri Lanka, Tajikistan, The former Yugoslac Republic of Macedonia, Tunisia, Turkmenistan, Ukraine and Uzbekistan participated as well as representatives of the Palestinian Water authority, International Telecommunication Union,The World Bank, UNESCO, United Nations Environmental Programme (UNEP), United Nations Framework Convention on Climate Change (UNFCCC), World Meteorological Organization (WMO), United Nations Convention to Combat Desertification, International Commission for the Protection of the Rhine, International Sava River Basin Commission, International Water Assessment Centre (IWAC), Niger Basin Authority (NBA), Organisation of Economic Co-operation and development, Organization for Security and Co-operation in Europe, RAMSAR-secretariat, Southern African Development Community secretariat attended.

In addition, representatives of the following Non-Governmental Organizations participated: Adelphi, Albania INEUM, CIWEM, Daursky Biosphere Reserve WWF Russia, Ecoglobe-Ecology Discovery Foundatian New Zealand, Fridrich-Ebert Stiftung, German international cooperation, Global Instituet for Water, Environment and health, Global Water Fund, Global Water Partnership-Mediterranean, Green Cross International, Institut for Agricultural and Forest Environment Polish Acadamy of Sciences, Institute of Nature Conservation in Albania, International, Centre for Trade and Sustainable Development, International Network of Water-environment Centres of the Balkans, International Rainwater Harvesting Alliance, Terra-1530, Ecospectrum, Stockholm International Water Institute, Eco TIRAS International Environmental association of River keepers, Regional environmental centre for Central Asia, Ukranian National academy of sciences, Verbund hydropower AG, Wetlands International, World Business Council for sustainable development, World Wildlife Fund, Ingénieurs du Monde, African Commercial Center, Graduate Institute of International and development studies, IHEID, National Research Council, NovioConsult, University of California-Davis, University of East-Anglia, University of Geneva, University of Leipzig and the World Trade Institute.

The workshop was organized under the leadership of the Governments of the Netherlands and Germany, with the support of the UNECE secretariat. Funding for pilot projects and the platform for exchanging experience was provided by the governments of Finland and Switzerland. The workshop was also supported by GWP-Mediterranean, in the framework of the project IW:Learn3.

Organization of Work

The workshop consisted of the following sessions:

Session 1: Opening Session

Session 2: Jointly assessing climate change impacts

Session 3: Climate change impacts on water-related sectors and joint responses

Session 4: Planning water management under uncertainty

Session 5: Ecosystem-based adaptation

In addition, on 12 of April, a panel discussion took place in which the pilot projects shared their progress and the lessons learned so far. Also on 12 April a special lunchtime session was held to inform the participants about the UNECE Environment Division and in particular on the Water Convention. On 13 April a special lunchtime session was organized by the EU funded research-project Twin2go on the issue of 'Making water resources management more adaptive – are policy lessons and best practices transferable across basins?'

Conclusions and recommendations

Climate change and extreme weather events often involve too much or too little water. Although there is still a lot of uncertainty about the impacts of climate change in many regions and basins the weather will be more extreme, with more frequent and more intense droughts and floods. It should be realised that changes in the extremes will have more effect and are indeed more important to know than changes in the averages alone. In looking at adaptation measures, natural variability in different countries provides lessons how adaptation can be done and how resilience can be improved.

Countries must adapt to these changes and work together when doing so. "Cooperating to jointly assess impacts of climate change, share results and make sure that measures in different riparian countries are mutually sustaining rather than conflicting sounds logical and thus should be the norm, but it is not. Although many countries are now starting to assess climate change impacts and to develop adaptation strategies for their own territory, still very little is done at the transboundary level. This brings the risk that countries take adaptation measures with unintended negative effects on their neighbours"[1].

Transboundary cooperation

For this reason, transboundary cooperation is essential in adaptation; countries should be willing to cooperate and realize that they cannot effectively adapt to climate change on their own. To achieve cooperation in a transboundary basin, a common understanding and a common knowledge base is needed. Institutional and cultural differences may hinder cooperation but these can be overcome. For example, countries can look for what they have in common as a basis for cooperation, like a shared interest. The project '*Dauria going dry*', for instance, implemented in a region where competition over water makes countries hesitant to share information, focuses on nature conservation. All parties have an interest in this for various reasons. Cooperation helps them to improve the information base and setting of targets.

Transparency and openness are important values, when working together in a transboundary basin: transparency in methods used, transparency on uncertainties, on interests etc. It is important to have open access to information between countries. This can be ensured by expert discussion; the professional interest of the people who work together can be an important driver for cooperation. A discussion within a group of experts often makes it easier to find solutions as they have no political interest in certain outcomes. In such discussions, civil servants and stakeholders should be engaged. But it is also necessary to involve the political level at an early stage to ensure the ownership on that level. Next to that, informal meetings outside the conference room, like site visits, help to increase the mutual understanding and cooperation.

[1] Mr. Ján Kubiš, Executive Secretary of the United Nations Economic Commission for Europe.

River basin commissions are vital to create transboundary understanding about upstream and downstream interests. But time is needed to build up the trust necessary for good cooperation. It took the Rhine Commission 50 years and the Mexican and US-governments 65 years to reach the current level of cooperation. Therefore cooperation should start today. Nevertheles, institutional en legal settings are needed for enforcement and funding of adaptation measures and river basin commissions themselves will mostly not provide for this.

Action is needed now, despite uncertainty

Several speakers stressed that adaptation to climate change is needed now and uncertainty is not an excuse to wait. There should be more focus on what is already known, not on what is still unknown. "It is better to be approximately right, than precisely wrong"[2]. The expected impacts of climate change in monetary terms provide already with sufficient incentives to invest in adaptation measures today; the costs of impacts are expected to be so high that investments to prevent them are reasonable. As Mr. Babych from Ukraine stated: 'We can prevent having to spend 7 Hryvnia or Euro by investing 1 now'. Although the uncertainty may be high and the information may be insufficient, much is already known and no-regret, low regret or win-win measures can be defined.

The quality of the output of models is not expected to improve much in the near future, so it is necessary to find a way to deal with this uncertainty. "The models are not ready for prime time yet"[3], but they are the best with the given knowledge. Moreover, the quality of the output of a model also depends on the quality of the input (socio-economic and hydraulic data, population figures, etc.) and often this information is lacking or of poor quality. "What you haven't measured you can't phrase."[4] . Models need to be improved and guidance on their limitations is needed as otherwise anyone would pick the model that suits him/her best. Despite the uncertainty in the model outputs, it is necessary to start adapting to an uncertain future and in the mean time work in parallel on improving the models.

In transboundary basins, international harmonisation of models or the use of joint models are preferable. In a situation where there are no harmonized models, national models can be linked together and compared in a transboundary basin while making adjustments at the respective borders, as the AMICE-project shows.

Next to climate models and hydrological models, other models and tools should be taken into account. For instance economic tools and models can be very useful in decision-making processes towards adaptation measures. Conceptual schemes like the SADC 'Adaptation cube', may help to understand the complex problems of climate change and can support the decision-making process. A Risk management approach is important for dealing with uncertainty. Tools like Multi Criteria Decision Analysis (MCDA) can be helpful in this.

To be able to adapt to climate change, a mixture of structural and non-structural adaptation measures is needed. Structural measures like dams, dykes, flood forecasting systems are necessary, but non-structural measures like water use reduction or water use efficiency, increasing ecosystem resilience and land use reform can be highly effective.

Healthy ecosystems can help in adaptation. Ecosystems often provide natural buffers against extremes and thus increase resilience. Maintaining or restoring ecosystems

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[2] *Mr. Bertrand Meinier*
[3] *Mr. Zbigniew W. Kundzewicz*
[4] *Mr. Joost Buntsma*

entails recognizing that ecosystems are important water users. Ensuring environmental flow is a means to secure this. Natural variability provides lessons on how adaptation can be implemented and how resilience can be improved. New infrastructure may not be needed if one uses the available 'natural services'. Indigenous knowledge may help in this regard.

Climate change is not the only driver which puts the water cycle under pressure. For instance, land use planning plays an important role in adapting to climate change. "We will have to look at the land to help us looking after the water."[5]. An obvious example here is the growing population density in flood-prone areas.

Water is and should be at the centre of climate change adaptation. Water is essential for many sectors while climate change has important implications on sectors especially through the hydrological changes. An important part of adaptation is therefore dealing with water. Because of the many interlinkages, todays problems with the demands for natural resources are complex. Tools like MCDA can help to find a balance for instance between the water needs of hydropower and agriculture as the presentation of Mr. Horton and the case of the Mesta/Nestos showed.

The workshop showed that climate change adaptation should account for the three P's; People, Planet and Profit. The many activities presented also showed that people and their willingness to cooperate, even in a transboundary context, make the difference.

[5] Contribution from the audience

Summaries of the presentations

1 Keynote speech

Climate change impacts on water resources in Europe - regional and sectoral perspective- Mr. Zbigniew W. Kundzewicz- Polish Academy of Sciences, Coordinating Lead Author of the water chapter in the fourth IPCC assessment report

Among all the climate change impacts in Central and Eastern Europe, those related to water resources are probably most essential. There is a justified concern that all three principal classes of water-related problems – having too little water, too much water, or polluted water may get exacerbated by climate change.

In Central and Eastern Europe, several facets of climate change have been already observed. Warming has been ubiquitous and the rate of warming has accelerated in recent decades. However, in contrast to temperature change, changes in other variables of relevance to water management are far more complex. There are evident changes in seasonality of precipitation, such as decrease of the ratio of summer precipitation to winter precipitation, and change of the distribution of the phase of winter precipitation. Less snow cover in Central and Eastern Europe results in less, and earlier, snowmelt. Rivers freeze less frequently and ice remains shorter. Intense precipitation is on increase. However, observations to-date provide no conclusive and general proof of ubiquitous increase in flood discharges.

Mean annual precipitation and river flow are likely to decrease over much of Central and Eastern Europe, but intensity of rainfall events is projected to increase. The seasonal distribution of river runoff is also projected to change. Precipitation and river runoff would increase in winter, but it may decrease in summer (according to some, but not all, models). There have been recurring and prolonged dry spells in recent summers (e.g., in 2003 and 2006) – possible harbingers of future droughts, with adverse consequences to agriculture and other sectors.

The expected decrease in summer flow, combined with increased temperature in lakes may have negative consequences for water quality. But also where the runoff is projected to increase, risk of water quality problems can grow, because of flushing of contaminants. The region can be increasingly affected by eutrophication, accompanying increase in water temperature.

Climate changes have strong impacts on agriculture via weather extremes. Already now, in much of the region, evapotranspiration exceeds precipitation during summer, hence the water storage (in surface water bodies, soil and ground) decreases. Summer precipitation deficit is projected to increase considerably in the future and decrease of some crop yields (e.g. potatoes and wheat) is projected.

Undoubtedly, climate change requires adaptation, yet the climate change signal, except for the warming, is not strong and unequivocal, due to strong natural variability. Moreover, there exist of multiple non-climatic factors driving water resources, e.g. related to land-use and land-cover change.

Precipitation is not simulated with adequate credibility in present climate models. Projections are model- and scenario-specific, and loaded with high uncertainty. Hence, quantitative projections of changes in river flows at the river basin scale, relevant to water management, remain largely uncertain. A question: ”Adapt to what?” comes about. However, water management has always meant adaptation to natural variability, and the latter is likely to increase due to climate change.

Enhancing water storage, and in particular – small retention is advantageous for both adaptation (storing water when abundant and releasing when scarce, hence weakening hydrological extremes that may become more extreme) and for mitigation (small hydro-power without fossil fuel burning). Yet, construction of large reservoirs involves serious environmental and social concerns.

Adaptation is basically local, but the European Union plays a coordination role when dealing with trans-boundary issues and sectoral policies. It provides co-funding for a range of projects - use of structural and cohesion funds serves improvement of water supplies, e.g. in the rural communities (of climate change relevance). The EU creates enhancing environment. There are legal acts of the EU, setting a framework for actions in the field of water policy, including adaptation to climate change.

The observed climate change in the Central European region has not been strong enough yet to persuade the water management community to change standards, criteria, and evaluation procedures. Projections of future precipitation and river discharge largely differ between models (and scenarios), hence GCM-based information is found too vague to be used.

However, water management community shows interest in climate change observations, projections, and impact assessments. Due to the large uncertainty of climate projections, it is currently not possible to devise a scientifically-sound procedure for redefining design floods (e.g. 100-year flood) under strong non-stationarity of the changing climate and land use. For the time being, adjusting design floods using a "climate change factor" approach seems adequate.

2 Jointly assessing climate change impacts

2.1 Formulating and evaluating water resources adaptation options to climate change uncertainty in the Ukrainian Carpathian region - Mr. Mykola Babych, State Committee for Water Management, Ukraine

In Ukraine, there was a series of catastrophic floods in Carpathian region within the last decade; the most hazardous being in the years 1998 and 2001 in the Tisza River Basin (western watersheds of Carpathian mountains), and in July 2008 in the Dniester and upper Prut Basins (eastern watersheds of Carpathian mountains). The National program on flood mitigation for both these areas were initiated in Ukraine at 2001 and 2008 respectively. Taking into account the latest recommendations of the Intergovernmental Panel on Climate Change (IPCC), UNECE Water Convention Guidance on water and adaptation to climate change, the system of the flood management issues developed for the program should include adaptation options to climate change uncertainty. The contemporary method for the quantification of regional climate changes is based on the downscaling of the IPCC global climate models (GCM) scenarios using Regional Climate Models (RCM). Using these scenarios as the common baseline, the influence of climate variability on the watershed and existing water control system can be simulated by the distributed watershed hydrological models. The studies within this approach are provided in Ukraine under the National Programs and under the recently started project of CRDF Global (U.S) in which a partner of Ukrainian experts is US Army Corps of Engineers Institute for Water Resources.

The primary objective of the CRDF project is the formulation and evaluation of water resources adaptation options to climate change uncertainty for flood management, using integrated modeling as a key instrument of the river basin management. The following primary objectives are part of this proposal:

- To provide downscaling of scenarios of the IPCC / GCMs for the distributed modeling of the river basins in the Carpathian region
- To quantify the effects of GCM scenarios and climate variability and uncertainty on river flow and flooding, flood damage forecasts;
- To formulate and to evaluate the water resources adaptation options to climate changes taking into account uncertainties in the quantification of the regional flow

The mountain Ukrainian Carpathian watersheds that are used in the study are generated by the flow via transboundary rivers – Tisza, Uzh, and Dniester. The results of the Dniester study can provide the input into the UNECE pilot project « Reducing vulnerability to extreme floods and climate change in the Dniester basin » as assement of the inflow from the Ukrainian Upper Dniester basin into tranboundary part of the river.

Lessons learned

- There is a need for continuous monitoring of the hydrologic condition of the river basin and for a catchment area evaluation;
- An early prediction of the situation is needed, as early as possible;
- Inform the authorities and the public promptly and correctly about potentially complex and critical situations;
- Protect forests, because mature forests can prevent, to a certain extent, the rapid slide down of water from slopes;
- River channel can not be unlimitedly compressed by dams, bridges and other structures. Watr should have sufficient spac for flow;
- It is more rational and economical to delay the flood runoff in the catchment area than to build significant facilities on major rivers;
- Each dollar invested in to prevent floods will save seven dollars, needed to spend on flood relief afterwards;

- There is a need to study the situation with the passage of high floods for the most continuous period possible.

Zheleznyak M.[1)]*, Babych M.*[2)]*, Duplyak V.*[3)]*, Kovalets I.*[1)]*, Stakhiv E.*[4)]
[1)]*Ukrainian Center of Environmental and Water Projects of Academy of Technological Sciences*
[2)] *State Committee of Ukraine of Water Management*
[3)] *Ukrhydroproect Inc*
[4)] *US Army Corps of Engineers Institute for Water Resources*

2.2 Transboundary modelling in the Meuse basin - Ms. Maïté Fournier, Etablissement Public d'Aménagement de la Meuse, France, AMICE project

Climate scenarios

In the last episode of AMICE, you heard the story of 17 Partners sharing the same river basin: the Meuse. This basin, like any other in the world, is impacted by climate change and together, we want to understand it and adapt.

In 2009 we developed 2 climate scenarios: wet and dry, to take into account the range of possible climate evolutions. They were included in rainfall-runoff models to quantify the impacts of climate change on the river discharges. Flood peak discharges could increase up to 15% by 2050 and up to 30% by 2100. In dry conditions, discharges could be reduced by 10% to 40% by the end of the century.

Hydraulic modeling

There are 5 different regions and States on the Meuse basin and, obviously, each one has its own hydraulic model ! Models are usually not overlapping except between Flanders and the Netherlands were the Meuse makes the frontier.
Our aim is to run the scenarios from spring to mouth. But there is no time nor money to create a new transnational model that would cover the full length of the river. The best way is to connect the existing models.

How do we proceed ? The following methodology was elaborated by the University of Liège. The first step is to send-out questionnaires to each Partner to understand the characteristics of each model, in particular the spatial resolution and modeling mode. The differences observed are related to the topography of the basin that required different approaches to deal with the diversity of topography and human settlements density.

In addition, we realized that the statistical methods used to calculate the extreme return periods as well as the discharge-height relations were different. However, these appeared to be quite small compared to the uncertainties of the model themselves and of climate change projections. Each country can then keep using its current statistic relations.

The geographic systems are also different. The 0 level in Belgium is 1.8m higher than in France and 2.3m higher than in the Netherlands. To solve this, we established a matrix that converts the water depth results into one or another geographic system.

Our first idea was to run the models sequentially. But that would have required too much time. Moreover, the upstream (US) model also needs information about the downstream (DS) boundary conditions, and these would not be available if the DS model is not run.
Instead, we chose to run all models in parallel, first with the results of the rainfall-runoff modeling and afterwards with the US and DS boundary conditions. In between the two runs, we check the consistency of results on the borders.

Ensuring consistency was not really easy, it required extra meetings between Partners to understand why our results were so different:

- Wrong relation between discharges and water heights: the relation in France is wrong and was corrected with the Belgium one. That had never been obvious before because we only worked with return periods below 100 years.
- Different updates of the models : the Belgium model did not take into account recent dredging that resulted in a lower riverbed. That created a 'jump' of water 2 meters higher when crossing the French/Belgium border.
- Differences in the flood shapes. That created differences in the timing of the flood; however, since we are interested in the impact resulting from climate change only, this will not affect our results.

- The Dutch model assumes the dikes will not be overtopped: the dikes are modeled as a wall of infinite height. On the Flemish sides, the possibility of dike overtopping was included, and that indeed happens when discharges are increased. The Dutch model parameters need to be changed.

Finally, we managed to get very good consistencies on the borders.

Return of experience:
- Let the technicians discuss – no politics!
- Be open about your model's characteristics, updates, parameters
- Extra bilateral meetings are required (web tools)
- Accept that your own model can be improved
- Do not forget the purpose of the study : the additional impact of climate change

Flood damage calculation
We also used questionnaires to know which are the practices in each State.

Regarding the damage functions, it was quite obvious that, for the purposes of our study, we had to focus on direct and tangible damages. All countries had such kind of assessments.
Regions of the Meuse basin do not have the same economic wealth: houses have a greater economical value in the Netherlands than in France (at least in this part of France!). This difference needs to be kept to show the territories' vulnerabilities.
But the damage values were evaluated in very different ways: you can use insurance damage declarations or property price estimates by experts.
Even within one country, methodology can differ. If each country uses its own assessment method, we will not be able to compare our results. On our neighbour basin the Rhine, a common approach was elaborated, which is called IKSR. We will use this approach, update it (it was carried in 2001) and slightly adapt it to our territory. That will be the IKSM approach!

So, each Meuse State will carry damage calculations with its own national method (so climate change can be integrated in national assessments) and with the IKSM approach to produce comparable results with the neighbour countries.

Regarding land-uses, Corine Land Cover is the only common database covering the international Meuse basin.

Return of experience
In each step of the AMICE project, we were faced with different methodologies or tools between the Meuse countries. Depending on the level of similarity, and on the available time, we found solutions to create comparable results.

2.3 Assessment of climate change impacts on water resources of the Khrami-Debed (Armenia-Georgia) and Aghstev (Armenia- Azerbaijan) transboundary river basins - Mr. Vahagn Tonoyan, United Nations Development Programme (UNDP)/ Environment and Security Initiative (ENVSEC) "Regional Climate Change Impacts Study for the South Caucasus", Armenia

Background and Achievements

The UNDP/ENVSEC "Regional Climate Change Impacts Study for the South Caucasus Region" project aims to contribute to the reduction of climate change risks in the South Caucasus region. The immediate objective of the project is to improve understanding of South Caucasus countries on regional climate change impact and enhance cooperation among them to address common climate change concerns.

The project brings together leading national experts, engaged in preparation of second national communications of Armenia, Azerbaijan and Georgia under UNFCCC, to undertake technical discussions which will help to decrease uncertainties with predicting potential climate change risks (probabilities, magnitude, timeframe of occurrence, and geographic spread). These consultations help in adjusting climate change scenarios taking into account a regional perspective; in identifying potential needs for common/coordinated adaptation solutions in the context of transboundary geographic areas; and in assessing the viability and proposing ways to improve cooperation and exchange of data/information and expertise in the area of climate risk management.

One of the key components of the project was identification of risks that may require concerted adaptation responses (especially on cross-border geographic areas or in relation to transboundary water management). In this regard, vulnerability of water resources due to climate change was considered as one of the priorities in the South Caucasus region and two transboundary pilot river basins were selected (Khrami-Debed River basin between Armenia and Georgia, and Aghstev River basin between Armenia and Azerbaijan) to study the impact of climate change on water resources.

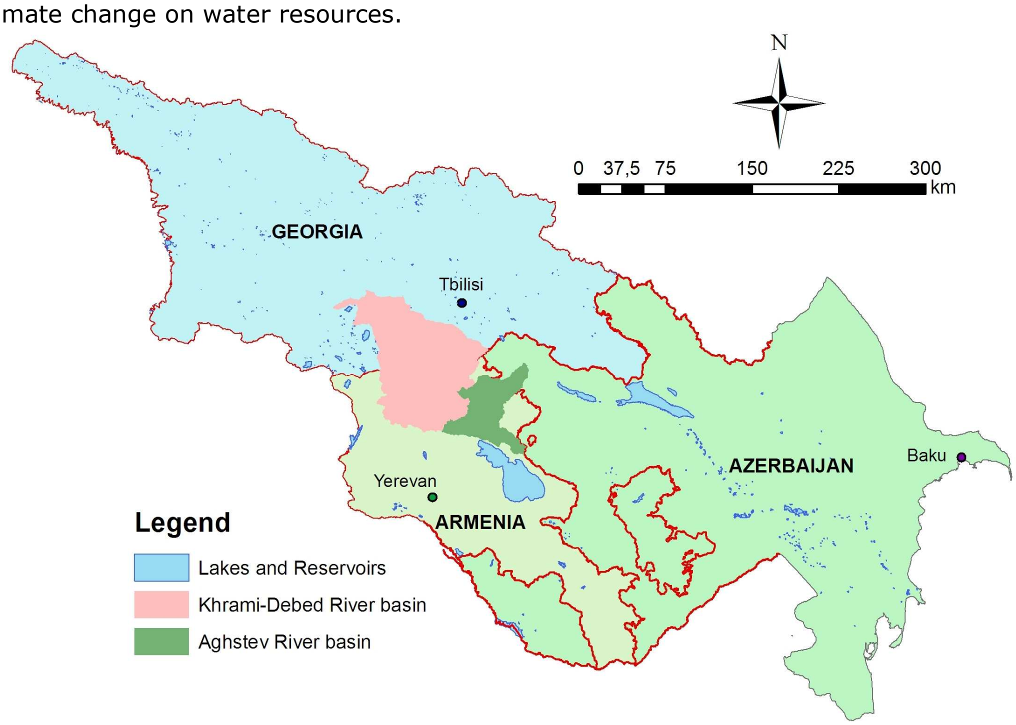

Figure 1: Location of Khrami-Debed and Aghstev Transboundary River Basins in the South Caucasus

Within the UNDP/ENVSEC project the following four global circulation models were assessed as the most appropriate for the South Caucasus region: ECHAM5, GFDL, GISS ER and Had_CM3. For these GCMs the annual changes in air temperature and atmospheric precipitation for the periods 2011-2040, 2041-2070, and 2071-2100 over the South Caucasus region were assessed, and compared to baseline averages.

The climate change impact on water resources was calculated using the physical-statistical or regression model, which has the following overall form: $W = K_1X + K_2T + B$, where W is the river flow (million cubic meters), X is the total atmospheric precipitation in millimetres, T is the air temperature in degrees centigrade, B is the free variable of the equation, and K_1 and K_2 are coefficients. Parallel to the physical-statistical or regression model, Arc GIS 9.3 package was also used.

The analysis shows that the forecasted average reduction (according to all four above-mentioned GCMs) of the river flow in Ktsia (Khrami)-Debed and Aghstev River basins is significant. Thus, it is expected that compared to the baseline average the river flow will decrease in Ktsia (Khrami) River basin by 9-11% in the period 2011-2040, by 25-29% in the period 2041-2070 and by 45-55% in the period 2071-2100. In Debed River basin the river flow decrease will compose 10-12% in the period 2011-2040, 28-37% in the period 2041-2070 and 53-62% in the period 2071-2100. In Aghstev River basin the river flow will decrease by 11-14% in the period 2011-2040, by 31-37% in the period 2041-2070 and by 62-72% in the period 2071-2100.

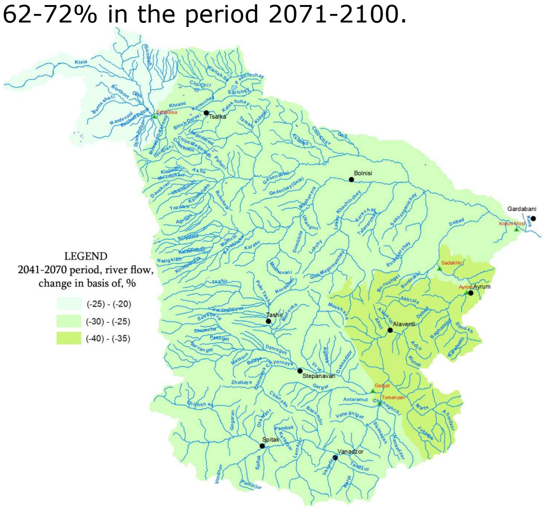

Figure 2: Forecasted changes in river flow in Khrami-Debed River basin in 2041-2070 compared to 1961-1990

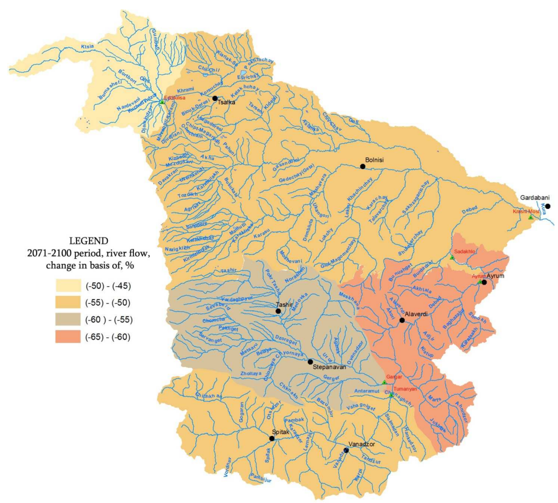

Figure 3: Forecasted changes in river flow in Khrami-Debed River basin in 2071-2100 compared to 1961-1990

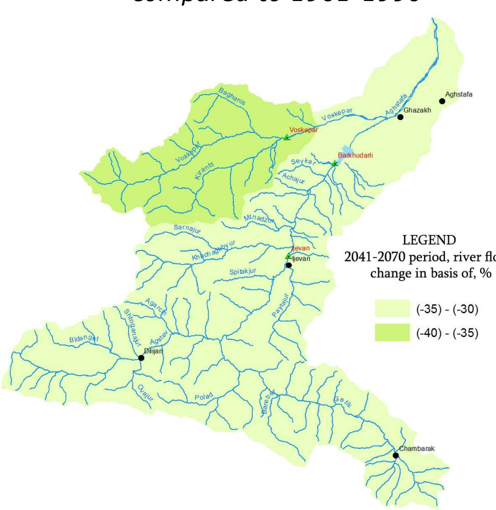

Figure 4: Forecasted changes in river flow in Aghstev River basin in 2041-2070 compared to 1961-1990

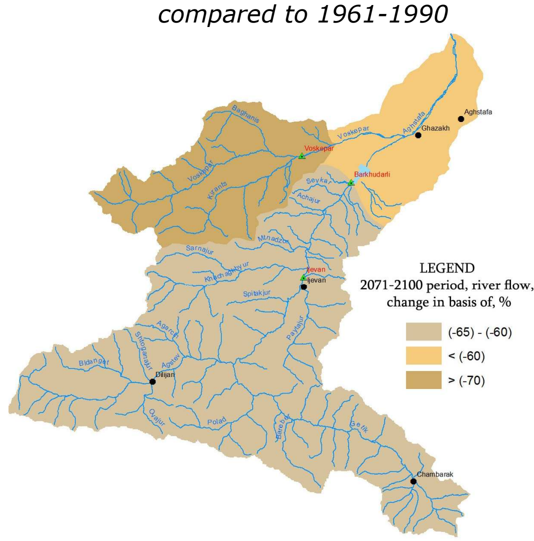

Figure 5: Forecasted changes in river flow in Aghstev River basin in 2071-2100 compared to 1961-1990

One of the achievements of the above-mentioned study relates to the fact that in all three second national communications of the South Caucasus countries the climate change impacts on water resources was assessed only in terms of changes in water quantity, whereas within this study the changes in water quality due to climate change are also being assessed for the first time in the region.

Secondly, for the first time in the region a joint assessment was conducted in a transboundary river basin between Armenia and Azerbaijan, which was not possible before, to show the advantages of cooperative approach in addressing global climate change issues.

Finally, the study has made proposals on mainstreaming climate change into river basin management plans, which is very timely, given the current initiatives of the Government of Armenia to develop pilot river basin management plans in the Northern Basin Management Area (which includes Aghstev and Debed River basins) in line with the EU WFD principles. As a result, Protocol of the Government of Armenia Session N4 of February 3, 2011 "On Approval of the Contents of Model River Basin Management Plan" was adopted, which includes the issues related to impact of climate changes as important components of the plans.

Policy Recommendations and Adaptation Measures

Many of the best climate adaptation measures that the South Caucasus countries can pursue are also important steps for economic development; these are "no-regrets" adaptation measures – no extra cost is imposed by climate change. In other words, they are measures that will improve economic and social outcomes regardless of climate change. Even some adaptation measures that do not directly aid economic development can be characterized as no-regrets because of their low or negative costs and high probability of leading to much larger positive economic outcomes given changes in climatic conditions. "Low-regrets" measures are those for which the benefits of avoiding climate damages outweigh the costs of new infrastructure or other responses. In the context of climate change, there should be no regret about funds spent to avoid what would have been costly future damage.

To offer the best protection for the households, farms and other businesses in the South Caucasus, the study proposes that significant climate adaptation be taken place in advance of climate damages. According to the study rapid implementation of climate adaptation measures is essential to prevent the worst effects of climate damages. The following adaptation measures are proposed as the most urgent.

- *Support essential research needs with state funding.* There are numerous gaps in research in the South Caucasus that – if filled – would reduce uncertainties about likely climate impacts and, therefore, would reduce the costs of climate adaptation. Among the most important research gaps are: the impacts of climate change on water quality; and the extent of current ground-water reserves and the likely changes to these reserves with climate change.
- *Improve existing water infrastructure in the context of current and future temperatures, precipitation levels, and river flows.* This is likely a "no regrets" measure because the advantages of investment appear to be justified in the current climate conditions and would help with adaptation to future climate change. At the same time, this is a large-scale project that may require additional water diversion between rivers, the replacement of much existing infrastructure, and the expansion of the irrigation water delivery system.
- *Promote water efficiency in households, farms and other businesses.* Reducing demand is an important step towards avoiding the water shortages made more likely by climate change. The South Caucasus countries can promote efficiency using monetary incentives, free equipment, public education, regulations on new building designs, and providing technical support. This is a "no regrets" measure because it would save money and resources in the near and long term.
- *Prepare farms for a changing climate.* As temperatures and precipitation levels change, the South Caucasus countries can provide agricultural extension services (public education and technical support) to help farmers adjust planting seasons, choose new crops, install irrigation equipment, or adopt a more efficient use of water.
- *Prepare for natural disasters through prevention and emergency response readiness.* Drought damages can be reduced by improving and expanding irrigation infrastructure or

farming techniques. Some floods, mudslides and landslides can be avoided through erosion control, reforestation, and river bed or irrigation canal maintenance. When disasters do occur, a well-funded and efficient emergency response system can greatly reduce loss of life and damages to infrastructure.

Difficulties Encountered and Lessons Learned

Numerous difficulties were encountered in the course of conducting the assessment. These difficulties related to availability of data, incomplete hydrological observations, gaps in the water quality time-series data, absence of groundwater data, outdated methods of data collection processing and analysis, uncertainties in dealing with climate change adaptation planning, and risk of not implementing the proposed recommendations & adaptation measures due to insufficient political will, as well as financial and institutional shortcomings. Thus, the study has also proposed pathway to overcome the above mentioned difficulties and shortcomings, including targeted funding to conduct further research; proper and sound economic valuation of the costs of climate change in the absence of adaptation measures, which will increase political will to address the problems; establishment of insurance systems, to partially cover the financial and institutional shortcomings and other measures.

Below the main lessons learned from the process are summarized:

- There is a large amount of uncertainty in dealing with climate change adaptation planning,
- The ability to adapt will depend upon provision of sufficient importance given to "climate proofing of development programs",
- Proper adaptation will be contingent upon how quickly the policies are implemented,
- Priority must be given to "no regret" measures, and then, potentially, to "low regret measures",
- Proposed communication of the results of assessment to primary stakeholders (governments, local self-governance authorities, private sectors, farmers, businesses, insurance companies, banks and others) is critical.

3 Climate change impacts on water-related sectors and joint responses

3.1 Water, energy, food, related policies - Mr. Paul Horton, Chartered Institution of Water & Environmental Management (CIWEM)/ European Water Association (EWA) Climate Change Working Group

The context of the following discussion is framed by the Perfect Storm where by 2030 it predicted that there will be:

- 50% increase in the demand for food;
- 50% increase in the demand for energy;
- 30% increase in the demand for water;
- all of this taking place against the background of changing climate and a scenario where we are likely to reach peak oil and peak water demand . . .

Annually somewhere in the region of 510,000 km^3 of water falls from the sky with approximately 110,000 km^3 ending up on land and the balance in the sea. Approximately 65% of this volume is green water which falls on land (Forests, Grasslands, Wetlands, Crops etc), the remainder being blue water (Rivers, Lakes, Canals), which is withdrawn and used for irrigation, public supply and industry, thus it is often water that is consumed. The majority of water we have access to is used for agriculture, globally on average approximately 70%, though of course this varies from country to country.

In terms of our Sustainable Future, it can be argued that water should sit at the heart of all policy development, why? Because it is fundamental to ensuring national security, food security, energy security, climate security and the security of water itself – this means that there must be a radical change to the way water is viewed, understood and valued. By 2030 in a business as usual scenario, the world will face a deficit of water availability for use in agriculture, industry and domestic consumption, even water efficiency improvements will not help to close the deficit.

Two thirds of the world's population is between 10 degrees and 40 degrees latitude – this has been termed the 10/40 window. Each year large volumes of water are consumed by the major water users which are households, factories, power plants and irrigation projects. This water is supplied from the reservoirs, rivers, aquifers and other freshwater and saltwater sources. High water consumption can be found in areas with high population density, Europe, India, China, Japan, the United States and parts of Latin America. What is emerging from the evidence is a picture that nearly a quarter of the world's terrestrial surface (excluding the ice caps) is in severe water stress.

In terms of water stress and developing resource problems, consideration must be given to the Water Exploitation Index, which is a measure of water abstracted and used against the long term renewability of the resource, the warning threshold for the water exploitation index (WEI), which distinguishes a non-stressed from a stressed region, is around 20 % . Severe water stress can occur where the WEI exceeds 40 %, indicating unsustainable water use. In Europe there are five countries that can be considered water-stressed, Cyprus, Belgium, Spain, Italy and Malta, however, it is necessary to take into account water abstraction for non-consumptive uses (cooling water) in Belgium which results in its high WEI. Most of the water abstracted in the remaining three water-stressed countries (Spain, Italy and Malta) is for consumptive uses (especially irrigation). One fifth of Europe's population still lives in water-stressed countries (approx. 113 million inhabitants) and the figure is over 50% across Asia.

For Europe as a whole, 45 % of freshwater abstraction is for cooling in energy production, followed by agriculture, 22 %; public water supply, 21 %; and industry, 12 %. However, in southern Europe agriculture accounts for more than half of total national abstraction, rising to more than 80 % in some countries such as Spain. Studies suggest that the consumption of water through crop growth and evaporation typically means that only about 30 % of the amount abstracted for agriculture is returned to the immediate environment.

It is important to understand the linkages between consumptive uses of water and the impacts on freshwater systems. One increasingly interesting concept is the water-footprint which has been introduced as an indicator that maps the impact of human consumption on global freshwater resources. Water footprint considers the volume of water used to produce goods and services, by individuals, communities and even countries. This is very relevant when the flow of goods around the world is considered and the water component of these products (embedded water) is looked at in relation to global economic activity. Does this lead to local water depletion, to water pollution, to poor water management? Given the extent of the trade in virtual water across the world, is the River Basin sufficient as the unit of spatial analysis?; Are goods with a high water component being produced in a water stressed area?; How vulnerable are the major food producing regions of the world to climate change?

An example of the possible consequences of our 'virtual water' demand is the Aral Sea which was the world's fourth largest lake but since 1960 it has lost 75% of its water volume. This loss is due to the diversion of the Syr Darya and Amu Darya rivers to support agricultural in Kazakhstan and Uzbekistan. The rivers are the Aral's main sources of inflowing water and the decrease in water level has led to severe environmental and salt problems which have changed the climate around the sea, resulting in major dust storms. Whilst this maybe an extreme example it does raise the question how often do agricultural policies take full account of the water dimension?

The importance of understanding how water is used and consumed is further highlighted when the changing pattern of natural disasters is taken into account. Over the past 110 years natural disasters have been getting more frequent, not just in terms of storms but also in terms of floods and drought incidents. This is backed up by studies made by the Munich Re Group who found that there were 3.2 times more major natural catastrophes - notably floods, storms and earthquakes - in the 1990s than in the 1960s, and their economic damage increased 8.6 times. Flood events over the past 10 years have had a nasty habit of occurring in very similar places to the areas that also suffer from periods of drought, areas that are often of agricultural significance and already water stressed. Another key question is the existing health of the world's river systems. A recent report in Nature highlighted that the rivers under most stress, and the resultant biodiversity impact, occur in the areas of greatest water stress, the 10/40 window. The negative impacts on biodiversity are from the stressors of population density, water consumption, urbanisation, modification of water bodies, and pollution etc.

At the same time that all this is happening there are huge pressures on our energy resources, the 'third' part of the perfect storm, with a number of analysts arguing that we have already reached 'peak oil' and there is a need to start to generate more energy from other sources, such as hydropower or more coal fired power stations. The decline of conventional oil production is driving up the use of gas, nuclear, hydro and coal with the resultant climate implications.

However there are complications, in terms of hydropower, the construction of dams does modify water bodies – in China, the Three Gorges Dam, developed as a mixture of flood control and power generation has affected the flow of the Yangtse River and in southern Turkey the GAP agricultural project is an example of where dams for irrigation have impacted on the Tigris and the Euphrates rivers.

In terms of 'clean energy' there are also question marks over hydropower with some studies suggesting that the facilities can actually have a greater CO_2 impact than fossil fuel plants especially if large areas of vegetation have been flooded, the decay leading to methane production which can be released into the atmosphere. Methane is a very significant greenhouse gas which therefore must be carefully managed and possibly recovered as an energy source. The construction of large dams can open up the areas to development, which can change the nature of these places in a negative way if they were previously acting as carbon sinks.

There is clearly a water-energy nexus that needs to be understood better. In addition to hydropower generation, water is used for cooling and emissions scrubbing in thermo-electric power generation and also in mining extraction, refining and processing. There is also an energy-water connection as water is treated and pumped to homes, businesses (using about 3-4% of total energy demand), and water is heated in homes (approximately 11-15% of total energy demand). What emerges is the need to consider this interdependency in terms of policy and governance. How much water used in power generation and mining is considered as consumptive use? How many existing and planned power stations use evaporative cooling systems and are they in areas prone to water stress now or predicted water stress in the future?

The energy story doesn't end there as the pressure to move away from oil and other fossil fuels grows; greater emphasis is being placed on biofuels, with policies being implemented to support bio-fuel production. This can be a particular problem with current generation crops in terms of land use, water demand and water quality, particularly in areas of water stress on land that might be used for food crops. Managing this issue, and assessing the environmental impacts, is a key part of future policy.
So is it time to re-think and make a 'paradigm shift' in how we approach our resource issues? Yes it is, and we need to begin to properly value our resources, in particular water, which should, as stated earlier, be at the heart of policy, and development, certainly for food, energy and climate; water should be addressed by the World Trade Organisation, there should be water work stream as part of the UN Negotiations on Climate Change (there isn't at present).

In terms of our thinking about water and water use, consumption is seen in terms of how much water is required for agriculture, industry, domestic use – there should be a fourth element, the ecosystem. What if the ecosystem was regarded as a consumer of water alongside the other sectors, how would that change our thinking and policy development? There is analysis which suggests that this approach could provide the necessary shift that would allow water to be better managed and valued. Two possible examples of this type of approach exist, the first is the European Union's Water Framework Directive, which is in the early stages of implementation but it does put water at the heart of the policy and the need to have good ecological quality of waters. It is not however being integrated properly with policies linked to food and energy at the EU level, nor indeed with the habitats directive. The second example is a project called SCENES, which is a 4-year project developing and analysing a set of comprehensive scenarios of Europe's freshwater futures up to 2025. These scenarios will provide a reference point for long-term strategic planning of European water resource development, alert policymakers and stakeholders about emerging problems, and allow river basin managers to test regional and local water plans against uncertainties and surprises which are inherently embedded in a longer term strategic planning process. The aim is to set the vision for 2025 and then back cast to see what policy there must be to make the vision a reality.

To conclude – Water must sit at the heart of all policy development as it is fundamental to climate security, food security, water resources security, energy security and ultimately national security. Water-Food-Energy and climate policy must be integrated within countries and between nations. Water must be better understood in terms of Blue, Green, Grey elements and the consumptive, non-consumptive uses of the resource. The ecosystem should be considered as a consumer of water alongside industry, agriculture and domestic demand. The interconnectivity between water-food-energy must be reflected at the policy level and we must create 'layered' maps where we set out all the stress factors and build in vulnerability, so our risk maps identify the 'hot spots'.
2030 should be used as our 'current year' – what do we want our vision of 2030 to be, what does that mean for our actions now.

3.2 World Bank assistance to Southeastern Europe and Central Asia on enhancing climate resilience in water, agriculture, and energy programs - Mr. Ron Hoffer, World Bank

Assisting partner countries in adaptation to climate change has been a growing priority for the World Bank's Europe and Central Asia (ECA) Region in keeping with the Bank's overall Strategic Framework for climate change and development approved by the Board in late 2008. While adaptation is a relatively new policy priority, the Bank has for many years been assisting clients in adjusting to extremes in recent climate variability with positive implication on climate resilience. Investments to restore eroded watersheds, degraded agriculture and pasture land, improve irrigation efficiency, and optimize hydropower dependant energy supplies, all have such co-benefits. Nevertheless, new tools and investments were recognized as needed given the severity of projected climate impacts on particularly sensitive sub-regions. The ECA Region's vulnerability to climate varies depending on the size/exposure of each country, inherent sensitivity on natural and human system, and the capacity of national institutions to respond. The most vulnerable countries include many in Southeastern Europe (SEE) and Central Asia.

A pilot program on climate adaptation was launched in early 2008, and most projects address climate resilience in water and related sectors. SEE pilots on (i) the hydropower sector in Albania; (ii) agriculture and irrigation in Albania, Macedonia and Moldova, and (iii) river basin management for the Sava Basin, assess risks and solutions using a variety of methodologies with different costs and capabilities. Close cooperation with national specialists and policy makers in all cases means that Bank staff and clients learn together while shaping future partnership strategies and projects. In the case of Albania's hydropower sector, a projected drop in runoff and power generation of 15% or more by 2050 can be almost completely ameliorated with improvements in the efficiency of energy generation and distribution. In agriculture, higher temperatures and more variable precipitation will dramatically reduce some crop yields by 2030. While irrigation in some cases will help slow the drops in yield for some crops, conflicts in water use needs to be examined. Bank and national specialists agreed on recommendations by agro-ecological zone to boost production, shift crop mixes, and improve sector implementation capacity to respond to projected changes.

New sources of financing are also being used to address water-related cross-sector climate issues. The Tajikistan Pilot Program for Climate Resilience is one of 11 global pilots funded by a multi-donor trust fund, and is an example of a new approach to coordinated support to Government efforts on better climate resilience. All major investment banks in Tajikistan share responsibility in assisting Tajikistan, with the World Bank focusing on better hydrometeorological services and sustainable land management practices; the Asia Development Bank (ADB) focusing on river basin management and climate science; and the European Bank for Reconstruction and Development (EBRD) on improved resilience of the hydropower sector. A Secretariat was established with ADB support in late March 2011 to coordinate all activities and facilitate mainstreaming in development planning. This example of close cooperation with all donors and government, and one harmonized strategy for tackling water and other sectoral issues on climate, is clearly the wave of the future under new climate financing.

Results from the first 3 years of many of the first set of pilot projects, and plans for the next set of pilots (including sustainable cities and social development), will be summarized in a Bank report available by the end of the year.
Details on ECA's program can be found at: www.worldbank.org/eca/climatechange.

Vulnerability of agriculture and water resources in the Ili-Balkhash region - Ms. Anna Kaplina, United Nations Development Programme (UNDP)

Central Asia (CA) is one of the world's most vulnerable regions to the impacts of climate change. Climate change is likely to manifest in CA as: increasing temperatures; changing rainfall patterns; increasing aridity; an increasing frequency of extreme weather events (such as dust storms, heavy rainfall, haze, heat waves and heavy winds); and an increasing frequency and intensity of climate-related disasters (such as floods, droughts, mudslides, avalanches and landslides). Indeed, trends over the last few decades indicate that these predicted changes are already being experienced in CA countries, and current climate variability is already adversely impacting on development. Considering that both current and future variability and changes need to be addressed and adapted to, Climate Risk Management (CRM) is an appropriate response, as it includes both climate-related disaster risk reduction and climate change adaptation.

The Central Asian Programme on Climate Risk Management (CA-CRM) will assist Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan to adjust their national development processes to address risks posed by current climate variability and future climate change. Its objective is to promote reduction of climate-related disasters and adaptation to climate change in CA and to integrate climate risk management into core development policy and strategies of the five countries. On a national level, the project will work to 1) strengthen institutional frameworks and technical capacity to manage climate change risks and opportunities in an integrated manner and develop climate-resilient strategies, policies and legislation in priority sectors and geographic areas; 2) expand financing options to meet national climate change adaptation costs and implement climate change adaptation interventions in priority areas; and 3) disseminate knowledge on how to incorporate climate change knowledge and risks into development processes at national, sub-national and local levels. On a regional level, the project will focus on 1) strengthening technical capacity to manage climate-related risks and opportunities; 2) sharing knowledge on adjusting national development processes to fully incorporate climate-related risks and opportunities; and 3) synthesising and further developing knowledge on glacial melting in CA.

Kazakhstan is likely to experience considerable economic loss, humanitarian stresses and environmental degradation as a result of current climate variability and future climate change impacts. Climate change impacts are likely to result in Kazakhstan, already a semi-arid country, becoming increasingly arid, with northward migration of humid zones by as much as 450kms[6]. These impacts will negatively affect *inter alia:* water resources; grain production; steppe and dryland pastures; sheep production; and forestry. If timely CRM measures combined with suitable policy and institutional changes are not implemented in Kazakhstan many hard-won development gains are likely to be jeopardized.

Almaty oblast has been found to be among the most vulnerable of the country's regions to climate change[7]. The climate risk assessment underpinning this conclusion compared projected physical impacts of climate change plus economic vulnerability, sensitivity of sectors to climatic changes, and exposure to disaster risk.

As most of the country, Almaty oblast experienced a significant positive trend in surface air temperature anomalies in all seasons. There has been an observed average increase across the region of 0.27°C every 10 years between 1941 and 2009 with the warming being most rapid in winter (0.38 °C every 10 years). There has been a slight increase in

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[6] UNDP-GEF 'Kazakhstan community based adaptation country programme strategy (CBA CPS)' 2008.
[7] National Adaptation Concept

winter precipitation, but in spring and summer, on the contrary, a slight decrease. In mountainous and foothill areas increased rainfall has been observed in winter and in summer. It is expected that by mid-century average summer temperature in oblast may rise by more than 1,5-2,5 C°. Also, it is likely that frequency of hot days and the duration of heat waves will increase. Even greater increase of 2-3 C° is expected in winter. According to scenarios, by mid-century precipitation in winter is expected to increase by 10-15%, while in summer in some areas can be expected to decrease by 10-15%.

The existing water and agriculture stresses in Almaty oblast are to be further aggravated by climate change impacts. As a result of glacier degradation there will be significant changes of water flows in the mountain rivers, which can seriously complicate agricultural activity in irrigated areas. Between 1955 and 2004[8], the Northern side of the Ileishy Alatau has decreased by 40.8%. Based on climate change predictions this could completely melt by the end of the 21st century whilst another glacier, the Jetysuisky Alatau, also in Kazakhstan, could melt in the next 40 years[9]. According to an expert estimate, due to glacier degradation, the river flow from the Zailyisky Alatau northern slope will decrease by 16 %, which may destroy Balkhash ecological system. The intra-annual distribution of river flows will change: its quantity in the summer months will decrease and in the spring–summer months will increase, having a negative impact on the agricultural production.

Another aspect of glacial melting relates to an increase in disaster risk. With implications for increased flood risk, projections for glacial melting indicate an increase in river flow in spring. When combined with greater snow accumulation due to increase in winter precipitation and an increase in air temperature in early spring, resulting in faster snow melting, this all equates to a projected increased flow in many rivers in spring and thus a scenario of greater flooding[10]. Furthermore, devastating landslides, avalanches, glacial lake outburst events and mudflows triggered by extreme weather events can all be expected to intensify in terms of their frequency and severity.

The projected changes in water supply and quality, reduction of land productivity, expanding desertification and disaster impacts affecting Almaty oblast as a result of climate change will first and foremost likely result in loss of income for the rural population – especially the poor who are most vulnerable[11]. Existing pockets of poverty will become more acute. This may lead to an acceleration of migration to urban areas (which often simply replaces one form of vulnerability in a rural context with a new form of vulnerability in an urban slum or peri-slum), which may arise local and national scale food security concerns.

The CRM in Kazakhstan Project, which is implemented under CA-CRM Programme, seeks to address this situation. Its objective is to improve the resilience of rural communities in Almaty oblast through improved water efficiency in agriculture and climate-related disaster management. To accomplish this, the project will:

a) Find ways to demonstrate the implications of climate risk to Kazakhstan's development goals on a cross-sectoral basis, to ensure that CRM becomes pivotal in decision-making processes at the national and local levels. In particular it will seek to lodge CRM as an overall development concern, and not limited to environmental considerations and *ad hoc* projects. Its especially close relationship with water resources has to be emphasized.

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[8] Second National Communication (2009) The Republic of Kazakhstan
[9] Second National Communication (2009) The Republic of Kazakhstan
[10] UNDP Kazakhstan Human Development Report 2008
[11] Approximately 45% of the rural population are already poor

b) Demonstrate the relevance of CRM to stakeholders in the agriculture sector, particularly in terms of water use, and support the harmonization of strategies with other sectors to avoid mal-adaptation.

d) Strengthen livelihoods and resilience among the most vulnerable rural communities in the region by improving efficiency in water use and the ability to anticipate, cope with, and recover from climate-related risks - especially drought, floods and mudflows.
e) Finally, it will ensure that lessons learned are captured and disseminated among key partners and the general public.

3.3 Impacts of climate change on hydropower: the case of the transboundary Mesta/ Nestos river - Mr. Charalampos Skoulikaris, Aristotle University of Thessaloniki- Interna-tional Network of Water-Environment Centres for the Balkans (INWEB)

The present work aims at exploring the impacts on hydropower production due to climate change. This is analysed by coupling hydrologic, hydroelectric and climate change models after downscaling the results of General Circulation Models (GCM). It is illustrated in the Mesta/Nestos river basin, which is shared between Bulgaria in its upstream northern part (Mesta) and Greece in its downstream part (Nestos).

The proposed approach was conducted with respect to the sustainable development of water resources projects and to practices and regulations enforced by the EU Water Framework Directive (WFD), which states that any water project should integrate economic aspects with social prosperity, environmental protection, and, in addition, with long term issues such as sustainability under climate change conditions. One of the sections influenced by variations in climate is that of renewable technologies, which completely rely on climate conditions. Hydropower generation is most affected, as it is sensitive to the amount, timing, and geographical pattern of precipitation as well as temperature

In this presentation, the results obtained in the UNESCO/HELP (Hydrology for Environment, Life and Policy) project on river flow simulation and hydropower generation under different climate scenarios are demonstrated. The UNESCO/HELP programme aims at promoting the concept of Integrated Water Resources Management (IWRM) through a worldwide network of river basins, and the Mesta/Nestos is one of these.

Climate change studies over the Mesta/Nestos area are based on the output of a regional climate model developed at the Max Planck Institute for Meteorology, Germany. The climate model uses a dynamically downscaling technique, where boundary conditions provided by global scale models (the coupled model ECHAM5/MPIOM, also developed by the Max Planck Institute) are adapted to local conditions, such as temperature and precipitation data and the river watershed relief. The temperature, precipitation and evapotranspiration results obtained from the climate model were introduced as input data to the spatially distributed hydrological model MODSUR-NEIGE for simulating the future water regime of the river basin. The effect of the decreasing snow cover in the mountainous area of the basin, due to climate change on the water flow in the delta region, was analysed. The dams' simulation was conducted with the HEC-ResSim (U.S. Army Corp of Engineers Hydrologic Engineering Center-Reservoir Simulation) tool, by taking into account the outputs of the hydrologic model.

The obtained results underline the importance of effective upstream-downstream cooperation in order to alleviate negative impacts from climate change on hydropower production. The analysis takes into account different operation scenarios, where priority is given either to satisfying augmented demand for water for irrigation purposes, which means less energy production, or is given to power production. By developing a special economic tool, which may be used in other similar projects, alternative solutions ensuring hydropower and irrigation viability under future climatic conditions were investigated and are shown for the Mesta/Nestos river basin.

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3.4 Improving resilience of water supply and sanitation in extreme events - Ms. Francesca Bernardini, Secretary of the UNECE Water Convention and co-Secretary to the Protocol on Water and Health

Climate change clearly has health impacts which are mostly related to water. Health hazards may be caused by extreme temperatures, an increase in water temperature, water scarcity, and chemical and biological contamination of water used for different purposes (including food production and processing). Increasing water scarcity may limit access to water for drinking water and sanitation, increase the concentration of pollutants, reduce the self-cleaning capacity of sewers and limit the ability of natural ecosystems to assimilate wastes.

Some figures to illustrate the issue:

- In the European Region, poor-quality drinking-water causes over 13 000 deaths from diarrhoea among children aged 0–14 years (5.3% of all deaths in this age group) each year. 140 million (16%) do not have a household connection to a drinking-water supply.
- In central and eastern Europe water is safe only in 30—40% of households.
- Emerging threats: protozoan infestations of drinking-water supply systems, proliferation of *Legionella*, and potential health problems related to the increasingly complex chemical environment.
- The average number of annual disastrous weather- and climate-related events in Europe increased by about 65% between 1998 and 2007 (EEA, 2008).
- Overall losses caused by such events increased during the period 1980–2007 from a previous decadal average of less than €7.2 billion (1980–1989) to about €13.7 billion (1998–2007).
- In terms of social impacts, the CRED Emergency Events Database (EM-DAT, 2009) (Centre for Research on the Epidemiology of Disasters) shows that in the past 20 years, about 40 million people required health assistance and had basic survival needs, such as safe shelter, medical assistance, safe water supply and sanitation. This represented an increase of about 400% compared to the 8 million people affected in the previous two decades (1970–1990).

Extremes such as floods, droughts and thermal anomalies are more and more recurrent worldwide and are a significant pressure on healthy environments. Water and waste water utilities are very vulnerable to extremes.

Under critical conditions water supply and sanitation services aren’t anymore a health delivery services, but a significant source of contamination, sometimes irreversible that may also affect areas beyond local and national borders. Health risk are not only related to direct damages and supply disruption but also to contamination of water and biota. In extremes, water and wastewater services systems stand to lose much of their environment and health benefits, for two main reasons:

1. They lose their ability to deliver the services required because of direct infrastructure damage (from floods, windstorms and tide surges) or from lack of water (e.g., when a cold spell turns water to ice);
2. they become a significant source of chemical and biological contamination of ecosystems, water bodies and soil by means of their discharges and polluted overload.

After heavy rains, storm water washes human, animal and other waste into unprotected resource waters, thereby chemically or biologically polluting water at the point of consumption; sometimes this is irreversible and reaches beyond local and national borders. Besides flooding, increasing water scarcity and droughts in many parts of the world may further limit access to water for sanitation, and consequently exacerbate health impacts and limit the ability of natural ecosystems to assimilate waste. In large cities, water scarcity is reducing the selfcleaning capacity of sewers. Droughts or shortages of water can also affect bathing-water quality, because the decreased stream flows do not sufficiently dilute sewage and wastewater loads, causing an increase in pathogen numbers and untreated chemicals.

Many drivers not related to climate change, act together with global changes to compound and affect extreme events, producing vulnerabilities in hydrological and ecosystems, as well as in economic and social systems. Urbanization has adversely influenced flood hazard by increasing the number of sealed areas and infrastructures. The trend towards growing urbanization is also leading to unplanned slum neighbourhoods with poor or non-existent basic water and wastewater services.

These close links among water, climate change and health are often overlooked. However, the Pan-European region has a unique instrument to deal with these challenges: the Protocol on Water and Health to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), which aims to protect human health and well-being through improving water management and through preventing, controlling and reducing water-related disease. It is unique among multilateral environmental agreements in the extent to which its objectives cross-cut environmental protection and human well-being: it offers a holistic framework for addressing the whole chain of cause and effect, from environmental degradation to water-related health effects.

Ultimately, the Protocol, jointly serviced by the UN Economic Commission for Europe (UNECE) and the Regional Office for Europe of the World Health Organization, aims to achieve access to safe drinking water and adequate sanitation to everyone, which has recently been recognized as a basic human right both by the UN General Assembly and the Human Rights Council.

Parties to the Protocol recognized the need to ensure that water supply and sanitation services are prepared for the widely anticipated consequences of floods and droughts, as well as other climate change impacts, already in early 2007 and set up a Task Force on Extreme Weather Events. The Task Force developed a **Guidance on Water Supply and Sanitation in Extreme Events** which was adopted at the second session of the Meeting of the Parties in November 2010 in Bucharest, Romania.

The Guidance is intended to provide an overview on why and how adaptation policies should consider the vulnerability of and new risk elements for health and environment arising from water services management during adverse weather episodes. It recalls the basic scientific findings, provides advice on communication issues, addresses the vulnerability of coastal areas and bathing waters, discusses the impact on human health, places extreme weather events in the context of water safety plans and formulates advice for adaptation measures for water supply and sanitation services during such events.

An integrated environment and health approach steers the overall document. Possible cross-cutting issues, such as the role of environment, climate and health sectors in weather extremes; the need for policy dialogue and multisectoral partnership building; the challenge of different settings (urban versus rural; small versus centralized, large-scale suppliers) are addressed. The Guidance underlines that the effectiveness of risk reduction in extreme conditions relies upon a commitment to apply integrated risk management principles in development planning, the existence of well-defined institutional responsibilities, a democratic process of consultation, and an information and awareness campaign. It moves beyond disaster response and reaction, towards risk anticipation and mitigation.

The Guidance is available at:
http://www.unece.org/env/water/whmop2/WHO_Guidance_EWE_Final_draft_web_opt.pdf

4 Planning water management under uncertainty

4.1 Twin2Go – Best practices and policy lessons on adaptive water governance - Ms. Annika Kramer-Adelphi for the Twin2Go Consortium

Failures of governance systems have been identified as one of the most important reasons for poor performance and increased vulnerability of water management to climatic change. Where uncertainty cannot be reduced in the short-term, or where policy decisions cannot be postponed until better knowledge is available, adaptive and integrated management of water resources is required.

Against this background, the Twin2Go project has consolidated research on water resources management from river basins around the world. Twin2Go (www.twin2go.eu) stands for "Coordinating Twinning partnerships towards more adaptive Governance in river basins". Over the past years, the EU has funded several projects that undertook research on specific IWRM issues in case studies carried out on twinned river basins in Europe and the world. The aim of Twin2Go is to synthesise this research, to draw policy relevant results that are transferable to other basins, and to disseminate them to stakeholders, especially at the policy level. Funded under the EU's 7th Framework Programme, Twin2Go brings together partners from various countries that have undertaken research on IWRM in past and ongoing projects. Within Twin2Go they have carried out research and stakeholder dialogues in Africa, Latin America, South and South East Asia, Russia/New Independent States, and Europe.

In a first step, the Twin2Go carried out a comparative analyses of the governance regimes, to answer the question: How does the water governance regime impact performance of water resources management in different environmental and socio-economic contexts? To answer this question, an analytical framework was developed. It includes a questionnaire that covers a) the water governance regime, b) regime performance, and c) the societal and environmental context. The questionnaire was applied to collect data on 29 case study basins. The data was compiled and verified in five case study review workshops with more than 100 case study experts. In comparative analyses a set of hypotheses was tested that reflect major assumptions currently discussed in research on adaptive water governance.

To promote transfer from theory into practice, in a next step, Twin2Go identified best practices and innovative tools for making water governance more adaptive. The best-practices and tools identified fall into three main categories according to their main aim: a) Application of national water frameworks in river basins; b) Engagement and coordination among actors, forms of interaction/partnerships; and c) Enabling learning and building adaptive capacity in water governance. The best practices and tools identified in the case study basins have been discussed with stakeholders in a series of regional workshops, where participants have further been asked to present own experiences and practices. Challenges, opportunities, and constraints in the application of best practices for authorities, stakeholders, and end-users in the respective regions have been discussed.

A first analysis of common barriers in the implementation of best practices shows that the core reason for failures in introducing new practices and tools is often rooted in the implementation stage, for example if there are inadequate human and technical resources to implement a new practice, or when introduction of new practices leads to competition, overlap of mandates or loopholes between different institutions or actors. In several of the examples, the barriers to implementation were actually vested interests of single powerful actors or authorities who were able to hinder implementation. Another barrier that was often encountered was the fact that the tools did not fit with existing institutional frameworks or cultural context. Opportunities for the introduction of new practices and tools exist in building on existing scientific and technical networks that can act as drivers of change and to use policy and other institutional reforms as windows of opportunities to introduce change.

In the next steps, Twin2Go will further discuss the lessons learnt with policy and decision makers in four Policy Workshops to be carried out as side events to major water conferences. The detailed outcomes of the analyses and discussions will feed into Best Practice guidelines for the use of practitioners and will be summarized in Policy Briefing Papers that target national and local policy makers.

4.2 Adaptation strategy for water resources of a pilot river basin in the Czech Republic - Ms. Magdalena Mrcikova- Czech Republic

Presented study is an outcome of a five-year project called „Research on adaptation measures to minimize impact of climate change in regions of the Czech Republic" funded by the Ministry of Agriculture of the Czech Republic. During the initial phase of the project we developed „Guidelines for climate change impact assessment and proposal of adaptation measures" with focus on technical efficiency of measures. The guidance should be verified on three pilot river basins. The final version of the guidance should be useful for a planning process in compliance with the Water Framework Directive, especially during the second cycle of river basin management plans preparation when climate change should be considered as an additional driver.

During the last year we applied the guidance on the first pilot river basin – the Orlice river basin (2038 km^2). We selected this river basin because one of the main groundwater resource zones of a regional drinking water supply system is located there. The resource zone is also environmentally protected as a site NATURA 2000, thus conflicts of interests occur among water users and water authority, who is responsible for environmental protection.

Several analyses were conducted for the pilot basin. We analyzed trends in observed time series of air temperature, precipitation, groundwater head and discharge across the pilot river basin. We analyzed current use of water across the river basin (abstractions and disposals of treated waste water). To overcome uncertainties associated with future climate, outputs of hydrological balance modelling for projections of eight RCM models obtained for three future time horizons – 2025, 2055 and 2085 and one SRES emission scenario – A1B were applied as inputs into the simulation model. When selecting these projections, we tried to obtain a representative subset of models to keep the information about the range of uncertainty of the original multi-model ensemble.

Based on these results a preliminary risk analysis was worked out. Expected probability of occurrence and consequences of each identified hazard was evaluated based on qualitative scales. We identified several hazardous events with very high level of risk – high temperature of water in the Orlice river disabling the treatment process, overexploitation of groundwater resources in the main resource zone, low security of water quantity in the Orlice river during periods of drought and irreversible impact on biodiversity within the environmentally protected areas. For these hazards we tried to propose suitable adaptation measures.

Measures, which could help to minimize the expected impact, include optimization of operational rules of the existing water reservoir, new reservoir within the area which is preserved for this purpose by a national spatial planning document, groundwater recharge within the infiltration zone of the main groundwater zone or abstraction from the riparian zone instead of direct withdrawal for the river.

To check the efficiency of several identified structural adaptation measures we created a simulation model of a water reservoir system within the pilot river basin. Possible new water resources were also incorporated into the model. For running simulations we used the Hec-ResSim model developed by the US Army Corps of Engineers, which is suitable for water reservoir operation simulations. For the efficiency estimation of the particular measure we calculated the water levels in reservoirs for each climate change scenario and each time horizon. The average of all series of water levels in one time horizon was used to calculate the final probability of reliable water supply. By averaging the results of the climate change impact projections we can obtain a robust estimate of the future hydrological conditions. According to our results, the expected requirement of new water resources can be satisfied by a change in operation rules of the existing water reservoir for the most distant future time horizon with a probability of reliable water supply that is required by national technical standards without compromising current flood protection level. However for the "most pessimistic scenarios", it is obvious that it would be necessary to find out new water resources to satisfy water demand in the future time horizons.

When designing an adaptation measure for the mean value obtained from climate change scenarios, at least in 50% the solution will be insufficient, because the impacts will be worse than we expect. On the other hand when designing a measure for the worst climate change scenario, there is a high probability of unreasonably high costs of the measure.

Based on the results we would argue that simulation modeling enables us to estimate expected technical efficiency of a structural adaptation measure for a particular climate change projection and also to estimate the range of uncertainty associated with the RCM projections. Evaluation of the uncertainty associated with the final results might be a part of the solution when it is used for decision-making. When developing an adaptation strategy, it is necessary to get a common agreement on the acceptable level of risk related to underestimated impact of climate change. Final decision about the set of the most suitable adaptation measures should be based on discussion among experts, stakeholders and water authorities.

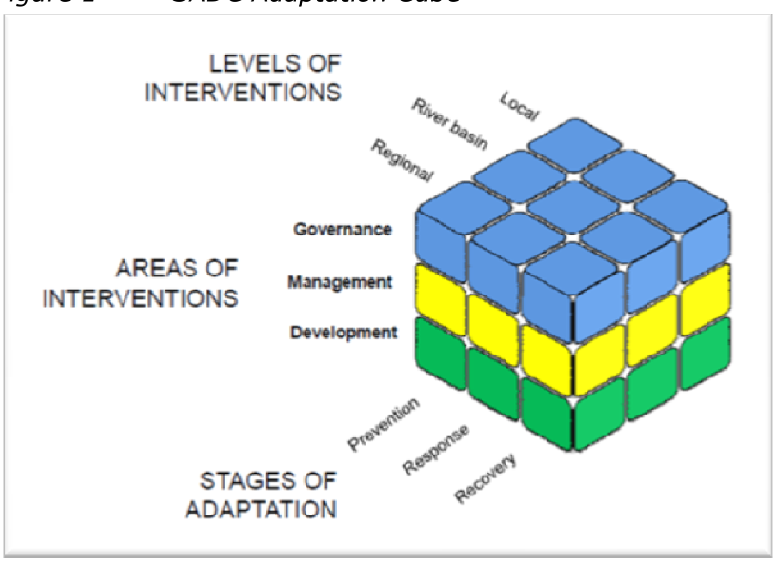
4.3 Southern African Development Community (SADC) Climate Change Adaptation Strategy for the Water Sector - Mr. Bertrand Meinier and Kenneth Msibi- SADC

Southern Africa is recognised as one of the world most vulnerable regions to the impacts of climate change. Adaptation measures are therefore needed to improve the resilience of societies and economies in the region, including mechanisms to reduce the risks associated with extreme events such as floods and droughts. To assist Member States with this process the SADC Secretariat has been working on the development of a Climate Change Adaptation (CCA) Strategy for the water sector. The development process of the SADC CCA Strategy was initiated in May 2008 during the second SADC Multi-Stakeholder Dialogue. Since then various consultations have been undertaken with stakeholders at all levels, including a formulation meeting with regional experts and the completion of national scoping studies in all Member States.

The main goal of the CCA Strategy is to improve climate resilience through the strengthening and adaptation of water resources management in Southern Africa. The objective is then to further develop the SADC water sector as a tool to decrease climate vulnerability while making sure that water management practices are well adapted to cope with increased climate variability. The Strategy focuses on the implementation of both "no-regret" and "low-regret" measures (refer to annex 1 for a list of the adaptation measures included in the CCA Strategy). The formers relates to measures that will prove worthwhile doing even if no (further) climate change will occur, and the latter, to measures that will only require small additional expenditures to cater for the negative effects of climate change.

The CCA Strategy promotes the adoption of a multi-dimensional approach to climate change adaptation, in alignment with integrated water resources management (IWRM). The strategy calls for the implementation of adaptation measures at different levels (local, river basin and regional), in different areas of interventions (water governance, water management and infrastructure development) and at different stages of the adaptation process (preparation, response and recovery). The Strategy is embodied in the "SADC Adaptation Cube" which was designed to raise awareness and facilitate coordination amongst stakeholders (figure 1).

Figure 1 SADC Adaptation Cube



Experience has now shown that the sustainable adaptation of societies to climate change can only be achieved through the adoption of a comprehensive approach. First, given the transboundary nature of climate changes, measures to increase the resilience of societies in Southern Africa must be carried out at different levels, from the local level up to the

river basin and regional levels. Second, adaptation is not just about prevention. In many cases, regardless of the level of preparation, extreme events such as floods and droughts will continue to occur in Southern Africa. The CCA Strategy must therefore provide recommendations on ways to respond to and recover from these extreme events. Finally, adaptation in the water sector is not just about water, it is also about the people who use the resource and who are affected by the variations triggered by climate change. The CCA Strategy addresses both the issues of water management and water governance. Additionally, given the limited water storage capacity in Southern Africa the CCA strategy highlights the importance of infrastructure development for improving the region's adaptive capacity.
The draft CCA Strategy will be presented for approval in June to the Members of the Water Resource Technical Committee and latter in September to the Ministers of Water for endorsement, before its actual launch in December at the occasion of COP 17.

The objectives of this contribution are i) to outline the CCA Strategy development process, ii) to introduce the CCA strategic framework and iii) to present key adaptation measures for the water sector in Southern Africa.

4.4 Water Management in the Colorado River Basin, a major challenge for Mexico and the United States, before Drought and Climate Change - Mr. Felipe I. Arreguín Cortés and Mario López Pérez, Comisión Nacional del Agua (CONAGUA) - Mexico

Background

The Colorado River satisfies a great part of the water needs of seven States of the United States (US) and two of Mexico. That represents a population of 30 million inhabitants that, according to projections, will reach 38 million in 2020. Over the last 100 years, the total percentage of surface affected by extreme climate droughts in the US has been of 14% annually in average, with a maximum of 65% in 1934. It is widely documented that the allocation, that currently has the water of the Colorado River to the States in the Basin took place during the wetter period (between 1905 y 1925), in a period of 400 years.

Recently, the west of the US has suffered a sustained drought, 30% of the region is subject to a severe drought since 1999, and the Colorado River has had, between 2000 and 2004, the lowest flow registered in a five year period. In addition to that, the US States in the southwest and the northeast States of Mexico are experimenting one of the fastest growing on those countries and generating a social, economical and environmental demand on the water resources, with the consequent legal conflicts.

Introduction

Given the growing water needs, since early 2008, the governments of México and the US work on joint cooperation actions in topics related with the Colorado River, such as urban, irrigation and environmental uses, the study of the hydrologic system and the potential impacts of climate change, including the effects of the current historic drought in the Colorado River.

Currently, they focus their efforts in the identification of opportunities for water conservation and an increase of the supply through sea water desalination and reuse, as well as in strategies aimed to decrease the variations to the Colorado River system and potential opportunities to make more efficiently the water deliveries to México from the Colorado River.

The objective of the joint cooperation process was to establish an international group of representatives from federal and state governments and users from experts NGO´s experts in Mexico and the US, to explore such topics, aiming to achieve potential binational benefits, in areas of environmental, irrigation and urban uses.

The present document includes a diagnostic of the Colorado River Basin, highlighting aspects such as the availability of water in Mexico, the physical framework and the distribution of water on both countries, relevant aspects of the 1944 Water Treaty are mentioned, the use of water in that region of Mexico is shown and the problematic in terms of the water resources, emphasizing the climate change.

A description of the schemes and the Mexico-US Joint Actions for the increase of water in order to counteract the drought in the Colorado River system analyzed by the US.

An analysis from Mexico´s vision is made about the cooperation in the Colorado River, the opportunities of cooperation and identified projects by the Workgroup, the actions to be followed, the challenges and how to confront them, as a conclusion a final message in which it is emphasized the great efforts that both governments make to achieve that this binational cooperation project, could be considered as an example at the international level, in terms of water integrated management at a basin level.

Diagnosis

The availability of water in Mexico is very unequal, since while in the southwest there is a per-capita water availability of 24,450 m^3 per year, at the border with the US it is only of

131 m^3 and it is in this region where the largest rates of population as well as economic growth take place.

The Colorado River has a length of 2,300 km, it has ten storage dams, one of them international, irrigates an area of 1.5 million hectares in the US and 170 thousand in Mexico, supplies water to 30 million inhabitants. The availability is 18,500 Hm^3 and the allocation is 20,352 Hm^3, in other words, there is over allocation.

In 1944, the US and Mexico signed a International Treaty of Waters, through which the US government assigns to Mexico, from the waters of the Colorado River, a guaranteed volume of 1,850.2 Mm^3 every year. From the delivered water, 80.6% is used for irrigation; el 8.9% is used for urban water supply, 7% is used by the industry and 3.5% in other uses.

Problematic

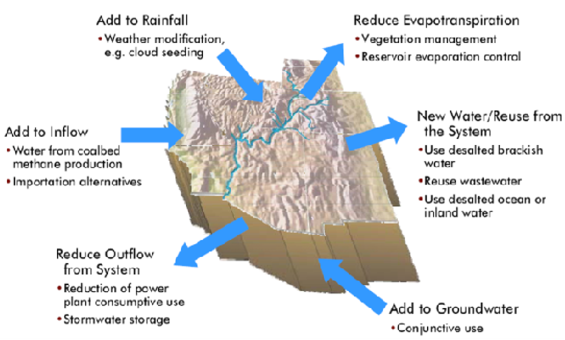
From the total groundwater availability in the region, 60% it's in the Valley of Mexicali and in the "Mesa Arenosa" (sandy plateau) of San Luis Rio Colorado, the first one destined for irrigation within the "Distrito de Riego" (irrigation district) 014 and the second one to supply of border cities from San Luis Rio Colorado, Son., to Tijuana, B.C.

The efficiency in irrigation is very low and there is waste of waste due among other causes to rudimentary irrigation practices, deficient conservation of the hydraulic infrastructure, grading problems and inadequate management of water at parcel level.

In regards to climate change, recent experiences suggest that the conditions are 'critical' in the basin. The variability and the climate change, added to an increasing pressure driven by development, will cause droughts of unknown magnitude for the institutions in the region, and will aggravate the conflicts among the water users.

Alternatives of solution

The US analyzes different schemes of water increase to counteract the drought in the Colorado River system, below is an example of the main options for water increase in the Colorado River basin.



Joint Actions among Mexico-US have been made to increment the offer of water and to counteract the drought in the Colorado River system; with the vision of integrally managing the basin, within the CILA/IBWC it was formed back in 2008 a base group and four working groups with representatives from federal and state governments and users from experts NGO´s in Mexico and the US.

The main objectives of Mexico are to attend the current and future water needs, for urban, irrigation and environmental uses at the Mexico-US border; evaluate the current climatological conditions, and future conditions of scarcity; identify new sources and increase the storage capacity and programs of binational investments for the conservation of water and environmental improvement.

The main objectives of the US are to attend the current and future needs of water in quantity and quality, for urban, irrigation and environmental uses at the Mexico-US; implement procedures to better management of water in scarce conditions; evaluate the potential exchange of water between Mexico and the US of new sources produced by the development of infrastructure, improvements or other projects and potential impacts of climate change in the Colorado River.

Mexico´s vision about the Joint Cooperation Actions with the US in relation to the Colorado River, is to develop projects that benefit to both countries, such as: increase of water in the system, flexibility in the management of scarcity, improve the ecosystem through allocation of part of the conserved water or generated by both countries to environmental purposes, mainly in the Delta; the utilization of the system in the US to make storages, deliveries, exchanges, transfers or opportunities for mitigation of scarcity, aiming to maintain better levels at lake Mead with the purpose of reduce the possibilities of apply reductions to the delivery of volumes to the users of the lower basin that depend on the levels of storage of that lake; also to increment the abilities on both countries to make a truly planning of the use and a rational and integral water management in the long term, ensuring a sustainable economic growth in the region.

Identified cooperation projects and in process of development
With the lining of 75 Km of the main network of the DR014, there will be a recovery of 46 hm^3/year. Currently there is a pilot binational project, both countries have agreed to equally finance the final design in 2011 and from the results there will be an analysis about the possibility of its implementation. It is expected that the storage water could be used for environmental purposes in the region. Identification of sites for the construction of desalination plants in Rosarito, B.C., and Puerto Peñasco, Son. In this regard, an on-going study about the feasibility of the Binacional Plant in Playas de Rosarito, B.C. is underway, with a capacity of 1,095 lps on a first stage until 2,190 lps as final capacity, the volume of desalinated water will be shared between Mexico and the US. The establishment of five priority conservation areas and a map of the water needs of the riparian environment and the Colorado River Delta. It is underway a pilot binational project that will cost 698 thousand dollars of which 372.5 have already been invested by the Mexican government, the remaining, will be provided by the US starting in 2011.

There is also monitoring of the aquifer, plans in case of scarcity or drought, annual and multi-annual storage in Mexico and the US. There is work being done on the modeling of the complete Colorado River system, in this regard, six scenarios are being simulated, taking in consideration flow to the Delta, savings due to modernization and technification for environmental use, storage in the dams and/or aquifers.

Challenges and how to confront them
Future scenario characterizes by larger population and economical growth rates at the border region of Baja California - California; growing competition for water resources; adverse scenario of climatic variability (and possible climate change); overexploitation and deterioration of sources.

Trying to balance the water needs at the cities, the agricultural sector, and the environment, is not an easy task, especially with a resources that is over allocated as in the case of the Colorado River. The great challenge to our interests is to find common ground in the water use, this will require good will to adapt from its historical demands.

It is uncertain if this could be reached in the short term, but what it is truth, is that the creative solutions to satisfy the multiple demands in the Colorado River Basin, are being implemented now and for the future.

Final message
The governments of Mexico and the US characterize themselves by its capacity to joint its efforts in order to strengthen the protection policies to the environment and the natural resources in a sustainable way; the will to cooperate in the search for joint actions that improve the quality of the environment and optimize the quality of life of the inhabitants of the border region that both countries share; as well as the importance of strengthen the cooperation through initiatives about priority issues of common interest; both governments will keep working hard so that this effort of binational cooperation be considered an example at the international level in terms of water integrated management at a basin level.

4.5 Multi-Criteria Decision Analysis (MCDA) in the participatory and integrated evaluation of the flood risk management alternatives – Mr. Markku Maunula - Finnish Environment Institute

Today's natural resource problems are complex. There is a great number of stakeholders with a wide spectrum of interests and objectives. Various interest groups often have different and even conflicting objectives. There is a need to find balanced and widely acceptable solutions which reconcile many different objectives, to compare alternatives systematically and comprehensively and to improve the involvement of stakeholders and other interest groups in the planning process. In addition, climate change adaptation and management in exceptional hydrological conditions has to be taken into account.

There is a great need to develop and apply new approaches and methods to facilitate the planning processes. Multi-Criteria Decision Analysis (MCDA) is a set of methods and approaches for structuring complex problems involving different values, intangible impacts and uncertainties. In Multi-Criteria Decision modelling, input values are, on one hand, information about the impact of different alternatives in water resource management, and on the other hand participants' opinions on the impacts and their importance. The target is to integrate the results of impact assessments of different alternatives and the interests and opinions of stakeholders. The major outcomes of the analysis are the calculated priority values for each alternative. The goal is to create a structured process to identify objectives, create alternatives and compare them from different perspectives.

Multi-Criteria Decision Analysis methods have been applied in the Finnish Environment Institute since the 1990s in several applications, such as water resource management, lake restoration and forest management projects. The presentation considered one example where Multi-Criteria Decision Analysis was used to revise the regulation rules of Lake Päijänne, and another case study regarding flood risk management planning.

Lake Päijänne is the second largest lake in Finland, with a surface area of 1100 km^2. An extensive lake regulation development project was carried out between 1995 and 1999. The aim of the project was to study ecological, social and economic impacts, to investigate the opportunities to revise the old regulations and to find new ways to mitigate against the adverse impacts of regulation.

The Decision Analysis process produced information about the importance of different attributes such as agriculture, infrastructure, recreational use and ecology, and this information was compared with three alternative regulation schemes. New regulations relating to Lake Päijänne have now been approved. As a result it was stated that the Decision Analysis process considerably improved the quality and efficiency of the collaborative planning process.

The second example presented the Multi-Criteria Decision Analysis process in flood risk management planning in Finland. It has also been decided to make use of Multi-Criteria Analysis in implementing the flood directive in Finland, initially as a case study of the River Kokemäenjoki (catchment area ca 27,000 km^2). The city of Pori lies within the Kokemäenjoki river delta, which is the most significant flood risk area in Finland. Direct damages as a result of a serious flood would likely to be in the region of EUR 200 – 300 million.

The flood risk management measures are in this case grouped into flood risk prevention, flood prevention, flood protection and preparedness measures. The main outcomes of the Multi-Criteria Decision Analysis process are: an evaluation framework (value tree), an impact matrix describing the consequences of measures, weight profiles for criteria (floods, economy, ecology, social), priority values and ranking of the measures.

The Finnish experience shows that there are several benefits if we interactively use the Multi-Criteria Decision Analysis methods in the water resource management planning process. The process:

- provides a logical framework for planning
- supports value-based planning
- supports the synthesis of information and helps to identify uncertainties
- supports participants' learning and understanding of the planning situation
- enables the comparison of unmeasurable impacts
- supports the systematic and transparent evaluation of alternatives
- clarifies issues of agreement and disagreement
- facilitates discussion
- supports democracy in planning
- supports the identification of balanced and widely acceptable solutions

4.6 Mainstreaming Economic Analysis of Climate Change Adaptation into River Basin Planning: A Pilot Case Study in the Lower Dong Nai Delta in Vietnam - Mr. David Corderi Novoa - University of California Davis, United States

The project aims at demonstrating the use of economic analysis in adaptation planning at the river basin level using a case study of the Lower Dong Nai Delta. The work is being developed in collaboration between the University of California-Davis and the Southern Institute of Water Resources Planning in Vietnam. The main expected outcomes of the project are:

- Demonstrate how economic analysis can help inform decision making at the basin level.

- Both autonomous and planned adaptation will be treated explicitly so that interactions between both types of responses can be better assessed.

- The assessment will focus on the analysis of adaptation to changes in hydrological extremes, i.e. the climate change impacts on both the monsoon season (when floods occur) and the dry season (when salinity intrusion happens)

- Uncertainty will be incorporated explicitly in the framework through risk based and real options analysis.

- The timing and sequencing of adaptation will be assessed using a multi-year investment framework at the river basin level.

The project is divided in two major sub-components to allow for a more specific treatment of the challenges that climate change poses on water resource adaptation. The current status and progress can be summarized as follows:

1- Adaptation to changes in the dry season.
Salinity has been identified as one of the major problems occurring during the dry season in the Lower Dong Nai delta. This component focuses on how agricultural production regions can economically adapt to increases in the level of salinity resulting from climate change. The study has created an economic evaluation framework to analyze both autonomous adaptation such as changes in cropping patterns and planned adaptation such as building water infrastructure or changing reservoir operating rules.

2- Adaptation to changes in the rainy season.
Climate change can worsen flooding problems in the rainy season through the potential increase of frequency and intensity of extreme rainfall. This component will develop an economic-engineering framework to analyze investments in flood protection infrastructure in the rural and urban areas of the Ho Chi Minh district. Risk-based optimization tools will be used to evaluate the economic viability of changing dyke height and setback to accommodate future changes in flood frequencies and urbanization. By focusing on structural adaptation options, this framework will provide insights into the economics of climate change and long-term flood protection at the river basin level.

The following difficulties have been encountered while implementing this project:

- Data availability and data quality are a concern if the results of the analysis are to be used for planning and decision making. Some of the data from weather stations and gauge stations are inconsistent and assumptions had to be made to continue with the work.

- Uncertainties with respect to both climate change scenarios, impact assessment model quality and socioeconomic scenarios remain to be an issue for the analysis.

- Integrating different temporal and spatial scales for different purposes of analysis has been quite challenging. This has also been the case when integrating different units of analysis such as irrigation districts and administrative units.

- Collaboration among people of different technical backgrounds always deserves an additional effort to make sure there is a common understanding on the approach and issues to be addressed.

Some of the lessons learnt from the project so far can be summarized as follows:

- Despite data limitations results can still shed some light when it comes to orders of magnitude and general directions in river basin planning.

- Changes in hydrologic extremes such as floods and droughts have more important implications than changes in the average hydrology when it comes to adaptation planning.

- Economic analysis can be useful for river basin planning:

    - It is useful to analyze tradeoffs inherent with investment planning and it can also shed light on decision making under uncertainty as well as the timing and sequencing of the investment plans.

    - It can be used to create policy planning tools that can easily be incorporated by local water planners to analyze medium and long term investment planning strategies for climate change adaptation.

    - It has to be acknowledged that economic analysis is also limited. All tradeoffs cannot always be fully quantified into costs and benefits. In that respect, other approaches such as multi-criteria analysis are also available to overcome these limitations.

- Collaboration between economists, hydrologists, engineers and water resource planners can build capacity by pursuing integrative approaches that search for a common understanding based on differentiated technical points of view.

5 Ecosystem-based adaptation

5.1 Incorporating ecosystem-based approaches in climate change adaptation strategies - Mr. Pieter van Eijk- Wetlands International

Major investments are being made in measures that help society adapt to the projected impacts of climate change. Many of these are infrastructure oriented. While infrastructural approaches are a necessity in some cases, they are expensive and provide static protection to often uncertain and unpredictable future changes. Moreover, the construction of infrastructure such as dams, sea walls and dykes often leads to the degradation of valuable ecosystems. This causes the loss of important ecosystem services that contribute to climate resilience. Drainage of peatlands and embankment of floodplains for example diminishes nature's capacity to regulate floods and droughts. Degradation of coastal wetlands such as salt marshes and mangroves increases vulnerability to storms and coastal erosion. Often the loss of such natural services is not directly visible; adverse environmental impacts take time to occur, or happen in downstream areas, out of sight of decision-makers. The consequence is that well intended infrastructure-based adaptation measures often result in mal-adaptation: they have a net negative impact due to the degradation of the environment, which exacerbates vulnerability.

To solve this situation, a paradigm shift is needed among adaptation planners and water resources managers. Instead of fighting natural processes, they should work alongside nature, and apply a well-balanced combination of adaptation measures. Several basic steps suffice to accomplish a transition towards integrated adaptation planning: vulnerability and risk assessments should not just focus on mapping of hazards and societal vulnerabilities, but also identify how ecosystems play a role in the regulation or buffering of such hazards. This allows for the identification of ecosystem management and restoration options as cost-effective, no-regret adaptation measures. Thus, a critical fundament is built to which additional adaptation measures, including infrastructural, institutional and community-based approaches can be connected. Next, it is crucial for the full range of costs and benefits of possible measures to be considered, including those that are not directly visible. A water reservoir for irrigation purposes, might accommodate to agricultural needs during drought periods, but could also result in water shortage and rampant lots of ecosystems downstream. Environmental Impact Assessments (EIA) and tools for economic valuation of ecosystem services have proven their value to assess such impacts properly.

Sectoral approaches to climate change adaptation are doomed to fail. For adaptation measures to become truly sustainable and successful, economists, engineers, ecologists and many others should join forces to bridge their approaches and bring complementary expertise together.

5.2 Adaptation responses in coastal ecosystems in the Drini and Mati River deltas - Ms. Miriam Ndini - Albania, Institute for Energy, Water and Environment

The low-lying coastal region of the Drini-Mati River Deltas is situated in north-west Albania. Under Albania's Climate Change Enabling Activities portfolio, the DMRD is prioritized as an ecosystem where climate adaptation response measures could be implemented. As well as forming a contiguous wetland area of national significance, the DMRD is an area of national development priority. This offers an opportunity to consider climate adaptation within the development policies for the region.

The lowland area is approximately 25km long and up to 3km wide and comprises a complex of habitats, including beaches, dunes and wetlands (predominantly saltmarshes and lagoons) with significant biodiversity values. These habitats and the communities that rely on them are vulnerable to future long-term climate change that will induce sea-level rise and increase storminess.

The project's overall goal is to assist Albania in establishing a mechanism by which strategies to moderate, cope with, and take advantage of the consequences of climate change are enhanced, developed, and implemented.

Human induced threats to biodiversity, such as deforestation, soil erosion, uncontrolled land-use, and a lack of sewage treatment and water management, have led to degradation and losses and will compound climate change-related impacts on biodiversity.

The project's specific objective is to build adaptive capacity in the DMRD to ensure resilience of key ecosystems and local livelihoods to climate change. This will be done by first identifying and then integrating climate change response measures into conservation and development programming in the DMRD.

As part of the overall objective, this report investigates and recommends practical coastal management actions for the DMRD within the context of climate change adaptation. This objective will be achieved through the following outcomes:

1. Capacities to monitor and respond to anticipated climate change impacts developed at institutional and community levels

2. DMRD regional conservation and development programmes, plans, and policies integrate climate change risks and take local pilot actions for coastal adaptation

3. Capacity for adaptive management, monitoring and evaluation, learning, and replication of project lessons developed

To date

- Current climate impacts and its extremes on the ecosystems, water resources, agriculture and tourism assessed;
- Habitat map, according to Nature 2000 and EU Directives for biodiversity prepared;
- Climate change scenarios for the area developed;
- Maps of expected changes of sea level rise and the study on the geomorphological evolution of the area under review.
- The capacities of local government (Regional Council, Lezha and Lac Municipalities) and Communes (under the project area and surrounding) related to the climate change risks are improved.
- The local stakeholders and decision makers have access to climate change impact information and adaptation options through dissemination of project findings in workshops and media programs/activities. They have been involved in risk analysis and development of adaptation plans at the commune level.
- The Regional Development Concept for Lezha for 2010-2015 has addressed the climate change adaptation measures/actions

Risk assessment
The objective of the risk assessment was three fold:

- Identify and prioritise the *potential risks* of climate change to the DMRD region
- Identify and prioritise *adaptation strategies* to address the identified impacts
- *Build capacity* of DMRD stakeholders (regional and local) to evaluate the impacts of climate change and develop adaptation strategies.

Adaptation Planning
Measures that build adaptive capacity

- **create information (**awareness raising, data collection and monitoring, and research
- **supportive social system (**organizational development, working in partnership, and institutions)
- **supportive governance (**Regulation, legislation and guidance

Measures that deliver adaptive actions

- **Offset loss by sharing or spreading risks and losses (**Insurance, sharing cost of response, and relief efforts)
- **Preventing effects or decreasing risks (**Change use or location and build resilience)
- **Exploit positive opportunities (**Introduce new or develop previously limited activities, species)

Some potential adaptation measures discussed in a wide participatory process with local community include:

- Disciplining of river beds by construction/rehabilitation of longitudinal embankments, weirs and cross panels along the rivers, lagoons and coastal areas.
- Rehabilitating of flood protection infrastructure which protect the agriculture land.
- Protecting of urban area and infrastructure in the DMRD areas.
- Reduction of erosion.

Lessons learnt

- Close cooperation with local government and its support is crucial;
- Focus on current climate vulnerability/risk and actions that are relevant in the present help building understanding of the impacts of climate change in the future;
- Dissemination of scientific information in a user friendly way for the non-scientific community;
- A combination of bottom-up and top-down approaches proved more effective in risk analysis, in designing practical adaptive measures.

Eglantina Bruci*, Miriam Ndini**
**UNDP Climate Change Programme , Albania*
*** Institute for Energy, Water and Environment, Albania*

5.3 Design of environmental flow requirements of Argun River and opportunities for their introduction into transboundary management - Mr. Eugene Simonov - WWF Russian Federation

Dauria wetlands support globally significant populations of at least 20 bird species on the IUCN Red List of Threatened Species, including the Red-crowned Crane, and resting and feeding areas for several million migratory waterbirds. Dauria International Protected Area (DIPA) was created by Mongolia, China and Russia in 1994 to protect and study ecosystems of the region. Increasingly altered by human activities Argun River basin with Dalai Lake and still relatively pristine Uldz River basin with Torey lakes form a great comparative pair for a study on transboundary water management options and climate adaptation in Amur River Headwaters. The project coalition led by Daursky Biosphere (representing DIPA) and WWF Russia is aiming to harmonize transboundary river protection and management in Dauria.

The indigenous 30-year climate cycle effectively drives the dynamics of Dauria ecosystems, but multiple manifestations of global climate change are also very evident there. In the last 55 years Daurian mean annual temperature has already increased by 2 degrees. In the past, in dry phases of the climate cycle, populations of rare species have been especially vulnerable to human pressure. There will be more prolonged severe droughts within the natural cyclical pattern, resulting in low grass productivity, higher evaporation, greater competition for remaining water bodies between humans, cattle and wildlife. Argun-Hailaer, Khalkh, Kherlen, Uldz, Onon rivers– virtually all notable basins of Dauria are transboundary. Greatest threat – competition for water made the goal of national policies and demolishing transboundary wetlands to store waters on national territories. Unfortunately this threat is rapidly unfolding into crisis as countries start to implement unilateral measures to alleviate drought consequences. Russia is the only country that at the moment cannot induce much harm to regional waters, because it does not possess any headwaters of common rivers.

Recent rapid socio-economic changes and loss of nomadic heritage in Dauria Steppe makes ecosystems and local communities less resilient to naturally fluctuating resources and to droughts and floods made more extreme through climate change. Drastically different cultures, population density and mode of economic development and water use in Russia, China and Mongolia, make it very difficult to build transboundary mechanism to protect common water resources. Meanwhile risks for wetland ecosystems and dependent population are further exacerbated by recent proposals for several inter-basin water storage and water transfer projects in the Argun River basin in China and Mongolia. China plans to increase water consumption in Argun-Erguna River basin by 1000% in 25 years. Just one Hailaer(upper Argun)river -Dalai Lake water transfer canal built in 2009 – can transport 1.05 cubic km. annually (or 30% of annual flow)
Water consumption from new reservoirs upstream is projected at 1.2 cub. km. annually. Cumulative impacts may be enormous, thus, several projects in China may reduce upper Argun River flow by 50%-60%, and stop flooding on which well-being of floodplain wetlands depends. Halted flood cycle prevents soil saturation and nutrient replenishment on the floodplain, decreasing pastures and hayfields; shrinking water supply forces communities in China and Russia to use polluted water, dig deeper wells, purchase water from elsewhere, or migrate to other areas.
And just one of those -Hailar-Dalai water transfer canals may cause the Dalai lake pollution, result in change in ecological character of the lake site by halting its hydrological dynamics and create an excuse for a large-scale industrial water supply to adjacent mines from Ramsar site. Protected areas that could be affected by the Hailaer-Dalai water diversion in China occupy more than 1 000 000 ha.

Environmental flow norms as part of the solution
Environmental flows describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems (Birsbane Declaration 2007). The goal of

environmental flow management is to restore and maintain the socially-valued benefits of healthy, resilient freshwater ecosystems through participatory decision-making informed by sound science. Sound environmental flow management hedges against potentially serious and irreversible damage to freshwater ecosystems from climate change impacts by maintaining and enhancing ecosystem resiliency.

Scientific research is undertaken by DIPA and project partners on the environmental flow requirements of the Argun and Uldz rivers during different phases of the climate cycle. The research will be collated into a technical guidance document, and the environmental flow concept will then be promoted and instituted amongst key water management agencies. Current thinking on key components of environmental flow is presented in Table 1.This will provide the technical foundation for harmonizing bilateral water management policies with Mongolia and China. Results will be used to promote the critical need for implementation of the existing Sino-Russian provincial agreement on the conservation of the Argun River Basin. The project will also develop another environmental flow case-study for model transboundary Uldz river basin.

Table 1. Critical components of Environmental Flow in case of *Hailar-Dalai water transfer*

	Critical Components	**Measurable parameters**
I	For Argun River	
1	Sustaining floodplain habitat for waterbirds and fish, meadow productivity	Timing of floods, flooding frequency, duration of rise and fall Flooded area (wetted perimeter) Density and breeding success of indicator species of birds and fish Area and productivity of meadows (ton/hectare) related to flooding frequency
2	Sustaining geomorphological processes	Reporduction of important stream habitats and meandering processes, braided channels. Frequency and magnitude of flow events necessary to reproduce habitat features Additional condition: limitations on length and location of embankements and other engineering structures
3	Biota survival in low flow periods and changing concentration of pollutants (minimal flow)	Timing, frequency and duration of low flow (and no-flow freezing) periods Critical low-flow discharge (still sufficient for survival of biota) Species composition, abundance and productivity of plankton and benthos, dynamics of fish populations, invasion of exotic species
II	For Dalai Lake:	
1	Sustaining cyclical habitat dynamics	Fluctuation of water level (magnitude, timing, speed, frequency) Habitat succession and acreage and abundance of indicator species
2	Sustaining geochemical dynamics of lake ecosystem	Cyclical change in water chemistry (salinity, PH, etc) Succession and abundance in indicator species, absence of exotic species Additional condition: limitations on pollutant discharge through diversion canal

Establishing environmental flow norms, we should also consider climate change effects on water temperature and flow volume, etc. In the last 50 years average thickness of ice cover on Dauria rivers decreased by 22 centimeters.

To protect and manage wetlands, we should consider flow dynamics interplay with other factors such as wildfires, overgrazing, waterfowl hunting and egg collection, thermal power plant impact and embankment construction.

Lack of field observations is the greatest impediment to developing environmental flow norms and therefore DIPA concentrates on data collection and management. In 2010 DIPA developed a monitoring system and established 3 field monitoring transects with more than 100 standard observation plots, which allow us to discern changes in stream flow, water surface and plant communities succession under climatic fluctuations. Agreed with DIPA partners on transboundary monitoring effort. We also started establishment of an International Bird Observatory: agreed on common monitoring protocols, developed network of observation points for bird migration and nesting periods. Wetland monitoring in both Argun and Uldz River basins is enhanced by developing combined remote-sensing and field-transect monitoring methods in transboundary wetlands. This will allow scientists to measure the effects of climate change and other impacts on water levels and ecosystem health and will help improve water management for human use and economic development.

Policy opportunities and challenges

From many multilateral conventions the Ramsar Convention is one of the most relevant policy tools in the Amur-Heilong basin with 15 wetlands already listed under the convention. The Ramsar Convention Regional Initiative approach provides a suitable framework for multilateral cooperation on transboundary water management and transboundary environmental flows for wetland conservation, but three countries are slow to realize it. All three countries also have bilateral agreements on Use and Protection of Transboundary Waters.

There are hopeful developments in each country: China has a strong National Wetlands Protection Policy and an Action Plan that prescribes water allocation to important wetlands(2003). Russia adopted a new Water Code prescribing the development of "Standards of acceptable impact" (SAI) for environmental flows, as well as chemical, thermal, radioactive and microbial pollution)(2007), Mongolia adopted a new law "On prohibition of mining in water protection zones"(2009).

We recommend the following priority measures to face transboundary water management challenges in Dauria:

1) The establishment of a Chinese-Russian-Mongolian intergovernmental task force on economic and ecological adaptation of management policies in Dauria to changing climate conditions
2) Agreement on the environmental flow norms for transboundary rivers of Argun basin and provisions for sustaining natural dynamics of water allocation to wetlands.
3) Expanding the transboundary wetland monitoring system to measure the effects of climate change and human impacts.
4) Wetland protected area network enhancement to provide for migration and breeding of species and preserves key hydrological features and all important refugia during drought period (e.g. expanding DIPA to Argun floodplain and Buir Lake). In 2006 the trilateral Joint Committee of DIPA approved a plan to expand and upgrade the nature reserves of the DIPA, but implementation of this plan needs strong international backing and additional resources.
5) An awareness raising program on climate adaptation in transboundary Dauria
6) Establishing a specific basin-wide agreements for Torey-Ulz and Argun basins protection and management.

Dr. E.Simonov, Consultant to WWF Amur Programme, Dauria International Protected Area (DIPA) & Dr.V.Kiriliuk, Daursky Biosphere Reserve (DIPA)

6 Presentations during the taskforce meeting

6.1 Climatological establishment of site studies and land use: The Carpathian region –Sandor Szalai – Szent Istvan University, Hungary

One of the largest problems is the availability of good quality long-term time series in the climate and connected sciences. This problem is based on the relative small countries in Europe, the difference in the measuring systems and data managements, and the general problem of data availability. Furthermore, the climatological data management was taken politically as a national task of the individual countries both on expert and financial point of view. This approach made not possible a powerful international co-operation.

Finally, the European Parliament accepted a Hungarian initiative to support an international co-operation on the climate of the Carpathian Basin in 2008 (the final title became Climate of the Carpathian Region, CARPATCLIM). The final tender call was published in June 2010 with a deadline of mid-August.

Establishments of gridded databases are widely distributed recently. Global gridded databases have been created earlier, but their spatial resolution is not appropriate for regional and even less for subregional level. EUMETGRID is the biggest attempt to create a European gridded database under the umbrella of EUMETNET, the co-operation of the European Meteorological Services.

The main aim of the project is to improve the basis of climate data in the Carpathian Region for applied regional climatological studies such as a Climate Atlas and/or drought monitoring. The project will investigate the fine temporal and spatial structure of the climate in the Carpathian Mountains and the Carpathian basin with unified or at least directly comparable methods. Currently, there is no valid description of the climate of the Carpathian Region.

The spatial area of interest includes the Carpathian Mountain Chain (including the Transylvanian Depression), the Carpathian Basin (i.e. the Pannonian Depression), and adjacent areas, necessary to study the climate of the area. This includes part of the territory of the following countries: Bulgaria, Czech Republic, Croatia, Hungary, Moldova, Poland, Romania, Serbia, Slovakia, and Ukraine. The winner consortium has 9 participants, the (hydro)meteorological institutes and services of Czech Republic, Slovakia, Austria, Poland, Ukraine, Serbia, Hungary, and the National Research and Development Institute of Environmental Protection of Romania and the Szent Istvan University from Hungary. The Croatian Hydrometeorological Service takes part in the project as well. The Slovenia supports the initiative. For the production of the digital climate atlas, the resulting climatological grids should cover the area between latitudes 50°N and 44°N, and longitudes 17°E and 27°E, approximately.

The work is divided into three modules:
Module 1: Improve the availability and accessibility of a homogeneous and spatially representative time series of climatological data for the Carpathian Region through data rescue, quality control, and data homogenisation.
Module 2: Ensure Carpathian countries data harmonisation with special emphasis on across-country harmonisation and production of gridded climatologies per country.
Module 3: Develop a Climate Atlas as a basis for climate assessment and further applied climatological studies, create publicly accessible dedicated web site of the Climate Atlas, including a web map server and data download/access infrastructure, freely available gridded climatological datasets and searchable metadata catalogue for the Climate Atlas.
The planned timeframe of the action is 1961-2010, but the consortium tries to enlarge this period according to the possibilities.

Annex1: Impact in the Media

Europe faces 'drought and flood burden': scientist

A leading climate scientist warned Tuesday that Europe should take action over increasing drought and floods, stressing that some climate change trends were clear despite variations in predictions.

"There are some robust areas like Siberia, we know what the climate will be, another robust area is the Mediterranean, because the models tell the same story," said Zbigniew Kundzewicz, review editor of the Intergovernmental Panel on Climate Change's (IPCC) chapter on freshwater resources.

"Climate change will pose two major water challenges in Europe: increasing water stress in southern Europe and increasing floods elsewhere," he added during a workshop organised by the UN Economic Commission on Europe.

"Current water management practices may be inadequate to reduce adverse impacts of climate change."

The Polish scientist said southern Europe would be more affected than northern Europe, with evidence already of hotter weather and longer drought leading to water shortages, harm to agriculture, a 20 to 50 percent decrease in hydro-electric power and denser water pollution.

Nonetheless, the intensity of rainfall when it does occur is also growing with warming, raising the threat of sudden summer floods such as those that hit eastern Europe in August 2002.

Kundzewicz also highlighted the amplifying impact of shifting land use, including more urban areas which absorb water less readily than rural areas during sudden rainfall.

"One hundred years floods may become a 50-year or 20-year flood," he explained.

The IPCC expert acknowledged that more than a dozen climate change models were "not ready for prime time" because of the way they sometimes differed on detail, partly because of the lack of a clear picture of future carbon emissions.

"We can't adapt to one fixed, crisp number, but we know a range and sometimes the range is disturbing," he added.

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Published on ***FRANCE 24***
Source URL: http://www.france24.com/en/20110412-europe-faces-drought-flood-burden-scientist

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Impact in the Media : Second Workshop on adaptation to climate change in transboundary basins: challenges, progress and lessons learnt" (Geneva, 12-13 April 2011)

Europe faces 'drought and flood burden': scientist	France 24	http://www.france24.com/en/20110412-europe-faces-drought-flood-burden-scientist
Europe faces drought and flood burden: climate scientist	Radio Netherlands Worldwide	http://www.rnw.nl/international-justice/bulletin/europe-faces-drought-and-flood-burden-climate-scientist
Europe faces drought and flood burden: climate scientist	News MSN	http://news.ph.msn.com/top-stories/article.aspx?cp-documentid=4772283
Europe 'faces' drought and flood burden	Gulf Times	http://www.gulf-times.com/site/topics/article.asp?cu_no=2&item_no=427921&version=1&template_id=39&parent_id=21
Europe faces drought and flood burden: climate scientist	Expatica	http://www.expatica.com/ch/news/swiss-news/europe-faces-drought-and-flood-burden-climate-scientist_142162.html
Europe faces drought and flood burden: climate scientist	AFP	http://www.google.com/hostednews/afp/article/ALeqM5h3whsEeOLiATPqy1I7Zfvzp4qvlg?docId=CNG.10d3a9e29c2cbf7d2da3ebd746b3a9f1.641
Europa debe prepararse para sequías e inundaciones en serie (experto IPCC)	Terra Argentina	http://noticias.terra.com.ar/sociedad/europa-debe-prepararse-para-sequias-e-inundaciones-en-serie-experto-ipcc,b18143a6d2b4f210VgnVCM20000099f154d0RCRD.html
Europa debe prepararse para sequías e inundaciones en serie	La Segunda Online	http://www.lasegunda.com/Noticias/Internacional/2011/04/640122/Europa-debe-prepararse-para-sequias-e-inundaciones-en-serie
Europa debe prepararse para sequías e inundaciones en serie (experto IPCC)	Terra Colombia	http://noticias.terra.com.co/calentamiento-global/europa-debe-prepararse-para-sequias-e-inundaciones-en-serie-experto-ipcc,342f447d53b4f210VgnVCM3000009af154d0RCRD.html
Europa debe prepararse para sequías e inundaciones, experto	Terra Mexico	http://www.terra.com.mx/noticias/articulo/1088278/Europa+debe+prepararse+para+sequias+e+inundaciones+en+serie+experto+IPCC.htm
Europa debe prepararse para sequías e inundaciones en serie (experto IPCC)	Univision	http://feeds.univision.com/feeds/article/2011-04-12/europa-debe-preparase-para-sequias?refPath=/noticias/mundo/noticias/
Europa debe prepararse para sequías e inundaciones en serie (experto IPCC)	El Economista	http://ecodiario.eleconomista.es/internacional/noticias/2986248/04/11/Europa-debe-prepararse-para-sequias-e-inundaciones-en-serie-experto-IPCC.html
Europa deberá prepararse para afrontar episodios de sequía y de inundaciones en serie	El Aragüeño	http://elaragueno.gesindoni.com.ve/internacionales/articulo/4884/europa-debera-prepararse-para-afrontar-episodios-de-sequia-y-de-inundaciones-en-serie
Europa debe prepararse para sequías e inundaciones	Espectador.com	http://www.espectador.com/1v4_contenido.php?id=209816&sts=1
Europa debe prepararse para sequías e inundaciones en serie	El Nacional	http://www.el-nacional.com/www/site/p_contenido.php?q=nodo/199390/Mundo/Europa-debe-prepararse-para-sequ%C3%ADas-e-inundaciones-en-serie
Réchauffement global : l'Europe doit se préparer à davantage de sécheresses et d'inondations	Catastrophes Naturelles.net	http://www.catnat.net/veille-catastrophes/changements-climatiques/12177-rechauffement-global--leurope-doit-se-preparer-a-davantage-de-secheresses-et-dinondations
L'Europe doit se préparer à des sécheresses et inondations en série (expert Giec)	Daily Bourse.fr	http://www.daily-bourse.fr/l-europe-doit-se-preparer-a-des-secheresses-et-ino-Feed-AFP110412152824.z7fygm61.php
L'Europe doit se préparer à des sécheresses et inondations en série	Romandie.com	http://www.romandie.com/infos/news2/110412152824.z7fygm61.asp
Europe faces drought and flood burden: climate scientist	The West.com.au	http://au.news.yahoo.com/thewest/a/-/world/9184932/europe-faces-drought-and-flood-burden-climate-scientist/
Europe faces drought and flood burden: climate scientist	The Age.com.au	http://news.theage.com.au/breaking-news-world/europe-faces-drought-and-flood-

		burden-climate-scientist-20110413-1dcu2.html
Europe faces drought and flood burden: climate scientist	The Brisbane Times.com.au	http://news.brisbanetimes.com.au/breaking-news-world/europe-faces-drought-and-flood-burden-climate-scientist-20110413-1dcu2.html
Europe facing drought, flood burden	IOL	http://www.iol.co.za/scitech/science/environment/europe-facing-drought-flood-burden-1.1056066
Europe faces drought and flood burden: climate scientist	Bangkok Post	http://www.bangkokpost.com/news/world/231700/europe-faces-drought-and-flood-burden-climate-scientist
Europe faces drought and flood burden: climate scientist	Sidney Morning Herald	http://news.smh.com.au/breaking-news-world/europe-faces-drought-and-flood-burden-climate-scientist-20110413-1dcu2.html
How Will Climate Change Affect Europe?	Red Orbit	http://www.redorbit.com/news/science/2029044/how_will_climate_change_affect_europe/
Climat L'Europe future entre sécheresse et inondations en série	L'Alsace.fr	http://www.lalsace.fr/actualite/2011/04/13/climat-l-europe-future-entre-secheresse-et-inondations-en-serie
Sécheresses et inondations seront plus fréquentes en Europe (expert Giec)	La France Agricole	http://www.lafranceagricole.fr/actualite-agricole/changement-climatique-secheresses-et-inondations-seront-plus-frequentes-en-europe-expert-giec-41597.html
Europa va fi lovita de seceta si inundatii in serie, sub efectul schimbarilor climatice (Europe will be hit by drought and flooding in the series, under the effect of climate change)	Observator de Constanta	http://observator.ro/europa-va-fi-lovita-de-seceta-si-inundatii-in-serie-sub-efectul-schimbarilor-climatice-82527.html
ONU: Europa trebuie să se pregătească pentru inundaţii şi secetă (UN: Europe must prepare for floods and drought)	Adevarul	http://www.adevarul.ro/actualitate/ONU-Europa-trebuie-pregateasca-inundatii_0_461953995.html
Europa va fi lovita in mod repetat de secete si inundatii (Europe will be repeatedly hit by drought and floods)	Agenda.ro	http://www.agenda.ro/news/news/41333/europa-va-fi-lovita-in-mod-repetat-de-secete-si-inundatii.html
Europa va fi lovita de seceta si de inundatii - expert ONU (Europe will be hit by drought and floods - UN expert)	Ziare	http://www.ziare.com/social/meteo/europa-va-fi-lovita-de-seceta-si-de-inundatii-expert-onu-1088098
Vom avea o vară cu arşiţă, dar şi cu furtuni violente (We have a summer heat, but violent thunderstorms)	Click.ro	http://www.click.ro/actualitate/din_tara/vara-arsita-furtuni-violente_0_1156684440.html
Europa va fi lovită succesiv de secete şi inundaţii (Europe will be hit by successive droughts and floods)	Romania Libera	http://www.romanialibera.ro/actualitate/fapt-divers/europa-va-fi-lovita-succesiv-de-secete-si-inundatii-222352.html
ONU: Europa trebuie să se pregătească pentru inundaţii şi secetă (UN: Europe must prepare for floods and drought)	Realitatea	http://www.realitatea.net/europa-trebuie-sa-se-pregateasca-pentru-inundatii-si-seceta_824426.html
Europa trebuie să se pregătească pentru inundaţii şi secetă (Europe must prepare for floods and drought)	Money.ro	http://www.money.ro/europa-trebuie-sa-se-pregateasca-pentru-inundatii-si-seceta_927286.html
Europa va fi lovita de seceta si inundatii in serie, sub efectul schimbarilor climatice (Europe will be hit by drought and flooding in the series, under the effect of climate change)	Mondo News.ro	http://www.mondonews.ro/Europa-va-fi-lovita-de-seceta-si-inundatii-in-serie-sub-efectul-schimbarilor-climatice+id-36623.html
Europa s-ar putea confrunta cu episoade succesive de seceta si inundatii (Europe would be confronted with successive episodes of drought and floods)	EurActiv.ro	http://www.euractiv.ro/uniunea-europeana/articles|displayArticle/articleID_22562/Europa-s-ar-putea-confrunta-cu-episoade-succesive-de-seceta-si-inundatii.html
Episoade succesive de seceta si inundatii vor avea loc in Europa (Successive episodes of drought and flooding will occur in Europe)	Romania International	http://www.romaniainternational.com/externe/episoade-succesive-de-seceta-si-inundatii-vor-avea-loc-in-europa-11397
Europa trebuie să se pregătească pentru episoade succesive de secetă şi inundaţii (Europe must prepare for subsequent episodes of drought and floods)	ZF Business International	http://www.zf.ro/business-international/europa-trebuie-sa-se-pregateasca-pentru-episoade-succesive-de-seceta-si-inundatii-8152318
Secete și inundații succesive peste Europa (Successive droughts and floods across Europe)	Ziuaveche.ro	http://www.ziuaveche.ro/international/externe/secete-%C8%99i-inunda%C8%9Bii-succesive-peste-europa-29758.html
Europa trebuie să se pregătească pentru	Gandul.info	http://www.gandul.info/news/europa-

episoade succesive de secetă şi inundaţii - expert ONU (Europe must prepare for subsequent episodes of drought and floods - UN expert)		trebuie-sa-se-pregateasca-pentru-episoade-succesive-de-seceta-si-inundatii-expert-onu-8152445
Europa trebuie să se pregătească pentru episoade succesive de secetă şi inundaţii (Europe must prepare for subsequent episodes of drought and floods)	Anima News	http://www.animanews.com/index.php?option=com_content&view=article&id=38:europa-trebuie-s-se-pregteasc-pentru-episoade-succesive-de-secet-i-inundaii&catid=6:mapamond
Seceta şi inundaţiile ameninţă Europa (Droughts and floods threaten Europe)	Jurnalul	http://www.jurnalul.ro/stiri/observator/seceta-si-inundatiile-ameninta-europa-575082.html
Piden a México y EUA reforzar protección ambiental en río Colorado	SDP Noticias	http://sdpnoticias.com/nota/36387/Piden_a_Mexico_y_EUA_reforzar_proteccion_ambiental_en_rio_Colorado
Europe faces drought and flood burden: climate scientist	Yakarta Globe	http://www.thejakartaglobe.com/afp/europe-faces-drought-and-flood-burden-climate-scientist/435110
Europe faces drought and flood burden: climate scientist	Tehran Times	http://www.tehrantimes.com/index_View.asp?code=238662
Trebuie să ne obişnuim cu seceta (You have to get used to drought)	Romania Libera	http://www.romanialibera.ro/actualitate/eveniment/trebuie-sa-ne-obisnuim-cu-seceta-222448.html
Europa, lovită de secetă inundații (Europe hit by floods drought)	Liber Tatea	http://www.libertatea.ro/detalii/articol/europa-lovita-de-seceta-inundatii-330722.html
Europa va fi lovită de secetă şi inundaţii (Europe will be hit by drought and floods)	Monitorul	http://www.monitorulbt.ro/Stiri/International/2011-04-14/Europa+va+fi+lovita+de+seceta+si+inundatii.html
Europa va fi expusa la fenomene meteo extreme in urmatorii ani (Europe will be exposed to extreme weather in the coming years)	1asig.ro	http://www.1asig.ro/Europa-va-fi-expusa-la-fenomene-meteo-extreme-in-urmatorii-ani-articol-2,3,117-41571.htm