THE ARAL SEA BASIN MANAGEMENT MODEL*
FOR AWARENESS RAISING AND STRATEGIC DECISION SUPPORT

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The Aral Sea Basin comprises the Aral Sea, which is now divided into the Large Aral Sea (the southern part) and the Small Sea (the northern part), the dried out coastal areas around the Aral Sea (Priaralye) and the Amu Darya and Syr Darya riverbasins. The main water management isssues of the Aral Sea Basin result from intensified irrigation for agriculture which caused the Aral Sea to shrink rapidly, especially during the last 40 years. Moreover the amount of water available fluctuates over time and due to climate change effects the amount of water discharged by the rivers is assumed to decrease again over the decades to come.

At the start of the third millennium we face the enormous dilemma that, due to economic development and population growth, the demand for water may increase. This may cause conflicts of interest between demand for water by competing sectors of which irrigation and hydropower production are the most prominent. A main issue is to moderate water demand for irrigation on the one hand and find a balance between irrigation and hydropower water release requirements on the other.

The Aral Sea Basin Management Model (ASBmm) intends to contribute to a better understanding about water management issues among the many different stakeholders (states, regions, farms, cities, individuals) of the Aral Sea Basin. It incorporates hydrological modules and socio-economic and demographic growth modules that have been developed by experts in the region and it can facilitate researching of the complexity of decision making for water management in Central Asia. The models use data that have been collected in many various projects implemented in the region throughout the years

The model (which is available at CD-rom, see also site http://www.cawater-info.net/asbmm/index.htm) is serving different objectives:

- enhance awareness among a wide public (students, scholars) on the problems that face the Aral Sea Basin and the solutions that are possible. The model should be able to assess the consequences of population growth, economical change and climate change in combination with region wide implementation of certain measures, with a minimum requirement to the computer software and hardware.

- enhance awareness of policy makers by giving them the possibility to calculate the probable consequences for the region of different developments of population growth, economic

* *The production of the Aral Sea Basin Management Model was first commissioned by and designed within UNDP Aral Sea Basin Capacity Development Project (Dr. Andriy Demydenko, Project Manager) in 1999-2001. After finalization of this project, further work on the completion of the model and interface was sponsored by the Project Implementation Unit of the GEF World Bank Project Office in Tashkent. The project has been jointly implemented by Resource Analysis of the Netherlands and the Scientific Information Centre of the Interstate Commission for Water Coordination in Tashkent. The producers want to thank both the UNDP and the World Bank for their continued confidence and appreciation for the many efforts that it has taken to make the Aral Sea Basin Management Model into the fine instrument that it has eventually become.*

growth and climate change. The model should be able to distinguish different measures for different countries.

- advice policy makers on the feasibility of different alternatives. This requires a model on a more detailed scale.

The prototype version was developed for awareness raising among a wide audience, but during workshops with policy makers to evaluate the prototype, it was recognised that awareness raising among policy makers required more possibilities to view and change input data and to evaluate output data. The objectives are so different that they required different user interfaces. Therefore, every CD-rom that is distributed contains two different versions ASB-MM: the "ASB-MM" which is for awareness raising among the wider public, and "ASB-MM-expert" which is for awareness raising among policy makers.

The third objective, advice to policy makers, is achieved by the development of a model with far more detail, the "ASB-MM Planning Zones Model". This complex model consists of a more detailed hydrological and socio-economic module, with a distinction of 45 planning zones in the Areal Sea Basin. The model serves for SIC-ICWC to advice policy makers, but is not distributed widely.

The Issues of the Aral Sea Basin

Irrigated agriculture in Central Asia has a history of more than 5 thousand years. During the last 40 years almost all water that used to go to the Aral Sea was being used for irrigation, which resulted in the Aral Sea crisis. This is shown in a graph produced by the model. The amount of available water fluctuates over time and due to climate change effects the amount of water from the rivers is slightly diminishing over the years.

At the start of the third millennium we face an enormous dilemma: due to economic developments the demand for water could increase again, even to a level using all available water, which would leave nothing for the Aral Sea. The challenge is to moderate water demands either to remain on the current usage level but better still, to improve the situation for the Aral Sea and it's coastal areas by reducing demands.

By the way, the annual available amount of surface and groundwater is enormous: if it was Cola, every person on earth could drink 50 litre bottles each day, which is a 120.000.000.000.000 litre per year in total! However, the economies of the states depend on agriculture by irrigation, which uses a lot of water, in particular in the way that it is practised.

The high demand for water from irrigation is not the only problem that the region is facing. There are other issues that make finding sustainable solutions very challenging. This is also extremely relevant for the rest of the world: today's problems of the Aral Sea Basin could easily become tomorrow's problems of the World.

The population is growing very rapidly, despite of the uncertain future. At the current growth, the population will almost double in the coming 25 years. This will put high demands on food production and water.

Climate change

That climate change is occurring is no longer a point of discussion. Unclear is if this will lead to more or less available water. In the short term it is possible that snowmelt will increase and

therefore more water will be available. However, most probably in the long term less water will be available per year.

Hydropower

Water is not only used for irrigation but also for electricity generation. Demand for electricity is highest during wintertime. The water reservoirs need to be full then. This means that water is stored during the summer, when demands for irrigation water are highest. These are conflicting interests!

Political setting

Demands and availability of water in the five states are different and change over time. As water is scarce and economies depend so much on it, this generates political friction, which is fed by other issues like territorial disputes.

Salinization

All water contains a little salt. Irrigated land will evaporate part of the water, leaving behind the salt in the soil. Additionally capillary rise of groundwater salinates the soils. This salt accumulates over the years, unless it is washed away, which requires a lot of water. This mineralization became more and more serious the last few years: land productivity is decreasing now by an estimated 5-6% annually.

It is clear that we need to find ways to diminish the amount of water used, but at the same time we need to offer opportunities for economical growth, while improving the social situation.

This is a major challenge, which cannot be met by simple measures. Furthermore, interventions not only influence the aspects they are aimed at, but often have side effects that can be positive or negative.

To be able to develop viable, sustainable solutions it would be helpful to “test” these before really implementing them. This is where computer models come in. The software contains a socio economic (SEM) and a hydrological model (HM) to describe what will happen with the water as well as with the people in the near future. These forecasts can be made with and without interventions. It is also possible to compare different cases. The software can thus help in finding better solutions and will raise awareness of the problems in the region as well as their complexity.

A hydrological and a socio-economic model interlinked

The flow of water in the Aral Sea Basin is completely controlled by humans. Large structures like dams, reservoirs, channels, bifurcations and constrictions determine where, when and how much water will flow. A model describing these flows requires a lot of specialized knowledge, which the SIC-ICWC experts presented. The details (which elements are used) as well as the software are hidden from the user. The results, however, are made available. The model is capable of allocating water depending on activities and considerations as “hydropower first”, “irrigation first”, or “balance water between irrigation and hydropower”.

Given the complexity of the system, even a powerful computer needs some time to calculate the water flows and mineralization.

This model attempts to predict what will happen with the socio-economic system. Human behaviour is very important here, and not very predictable. Nevertheless it is possible to extrapolate some current figures to future situations. The model does this for:

- population (number of people)
- economy (growth, income, Gross National Product with a distinction between the sectors agriculture, industry and services)
- water (demands from agriculture, industry and domestic use)
- agriculture (crops, cattle, arable and irrigated land, yield)
- investments (in the improvement of irrigation efficiency and in new irrigated land)
- energy (production and consumption)
- nutrition (production and consumption in calories and by food basket)

There is interaction between this model and the hydrological model: water usage is determined by the demand (calculated by the SEM) versus the supply (calculated by the hydrological model). The socio-economical model deals with this. The "ASB-MM" interface helps the user by offering a limited possibility for changes in the socio-economic model. Users who want to be able to change all parameters can use "ASB-MM-expert" model.

The basic idea

The user is faced with the situation in 2000. The programme allows the user to take measures; this will change the target situation in 2020. The main influences concern hydropower generation and irrigation practices, but also the water use by towns is taken into account. As it is not clear what the future will bring, the user also chooses a set of scenario variables that describe for the period 2000-2020 the population growth rate, the growth in Gross National Product and the impact of climate change. The user will do this for the region as a whole. The model will disaggregate these values to the different countries and interpolate to the years in between 2000-2020. The disaggregation and interpolation is based on expert knowledge of the current and future situation of the different countries and on how fast measures can be implemented. A hydrological module and a socio-economic module exchange information and together compute the developments between 2000 and 2020. The situation in 2020, which is not necessarily equilibrium yet, will be expressed with use of different criteria that give an impression of sustainability.

Examples of model application

Examples of model application one could find at the web-sites (www.grida.no and http://www.cawater-info.net/asbmm/index.htm) and in publications dedicated to the Central Asian report to the World Summit on Sustainable Development (Johannesburg, 2002), which are available upon request.