




Approaches to Adaptive Water Management
in the Amudarya River Basin

New Approaches to Adaptive Water Management under Uncertainty
NeWater

Integrated Project
in the
6th EU framework programme

New approaches to adaptive water management under uncertainty - the NeWater project

NeWater (New Approaches to Adaptive Water Management under Uncertainty) is a transdisciplinary research project funded by the European Union within its 6th framework programme (contract No: 511179 GOCE). It joins 35 research partners from Europe, Central Asia and Africa and many associated organizations from the water resource management area. Within the framework of the project research and stakeholder activities were carried out in seven river basins in Europe, Africa and Central Asia.

Aim

The aim of the project is to improve existing methods and develop new approaches for integrated water resources management taking the complexity of river basins and uncertainties of climate and socio-economic changes into account. The project focuses particularly on opportunities and barriers for a transition to more adaptive water management needed to prepare river basins for the challenges of sustainable resource use under current and future conditions.

Approach

NeWater concentrated on those elements of a water management regime that are essential for integrated and adaptive water management. It developed a framework and methods to analyze those elements and to achieve a transition to more adaptive water management. Concepts and methods were applied to analyze the current water management regimes in the case studies. Stakeholder processes were initiated to assess major shortcomings in current policies and develop methods to address them.

Key areas critical for adaptive management that were addressed in the NeWater project are:

- governance in water management
  methods to improve governance and stakeholder participation in IWRM
- sectoral integration
  integration of land and water use sectors; integration with climate change adaptation strategies
- scales of analysis in IWRM
  methods to resolve water resource use conflicts; transboundary water management
- information management
  novel monitoring systems for decision support in water management
- risk mitigation strategies in water management
  development of new instruments
- stakeholder participation
  promoting new ways of bridging science, policy and implementation

Main Results

- water management has to learn how to deal and live with uncertainties caused by local and global change; however, there is still much reluctance to acknowledge and accept uncertainties
- transparent learning processes are a key requirement to address uncertainties and develop the capacity to respond to new insights and unexpected changes
- decentralization and coordination in management needs to be balanced
- unavoidable uncertainties should be accepted and resources should be devoted to develop strategies how to deal with them
- risk management has to change from probability-based approaches to integrated risk management and the development of robust policies
- management strategies should be robust and perform well under a range of possible future developments
- experimental learning cycles need to be integrated into policy and management processes

NeWater in the Amudarya River Basin

The research topics that were addressed in the Amudarya case study were determined at the beginning of the project based on consultations of relevant stakeholders from Uzbekistan and representatives from Tajikistan on the most pressing issues in the river basin. Most research activities focused on the lower reach of the Amudarya River in Uzbekistan.

The main priorities were:

(1) Basin-wide management of water and soil quality

(2) Coping with high variability of river flow

(3) Incorporating the social dimension into water management

(4) Institutional change & methods for stakeholder participation

Adaptive Management is an organized process to improve management policies and practices by systematic learning from the outcomes of implemented management strategies and by taking into account changes in external factors. It extends the integrated water resource management approach by explicitly recognizing uncertainty and complexity and the need for learning from past experiences. Adaptive Management may require major transitions of water management regimes to achieve suitable structural conditions.

Research and stakeholder activities in the Amudarya case study were carried out by 15 teams from European and Central Asian organizations and institutes. The project organized small and large scale stakeholder workshops to assess selected aspects of the current water management regime and the ongoing institutional change, identify problems and critical issues and discuss potential strategies and methods to address them. Several models and tools for water allocation planning and scenario analysis were developed based on extensive data analysis. The issues covered by the project work span a range from transboundary to local.

The research revealed that adaptive management can help to address current challenges in the river basin by

- recognizing a diversity of water uses and their needs
- promoting the participation of all water users
- providing tools to assess the impact of uncertainties and management measures
- supporting learning from past experiences, e.g. the severe drought in 2000/2001
- enhancing cooperation across administrative levels, e.g. by strengthening smaller scale governance units
- improving monitoring by integrating different knowledge sources, e.g. measurements by specialized agencies with assessment by users
- adapting an environmental flows approach by incorporating water needs for ecosystems into water allocation planning

Overall, NeWater in the Amudarya river basin

- created awareness of uncertainties and the need to take them into account for forecasting, assessment and development of measures for water management
- demonstrated the potential of stakeholder participation for shared problem understanding and solving
- transferred new methods and tools for planning, integrated assessment and implementation of adaptive integrated water management
- built capacity of stakeholders, local scientists and students

NeWater project partners involved in the Amudarya case study

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Cemagref
Center for Development Research, University of Bonn
Ecologic
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Helmholtz Centre for Environmental Research - UFZ
IIASA - International Institute of Applied Systems Analysis
Institute of Bioecology, Karakalpak Branch of the Uzbek Academy of Sciences
IRSA - Instituto di Ricerca sulle Aque
Max Planck Institute for Meteorology (MPI-M), Hamburg
NIGMI - Research Hydrometeorological Institute of the Center of Hydrometeorological Service at the Cabinet of Ministers of the Republic of Uzbekistan
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The challenge of managing a transboundary resource

Situation

Transboundary water management in the Amudarya Basin is characterized by the very specific transition from a centrally planned approach to a situation where newly independent states compete in one basin for the same vital resource. Water is a key input variable for all Central Asian economies and competition derives from different modes of water use: hydropower generation in the upstream, intensive irrigation in the downstream countries. This competition furthermore takes place in a setting were ecosystems are under severe pressure, caused by over-abstraction of water as well as widespread water pollution. The degradation of the Aral Sea is only one of the drastic results with far-reaching environmental and social impacts across the region.

After the break-up of the Soviet Union international agreements have been established bi- as well as multilaterally in order to determine the allocation of the resource as well as to foster cooperation on water resource management. Still, water management is the subject of much contestation in the region, while new factors, such as climatic change and new geopolitical factors become more and more relevant in this context. This scenario points to the necessity of adaptive management approaches and the difficulties to realize these in a rather inflexible and thus complex regime as the Amudarya.

Aim

Under the impression of these challenges, we aimed to identify access points for facilitating a transition to a more adaptive water management in the specific setting of a transboundary basin.

Since information management and the issue of finance are considered key prerequisites for adaptive water management at the transboundary level, we focused on the role of 'science/information management' and 'donors' in

- facilitating and ensuring transboundary collaboration among scientists and policy makers. What is the current situation in terms of information management in the Amudarya riparians? What are problems?
- facilitating transboundary cooperation. How do donors relate to challenges with regards to information management?

Approach

Information and data on information management structures as well as donor involvement were collected during two field trips to the region (covering Tajikistan, Turkmenistan and Uzbekistan) as well as guided group discussions during two workshops, organized in 2006 and 2008. These constituted the empirical foundation for conceptual work and analyses in the context of the NeWater framework.

Results

Information management:

Technical and coordinative problems hamper the effective production and use of information for decision-making processes at the transboundary level and the creation of an atmosphere of trust and openness among the negotiating parties. Institutions established for the management of data at the transboundary level have only partly addressed this challenge in the past.

In some riparian countries, infrastructure is not well maintained and the upgrading of water infrastructure is lagging behind. Information exchange is hindered due to lacking exchange networks among specialists in the riparian countries, outdated data-transmission systems, different data formats and terminologies.

Due to these factors, the quality of data that is actually broadly available is low, incomplete with regards to water quality and not detailed enough to account for the impacts of climate change.

Donors:

Donors struggle with identifying viable follow-up strategies to previous efforts. They are currently focusing on strengthening integrated water resources management at the national level in order to form a sound basis for transboundary collaboration at the regional scale. Still, efforts to foster such collaboration are rather haphazard and have not lead to any substantial improvement of water management at the transboundary scale.

Conclusions

With trust-building among riparians being a continuously challenging issue, it should be an absolute priority to work with the information available at the moment. This should be supported by a common legal basis to improve joint information production and exchange. Placing more focus on water quality data as well as potential regional impacts of climate change, which are of crucial relevance for all countries, could be used as a trigger to establish a stronger understanding for regional collaboration on water resources.

Donors could play a potentially supportive role here. Building on their work on Integrated Water Resources Management (IWRM) in individual countries, national strategies could be scaled-up to the transboundary level. This support would then not only include funding for information infrastructure but also cover methodologies for data assessment and modeling.

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Advanced Monitoring Systems for Adaptive Management

Situation

The awareness of the increasing complexity and uncertainty of river basin management poses new challenges to environmental monitoring as complex environmental phenomena have structures and functions that cover a wide range of spatial and temporal scales. The impact of a given management action may vary at different scales, e.g. the impact can be positive at local scale and negative at larger scale or vice versa; an action can have a positive impact in short time horizon but a negative one in long terms. Monitoring thus has to tackle the issue of spatial and temporal scales.

Taking these issues into consideration, environmental monitoring often needs to monitor a broad set of variables. Prohibitive costs emerge if the monitoring is based only on traditional scientific methods of measurements. This impedes the economic sustainability of the monitoring system over time.

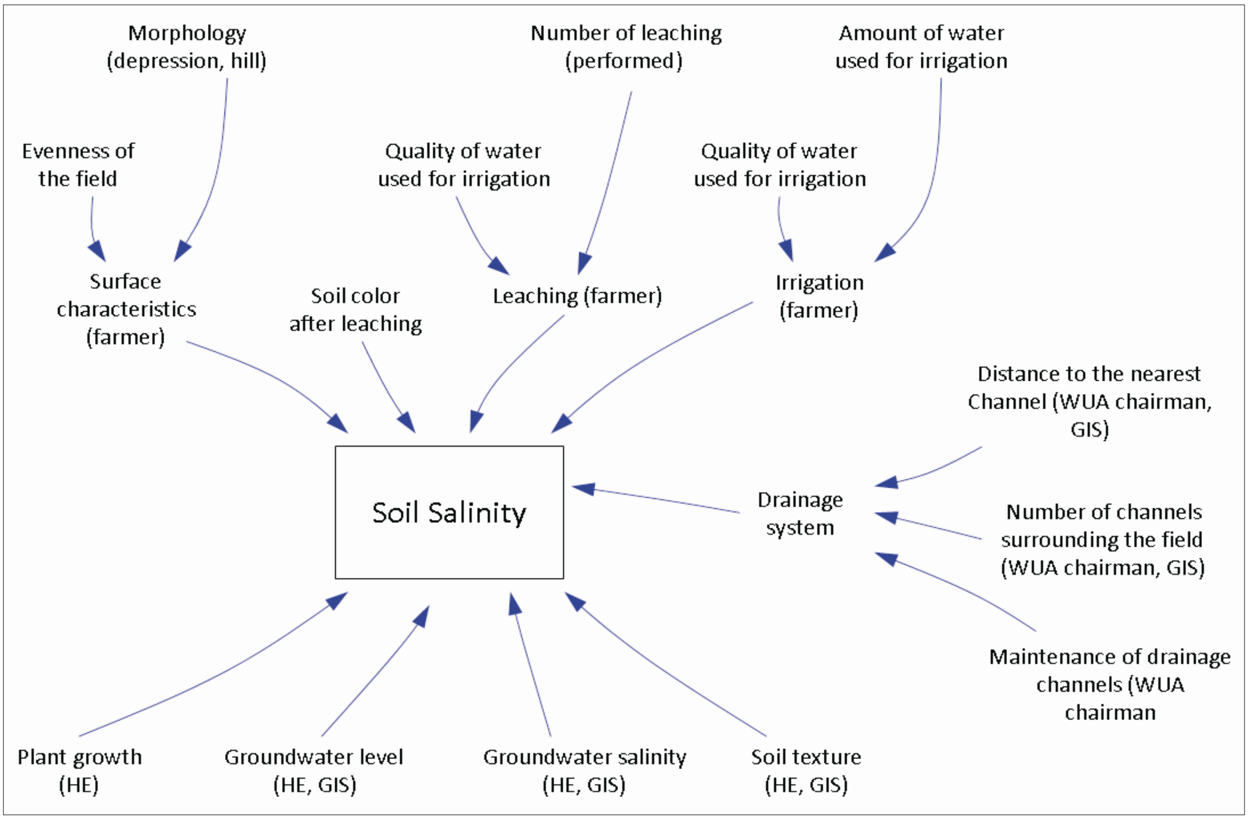
To deal with these issues, the design of a monitoring program should be based on the integration of various sources of information.

Aim

The research activities carried out in the Amudarya river basin aimed to investigate the potential of using knowledge from local communities to support environmental monitoring. The main goal was to integrate an innovative monitoring approach, based on the knowledge of experienced farmers, into the current soil salinity monitoring in the Khorezm oblast.

Two important issues had to be addressed, i.e. how to facilitate the involvement of local community members in monitoring activities, and how to improve the reliability of locally-based information in order to enhance its use in environmental management.

Factors affecting soil salinity



Approach

The involvement of local communities in environmental monitoring cannot be achieved by using complicated monitoring methods. The key is to keep monitoring as simple and locally appropriate as possible. Moreover it should be as similar as possible to the traditional methods for environmental assessment. Thus, individual interviews and group debates have been organized with experienced farmers to collect information about traditional methods used by local community members to assess the soil salinity during their normal activities.

The skepticism of scientists and managers could impede the practical implementation of the locally-based monitoring system. The usability of locally-based information in decision making strictly depends on the reliability of such information. To this aim, an integration of local and expert knowledge has been adopted. This integration allows the validation of causal linkages between the actual soil salinity and the visual assessment made by farmers.

Results

An Advanced Monitoring Information System (AMIS) has been developed. AMIS is composed of a technical part, a Geographical Information - based system (GIS), and a monitoring programme. The GIS-based system can manage qualitative information and integrate it with the information of the traditional monitoring system. The monitoring programme specifies the different steps and responsibilities for data collection, analysis and storage.

The latter has been developed after consultations with water managers, local experts of soil monitoring, Water User Associations (WUA) and experienced farmers. Two types of inputs were considered: (1) the information provided by farmers and (2) the soil salinity risk factors provided by experts.

(1) Based on the results of the interviews and group discussions a questionnaire was developed that is used to collect farmers' monitoring information. WUA technicians have the responsibility to interview farmers and collect their assessments. To keep the questionnaire as simple as possible, linguistic assessments are preferred to numerical inputs, and the terms normally used by farmers are included.

(2) Information about soil salinity risk is collected on the basis of the outputs of the "traditional" environmental monitoring system, i.e. groundwater salinity map, the groundwater level map, the soil type map, plant growth characteristics, etc.

Finally the salinity degree is calculated and associated to each field based on the integration between farmers' end experts' factors. A soil salinity assessment map is generated. The information contained in this map serves an improved definition of homogeneous areas of soil salinity. The map is then used to support the subsequent soil sampling procedure.

Conclusions

AMIS implementation in the Amudarya river basin aims to support integrated soil and water monitoring by improving some phases of the current soil salinity monitoring. Efforts have been made to integrate the "innovative" approach within the "traditional" monitoring practices, rather than substituting it. Moreover, the developed monitoring programme is entirely integrated in the farmers' daily activities. Thus, it does not require added efforts from farmers.

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Institutional barriers and opportunities for the transition to adaptive management

Situation

In the past water management in Uzbekistan has been characterized by a centralized top-down technocratic approach. In response to ongoing land reforms started after the independence of Uzbekistan in 1991, water management reforms have been introduced as elements of an Integrated Water Resources Management (IWRM). The basin principles of water management were introduced in 2003. In Uzbekistan, changes in irrigation water management mainly focused on transferring management responsibility to water user associations at the secondary canal level. Despite the fact that there have been several international donor projects promoting IWRM in the river basin, there has been little progress towards the implementation of IWRM. The reasons are insufficient economic and institutional conditions and weak mandates of water management authorities on all levels. Under these circumstances, the introduction of adaptive management strategies requires technologies and institutional settings that are flexible and error-tolerant plus learning and decision making processes that are transparent.

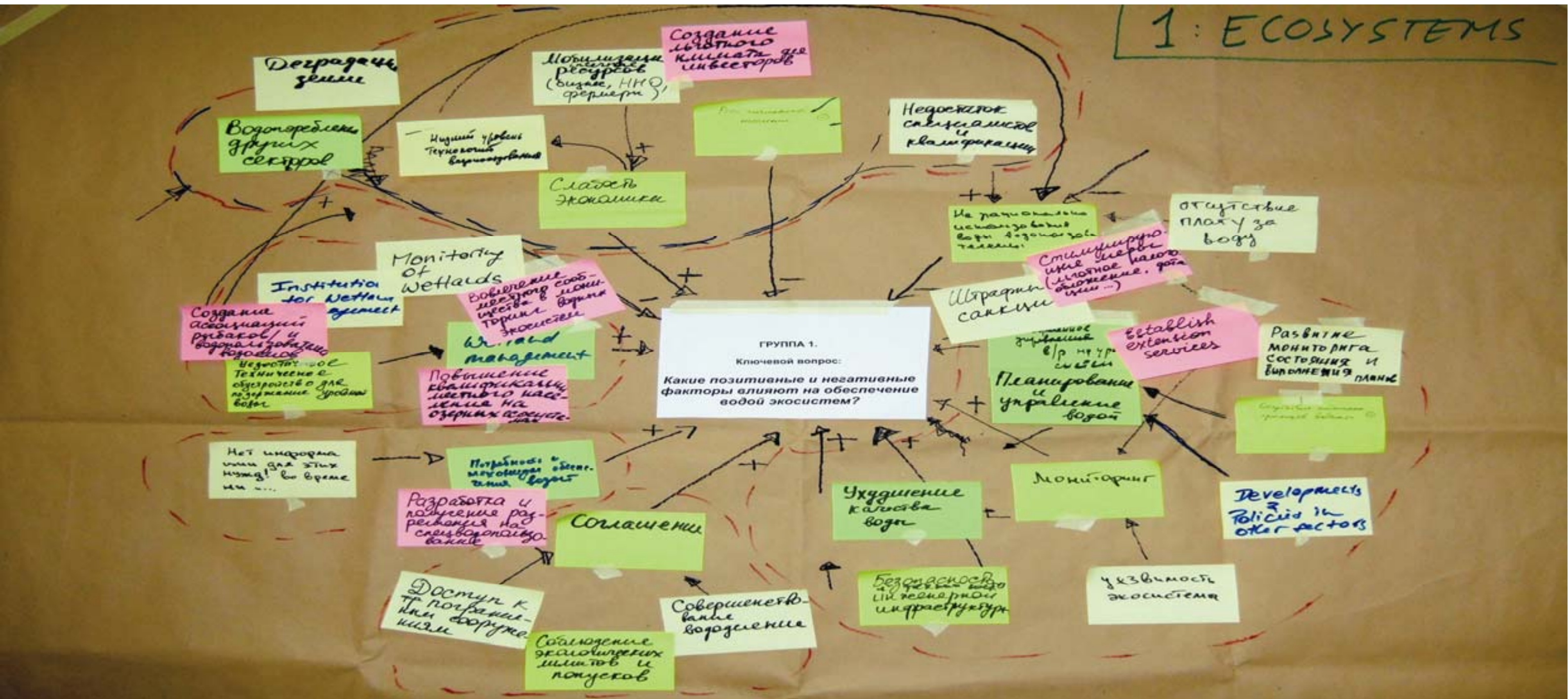
Aim

The goal of our research was to assess institutional barriers for a transition to a more adaptive water management in the Lower Amudarya River Basin. A transition implies that next to technical approaches, issues of improving the governance of water resources and allowing for social learning and adaptation of management practices have to be taken into account. We focused on the current water sector reforms and the reactions of stakeholders to environmental change, such as (severe) droughts and water deficit years.

Approach

During an initial stakeholder workshop in May 2006 the research activities on this topic in the Amudarya case study were presented and feedback on research needs was obtained. The research activities were supported by expert interviews, group discussions with relevant stakeholders and participatory observation. Additionally, the expertise of stakeholders from different management levels and their views and priorities

Resulting group model of stakeholder workshop



concerning the current policy of coping with extreme events were identified in workshops using the Nominal Group technique (NGT). The exercise addressed problems and lessons learned from the last extreme drought in the years 2000/2001. The aim was to develop feasible measures to address problems of water deficit, their consequences and potential solutions such as water saving strategies.

Results

The research on barriers showed that current pressing social - economic and environmental issues, such as the lack of skilled staff, job migration, income instability and the weak decision-mandate of newly responsible authorities in water management leave little room for thinking about the future. Moreover the pace of transition is low due to the large irrigation complex, the high numbers of involved organizations and large proportion of rural population. However, while the ongoing institutional and societal changes create a high level of uncertainty, they can also provide new opportunities. The following measures were suggested by stakeholders to cope with droughts and enhance the preparedness for extreme events in Uzbekistan:

- implementation of new policies and institutions to cope with extreme events,
- learning from past natural catastrophes or severe events,
- development of water saving strategies as economic, legal and technical solutions and issues of capacity building,
- transboundary cooperation

Moreover, horizontal (e.g. through a reduction of the dominance of the agricultural sector in water use and water management) and vertical (improving water allocation across scales and communication between organizations with similar responsibilities such as BUISes, UISes, WUAs) integration in the Amudarya Case study should be improved.

Conclusions

The activities on institutional barriers and opportunities have contributed to the formation of an integrated understanding of the current regime and its ongoing transition process. Critical elements promoting or inhibiting the transition towards a more adaptive management were identified. The results of the activities described above were integrated and supported an informed tool development.

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Resolving conflicts between water quantity, water quality and ecosystems services

Situation

Water of sufficient quality is scarce in the Amudarya delta, especially during low discharge years, when different water users compete for a sufficient share. Agriculture is the largest user, but also the restored lakes and new ecosystems in desert depressions need water. The delta lakes provide valuable opportunities for additional livelihoods of local inhabitants but are vulnerable to changes in the availability of water and high salinity levels. Future water supply is highly uncertain due to climate change and the changing water requirements of upstream areas and neighboring countries. Furthermore an increase in hydroelectric power generation might result in a more regulated flow. All these changes will have an effect on the concentrations of salt and will affect the availability of water of sufficient quality.

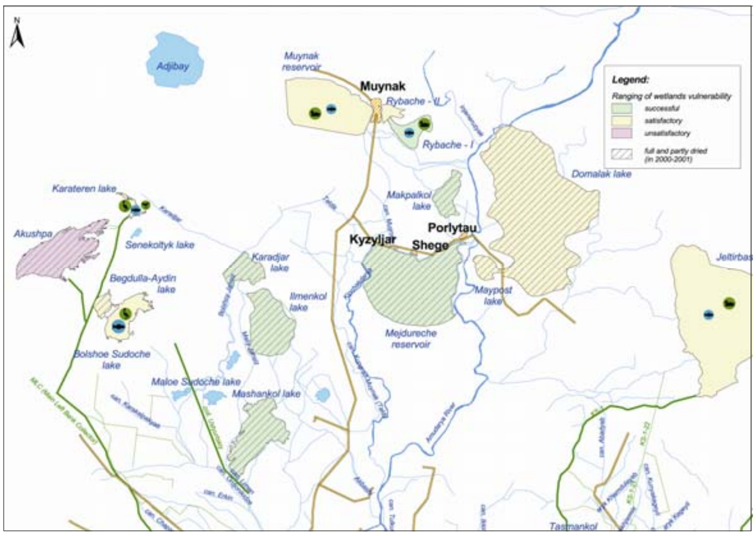
Aim

Research and tool development focused on the interaction between water quantity, water quality and ecological aspects in the Amudarya delta. Different models, varying from simple relationships to process oriented modeling approaches have been developed and tested. The objective was to predict the impacts of climate change on agriculture and the delta ecosystem and assess the possibilities of improved water allocation on a catchment wide scale, integrating soil, land use, water quantity, water quality in surface water and groundwater.

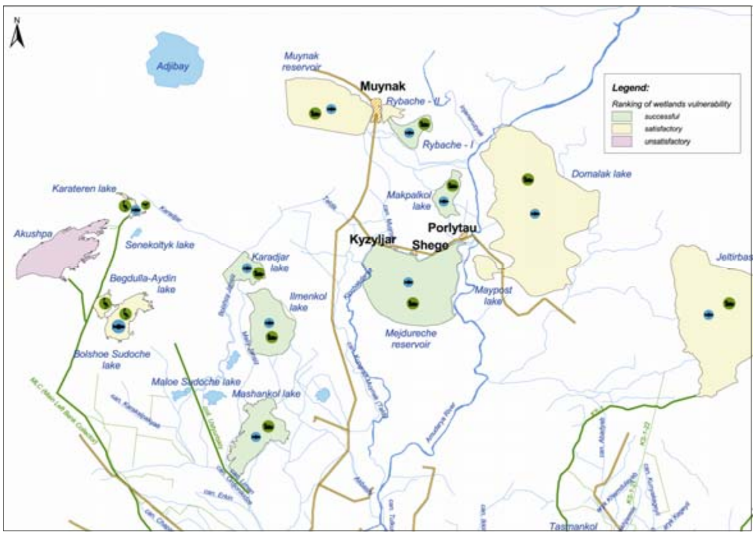
Approach

A data driven and model oriented approach was followed. In the Amudarya case study process oriented models were used (MODFLOW-SIMGRO) in combination with fish-population modeling and supported by an assessment of the vulnerability of the delta ecosystem. Satellite data was used to define the land use and to relate changes in land use in the Amudarya delta to fluctuations in river discharges. Via the Environmental Flow Network initiated by the World Conservation Union (IUCN) the research on water demands for ecosystems (environmental flows) in the Amudarya catchment was placed in a wider perspective and linked to the global research and water management community.

State of the Lake Ecosystems in North Karakalpakstan - Low Water Year



State of the Lake Ecosystems in North Karakalpakstan - Mean Water Year



Results

The modeling systems create the opportunity to evaluate the effects of both climate change and changes in the management and agricultural practices. Hydrological models were combined with fish population models to assess the impact of changes in flow regime on the viability of fish populations in deltaic lakes.

It was shown that it is possible to develop and apply strategies to reduce the impact of climate change on the ecosystem in the vulnerable deltas. By means of an adaptive water management approach nature and agricultural production can be better protected.

The Environmental Flow Network connects to NeWater and the Amudarya case study as a portal for communicating the importance of adaptive water management in river basins. A general framework was adapted from *FLOW: The essentials of environmental flows* and applied in the Amudarya Basin (www.eflownet.org).

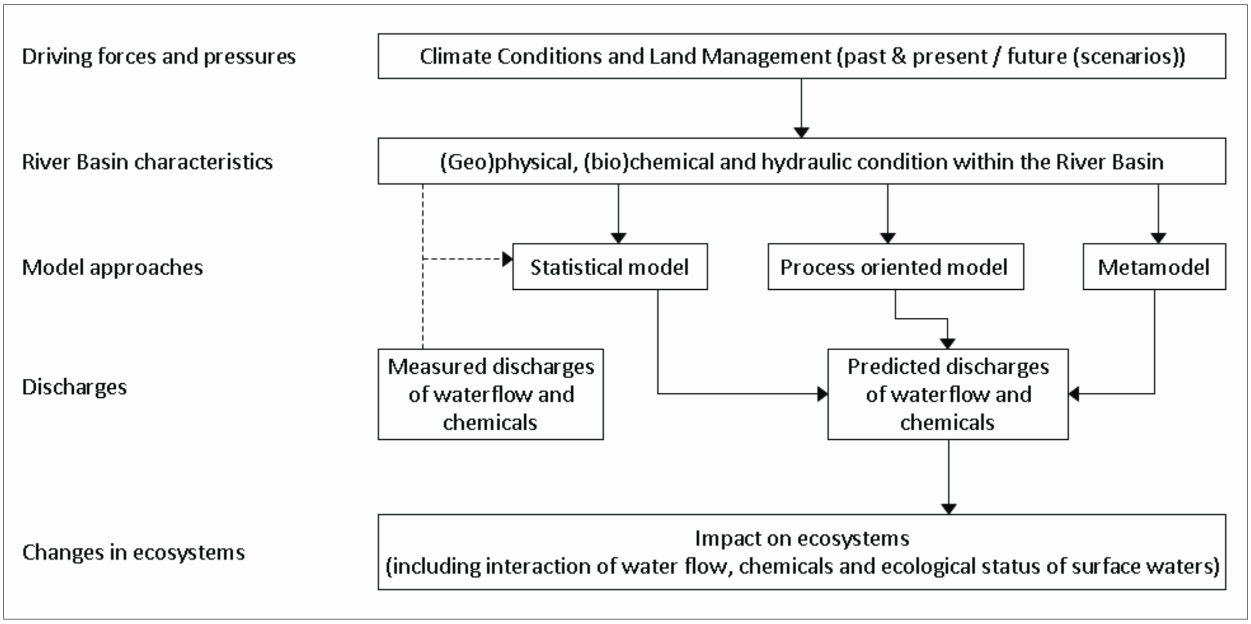
Conclusions

The Amudarya water system is highly managed and only models with sufficient management options will be capable of simulating the system dynamics. Data is not only needed to check a model, but a model is also needed to check the data. A model can be an integrating tool between different kind and different sources of data.

Climate change will aggravate the lack of water in low water years, due to lower runoff into the delta and higher crop evapotranspiration. Delta lakes can dry out. However, a better water allocation could provide a minimum of environmental flow against limited agricultural losses.

In order to ensure that vital freshwater ecosystem functions do not further decline, it is necessary to manage freshwaters in a more holistic way, looking at water quality, water quantity and ecosystem water needs simultaneously.

Conceptual Approach for Impact Assessment System



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Social Dimensions of Water Management

Situation

Recent environmental changes have posed substantial challenges to scientific research and policy making in Uzbekistan in search of a sustainable, efficient and equitable development path. There is a need for greater understanding of how deteriorating ecosystem services impact local livelihoods, aggravate socio-economic and gender inequalities, and, create water related health problems. NeWater research on social dimensions responded to complement this understanding through local level participatory research to articulate local needs and knowledge on environmental change and policy impacts.

Aim

The research aimed to understand the impacts of environmental change on human well being and sustainability of ecosystem functions. It attemptted to gain insights into the effectiveness of recent reforms in water and land management to improve livelihoods of farmers, fishers and homestead users. Further, it focused on the health impacts of a deteriorating environment. With the aim of achieving an inclusive and equitable water management, the research also looked into the differential impacts of environmental change and policy implications based on the socio-economic and gender attributes of the stakeholders.

Approach

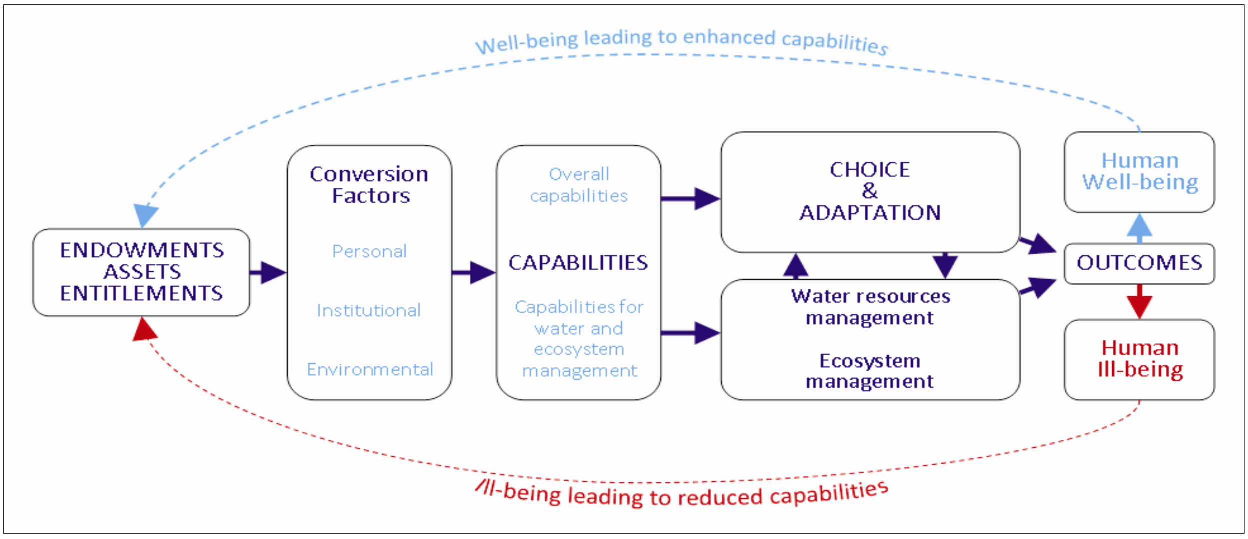
The research approach includes developing a conceptual framework to capture the interrelationship between livelihoods, resources and institutions. This framework emphasizes a holistic and locally grounded approach that needs to be adopted by water managers at all levels, including the national and river basin levels.

The field research was based on a questionnaire survey and participatory methods, including public communication meetings, focus group discussions, and dialogues with individual water users during a 20 month period from 2006 - 2008. Validation workshops were organized where stakeholders engaged in role playing games and formulated a set of local level strategic options.

Results

The above research on social dimensions pointed out a number of actions in order to embark on an efficient and equitable path for long-term improvement and sustainability of human well-

A conceptual framework for Learning and Adapting to Social and Environmental Realities (LASER)



being and ecosystem services.

These actions are:

(1) Recognize a diversity of water uses, instead of a narrow focus on cash crop production through intensive irrigation. Particular attention needs to be paid for improvement of water allocation in favor of homestead producers, pasture, and open access ecosystems that provide valuable food, fodder, fuel and construction materials.

(2) Prioritize provision of safe drinking water to reflect local concerns on the poor quality of drinking water, including high salinity, turbidity and suspected fecal contamination that might be linked to prevalence of water-related diseases, like diarrhea and hepatitis.

(3) Improve water allocation across the scales among upstream and downstream users and between agricultural land and fishing lakes.

(4) Extend the scope of formal water user networks, as the WUA to include the livelihood concerns of all water users, such as small dekhan farmers, homestead producers and fishermen.

(5) Recognize the impact of adverse environmental changes on women producers, particularly in fishing industry and homestead agriculture and formulate policy to reduce gender inequalities in the land and water management sectors.

(6) Incorporate a participatory approach in national planning tools to integrate relevant stakeholder knowledge on impacts of environmental change and adaption at local levels, e.g. for developing crop varieties to suit water scarce and saline soil conditions for improving water saving techniques in current irrigation practices.

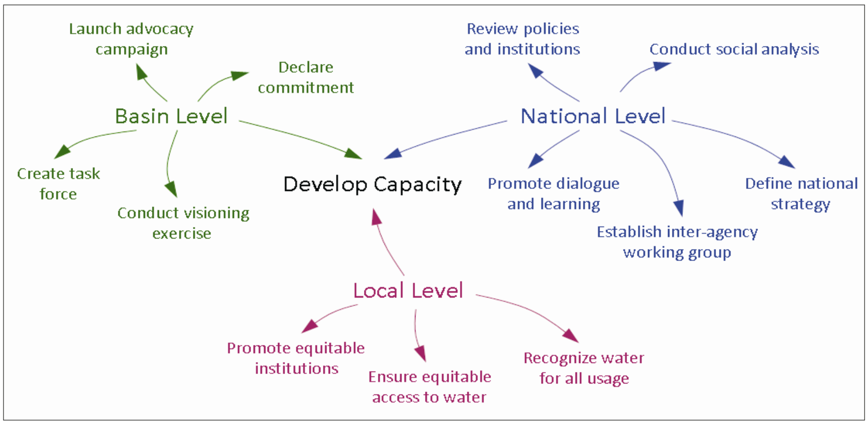
(7) Support the effective functioning of WUAs which is among one of the most important factors impacting water resources management. The WUA with high Participation and Awareness (PA) and Egalitarian Decision-Making (EDMI) Indexes are characterized with better water supply and water availability parameters that allow sustainable yields. This encouraging result should be sustained and shared with other WUAs for extended application.

Conclusions

Integration of local livelihoods, gender and health issues in adaptive water management is an important step towards achieving adaptive water management. An active learning process by all stakeholders and inclusion of all water uses are essential to this. NeWater research has suggested a number of tools in terms of policy commitments and institutional measures to make this possible (as presented in the Figure below).

The outcome will depend on how effectively policy makers and scientists in Uzbekistan can undertake multi-stakeholder dialogues to clearly identify local needs and incorporate experience-based knowledge that is increasingly recognized as an important asset in combating global environmental changes.

Addressing poverty, gender and health issues at the local, national and basin Levels



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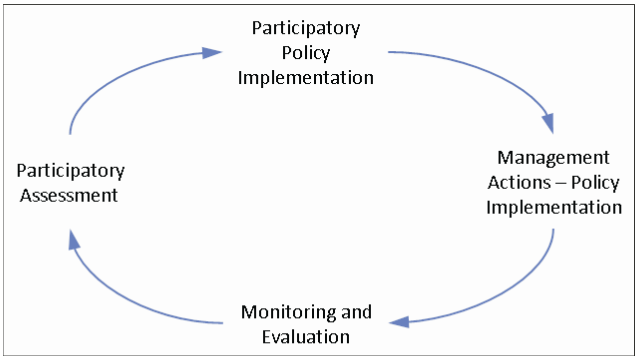
Development and Application of Tools for Adaptive Water Management in the Amudarya case study

Different tools, ranging from modeling systems to participative methods, have been developed and applied in the Amudarya case study. They aim to support activities relevant at different phases of policy making for adaptive water management (see figure on the right side), e.g. the planning of measures for policy implementation or the monitoring and evaluation of their effects.



Policy Cycle of Adaptive Management

Tools developed and/or applied in the Amudarya case study

Name	**Type**	**Purpose**
WEAP	a software tool that supports an integrated approach to water resources planning	strategic water allocation planning
Amupredict	statistical model	to support operational water allocation
MODFLOW-SIMGRO Amudarya	spatially distributed hydrological model, integrating groundwater, surface water and water management	to assess the effects of climate and socio-economic changes on water quantity and quality as well as the environmental flows to the delta lake ecosystem
DELTA PREVIEW	prototype runoff and land use prediction model	to give an early quantitative prediction of runoff into the Amudarya delta during the growing season and the related cropped area
LAKEFISH	hydro-ecological model of fish populations in deltaic lakes	assessment of impact of hydrological regime on fish survival and productivity
Adaptive Monitoring and Information System (AMIS)	Geographic Information-based monitoring and information system	to support environmental monitoring in data scarcity situations by facilitating the integration of different sources of information
Management and Transition Framework (MTF)	relational database	a framework to support the analysis of a management regime
Nominal Group Technique	participative method	elicitation of stakeholder views, development of measures
Cognitive Mapping & Group model building	participative method	elicitation of stakeholder views, participative development of measures
Strategic Choice approach	participative method	participative development of measures
Role Playing Games	participative method	understanding of management and adaptation options of local communities

WEAP

Type

The Water Allocation and Planning System (WEAP) is a computational system for strategic water allocation planning that takes the needs of different sectors into account. It attempts to assist planners with integrated water allocation planning and policy analysis by providing a flexible and user friendly framework.

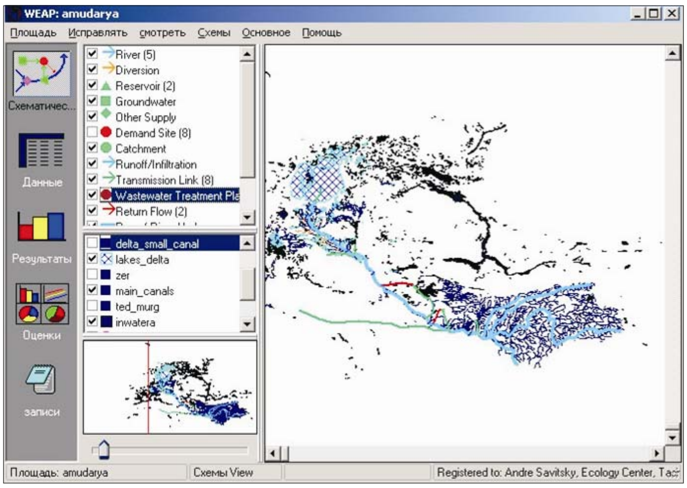
Purpose

WEAP represents relevant hydrological and water management processes with sufficient detail and accuracy while being simple enough to have reasonable data demands and be easy to use. This distinguishes it from other excellent models and computational systems for water distribution and water resources use that are often either very simple and tailored for a single situation or very complicated and thus data intensive. This makes it a valuable tool to be used by water management organizations in Central Asia.

Application

Within the framework of the NeWater project the WEAP system was improved and adapted to the local context to serve as a water management planning support system for the region. The following developments were made:

- The user-interface and help manuals of WEAP were translated into Russian.
- Water quality modeling in WEAP was improved. A link was established to external mathematical models for water quality modeling that take the specific conditions in the Amudarya into account.
- A subsystem for water runoff predictions was elaborated which calculates runoff forecasts based on historical data. A direct link was established between existing runoff databases and the subsystem to facilitate easy transfer of newly available data into the modeling system. The current prediction error is <20%. The prediction system was improved (error <10%) with the help of remote sensing information (MODIS).
- A curriculum for a master's course on integrated water resource management using WEAP was developed. Several additional features were added to WEAP, such as a computer-aided education system based on the WEAP help system.



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MODFLOW-SIMGRO

Type

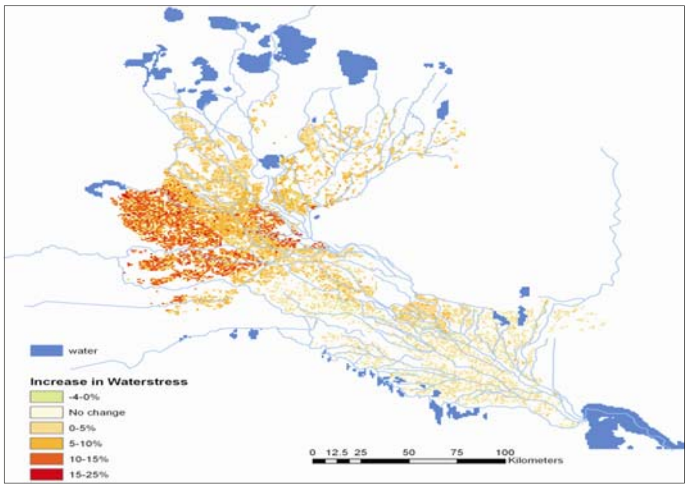
The MODFLOW-SIMGRO tool is a spatially distributed hydrological model, integrating groundwater, surface water and water management. It not only focuses on water quantity but also on its quality, i.e. salinity. The MODFLOW-SIMGRO tool supports scientists and regional water managers to evaluate the effects of climate change and reallocation of water resources on a regional scale.

Purpose

Particularly in a river basin like the Amudarya, with its highly complex water management system and harsh and variable climate, support by modeling tools to explore the effects of future changes can contribute to a better adaptive water management. The objective was to implement MODFLOW-SIMGRO to assess the effects of climate and socio-economic changes on both the water quantity and water quality as well as the environmental flows to the delta lake ecosystem.

Application

The MODFLOW-SIMGRO modeling tool describes the Amudarya delta on a 1 km2 grid scale. The main irrigation canals and collector drains and five different forms of land use are modeled. Results show that in low discharge years crop yields decline, especially downstream. Increased evapotranspiration due to climate change aggravates this decline. Lake volumes decrease dramatically in a dry year. One dry year does not dry out most lakes, but two consecutive dry years will. However a different water allocation might result in more water for the lake ecosystem against limited agricultural losses.



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DELTA PREVIEW

Type

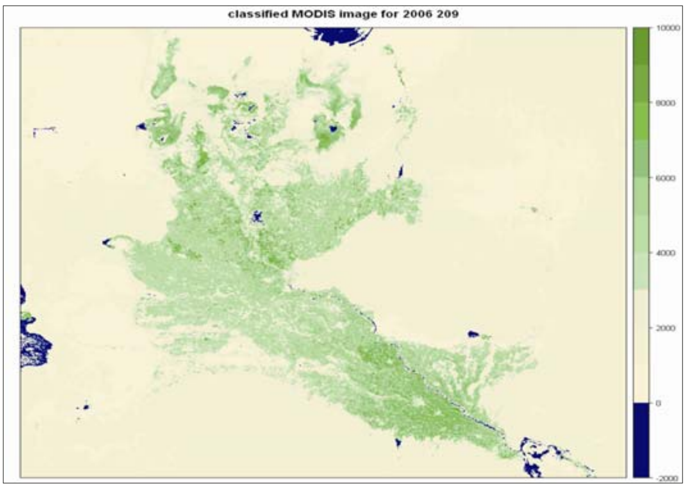
DELTA PREVIEW is a prototype runoff and land use prediction model which uses data on upstream discharges and satellite data on snow cover of the first four months of the year to predict the runoff to the Amudarya delta during the growing season. Based on the runoff prediction also the extent of the cropped area and yield can be estimated for different delta regions using empirical relationships between runoff, satellite derived cropped area and yield statistics of recent years.

Purpose

The purpose of the method is to give an early quantitative prediction of runoff into the Amudarya delta during the growing season and the related cropped area so that farmers, water managers and agricultural specialists can take timely measures.

Application

Preliminary results show that cropped area and crop yields start to decline in the downstream districts when yearly runoff to the delta drops below 20 km³. Especially for rice there is a strong relationship between runoff, cropped area and yields. The results also highlight the difference between the different regions and districts in land use adaptation in years of insufficient water supply. There is a clear distinction in response with the more upstream districts reducing cropped area only by a maximum of 8 % while downstream districts have to reduce cropped area by almost 20 %. Natural vegetation decreases by 20 to 30 % in dry years.



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LAKEFISH

Type

The LAKEFISH-Model is a hydro-ecological model that simulates the growth of fish populations influenced by changing lake water levels. The hydrological conditions within a lake are determined by the highly variable river discharge into the lake. This environment is strongly affecting the recruitment and survival of the fish population. Estimations of fish numbers under certain water flow scenarios help water managers to evaluate water distributions that can increase fish productivity.

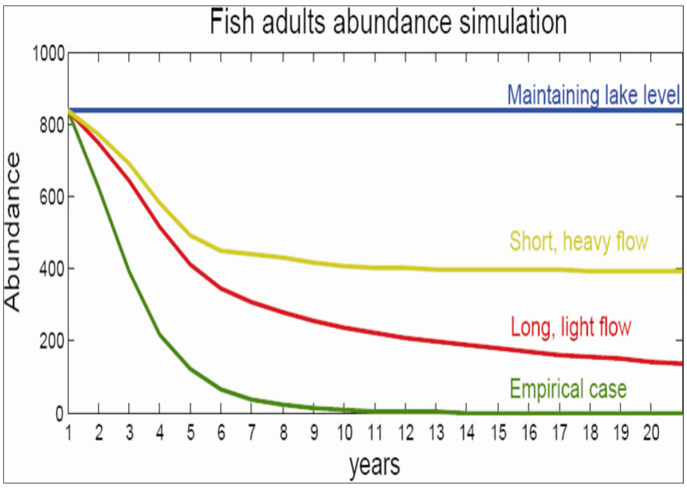
Purpose

Within the wetlands of the lower Amudarya river, fishermen face highly uncertain fish availability due to variable climate and management conditions. The objective of the LAKEFISH-model was to provide a qualitative evaluation of different river discharges and water distributions between lakes with respect to their impact on fish survival and productivity. Ultimately, this will contribute to balancing water partitioning between different water users in an adaptive water management context.

Application

Water allocation is of high concern for managers of the deltaic lakes because of its impact on fish productivity. The LAKEFISH-model assesses the ecological effect of hydrological changes. As an example, the model is applied to “Common carp”, a very robust and economically important species in the deltaic lake region. The model runs weekly time steps of river discharges to one or several lakes. It determines the impact of changing lake volumes on fish recruitment which is most important for the survival of the fish populations and needs to be taken into account when evaluating ecological effects.

Model results are the simulated numbers of fish of different ages. Outcomes should be interpreted qualitatively as comparisons between different scenarios. Because of lack of field or experimental data we could not verify the exact relationship of water level changes and fish survival rates. However, different percentages of fish numbers affected by river discharge might give a first indication of the relevance of regional water management for local fisheries.



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AMIS

Type

The Advanced Monitoring Information System - AMIS is a Geographic Information (GIS) -based monitoring and information system prototype.
The system is based on the open source GIS SAGA (http://sourceforge.net/projects/saga-gis/) and the object relational database management system PostgreSQL (http://www.postgresql.org/) with the spatial extension PostGIS (http://postgis.refractions.net/).

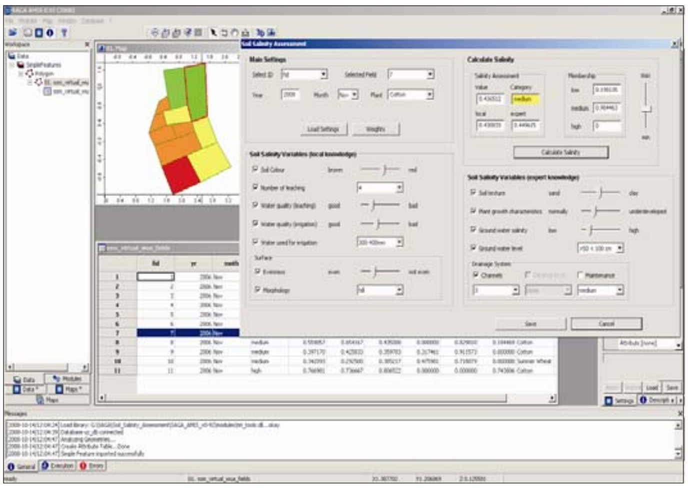
Purpose

The combination of GIS and relational database provides broad functionalities to administer and analyze environmental data with a spatial reference. AMIS supports environmental monitoring in data scarcity situations by facilitating the integration of different sources of information, such as qualitative and quantitative data. Due to the modular structure, the system can be easily tailored to specific requirements by implementing new algorithms or models.

Application

AMIS has been experimentally applied to support soil salinity monitoring in the Amudarya river basin. The figure shows the user interface to enter qualitative and quantitative information about soil salinity. A simple algorithm, based on weighting factors, calculates the degree of salinization according to the settings of the controls in the dialog. All data, parameter settings and salinity values, are assigned to a particular agricultural field and exported to the spatial database.

Download http://www.ufz.de/index.php?en=17262



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Participative Methods

Type

In the Amudarya Case study two types of participative methods were applied: mental models (Cognitive Mapping and Group Model Building) and small group discussion methods (Nominal group technique). With Cognitive Mapping each user draws his own model of important factors related to a specific question. In Group Model Building, a group of people creates a model according to their understanding of how a system works in relation to a selected issue. With Nominal Group technique people are asked to contribute their ideas in a discussion process using cards and flipcharts to organize.

Purpose

The application of participative methods can support the building of stakeholder commitment to management measures and policies. Two important building blocks to create commitment are:

- Achieving a joint understanding of the system in which the project is to be implemented: What is its purpose and what different factors and interests need to be taken into account?
- Allowing participants to express their own view and see how their input is taken up.

Application

Attaining on the methods Cognitive Mapping and Group Model Building was carried out in Uzbekistan. Subsequently both methods were applied in an expert workshop on environmental flow requirements in Nukus and in workshops discussing NeWater research results in Tashkent, Urgench and Nukus.

The nominal group technique was used for a stakeholder workshop in the lower Amudarya river basin to investigate the impacts of drought preparation measures and new institutions on water management at these levels.

The participants reported that the applied methods allowed them to better systematize their already existing knowledge and experiences as well as to better envision processes in the current water management. The interactive part of the discussions which helped to rank most pressing issues regarding water saving strategies as well as lessons learnt from the severe drought of 2000-2001 was considered as an opportunity to openly discuss pressing issues.

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Tools

Role Playing Games

Type

Role-Playing Games (RPG) are interactive simulations of the uses and dynamics of a resource within a community. In a RPG session, each participant is playing the role of a user or manager of the resource. The resource is represented through artifacts (pebbles, papers…) that can be distributed over a schematic representation of the territory. A game session is divided in several rounds. At each round, the participants must use or manage the resource, and the resource dynamics evolves consequently to their actions and to climatic constraints, following abacuses or a computer model. Settings and rules of a RPG consist in a simplified version of the socio-ecological system surrounding the resource.

Purpose

For scientists and managers, RPG are useful to feed back findings and to collect knowledge. RPG players may enhance their understanding of each others interactions and perspectives and of their system dynamics. They also may test alternative strategies and collectively think about new management scenarios.

Application

Two RPG were developed for tackling water management issues at the community level in the Amudarya delta. The fishing RPG "Balikshinar Oyeni" features fishermen and lake owners. The irrigation RPG "Fermerlarning o'yini" features farmers, WUA managers and mirabs. These RPG were played in four workshops held during the first week of April 2008.

Acknowledgements

The NeWater Amudarya team would like to thank the authorities and stakeholders in the Amudarya river basin for their support and participation in the project. We are grateful for the good cooperation with the ZEF/UNESCO Khorezm project and their generous support of our field research. We acknowledge the support of the WEAP development team of the SEI-US Center for the adaptation of WEAP. The project has been funded by the European Union within its 6th framework programme.

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