GEF AGENCY of the IFAS

ARAL SEA BASIN PROGRAM

Water and Environmental Management Project

Sub-component A1

National and Regional Water and Salt Management Plans

Joint Report No.1

INCEPTION

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HASKONING
Consulting Engineers
and Architects

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APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

ASB	Aral Sea Basin
BVO	River Basin Authority (Russian acronym)
CAR	Central Asian Republics
CIS	Commonwealth of Independent States
DBMS	Database Management System (like Microsoft Access)
EC-IFAS	Executive Committee of IFAS
EPIC	Environmental Policies and Institutions for Central Asia
EU	European Union
GAMS	General Algebraic Modelling System (optimisation software)
GIS	Geographical Information System
HPS	Hydro Power Station
HYDRUS2D	A computer program for simulating water flow and solute transport
ICWC	Interstate Commission for Water Coordination
IFAS	International Fund for saving the Aral Sea
ILRI	International Institute for Land Reclamation and Improvement,
M&I	Municipal and Industrial water supply
NWG	National Working Group.
PMCU	Project Management and Coordination Unit
PZ	Planning Zone.
PZEOM	Planning Zone Economic Optimisation Model
QA/QC	Quality Assurance/Quality Control
RBM	River Basin Model,
REALM	REsource ALlocation Model (software package)
RIBASIM	RIver BAsin SImulation Model (software package)
RWG	Regional Working Group.
SALTMOD	A computer program for the prediction of soil salinity
SIC	Scientific Information Centre of ICWC
SOE	State Of Environment (report)
SWB	Salt/Water Balance
TACIS	Technical Assistance to the CIS
USAID	US Agency for International Development
USD	United States Dollar (ISO currency designation)
VBA	Visual Basic for Application
WARMAP-2	Water Resources Management and Agricultural Production in the Central Asian Republics – Phase 2
WARMIS	Water Resources Management Information System

WB	World Bank
WEAP	Water Evaluation And Planning system (software package)

1 INTRODUCTION

1.1 The Water Resources Problems of the Aral Sea Basin

1. Problems relating to water resources in the Aral Sea Basin started to a significant degree following massive irrigation developments from the 1950s through to the 1980s, mainly for the growing of cotton. The increase in the volumes of water diverted annually from the two main rivers, the Syr Darya and the Amu Darya, has led to a substantial decrease in the volumes of water reaching the Aral Sea. Consequently, the Sea has shrunk in extent, exposing sediments containing high levels of pesticides and herbicides which are sometimes mobilised in dust storms. Also as a consequence, the salinity of the Sea has increased over four times, causing many of the fish and other water species to die out. In addition, the increase in the total irrigated area has resulted in substantial increases in the volumes of drainage water, containing salts and other pollutants, that are returned to the rivers. This increase in the amounts of pollutants, combined with the reduced river flows, has led to a significant reduction in water quality in the lower reaches of both rivers, with salinity levels of greater than 1 g/l in both cases and levels of other pollutants sometimes locally above recognised health standards. This reduction in quality has had a major impact, particularly in the case of the Amu Darya, on crop yields and domestic water supplies in the delta areas. Overall these effects have had a major adverse socio-economic impact.

2. Excessive use of water for irrigation has led to the generation of large volumes of highly saline drainage water, which has to be disposed of partly in desert sinks to minimise return flows to the rivers. A lack of funds for operation and maintenance has resulted in a gradual decline in the condition of the irrigation and drainage systems, thus aggravating these problems.

3. The fact that agreed reservoir operation rules cannot always be complied with is another source of concern to the five Central Asian Republics. The requirements of the upstream States, which produce most of the hydropower, sometimes differ from those of the downstream States where irrigation is of greater importance. There is a need for a joint management system which can achieve a compromise that is agreeable to all parties.

4. Currently, the management and allocation of water resources in the Basin is carried out in accordance with a series of bilateral and multilateral agreements between various States. These relate principally to releases for irrigation and hydropower, and do not address issues related to water quality. By the very fact that these arrangements do not include all States, they may form a potential source of disagreement and conflict on the part of those States that are excluded. There is therefore a need for an agreement, or series of agreements, between all States which deals with water resource management in a way that is seen as being equitable to all parties. Also, because of the importance of water quality in the lower reaches of the two rivers, and because pollution occurs to an extent in all States, there is a need for the agreements to include water quality considerations.

5. A vast amount of work has been undertaken over the past few years in studies of the two river basins, resulting in a proliferation of reports and recommendations. These have examined exhaustively both the land and water resources, the management and operation of the resources and the control infrastructure, and the economic, financial and institutional framework related to water. The time has now come to bring together the results of these studies to give clear cut recommendations on affordable and reliable water saving techniques and institutional changes, and to provide guidelines within which to draft the interstate agreements.

1.2 Objectives of Sub-component A1,

6. The broad objective of Sub-component A1 is to provide these guidelines in the form of national and regional (i.e. basin-wide) water and salt management plans. One aim is to provide a consistent set of national and regional policies, strategies and action programs for the Basin which will address national priorities in the water resources sector and work towards medium and long-term targets for:

- water conservation and reduction of soil salinity;
- rehabilitation and improvement of irrigation and drainage infrastructure; and
- improvement of the operation and maintenance of main and on-farm canal systems.

7. A further aim is to develop a framework for the preparation of international agreements which will, amongst other things: (i) define water allocation mechanisms and river salinity standards, control mechanisms and measures, (ii) remove constraints on investment in national and regional water infrastructure, and (iii) remove constraints on funding of the further development of the regional agencies in charge of planning and management of the basin’s water resources and infrastructure. The framework will comprise:

- an integrated national and regional policy, strategy and action program,
- a common understanding of the value of water and of the need for water conservation,
- a comprehensive knowledge and information base for use in implementing and monitoring the action program, and in updating and enhancing the program in future.

1.3 Project Team Structure and Composition

8. The team that has been assembled for the project comprises a Regional team, which has the task of considering the problems and solutions from an overall Aral Sea Basin perspective, and five National teamsdrawn from each of the Central Asian Republics. The Regional team has two components. One is an international component, which is provided by HASKONING. The other is a National component, which comprises two consultants drawn from each of the five States plus several other specialists.

9. The international component also provides the overall management for the project. Each National team, as well as providing assistance at State level to the

various Basin-wide studies, has the task of developing a water and salt management plan for its own State which also accords with the overall regional plan. The organisation and management of the team is described further in Chapter 6.

1.4 Objectives of This Report

10. The Inception Phase has been one of familiarisation, in which we have reviewed the available data and computer models and held discussions with many of the relevant government agencies. On the basis of this improved knowledge we have, in consultation with the National teams, refined our methodology and finalised our team organisation and project management structure. The objectives of this Inception Report are to:

- record the data and discussions held,
- provide our assessments of the data and tools available for the project,
- describe our proposed approach, methodology and workplan for the remainder of the project.

2 BASIN FRAMEWORK FOR WATER RESOURCES MANAGEMENT

2.1 Water and Salt

11. A great amount has been written in recent years about the river flows and salinity levels of the Aral Sea Basin. In brief, the total average annual flow from all rivers in the Basin is estimated at about 116 km^3, of which 68% occurs in the Amu Darya and 32% in the Syr Darya. There are more than 80 significant water storages in the Basin, many associated with hydropower generation stations, and as a result the river flow patterns are highly modified. About three quarters of the river flow is diverted for irrigation, and much of the remainder is lost by evaporation, seepage, and other losses. Drainage return flows amount to about 36-38 km^3 annually, or about 40-45% of total diversions.

12. River salinity levels in the Syr Darya average about 1 g/l in the middle reaches, and often exceed 2 g/l in the lower reaches. Salinity levels are lower in the Amu Darya, averaging about 0.6 g/l in the middle reaches and often exceeding 1.5 g/l near the delta.

13. Most precipitation occurs in the upland areas, generating nearly all the surface water flows of the Basin and some of the groundwater flow. The sediments underlying the vast desert zones contain sequences of aquifers which store large volumes of brackish groundwater. Fresh groundwater occurs mainly in elongated alluvial sediments along existing or ancient river channels. Aquifer recharge from direct rainfall is limited in the arid to semi-arid zones in the west of the Basin, and recharge from rivers and canals is the predominant mechanism. It has been estimated that more than 80% of the region’s renewable groundwater resources are connected with surface water courses .

14. Shallow groundwater salinity levels in the upper reaches of the two river basins typically range from less than 1 g/l up to 3 g/l, while in the middle and lower reaches they range typically between 5 and 20 g/l for the Amu Darya and between 3 and 10 g/l for the Syr Darya. The expansion of irrigation and drainage in the last forty years has increased groundwater flows and hence has mobilised the salt contained in the groundwater.

2.2 Irrigated Agriculture

15. Irrigated agriculture is the backbone of agricultural production in all of the Central Asian states except Kazakhstan. Out of a total irrigated area of about 7.9 million ha, around 4.5 million ha (53%) are located in Uzbekistan. The total area of irrigated land has not changed significantly since Independence, with reductions in some States being offset by expansion in others, especially in Turkmenistan. Major reasons are the differences between the States in: the reactions of the agricultural sector to privatisation efforts, public sector investment policies, and economic capacity to maintain the existing irrigation and drainage infrastructure.

16. Although the total area under cotton has declined since 1990, it remains one of the most important crops and accounts for the majority of export earnings. In that period a significant shift in cropping patterns has occurred in favour of wheat, basically as a response to government policies to achieve self-sufficiency in that commodity. The area planted to wheat has more than doubled, primarily at the expense of fodder crops and cotton, leading to, declining soil fertility and a sharp reduction in animal production. The area devoted to rice has reduced substantially in the lower reaches.

17. In general, yields for both cotton and wheat are considered low, and in the various States have decreased between 5% and 30% since 1990. The major reasons are low input use (due to their high prices) and insufficient production incentives. Water use per hectare has gradually been decreasing over the last ten years but there is still a substantial difference between actual and required water consumption. While recommended annual irrigation rates ranged between 3,800 m^3/ha and 11,200 m^3/ha, actual consumption in 1990-1998 ranged between 4,500 m^3/ha and 20,600 m^3/ha. Water losses caused by the deteriorated irrigation infrastructure, subsidised tariffs for electricity (water pumps), and minimal water charges are some of the main reasons for the excessive water use.

18. A large proportion of the irrigated area requiring drainage is provided with the necessary facilities, but much of this infrastructure is not operating because of low budgetary provisions and a consequent lack of maintenance. As a result of these problems, the area with shallow watertables increased from 25% to 34% of the total irrigated area between 1990 and 1998, while in the same period the area of moderately and highly saline land increased from 23% to 29% of the total irrigated land.

2.3 Socio-Economic Setting

19. With the exception of Kazakhstan, irrigated agriculture accounts for the bulk of the agricultural production in the Central Asian Republics. Although wages and living standards are low in the agricultural sector, the economic crisis following the break-up of the Soviet Union has forced the majority of the rural population to remain in agriculture, which at least provides them with the land to provide their family food requirements. The current land reforms and the options to cultivate private plots allow many people to achieve food self-sufficiency.

20. In general, the five Central Asian Republics are shifting from centrally-planned to free-market economies, but progress has been varied. While Kazakhstan and the Kyrgyz Republic have made early commitments to structural reforms, Turkmenistan and Uzbekistan have followed policies of gradual transition in order to avoid drastic economic consequences for their population. In these two States, while social welfare programs have been used to buffer the impacts of the economic reforms, the governments still retain control over key sectors of the economy, especially agriculture. In Tadjikistan, the reform process has been hampered by the low economic base and the ongoing internal conflicts.

21. Although the industrial and service sector is expanding, non-agricultural employment opportunities remain limited, and the high number of people in the agricultural sector is a sign of hidden unemployment and lack of alternatives. Limited job opportunities and the higher cost of living in urban areas discourage rural to urban migration. Population growth is slowly declining in all five States, but growth rates of 1.5-2% per year still apply, and these represent a considerable challenge for the various economies, especially with regard to the creation of additional employment. About 40% of the population are under 15 years old, indicating the need for creation of non-agricultural job opportunities in the national workforces.

22. From a macroeconomic point of view, the general economic conditions in the Central Asian Republics are less than optimal for investment in irrigation infrastructure, despite the growth potential based on the natural resource endowment. Features common to all economies include:

- a continuing decline in production since Independence as a result of the loss of major market outlets, high inflation rates and a weak economic base in transition to a market-oriented economy;
- scarce financial resources, thus limiting the ability of the States to maintain basic services;
- low income levels, which make it difficult to introduce full cost recovery tariffs for public utilities and irrigation water;
- continuing population growth and sharply contrasting standards of living between urban and rural populations.

23. In the agricultural sector, the adoption of market prices and the dismantling of the state order system is continuing. Privatisation of land and the other assets of collective farms, and the introduction of competitive markets for input and outputs, is also taking place. Although the extent of structural reforms varies substantially between the five States, it is expected that the existing market and price distortions will gradually disappear over the planning period.

24. The current low yield levels achieved for major crops (cotton, wheat) under irrigated conditions are not only an indication of technical constraints, but are the result also of insufficient production incentives and the reduced use of inputs. The potential for growth and higher foreign exchange earnings can be seen in improved quality (cotton, wheat) and the increased processing of agricultural produce (cotton, fruit, vegetables). In terms of land and water use, this suggests that cropping patterns will change as farmers respond to market forces.

25. Reasonable farm incomes will not only result in increased land productivity, but will also allow the introduction of fees for water delivery that reflect the true costs of supply. This will lead eventually to rehabilitation and improved operation and maintenance of existing irrigation infrastructure, reduced waste of irrigation water and improved water quality.

2.4 Ecological Environment

26. The large Aral Sea wetland ecosystem has become degraded over the last 40 years. The salinity of the sea water currently exceeds 40 g/l, in contrast to the average value of around 10 g/l which prevailed up to the 1960s. The Aral Sea itself now contains little in the way of living species, while the wetlands in the river deltas and in the floodplains have deteriorated. The riverine Tugay forests that depended on floodwaters have been decimated. The dams that have been constructed in the various river reaches effectively block fish migration and affect the biota, while increasing salinity levels of the river water have had adverse effects on fish reproduction.

27. On the other hand, the opportunities for greater biodiversity have increased in many ways, particularly in the middle reaches of the main river basins. Chains of smaller wetlands have developed in areas where river water is diverted, or in desert areas where the disposal of drainage water has formed lakes. The largest example is Arnasay Lake in the Syr Darya basin. Others include Lake Dengizkul, Sultandag, Karakir, Sarikamish Ayakagitma, while in the delta, Sudoche, Mezdureche and Djilterbas are good examples. They are feeding and breeding places for waterfowl, they have potential for fisheries, and they attract a large variety of terrestrial fauna when salinity levels remain below critical limits.

28. Although the young wetlands demonstrate that viable ecological environments can develop over relatively short periods of time, they can collapse just as rapidly if the hydrological regimes are unstable. This is currently the case in the deltas, where there are large seasonal and inter-annual fluctuations in inflows and water levels. The ecological environments in many desert sinks are also at risk, as the salt load in the drainage flows accumulates and salinity levels increase steadily.

29. Salinity is presently considered to be the critical factor in terms of river water pollution. The levels of pesticides, trace metals and other hazardous chemicals in the rivers have reduced significantly since the collapse of the Soviet Union, because of a reduction in the use of pesticides in agriculture. In general, pollutant concentrations do not exceed drinking water quality standards, although locally trace metals like antimony and mercury sometimes exceed the standards locally as a result of mining activity. Bacteriological pollution is widespread, because few treatment facilities for domestic wastewater are operating effectively.

2.5 Institutional and Policy Development Environment

30. Before Independence the allocation of water and energy among the Central Asian Republics was decided by the Soviet government. These basin arrangements (and the implementation of drainage and wetland development programs) were seriously affected by the collapse of the Soviet Union in 1991. Although the previous annual water allocations among the States were maintained, agreements became increasingly difficult to negotiate and implement, for political, economic and technical reasons and also due to differing interests becoming more apparent.

31. Until recently, donor organizations have had little success in supporting improvements to basin water management, including changes to interstate institutional arrangements, despite considerable efforts made over the last few years. In 1994 the Aral Sea Basin Program (ASBP) was formulated with the support of World Bank, UNDP and UNEP. A new regional organization was established to implement the program - the International Fund for Saving the Aral Sea (IFAS) and its executive body EC-IFAS. Although the Board of IFAS consists of Deputy Prime Ministers from each State, the IFAS structure operates as a funding organization rather than a basin water management organization.

32. The Interstate Commission for Water Coordination (ICWC), which had been created in 1992, was later, with its affiliated Secretariat and Scientific Information Center (SIC-ICWC), placed under IFAS. The responsibilities given to the ICWC included: determination of water policy for the region and limits on annual water consumption for each State and the whole region, allocation of available water resources including water from the Aral Sea, and scheduling of water reservoir operations. The operational responsibilities for executing ICWC decisions were given to the Syr Darya and Amu Darya River Basin Water Associations (BVOs).

33. A first attempt to address regional and national water resources policies, strategies and action plans was undertaken in 1995-96 in the form of the Aral Sea Program Project No. 1, in which reports on water-related issues were produced for each of the five States and the region as a whole. This has been followed by the Water and Environmental Management Project (WEMP), often also referred to as the GEF Project of IFAS. The project is seen as the vehicle by which a common basis for policy, strategy and action programs will be created. Substantial analytical work has recently started on clarifying the strategic choices to be made and their impact on the economy and environment of the five States. However, their progress and impact may be adversely affected by inefficient working of the water management structures at the national and basin level because of economic difficulties.

34. The European Union has also provided support for the ASBP through its WARMAP 1 and 2 projects undertaken by TACIS (Technical Assistance to the Commonwealth of Independent States). The two regional WARMAP projects were directed towards water resources and agricultural sectors and were implemented with ICWC and its affiliations as the primary client and beneficiary. Apart from databases and modelling tools for water resources planning, two draft interstate agreements were prepared: on data and information exchange and on the development and strengthening of institutional arrangements for basin water management. WARMAP 2 ended mid 2000.

35. US support has been provided through the US Agency for International Development (USAID) which initiated the EPIC project. This project was linked to the regional body CAEC (Central Asia Economic Council) with whom they created the Energy and Water Round Table, thus combining water and energy issues. Their focus was on potential and real disputes over management and operation of the Naryn Cascade, and resulted in a framework agreement on water/energy exchanges. EPIC ended by the end of 1999.

36. Two other regional projects started about the end of 2000. One is the UNDP-supported SPECA project under the auspices of the CAEC, which has a component on regional water and energy management. The other is a large USAID-supported project which also has a substantial component on water and energy management.

37. The number and diversity of projects demonstrates the need for more effective co-ordination, both between the States and between the donor community, with the lack of common platforms at national and regional level leading to counterproductive competition between organisations and duplication of work.

38. Although an increasing number of investment projects are being implemented, they are facing complications because of interstate issues over water resources or water infrastructure. None of these projects addresses the key issue at the national level, namely: the absence of a national focal point or body with the political mandate and competence to accommodate the differing positions and conflicting interests of the various sectors and agencies.

3 THE INCEPTION PHASE

3.1 Objectives of Tasks R1 and N1

39. The Inception Phase of Sub-component A1 comprises Task R1 and N1 as set out in the Terms of Reference. The objectives of those tasks are to:

- assess the usefulness of the available information for complete implementation of the project, and identify the data gaps;
- assess the available tools, in particular the WUFMAS and WARMIS databases and models, and identify needs for any further model development during the project;
- develop detailed approaches and methodologies to fill the data gaps and undertake the necessary model development;
- develop detailed approaches and methodologies for full completion of the various tasks described in the Terms of Reference;
- prepare a detailed work plan and project management plan.

3.2 Performance of Tasks

40. During the Inception Phase the project team collected and reviewed a considerable number of documents. They are all listed in Appendix A. Reports of particular importance included those describing:

- Aral Sea Project 1.1, Basic Provisions for the Development of the National Water Management Strategy, 5 States;
- Aral Sea Project 3.1B, Agricultural water Quality Improvement – ILRI;
- The Preparation Study of the Uzbekistan Drainage Project – Mott McDonald Temelsu;
- Environmental Assessment of the Uzbekistan Drainage Project in the Amu Darya Basin – IWACO;
- WARMAP-2 and WARMIS – Tacis.

41. The National teams participated in the preparation of this report through discussions with the Consultant in the States, participation in the working session on the inception phase, and by providing their reports in response to Terms of Reference. With one exception, the written contributions received demonstrate the need to establish a quality assurance manual suited to the project needs. The teams also provided information on the sources and availability of data of interest to the project.

42. There was close interaction between the Regional team members and staff of the Scientific Information Centre (SIC) of the Interstate Commission for Water Coordination of Central Asia in developing an understanding of the WARMIS database and models. Our evaluation of WARMAP was hindered by incomplete documentation of the project in English.

43. Table 1 lists the various national, regional and other international agencies, and the relevant personnel, that were contacted during the Inception Phase.

Table 1 Agencies and People Contacted During Inception Phase

Agency/ Institute	Name/Position
Kazakhstan	
State Committee on Water Resources	A. Ramazanov, Chairman
	K. Askarov, Chief of Water Management Dept
	T. Sarsembekov, Leader of the NWG
Institute Kazgiprovodkhoz	L. Dmitriev, Director
	A. Zemlynikov, Chief Engineer
	M. Nurtazin, Senior Specialist
JSC Yuzgkazvodproekt	M. Dzhunusov, Director
	V. Petrashov, Chief Engineer
Kyrgyzstan	
Ministry of Agriculture and Water Resources	A. Kostuk, Minister
	B. Koshmatov, Director of Water Management
	K. Beyshekeev, 1st Deputy Director of Water Management, Leader of the NWG
	A. Djailoobaev, Energy Specialist
AOOT Kyrgyzsuudolbor	T. Sarbaev, Chief of Marketing Department
	A. Bekenov, Chief Engineer
State Energy Agency	M. Mateev, Director
Tadjikistan	
Ministry of Water Resources	M. Nazriev, Deputy Minister and Leader of the NWG
	A. Kholmatov, O. Komilov
TadjNIIGIM	B. Rakhmonov, Y Pulotov, S. Kamolov,
Ministry of Agriculture	A. Kamolitdinnov
PowerCompany “BarkiTochik”	B. Garibmakhmadov
Ministry of Economy	D. Valiev
Turkmenistan	
Ministry of Water Resources	A. Khatamov, Leader of the NWG
	A. Berdiev, Senior Specialist
	B. Annaev,
	O. Orazmamedov
Institute Turkmengiprovodkhoz	V. Golubchenko, S. Aganov, A. Avanesov
Ministry of Agriculture	D. Goshaev
TurkmenGeologia	A. Avanesov
Uzbekistan	
Ministry of Agriculture and Water Resources	A. Djalalov, 1st Deputy Minister
Uzgipromeliovodkhoz	U. Abdullaev, Director
	M. Gulayev, Chief Engineer

Agency/ Institute	Name/Position
	Gontsharov, G. Khasankhanova, Lutay
SANIIRI	M. Horst, Principal research associate
	Nerozin, Senior Specialist on Soil
Technical University Irrigation Institute TIIMSH	G. Yusupov, Hydrogeologist
Ministry of Macro-Economics and Statistics	D. Barraclough, Team Leader Water Supply, Sanitation and Health project
Regional Agencies	
EC-IFAS	T. Altyev, Chairman
	U. Saparov, Technical Director
SIC-ICWC	V. Dukhovny, Director
	V. Sokolov, Chief of Information Centre,
	A. Sorokin, Chief/Regional Water Man. Dept
	A. Shapiro, Chief Groundwater Specialist
Other International Agencies/Consultants	
The World Bank Uzbekistan Country Office	D. Pearce, Chief
	A.Krutov,
	T. Lennaerts,
	N. Egamberdiev
DHV	P. van den Hoven, Team leader, WARMAP-2
GTZ - Tashkent	Dr. F. Hufler. Team Leader, Sustainable agricultural development project
IMF - Tashkent	C. Rosenberg, Resident Representative
TACIS - National Coordinating Unit	P. Reddish, Team Leader
UNDP - Tashkent	M. Anstey, UNDP GEF Biodiversity Adviser
USAID - Kazakhstan	John C. Starnes, Office Director, Office of Energy and Environmental Initiatives

3.3 Team Working Session

44. A four-day working session was held in Tashkent during the Inception Phase, involving several members of each of the five National teams and the international component of the Regional team. In all, 35 members of the National teamss and six members of the Regional team attended. The objectives of the working session were to:

- enable the members of the regional and National teams to meet and get to know each other, and thus foster a team spirit and facilitate communications and cooperation in the later phases of the project;
- discuss the availability and quality of data in the various States, identify gaps, and consider the necessary measures to fill the gaps;
- discuss and reach agreement on the tasks to be performed by the National teams, in terms of methodology, required outcomes, and work programs.

45. The first day consisted of plenary sessions in which the overall project, the future mode of operation of the team, and procedural arrangements, were described. In the following two days, group sessions were held relating to the individual tasks set out in the project terms of reference. The sessions focused on the availability and usefulness of data and the methodologies proposed for each task. The outcomes of the group sessions were reported back to the whole assembly on the final day. Where the outcomes of the working session may affect the tasks, they are discussed in the sections describing the proposed task methodology. We believe that this interaction assisted us in developing a practical approach which builds on previous studies and projects. The National Co-ordinators and Team Leaders played an important role in facilitating this process. Major points/outcomes of the working session are reported below.

46. Following the working session, the National teams were requested to assess the availability of various types of information within their States. The results of their assessments are presented in the relevant sections of Chapter 4 below.

47. The group working sessions on ***policy guidelines and planning principles and criteria*** as well as on ***scenario development*** focussed on the need to apply such tools in the whole process of arriving at national and regional policy, strategies and action plans to be presented to governments and regional organisations for decision making. In general, not all participants were familiar with these concepts, but they voiced their opinion that it would not be necessary to introduce new concepts in water resources planning. Further introduction and clarification is needed and has to be provided at the start of the tasks.

48. The discussions on ***participation of beneficiaries in the planning process*** focussed first on communicating the principles of participation of stakeholders and continued with a discussion on who should take part. In summary the group was of the opinion that we should consider at least the following aspects:

- Target groups at different levels should be included;
- All significant categories of water use should be included, including farming, environmental use, fisheries, domestic water supply, etc.;
- Water user associations formed at a pilot level in various States could be involved in the participation process;
- Participation mechanisms exist in some States, and these should be considered for inclusion in the participation process.

49. No consensus could be reached on a definition of ***sanitary and ecological water demands***. It appeared that the participants were rather unfamiliar with the concept of sanitary and ecological water requirements. Although the presentations provided by the international consultants focussed on sustainability criteria for the various wetlands and other water bodies, a debate developed on different water quality standards in force in the States and the implications these have on the definition and delineation of transboundary and national water resources. Agreement on the methodology to be applied for the assessment of the sanitary and ecological water demands could not be reached. Based on the outcome, we propose a definition and a methodology in the Inception Report.

50. The methodology to be adopted in the assessment, definition and delineation of ***transboundary and national water resources*** provoked considerable debate and disagreement amongst participants. Depending on their geographic location in the basins, participants expressed different ideas on the definition of terminology used, and on the implications for water allocation and management, etc. It was also made clear by the participants that, although as technical specialists they may have an opinion on such issues, essentially this discussion has to be held at a higher (political) level. They also voiced their scepticism as to whether the project would at all be able to come to a consensus and agreement on this sensitive issue. Related to this is 'water allocation', and most participants expressed the view that the project has no mandate to suggest allocation approaches other than the existing water distribution agreement between the States. Much gain is still expected from water savings and the reduction of salt loads from drainage water to the main rivers and desert sinks

51. The discussions on all other technical matters did not provoke major disagreement on the methodologies presented. In these cases discussions went deeper into data requirements needed to accomplish tasks, ways to organise the implementation of tasks and detailed methodologies to be worked out and the interaction of the various tasks.

4 AVAILABLE DATA AND TOOLS

4.1 Data

4.1.1 Economic Data

52. Key macroeconomic data (e.g. GDP, exchange rates, taxes) and microeconomic data (prices for water, electricity, labour costs, agricultural products and inputs) are available in the WARMIS database for the years 1990, 1995, 1996 and 1997 only. The WUFMAS database also provides detailed information on agricultural product and input prices for the years 1996, 1997 and 1998. All price information is expressed in financial terms and will require updating to current levels. Other sources of information will include the national statistics and economic departments within the Ministries of Agriculture and Water, Communal Services, and Energy.

53. In order to assess the costs and benefits from improved water and salt management in the Aral Sea Basin, general agreement is required on calculation methodologies, currencies to be used and reference years for prices to be selected. The necessary calculation guidelines will be developed by the Regional team in consultation with the National teams and World Bank. However, as a first approach, those listed below are proposed.

- The reference year for all prices or costs to be collected is to be the year 2000.
- All prices in local currency are to be expressed in USD in order to allow uniform calculations and direct comparisons of cost.
- The exchange rate to be applied is to be the official exchange rate, adjusted by the foreign exchange premium to be determined by each National team according to the specific national trade policies (involving tariffs on imported goods, subsidies on exports, etc.) in each of the five States.
- All calculations are to be undertaken in constant economic prices. Financial prices and costs must be converted into economic values in order to demonstrate the net benefits to the national economies. Transfer payments such as taxes, subsidies, and other price distortions must therefore be excluded in the calculation.
- For all traded agricultural products (cotton, wheat, etc.) it is proposed to apply import parity or export parity prices as appropriate in the calculation of agricultural gross margins. For the non-traded products the average annual local market prices are to be applied as they require no price adjustment.
- For all traded agricultural products it is proposed to use the year 2010 price levels presented in the World Bank commodity price forecasts as the prices applying throughout the 25-year modelling period. The year 2010 has been adopted because it is the latest year for which price projections have been prepared and it falls near the middle of the modelling period.

- In accordance with the World Bank, a uniform economic discount factor in the range 10-12% is proposed for discounting future costs and benefits over the 25-year modelling period.
- Economic evaluation criteria used will include: Net Present Value (NPV), Benefit/Cost Ratio (BCR), and Internal Rate of Return (IRR).

4.1.2 Agricultural Production and Land Use Data

54. In order to provide a realistic picture of the impacts of the new economic conditions on the farming sector following the break-up of the Soviet Union, a proposal was made in late 1995 under the WARMAP program to launch the Water Use and Farm Management Survey (WUFMAS) as one of the project activities. The proposal was adopted, and the survey was carried out annually between 1996 and 1998. It consisted of a programme of systematic measurement of inputs and output in sample fields on 36 representative farms, located according to the distribution of irrigated land in the Aral Sea Basin. Five National teams were responsible for data collection. The data have been verified at national and regional levels.

55. The survey results were published in three annual reports. Due to budgetary limits the number of sample farms was reduced to 22 in 1997, while in 1999 the only activities were selected irrigation trials on nine sample farms. Ongoing financial constraints have made the continuation of data collection and processing almost impossible, and requests to the international donor community for assistance have so far not led to any positive response.

56. However, the data collected are considered to reflect realistically the current production and productivity levels and the intensity of input use under the different economic conditions of each of the five States, which have adopted different rates of transition to market economies. Originally, the farms selected were kolkhozes (State farms) and although farm sizes changed in the course of privatisation, the initial kolkhoz entity was retained. The sample farms are distributed between six agro-climatic zones, which are representative of the whole Aral Sea Basin and reflect typical cropping patterns for all five States (cotton, winter wheat, rice, forage crops and some plantations). Total farm areas range from 6,000 to 12,000 ha and sample fields are in the range of 5-10 ha in area. The proportions of irrigated area vary from 93% in Turkmenistan to 26% in Kyrgyzstan, where much of the land is used for pasture and rainfed crops.

57. Data about the whole farm have been collected annually and monthly from farm records. The use of all inputs in each of the 10 sample fields per farm have been precisely recorded, and agronomic measurements including yield have been made. Soil surveys were carried out in each sample field and periodic samples of soil, and irrigation, drainage and ground water, were sent to the SANIIRI research laboratory for analysis. Monthly average climatic data were collected from the closest meteorological station, while pan evaporation and rainfall were measured directly on the farms. All data collected have been entered in the WUFMAS database in MS Access. This database is now managed by SANIIRI.

58. Analyses that have been carried out on the data include:

- Evaluation of real and potential land and water productivity;
- Evaluation of various levels of input use against the optimum crop growth;
- Identification of water saving options and possibilities;
- Selection of alternative ways of increasing the economic efficiency of irrigated agriculture.

59. The collection of climatic, soil and agronomic data, and of water resources, irrigation, and financial data (costs for all agricultural inputs: seed, machinery, labour, fertiliser, agrochemicals, product prices) allows the calculation of crop gross margins and profitability of crop production. Prices applied are financial as well as economic prices, allowing for separate analysis of agricultural profitability at a farm level as well as at a national level.

60. Although WUFMAS is principally of a descriptive nature, with only limited detailed analysis of the data, the high quality of the data makes it a suitable basis for all countries to design appropriate agricultural development strategies. For example, WUFMAS data have been applied in the WARMIS model to calculate the benefits for several planning zones in the Ferghana valley. The quantitative data are considered to be representative for the majority of the Aral Sea Basin, and it is concluded that they will provide an adequate basis for the financial and economic analyses related to agriculture to be carried out in Subcomponent A1. However, the data on product prices and input costs will require updating to the agreed reference year 2000 in economic terms.

61. As has been the case with many of the other types of data, detailed land use records were kept in Soviet times which recorded by oblast and rayon the areas planted to the various crops. The responsible agencies were the State Ministries of Agriculture (and Water Resources). The data gathering has continued since Independence, but with the rapid changes that have taken place in some of the States, and also funding shortages, the more recent data are considered less reliable. Nevertheless, it is considered that adequate data are available for the purposes of the study.

4.1.3 Hydrological Data

62. A large amount of official data and hydrologic analysis work is available at the recognised agencies in the five States. Hydromets generally record precipitation data, and data on river discharge and river salinity, while the Ministries of (Agriculture and) Water Resources collect data on irrigation water and drainage water flows and salinity levels of drainage water.

63. In the regional working session, the National teams expressed the view that different data sets are required for different assessment purposes, and that there should be recognition of the fact that changes in conditions over the last 10 years have had a considerable impact on the recorded flows and salinity levels. The changes include:

- deterioration of irrigation and drainage infrastructure;

- decline of agricultural production;
- changes in cropping patterns (mainly conversion of cotton to wheat);
- deterioration of monitoring networks.

All National teams agreed that precipitation, evaporation, discharge and salinity are the main parameters for the assessment. They also agreed to the adoption of time series periods shown in Table 2.

Table 2 Agreed Data Series for Hydrological Studies

Purpose	Data	Time series
1. To evaluate long-term water resources availability	Monthly flow data at source gauging stations	1960-1998
2. CDW flows	5-year average CDW flow data (planning data)	1980-1998
3. To evaluate salt loads in CDW flow	Monthly salinity data in rivers and drains	1980-1998
4. To evaluate water use	Water intake data	1970-2000

CDW: Collector Drainage Water

64. The period 1960-98 comprises the relatively wet 1960s, relatively dry 1970s and relatively wet 1980s and 1990s, and therefore provides a reasonably representative long term series. In the 1980s the hydrometeorological network was fully operational whereas in the 1990s there was a progressive deterioration of the network. The National teams agreed that variability over time could be adequately accounted for by using 50% and 90% probability of exceedence of discharge. The required data series for precipitation and evaporation were not discussed in detail, but it is proposed to use the same as for the source gauging stations (1960-1998).

65. The availability of hydrological data has been investigated by the National teams, and the results are presented in Appendix D.

4.1.4 Salinity Data

66. Comprehensive data on the salinity levels in all relevant rivers, canals and collector drains were collected and recorded in Soviet times, and this data collection has continued since Independence, although often at fewer locations and with less frequency because of a lack of funds. The records are held by the relevant national water management agencies. Because of the problems brought about by the lack of funding, the more recent data are considered less reliable.

67. The raw data have been analysed and are summarised in many of the reports on the Aral Sea Basin that have been prepared in recent years. The results of the assessments by the National teams of data availability are presented in Appendix D.

4.1.5 Hydrogeological Data

68. A large amount of official hydrogeological data and analysis work is available for the Aral Sea Basin at the recognised agencies in the five States. A detailed listing of availability is presented in Appendix D. The relevant hydrogeological agencies include:

- State agencies on geology and natural resources protection or: piezometric maps of deeper groundwater, groundwater abstraction data, aquifer characteristics and groundwater balances per administrative zone (state, oblast and rayon);
- Ministries of (Agriculture and) Water Resources: depth to watertable and shallow groundwater conditions in irrigated areas.

In the regional working session held in September 2000, the National teams confirmed that the five States can make these data available for use under the present project. They concluded that the information in the Table 3 is the most useful or relevant.

Table 3 Relevant Information for Hydrogeological Studies

Purpose	Data	Time Series
1. Evaluate flow volumes and salt movement in deeper groundwater	Piezometric maps, groundwater mineralisation and aquifer characteristics for irrigated areas and areas adjacent to interstate borders and major rivers (1:500,000)	around 1990
2. Evaluate source areas of soluble salts that generate a salt load to surface waters	Hydrogeological and geological maps and studies	1980s
3. Delineate aquifers and identify aquifer configuration	Hydrogeological maps Hydrogeological cross-sections	1980s
4. Evaluate impacts of groundwater abstraction (transboundary and impact on surface water flow)	Groundwater assessment data (certified, assessed and estimated yields), abstraction permits granted, groundwater balances	1990s
5. Evaluate transboundary impacts of groundwater pollution	Nitrate and sulphate	1990s

4.1.6 Domestic and Industrial Water Supply

69. Of the total water use in the Aral Sea Basin, approximately 6% is directed to municipal and industrial use, while an additional 1.6% is used for rural water supply. Urban water supplies in Uzbekisan are under the direct control of the Ministry of

Communal Services in four regions, including Karakalpakstan and Khorezm. In other parts of the country, such as the Fergana valley, urban supplies are controlled by local bodies. From enquiries with the Ministry it appears that there has been no compilation of this information for the whole of Uzbekistan, although the information for Karakalpakstan and Khorezm is available through the Water Supply, Sanitation and Health Project. It has been indicated that requests for this data for other areas would need to be made through the Ministry of Communal Services. It is likely that similar situations apply in the other States. Ongoing rural water supply projects, e.g. in Kyrgyzstan, will also serve as sources of information.

70. Rural water users also use the river water for domestic purposes, and must be included. Water supplies to rural consumers are generally under the control of the Ministry of Water Resources and Agriculture in most States, and records on the numbers of rural consumer households will be obtained from those agencies.

71. The volumes of industrial water usage are recorded by rayon in the WARMIS database, but the type of industrial use is not specified. The type of use is important, and the proposed methodology for obtaining this information is discussed in Section 5.9.5 below.

4.1.7 Infrastructure

72. Infrastructure items that might be affected by soil salinity or waterlogging include:

- roads;
- irrigation and drainage infrastructure;
- major water supply and gas pipelines;
- electricity transmission lines;
- urban infrastructure and buildings.

No specific listings or databases relating to these items exist. The intention is for National team members to obtain the necessary information on these aspects by visiting locations where there is potential for effects and holding discussions with relevant agencies. The methodology is discussed further in Section 5.9.5 below.

4.1.8 Environment

73. The environmental management issues in the Aral Sea Basin have been the subjects of a number of studies. The relevant documents include:

- reports on the Aral Sea Wetland Restoration Project, Project 1 of Aral Sea Program 4, 1995 and 1996;
- reports on the Environmental Assessment of Irrigation and Drainage in the Amu Darya Basin, Phases 1 and 2, 1998 and 1999;
- State of the Environment Report for the Aral Sea Basin, including the five individual country reports, 2000.

It is considered that these documents, together with the knowledge of the ecological specialists in the Regional and National teams, will provide an adequate basis on which to undertake the environmental management segments of the project.

4.2 Database and Planning Tools

74. WARMIS is an Information System for land and water resources management developed under the TACIS-sponsored WARMAP and WARMAP-2 projects by the Scientific Information Centre of ICWC (SIC). It is designed for the collection, storage, processing and analysis of various data about the historical and actual situation of the land and water resources of the Basin and their use. A detailed description of WARMIS is presented in Appendix B.

75. The underlying concept of WARMIS is to support planning at the national and supra-national levels in the area of land and water management of the Central Asian States within the Aral Sea Basin. It is designed to provide an economic approach to land and water management through the provision of data and analysis tools. When completed the system will comprise the following inter-linked components:

- Database Management System (DBMS), containing tabular data;
- Geographic Information System (GIS), containing spatial data and spatial analysis tools. Data include:
  - cities, hydrological objects, intakes, outfalls, transfers, climate stations,
  - rivers, canals, collectors, administrative boundaries,
  - planning zones, reservoirs, lakes, irrigated areas, drainage zones, soil types, and the Aral Sea;
- Toolbox; comprising components for system maintenance, data verification, data exchange and security, user authorisation, etc.;
- User Interface for data input and output;
- Three modules for strategic analysis and/or decision support: Planning Zone Module, River Basin Module and Hydropower Module.

Not all of these components are fully operational. Some components have been programmed but not yet fully calibrated, other have still to be programmed, and yet others still have to be included. The most relevant to the present study is the GIS, which has been completed and is operational.

76. There are a number of issues which affect the utility of the WARMIS modules for the sub-component A1 study. The first of these is the incompleteness of the model. Even with funding available, a considerable period would be necessary to complete it. Associated with that is the risk that the model will not achieve its objectives, or that the data for the planning zones may not be available at the level of detail or accuracy required.

77. Secondly, the WARMIS modules have not been endorsed by the five States. Any results obtained using them, therefore, may not be universally accepted, and thus strategies developed on the basis of the model results could be undermined.

78. Thirdly, the model is a complex 'black box' with a number of the key variables modelled as non-dimensional 'factors' (with values between zero and one) which are multiplied together to give higher level factors. There is no independent way of checking the validity of these factors. Also, a number of key economic relationships are specified as differential equations. Although this may be a logically correct approach, it results in a lack of transparency regarding the workings of the model, which in turn may affect the credibility of the results.

79. Fourthly, the model as currently documented lacks a number of relationships that will be important in Sub-component A1, including: water consumption by domestic and other non-agricultural users; impacts of drainage improvements on water balance components; drainage water reuse; and investment lag effects on agricultural yields.

80. Finally, there is a lack of consistent model documentation in English, particularly in relation to: the linkages between components of the models; justifications for the selection of the values adopted in key assumptions; and sensitivity of the model to changes in assumptions.

81. In conclusion, when completed and endorsed by all five States, the WARMIS modules will be a valid and potentially useful tool for evaluating future scenarios for the development and management of water resources in the Aral Sea Basin. However, the drawbacks listed above are such that it is considered that, for the purposes of Sub-component A1, it will be better to develop a new model using a standardised water resources assessment framework and a transparent approach. The proposed approach and framework are discussed in Section 5.4 below. We propose, however, to make use of the WARMIS and its GIS; when obtained from TACIS, the RWG will distribute the database formats to the NWGs for verification and completion according to a specific ToR.

5 PROJECT METHODOLOGY

82. In this chapter we develop the approach and methodologies to be adopted for tasks to be undertaken during Phases II, III and IV. For Phases V and VI it is premature to develop such methodologies at this stage. We would like to emphasize that a presentation of a methodology differs from detailed tasks or job description. Based on the methodology presented, we have elaborated a number of specific Terms of Reference for Tasks and Sub-tasks to be executed by the National and Regional teams. These are still drafts and are disseminated to the National teams for review, and will be discussed and explained to them by the international consultants in November. The Terms of Reference will subsequently be finalised and the teams will present these to their governments to seek approval. The National teams see this as an important step, in order to obtain expedient acceptance of the outputs produced. The Draft Terms of Reference available at this stage are included in Appendix G.

5.1 Requirements for additional data/tools

5.1.1 Data

83. From the discussions with government and other agencies and the assessments of data availability carried out by the National teams, it is concluded that sufficient data exist on most aspects to enable the satisfactory completion of the project at the broad scale required. Areas where new or more data are required include:

- The effects of salinity on domestic and industrial water supplies;
- The effects of salinity and/or shallow watertables on roads and other rural and urban infrastructure.

The methodology and resources necessary to obtain these data are discussed in later parts of this section.

84. In order to manage the vast number of data, we propose to develop a Data Management Information System. It will consist of a number of categories, divided between a main database and a GIS (ArcView) database as shown in Table 4. The time unit will be one month, while the spatial unit will be a planning zone. The database structure will closely follow the existing WARMIS database structure, including field names and key parameters, so that, in the future, exchange of data between the two databases should be possible.

Table 4 Database Categories

Database (Access):	GIS layers (ArcView):
• Administration • Land • Water • Water Quality • Climate	• *point objects*; cities, hydrological objects, intakes, outfalls, transfers, climate stations, gauging stations • *linear objects*; rivers, canals, collectors, administrative boundaries

• Industry • Economy • Hydropower • Agriculture	• *polygons*; planning zones, reservoirs, lakes, irrigated areas, drainage zones, soil types, Aral Sea

85. Ideally, this database should be able to exchange data, reference and time series with the models to be developed. The software to be used will be Microsoft Access 97 (or later) with additional programming done in VBA. EXCEL spreadsheets could be used as an intermediate step between models and database. The GIS-part of the information system would be established using ArcView and its database, with a strong linkage to the main database.

5.1.2 Tools

86. The main tools for use in Sub-component A1, apart from the above database, will be the basin and soil water/salinity models. As discussed in Section 4.2 above, we will develop a new basin model using an existing standardised water resources assessment framework. The approach and proposed model are described in Section 5.4. Suitable soil water/salinity models exist, and the selection of the appropriate one is dealt with in Section 5.4.4

5.2 Task R2 – Planning Principles and Guidelines

5.2.1 Overview

87. The performance of Task R2 will be critical to successful completion of the remainder of the project. It will focus on the basic principles and policy guidelines that are to form the basis for, and will be followed in developing, the Water and Salinity Management Plans. These apply particularly to such matters as transboundary water resources and water allocations, and environmental sustainability. In broad terms we intend to adopt an approach involving:

- preparation of a discussion paper canvassing issues and options;
- a round of discussions between a group of senior team experts and senior officials from each of the five States,
- preparation of the Draft Regional Report No. 1;
- a high level workshop on the document, resulting in political guidance on the planning process.

These steps are described in more detail below.

5.2.2 Discussions with State Officials

88. The purpose of the meetings will be to obtain the views of the State Governments at a high level on the principles on which the project is to be undertaken. The State officials will meet with the project team group in turn for discussions. Before the start of this series of discussions we will produce a discussion

paper which will be distributed well in advance to allow prior consideration by the State officials. In preparing the paper we intend to refer initially to existing national strategies and visions for the future, and also to various agreements already entered into by the five States. The discussion paper will address the various issues and canvass the available options, and is intended to provide a focus and a basis for the discussions. The issues will include:

- criteria to be applied in water allocation objectives and principles and regional environmental demands;
- national and transboundary waters;
- the methodologies to be adopted for:
  - evaluation of social and economic development of water-using sectors apart from irrigated agriculture;
  - assessment of present and future national and transboundary water supplies and the boundaries between them;
  - determining agricultural water use (e.g. using CROPWAT);
  - assessment of overall economic prospects for irrigated agriculture;
  - assessment and aggregation of present and future water demands;
  - preparation of a program of investment in basin and national water infrastructure;
  - participation of beneficiaries in the planning process.

The last point has been added to the list because we feel that ‘participation of beneficiaries in the planning process’ is not yet very well understood in the region. The draft methodology presented under Task N2 demonstrates that an iterative process will be needed for the development of the Participation Plan. Hence, we put it also on the agenda in Phase II to communicate the ideas, and to seek high level political guidance in this matter.

5.2.3 Preparation of Regional Report No.1

89. Production of the Draft Regional Report No.1 will follow the round of discussions. The report will set out the positions of the five States in regard to the various issues, and indicate where there is likely to be general agreement and where the greatest effort is likely to be required to attain a consensus. For each issue the document will:

- describe the issue;
- summarise the various State positions;
- discuss the situations where there is not unanimous accord;
- suggest possible compromise positions and proposals for further steps to be taken to achieve consensus.

5.2.4 Political Guidance

90. The States and the concerned regional organisations will have about two months for internal discussions and review of the draft report. Then a workshop will be organized to allow each State, at the highest level, to air its views as to what is hoped to be achieved by the project. It is proposed that the workshop be held in

Tashkent over a period of three days, with the first day devoted to presentations the second to discussions and consensus building, and the third day to arrive at conclusions and agreeing on the workshop protocol. The project team leader will act as chief moderator. Other team members will assist him in the moderation task as necessary. The aim will be to produce at the end of the workshop an agreed basis for execution of the remainder of the project.

91. Although it is anticipated that the participants will have the authority to act on behalf of their respective governments, in view of the often very sensitive issues concerned and possibly far reaching consequences involved, the participants may wish to present the outcomes of the workshop to their governments. We foresee that this may be the case and that a second workshop may be needed to come to final agreement on the policy guidelines, planning criteria and on the methodologies to be adopted in the remainder of the project.

5.3 Task N2 – Participation of Beneficiaries in the Planning Process

5.3.1 Task Objectives

92. The Terms of Reference state that: *'an important part of developing a pragmatic and sustainable strategy will be the full and active participation of farm-level water users, and rayon, oblast and central government level water management officials in identifying needs, assessing options, and priority setting'*. The Consultant is required to design, organize and carry out a participation plan to support the planning process. It is also required that active use be made of previous work on social assessment and participation carried out during preparation of investment projects financed by the World Bank in irrigation and drainage rehabilitation and water supply, with particular attention paid to the experience acquired by the national social science network. The Consultant is to coordinate activities closely with Component B of WAEMP (Public Awareness) and the results of Sub-component A2 of WAEMP (Participation in Water Conservation).

5.3.2 Coordination with Other Programs

93. Component B has been conceived to raise appreciation, particularly amongst users of irrigation water, of the value of water as a key resource. Its main purpose is to promote behavioural change. Its goals are principally to educate the public about the value of water and identify and popularise measures for saving irrigation water. Component B has teams within each of the five States, which undertake activities such as production of press releases and running of workshops. These, however, are more for the dissemination of information than seeking input. The NWGs of Component B can be involved in Task N2, coordination of activities is the responsibility of the NWG team leaders of Component A1 and B.

94. Sub-component A2 of WAEMP is titled 'Participation in Water Conservation'. The main objective is to demonstrate that substantial water savings are possible in irrigated agriculture. Essentially this sub-component has involved a

competition in which cash prizes have been offered for novel ideas that have resulted in practical water savings.

95. Contact has been made with the head of the World Bank social development team who is currently working to co-ordinate national social science activities in Uzbekistan. She recommended a consultant who has worked throughout central Asia on a number of World Bank and other projects and has access to a competent network of social scientists in the five States who would be available to carry out the Participation Plan.

5.3.3 Outcomes of Working Session

96. Comments on the proposed methodology for Task N2 made at the four-day working session in September included the following:

- Target groups at different levels should be included;
- All significant categories of water use should be included, including farming, environmental use, fisheries, domestic water supply, etc.;
- Water user associations formed at a pilot stage in various States could be involved in the participation process;
- Participation mechanisms exist in some States, and these should be considered for inclusion in the participation process.

These comments will be taken into account in preparing the Participation Plan.

5.3.4 Stakeholders

97. There is a multitude of stakeholders with interests in the management of the water resources of the Aral Sea Basin. These range from individual irrigators to communities seeking clean drinking water supplies up to the government agencies with the responsibility for management of the resources. The stakeholders include also those concerned with the ecology of the water bodies in the basin, industrial water users and people involved in the fishing industry.

98. The largest water user in the Aral Sea Basin is the irrigated agriculture sector with 7.9 million hectares of land and millions of water users in five States, and therefore the participation of this group of stakeholders is of particular importance. Currently most irrigation schemes are still managed by state organisations, but in some cases Water User Groups (WUGs) have been established for tertiary units covering areas between 250 ha and 750 ha and Water User Associations (WUAs) for secondary units covering areas between 2000 ha and 3000 ha. The latter often coincide with the areas of the former sovchoze or kolchoze. A third decentralised level involves Federations of WUAs covering primary canal systems of 50.000 ha to 150.000 ha. The boards of the WUGs and the WUAs come directly from the water users whereas the management of the Federations is a combined responsibility of water users and state officials.

5.3.5 Objectives of Participation

99. With the many economic, social, environmental, and national political issues at stake, and the large range of stakeholders , it will be impossible to talk and respond to everyone and to find time to listen to everyone.

100. With respect to the objectives of the project, all relevant high level authorities from the five states (ministries, national institutes) are already involved in one way or another in the project. Through national and regional seminars these persons and probably a large number of high level persons in their 'vicinity' will be well informed on the project. It can be concluded that participation of high level authorities is included in the project approach and does not need a specific participation plan.

101. It is towards the lower level stakeholders like WUGs and WUAs and communities seeking drinking water that the participation effort must be directed. Although this effort might be seen as a time-consuming burden, in fact participation is likely to have many positive benefits because the stakeholders may:

- provide insight into the current water problems;
- suggest (institutional) water management solutions for these problems;
- provide insight on the effects of certain project proposals and may come up with alternatives;
- be more willing to accept institutional changes once involved in the decision-making process.

102. The participation of low level stakeholders can sometimes be regarded by agency staff as impossible because most stakeholders are seen as laymen. This is often at least partly true because, although many water users may have a good understanding of their own irrigation systems, they are unlikely to have a full understanding of the functioning of, for instance, the distribution system throughout the river basin. This is not a reason to exclude them, however, but to improve their knowledge so that they can participate in a useful way. Therefore, to increase the efficiency of participation and to make the participation real, the project will have to provide the proper information to the representatives of the low level stakeholder groups. This means that the project working program, the project approach and the project results will have to be made available to the involved stakeholders before the decisions are taken. Thus, a communication strategy will be an important part of the participation plan. The strategy will focus first of all on providing information to the relevant stakeholders, and afterwards to gathering information from stakeholders.

103. Taking into account the above, it will be our objective to develop a Participation Plan that on the one hand makes it possible for relevant stakeholders in the water to participate effectively, while on the other hand obtains the input from the participation process in time to be incorporated in the project results and to provide feedback to the stakeholders.

5.3.6 Draft Methodology

104. Projects continue to emerge in the Central Asian Republics to promote decentralisation of water management and set up WUGs and WUAs. The reason for this development is that devolution of the water management responsibilities and/or privatisation of the irrigation (and drainage) systems to new decentralised institutions are seen as the best way of improving water efficiency and increasing agricultural production. Since it seems that this important institutional transition has been set in motion on a pilot scale, the question to be answered during the establishment of the Participation Plan will be which levels of stakeholders from irrigated agriculture should be invited to participate. Should only the governmental irrigation managers be invited, or should the focus be on the representatives of WUGs, WUAs or Federations of WUAs.

105. In designing the Participation Plan, the regional participation specialist in consultation with the other RWG members will first define the issues to be addressed by the Plan. Then, he will consult with World Bank on the previous work carried out on social assessment and participation, with particular reference to the resources available through the national social science networks to undertake participation activities. He will similarly consult with the Component B team. The regional specialist will then prepare the framework for the Participation Plan and circulate it to the National participation specialists.

106. The regional specialist will then hold a series of workshops in the various States, involving in each case several of the National team members for the particular State. These are likely to include the National participation specialist, the water resources management engineer and the ecologist (water pollution). Other National team members may be included as appropriate. The purpose of the workshops will be to design the final Participation Plan. Important elements of the plan will be:

- an assessment of the most important issues for participation;
- participation objectives and expected results;
- a list of stakeholders and their importance in relation to the participation process, and how these stakeholders can be reached and involved;
- means of providing information to stakeholders;
- means of participation of stakeholders in the discussions;
- means of obtaining feedback from the stakeholders, and the activities required to obtain it;
- timing of activities in relation to the project program;
- locations, venues, numbers of attendees, etc. for any workshops or similar sessions;
- manpower inputs.

107. Persons/groups who might organize and carry out the plan include:

- the Subcomponent A1 national participation specialists;
- other national participation teams;
- the Component B National teams;
- national social science teams;
- a combination of the above.

108. With the results of the workshops, the regional specialist will prepare the final Participation Plan and circulate it to the national participation specialists. After their feedback the plan will be submitted to the PMCU for approval, and then implemented.

5.4 Task R3 – Basin Model Development

5.4.1 Model Concept and Criteria for Modelling Package Selection

109. It is concluded in Section 4.2 above that, for the purposes of Sub-component A1, a new basin model should be developed using a standardised water resources assessment framework and a transparent approach. The basic approach will be that planning zones represent the water use element (apart from hydropower) and a river network represents the water conveyance element, with interconnection of the two elements. Separate basin models will be developed for the Syr Darya and the Amu Darya. Three levels are envisaged for the modelling:

- Planning zone level
- National level
- River basin level

110. Since no modelling frameworks exist today that combines the complex salt mobilisation processes in groundwater with surface water we have to select two types of water/salt balance programs: for *surface water/salt balance* and for *soil water/salt balance*. Obviously, the first also contains groundwater but salinity is not modelled in groundwater in that model. Both balances will be modelled at planning zone level, but only surface water/salt balances at the National and river basin levels.

Criteria for selection of software for surface water/salt balance are:

- Capable of handling complex and large systems well;
- Capable of using sub-systems (at national level and at planning zone level) and integration of sub-models in the river basin model;
- Capable to direct return flows and drainage from users to various directions;
- Capable of exchanging input/output with the soil water/salt model;
- Capable of tracking conservative pollutants (salinity in our case) throughout the surface water network;
- Preferably working in the Windows environment.

Criteria for selection of software for soil water/salt balance are:

- Capable of handling groundwater flow in multi-layer systems;
- Capable to simulate salinity in incoming water, in the multi-layer system and in the drainage water;
- Allow for artificial drainage;
- Preferably working in the Windows environment.

5.4.2 Surface Water/Salt Balances

111. The Planning Zone (PZ) will form the basic spatial unit in the river basins, and will be specified in terms of basic information which will include mainly agricultural aspects such a soils, land use, and agro-economic information. The surface water/salt balances at the planning zone level will relate mainly to agriculture, although domestic and industrial water supply flows may also be modelled. Reservoirs and hydropower stations will be modelled only at the National or Regional level. The surface water/salt balance will consist of an accounting exercise, with no modelling of processes. It is envisaged that the model will keep track of all flows and salt loads in the system reaches and nodes and be able to generate reports on flows and salt loads at all key points in the network by months and years in tabular and graphical format. Output tables will be arranged so that they can be read into EXCEL for further processing. The proposed planning zone model is shown diagrammatically in Figure 1.

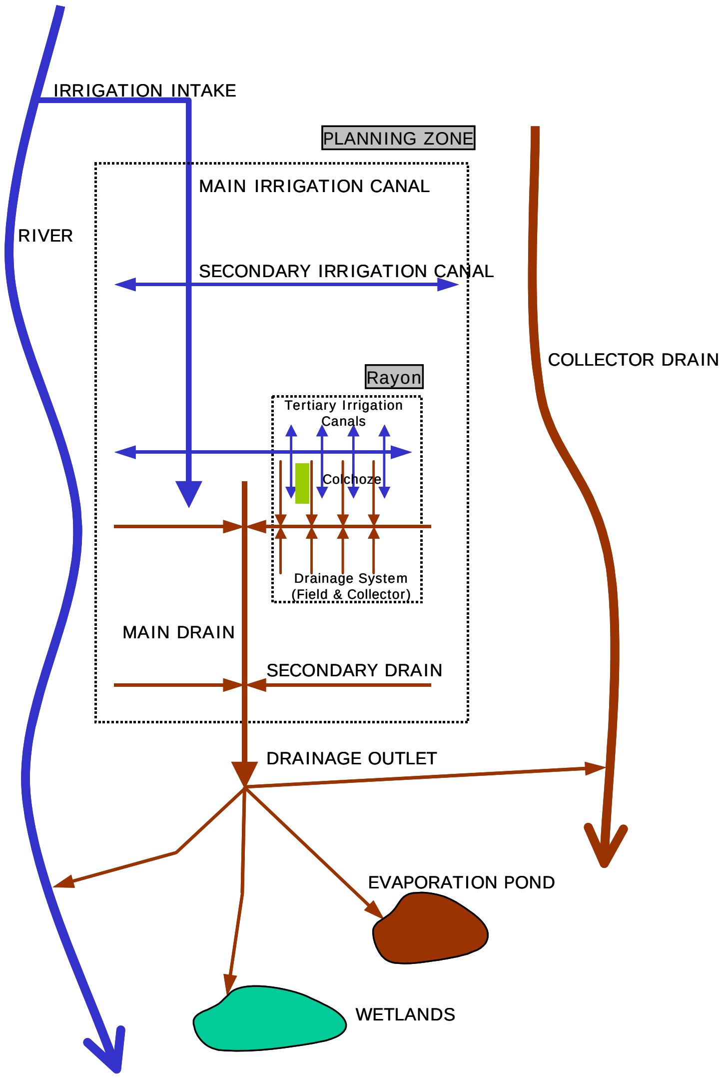

Figure 1 Typical Irrigation Layout Within a Planning Zone

112. The planning zone models will be linked at the national level via the surface water/salt balance. This model will combine the surface salt and water outputs and inputs from/to the planning zones and route this through the river system within a country. The aim will be to keep track of the transfer of salt and water between countries over time, to arrive at, for example, annual net transboundary transfers. A typical reach at national level is shown diagrammatically in Figure 2.

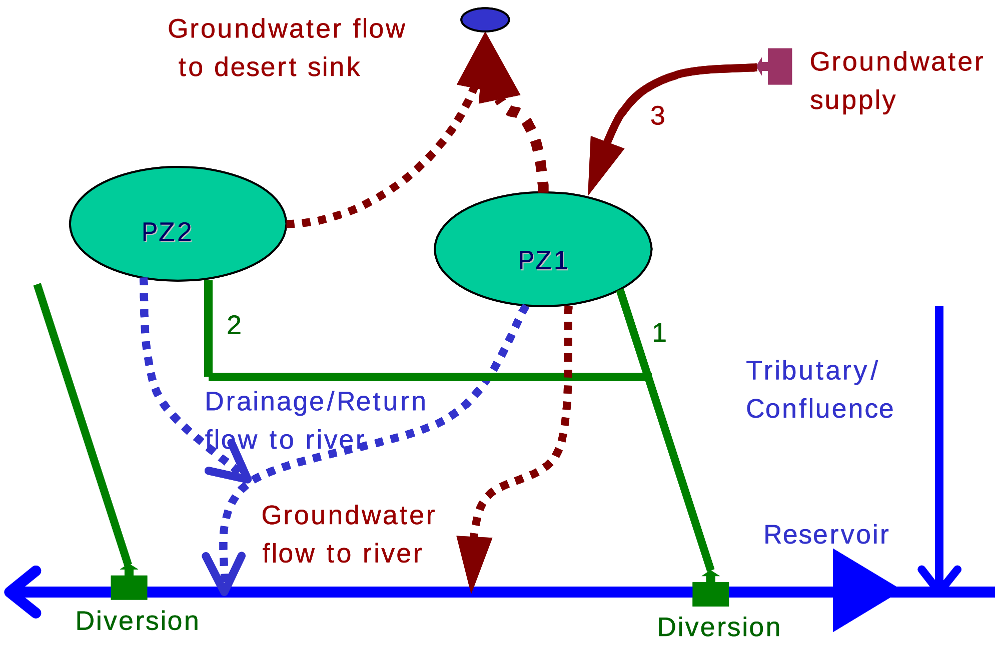

Figure 2 Surface Water/Salt Balance at National Level

113. Complete basin schematic layouts for the Syr Darya and Amu Darya basins are shown in Figure 3 and Figure 4 respectively. In view of the complexity of the systems, the regional models may be divided into several interlinked national sub-models, with, for instance, output from upstream sub-models forming part of the input for downstream sub-models.

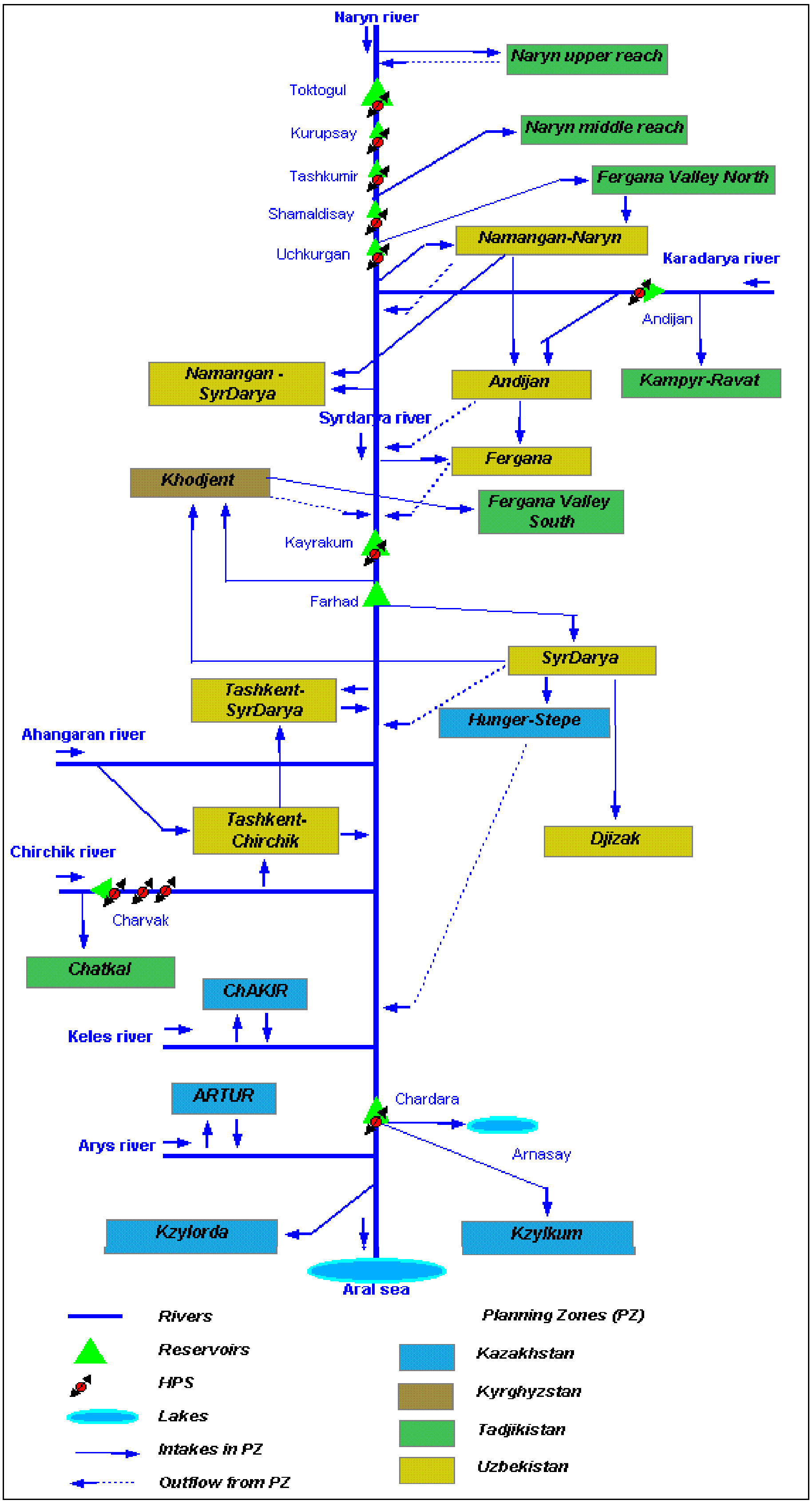

Figure 3 Schematic Layout of the Syr Darya Basin Network, including Planning Zones by Country (SIC-ICWC, 2000)

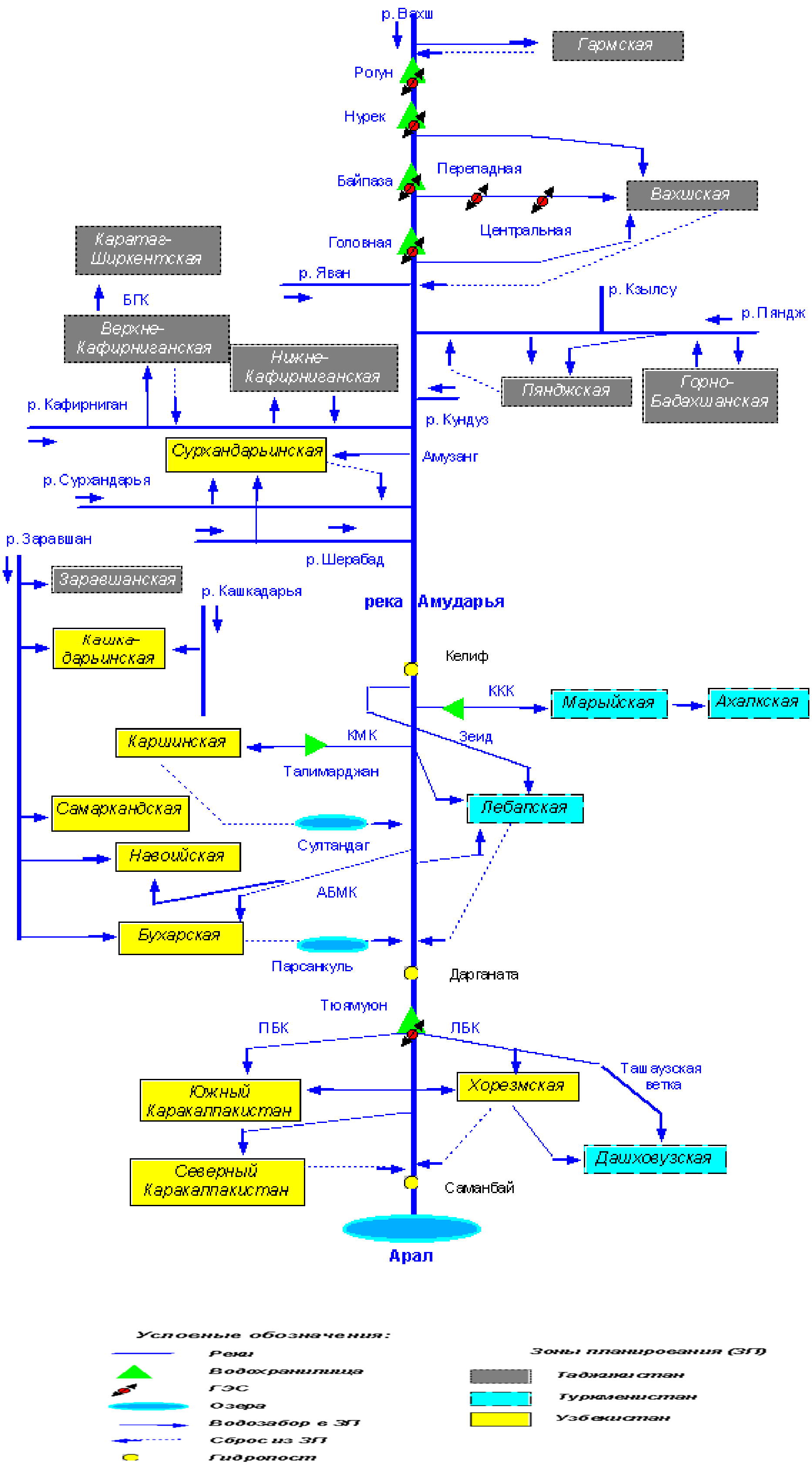

Figure 4 Schematic Layout of Amu Darya (SIC-ICWC, 2000)

5.4.3 Surface Water/Salinity Assessment Frameworks

114. We have evaluated three standard water resources frameworks with regard to their suitability for the surface water/salinity modelling. These are WEAP, REALM and RIBASIM. The relevant features of the models are described below.

WEAP

115. The Water Evaluation and Planning System (WEAP) is a program for the evaluation of water resource development projects. It provides an integrated framework with which to analyze supply/demand systems which may include rivers, creeks, canals, reservoirs and groundwater, as well as water withdrawals, discharges, wastewater treatment, instream flow requirements, and water pollution. WEAP can be applied to single or interconnected river systems at the city, regional or national level. As well as providing a framework for supply/demand systems, WEAP can be used as a forecasting tool, and also for policy analysis by simulating the effects—physical, economic, and environmental—of alternative water development and management programs.

116. WEAP simulations can also take into account the requirements of aquatic ecosystems by providing a summary of pollution from different water uses. Pollution is tracked from generation through treatment and outflow into surface and underground bodies of water. Unfortunately, WEAP does not track the pollutant loads through the entire system.

117. As with most programs of this kind, WEAP schematises the river basin network by means of arcs (sometimes referred to as links or carriers) and nodes. Reservoirs can be divided into up to four zones which, are the: flood-control zone, conservation zone, buffer zone and inactive zone. The conservation and buffer pools together constitute the active storage. The program allows release of water from the conservation pool to meet demands, but once the storage level drops into the buffer pool, releases can be restricted according to specified operating rules to conserve supplies.

118. In principle WEAP contains almost all the necessary elements for modelling the surface water balance at planning zone, national, and regional levels. It has the advantage of being simple and transparent, while a number of economic calculations can be done inside the model. Moreover, it can handle reservoir operation and priorities. However, it cannot perform a number of functions that will be required for the purposes of Subcomponent A1, its principal shortcoming being that it does not track surface water salt loads (or any other conservative pollutants) through the entire system.

119. WEAP is currently being transferred to operate entirely under Windows and the new release will have the following major improvements:

- a proper Windows graphical user interface;
- model limits depending only on the memory capacity of the computer;
- the capability to incorporate proper GIS (ArcView) map layers;

- automatic facilities to export result tables to EXCEL;
- a built-in mathematical expression builder,

On our request the new version could be enhanced further to keep track of conservative pollutants, like salt, in the system. We have been in frequent contact with the developers of the software, tested pre-releases and our estimate is that a full proof version containing the additions needed for the project, may not be available within six months.

REALM

120. REALM (REsource ALlocation Model) is a water supply system optimisation package that allocates the available water resources in a system to all demand centres based on a set of rules specified by the model user. It is a decision-making package that uses linear programming to decide where water is allocated in each time step.

121. A system is represented in REALM by a network of carriers (streams, channels or pipes) connected together by stream junctions, reservoir nodes and demand nodes, all with different rules applied to them. Inputs to this are time series of inflows, climate data and demands. The idea is to reproduce the current operating conditions of the system by calibration and then use the calibrated model as a basis for scenario modelling. The model specification contains information on reservoirs, demands, pipes, channels etc. as well as rules for reservoir transfers and demand restrictions.

122. Most modules in REALM run in DOS boxes under Windows. . An important advantage is that it keeps track throughout the network of conservative pollutants like salinity where complete mixing is assumed. REALM is well-documented and freely available. However, it is much more complicated to use and less transparent than WEAP. A disadvantage of REALM is that it uses ‘optimisation’ instead of ‘simulation’. There are various setbacks to optimisation techniques; especially in this project where the basins are located each in four countries - most of the regulating reservoirs located in the u/s countries, the major water users located in the d/s countries - that the use of objective functions and constraints functions would become very rigid , and hence there is little room to optimise water allocation.

RIBASIM

123. RIBASIM is the water resources modeling framework developed by WL|Delft Hydraulics. To perform simulations with RIBASIM, a model schematisation of the study area has to be made up, in which all the necessary features of the basin are reproduced by nodes connected by links.

124. Roughly speaking there are four main groups of elements to be schematised in the model:

- Infrastructure (reservoirs, rivers, lakes, canals, pumping stations, pipelines), both natural and man-made.

- Water users (public water supply, agriculture, hydropower, aquaculture), or in more general terms: water related activities.
- Management of the water resources system (reservoir operation rules, allocation methods).
- Hydrology (river flows, runoff, precipitation, evaporation) and geo-hydrology (groundwater).

125. These groups are each schematised in their own way. The core of the model is a *network of nodes and link*s. The node-link network configuration reflects the *spatial relationships* between the elements of the water resources system. For supply and discharge the water using activities are connected to the network in the nodes; also the natural supply to the network is concentrated in the nodes. The transport of water in the network – and consequently also between users -takes place in the links. The transport of water via the links is controlled by the operation rules to be specified for the system. The *time aspect* is brought in by time series of discharges (river inflows), rainfall and evaporation, but also in the form of time series of water demands by users.

126. RIBASIM contains a number of features that are of interest to the project, especially its modules AGWAT (powerful for determining agricultural water demands), and DELWAQ (water quality, including salinity) and financial and ecomic analysis possibilities. Input/output facilities are very good because entirely based on spreadsheets.

Model Selection

127. It is concluded that both RIBASIM and WEAP (when development is completed) will provide a suitable framework for the basin models, and that REALM is less suitable. RIBASIM has much more powerful modelling features than WEAP, and is supported by a professional water resources organisation. Our preference is to use RIBASIM.

5.4.4 Soil Water/Salinity Balances

128. The soil water/salinity balance will simulate the changes in salt and water content in the soil in the irrigated area of a planning zone as a result of rainfall, the application of irrigation water (including leaching) and evapotranspiration. In principle this is a relatively complicated process as shown in Figure 5.

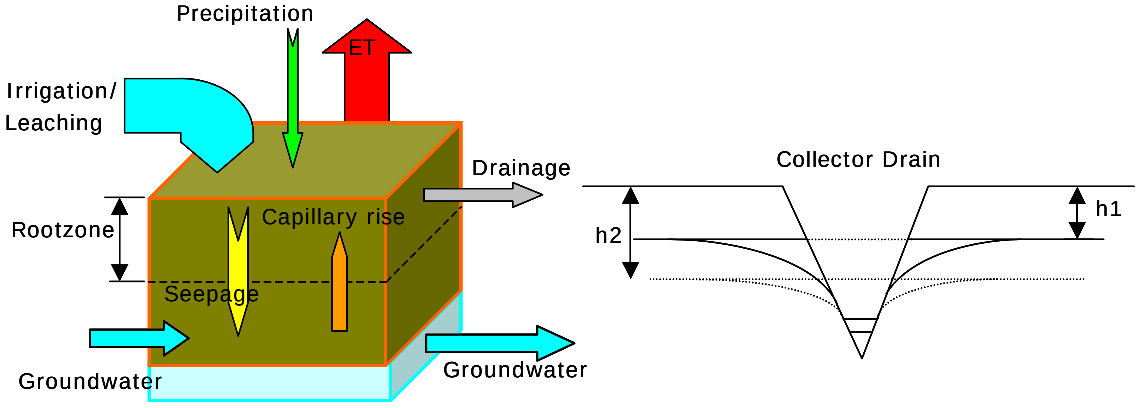

Figure 5 Schematic Diagram of the Soil Water/Salinity Balance and its Relationship with the Drainage System

129. The two main outputs required from the model will be, on a monthly basis, the depth below surface of the watertable, and root zone soil salinity (Ec_e). The watertable depth will be used to derive groundwater flows into the drainage system. In principle, the approach we will follow will be to develop curves relating the two, with the main governing parameters being soil type (and hence hydraulic conductivity) and drain depth. The inflows will be one of the connecting links between the soil water/salt balance and surface water/salt balance models. The calculated inflows, combined with groundwater salinity data, will give the salt loads discharged to the collector drains. Once the drainage water is in the collector drain, it becomes part of the surface water/surface balance, unless it is reused or mixed with fresh water.

130. The root zone soil salinity levels calculated by the model will be used in the economic component to derive yield losses and hence the benefits/disbenefits resulting from various scenarios. Average salt concentrations in the soil resulting from the introduction of different irrigation and farming practices change only slowly, generally taking years for significant variations to occur. The model will have to be capable of simulating both short term and long term changes in soil salinity.

5.4.5 Selection of Soil Water/Salinity Model

131. Two suitable models that are readily available are SALTMOD and HYDRUS2D. They are described below.

SALTMOD

132. This program predicts the salinity of soil moisture, groundwater and drainage water, depth of watertable, and drain discharge in irrigated agricultural lands under different hydrologic conditions, water management options and crop rotation schedules. The irrigation options include the use of water from the canal

system, and the reuse of surface drainage water and/or subsurface drainage water from pipe drains, ditches or tubewells.

133. The computation method used in SALTMOD is based on seasonal water balances of agricultural lands. Four seasons in one year can be accommodated, e.g. dry, wet, cold, hot, irrigation or fallow seasons. The model uses seasonal water balance components such as rainfall, evaporation, irrigation etc. as input data, while other water balance components such as downward percolation, capillary rise and subsurface drainage, are given as outputs.

134. SALTMOD models four different reservoirs, of which three are in the soil profile:

- a surface water reservoir
- an upper (shallow) soil reservoir or root zone
- an intermediate soil reservoir or transition zone
- a deep reservoir or aquifer.

The upper soil reservoir is defined by the soil depth from which water can evaporate or be taken up by plant roots. All water movements in this zone are vertical, either upward or downward, depending on the water balance. The transition zone is the zone containing any horizontal subsurface drainage. Again all flows are vertical except the flow to the drains. The deep reservoir accommodates the vertical subsurface drainage. Flows in the deep reservoir may be either horizontal or vertical. The three soil reservoirs can be assigned different thicknesses and storage coefficients as input data. Water balances are calculated for each reservoir separately. The excess water leaving one reservoir is converted into incoming water for the next reservoir. The depth of the watertable, calculated from the water balances, is assumed to be the same for the whole area under consideration. Evaporation from the watertable, which is a major part of the water balance, is a function of watertable depth, and the model uses a number of iterative calculations to find the equilibrium depth of the watertable for each time step The effects of both horizontal and vertical drainage can be modelled, including reuse of the drainage water via a reuse factor.

135. Salt balances are calculated for each reservoir separately, based on the water balances and the salt concentrations of the incoming and outgoing water. The salt concentrations of outgoing waters (either from one reservoir into the other or by subsurface drainage) are computed on the basis of salt balances using different leaching or salt mixing efficiencies. The effects of different leaching efficiencies can be simulated by varying the input values. Where drain or well water is reused for irrigation, the model computes the salt concentration of the mixed irrigation water over time and the subsequent impact on the soil and groundwater salinity levels. The long term impacts of different proportions of reuse water can be simulated.

136. If required, the responses of farmers to waterlogging and salinity can be automatically taken into account, for example by decreasing:

- the amount of irrigation water applied as the watertable becomes shallower;
- the proportion of irrigated land when the available irrigation water is scarce;
- the proportion of irrigated land when the soil salinity increases.

The responses influence the water and salt balances, and in turn change the rate at which the waterlogging and salinisation processes take place, until an equilibrium situation becomes established. The program can be run either with fixed input data (such as long term averages) for a number of years, or it can follow historic records with annually changing input values where the data are available.

HYDRUS2D

137. HYDRUS2 is a Microsoft Windows-based modelling environment for the analysis of water flow and solute transport in variably saturated porous media. The software package includes the two-dimensional finite element model for simulating the movement of water, heat, and multiple solutes in variably saturated media. The model includes a parameter optimization algorithm for inverse estimation of a variety of soil hydraulic and/or solute transport parameters. The model is supported by an interactive graphics-based interface for data-preprocessing, generation of a structured mesh, and graphic presentation of the results.

138. Agricultural examples of HYDRUS2D applications include:

- irrigation management;
- tile drainage design - flow to a drainage system;
- crop growth models, i.e., cotton model;
- salinization and reclamation processes, salt leaching;
- movement of pesticides; non-point source pollution.

Model Selection

139. SALTMOD is a relatively simple DOS-based program, which allows for easy integration with a spreadsheet. It is suitable for performing the soil water/salinity balances in the planning zones and for developing the time-based relationships between watertable depth and drainage water salt load. HYDRUS2D, on the other hand, is a much more sophisticated and complicated program. Simplicity is seen as an important feature, and SALTMOD is therefore the preferred model.

Operational Sequence of the Modelling Effort

140. It is envisaged that the operational sequence of the modelling effort using RIBASIM and SALTMOD will be as shown in Figure 6. It will involve:

1. Calculation of the surface water balance throughout the system on a national or regional level according to a specified scenario. Inflows and outflows to and from the planning zones will be determined in accordance with the scenario. This operation will be carried out entirely by RIBASIM. In this operation also domestic and industrial water supply flows and hydropower flows and generation will be calculated. This process will be repeated until the modeller is satisfied with the results with respect to flow deficiencies (reliability) and hydropower generation.

2. With the flows calculated in step 1) the soil water/salt balance will be calculated for each planning zone for each of the 25 years sequentially. This step will be carried out entirely in SALTMOD to give the salt concentrations or loads and drainage flows applying in the case of each planning zone. If these drainage flows differ substantially from the ones adopted in step 1), then step 1) will be re-executed until a satisfactory series of flow is obtained.

3. When all salt concentrations or loads have been calculated, the full salt balance will be calculated using all the flows obtained in step 1). This step will be carried out in a spreadsheet, to which all the flows from RIBASIM and all the salt concentrations from SALTMOD will have been exported.

4. Once the salt balances have been calculated, the future situation in the planning zones will have been defined, and the economic model will be applied to calculate the economic consequences. The economic model will be entirely executed in a spreadsheet,

5. Steps 1 – 4 will be repeated until all scenarios have been processed.

141. In detail these steps are complicated and depend on the data availability. Also, scenarios have to be carefully developed before the modelling effort can be started effectively. However, once a number of scenarios have been processed, it will be clear which direction to take for further improvement.

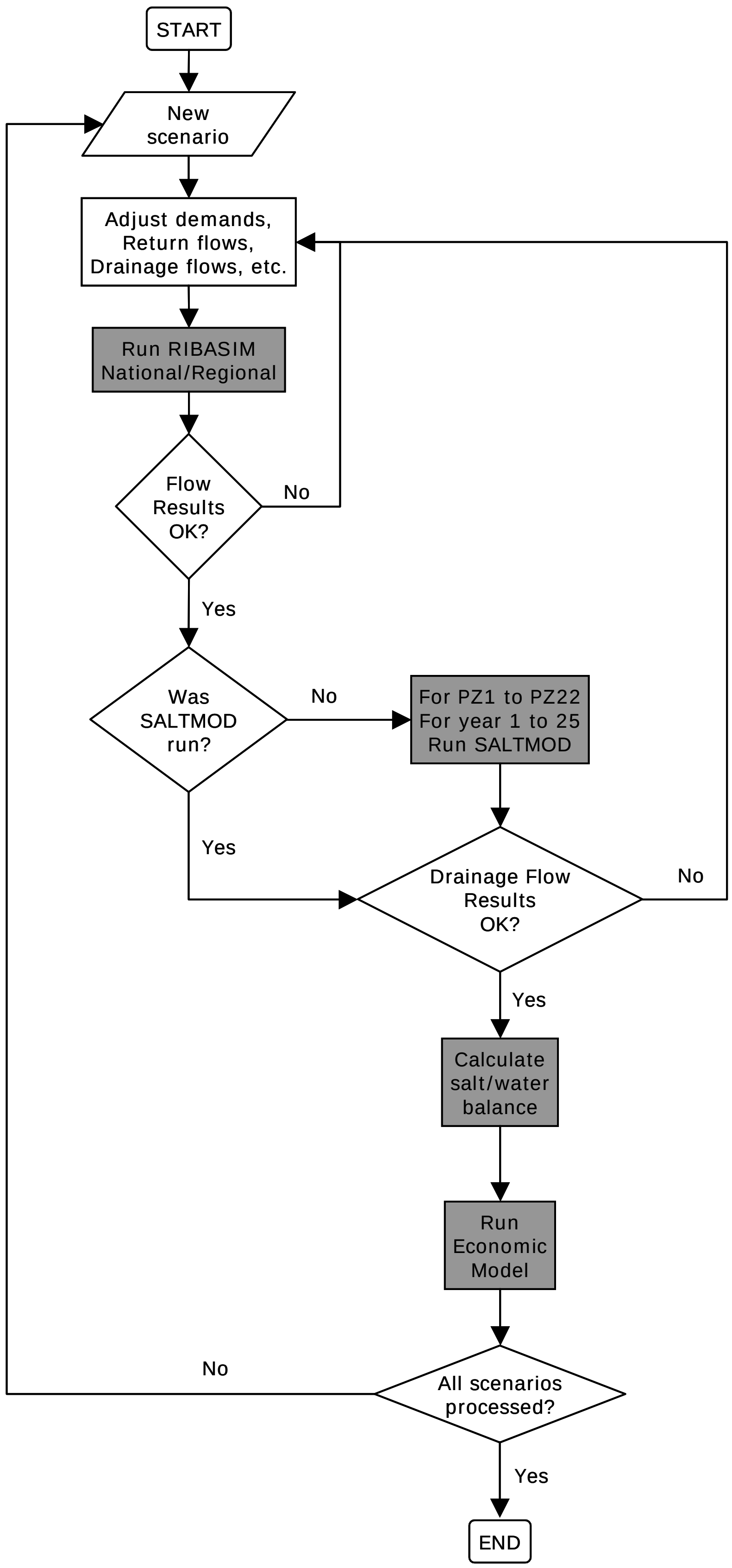

Figure 6 Operational flow diagram of modelling effort

5.4.6 Economic Component of Basin Model

142. We will develop an economic component for the basin model, which will take the form of a PC-based spreadsheet model. It is envisaged that it will consist of four inter-related sub-models representing the following water use sectors:

- irrigated agriculture;
- hydropower;
- domestic and industrial water supply;
- water resource infrastructure.

143. The model will simulate the economic impacts on each sector of alternative water quantity, water quality and investment scenarios. A time series of expected benefits and costs will be generated, from which economic as well as financial indicators can be derived. Uncertainty in model parameters may be modelled using monte-carlo simulation framework or alternatively using sensitivity analyses. The time horizon for the model will be 25 years, with 2000 being the base year. One or a range of economic discount rates will be used to bring future costs and benefits to present day values.

Irrigated Agriculture Sub-model

144. Irrigated agriculture will be simulated as a set of cropping patterns within a planning zone, with the cropping pattern generating a series of demands on the surface, groundwater or rainfall sources. At this stage it is envisaged that crop yields will be modelled using a water-crop production function. This function will simulate the effects of water stress in a given time step according to the crop water requirements, with the availability of water to irrigated agriculture depending on number of factors, including river flows, storage operation rules, the allocation to a planning zone, the prioritization of water uses, and the efficiency of the water distribution system.

145. Irrigation water salinity and soil salinity levels also impact on crop yields. Irrigation water salinity is a function of water use patterns and other developments upstream of the planning zone. Soil salinity levels will be derived from the soil water/salt balance model. The effect of salinity on yields will be modelled using 'bent-stick' functions relating the achievable yields to salinity levels. In quantifying these functions we will make use of the great amount of research already undertaken locally into salinity/yield relationships.

146. Waterlogging (i.e. the occurrence of saturated conditions in the root zone) can affect cropping in the low-lying areas where watertables are shallowest. It is envisaged that this will be modelled by reference to the depth of the watertable in a given time step, combined with a topography coefficient and a yield function relating the duration of root zone inundation to yield levels for each crop type. This will be undertaken where there are data available on waterlogging effects relating to the various crops.

147. Both soil salinity and waterlogging impacts are an outcome of the levels of operation and maintenance expenditure and investment in drainage, field irrigation

efficiency and delivery efficiency. They will be used to test the outcomes of scenarios involving various levels of investment and of changes to irrigation practices.

148. The value of irrigated agriculture will be calculated using crop prices and production costs adjusted to economic values. The model will assume that water is one of the major resource constraints on economic activity in the agricultural sector. Other key factors affecting crop yields such as production credit availability, input prices and institutional reforms will be external to the model, and their impact will be assessed through sensitivity testing of the model results.

Hydropower Sub-model

149. It is envisaged that the output from hydropower plant on water storages will be specified by the characteristics of the reservoir storage and power plant together with the rules for the operation of the reservoir. For run-of-river plant, the energy generated will depend on the flow available upstream of the hydropower plant intake and the properties of the generator.

150. The revenue from electricity generation will be calculated using the average price per kWh of electricity generated multiplied by the total output for the time step less the costs of operating the plant. As the market for electricity is not competitive, the issue of appropriate pricing for power generation is difficult to resolve. The selling price at generator terminals is assumed to be set administratively. The model will allow a range of average annual prices to be tested in different scenarios. In the longer term the Central Asian energy market may be liberalized with competitive pricing based on a pool dispatch system. In this situation the electricity price is likely to follow the load curve, with higher pricing in peak demand periods. The capability for simulating this type of pricing response will be included if appropriate.

151. The cost of power generation will be based on the operating and maintenance costs of the generation plant and other single purpose facilities, with an allocation for facilities shared between hydropower and other water uses such as irrigation and flood control. The cost will include a depreciation charge based on the book value of the generation and shared assets over the expected life of the assets.

Domestic and Industrial Water Supply Sub-model

152. The water requirements for domestic and industrial supply will be simulated as withdrawals from the supply network, which can be specified for each time step to reflect seasonal fluctuations in water demand. Given the high value of water for domestic and industrial uses, this category will be modelled to receive priority over other uses for available water allocations. Data will be obtained from oblast communal services departments.

153. The economic benefits will be modelled as the avoided costs of salinity damages or water shortages. Salinity cost functions will be used to simulate salinity damages to industrial equipment and domestic plumbing fittings (see Section 5.9.5 below).

Water Resource Infrastructure Sub-model

154. In regard to water delivery infrastructure, the costs of pumping will be computed based on the value of plant, the economic life of the plant, and operating and maintenance costs including the value of energy consumed. As noted above, the issue of appropriate pricing for electrical energy is difficult to resolve, and more than one energy value may be tested. Delivery costs via canals and pipelines will allow for operation and maintenance costs, a capital charge for major diversion and storage infrastructure, and an administration charge for relevant water agencies. Main, inter-farm and on-farm irrigation system costs will be taken from Task R5.

155. In regard to the impacts of shallow watertables and associated salinity on general infrastructure such as roads, pipelines, etc., these costs will be estimated using cost functions derived under Tasks R7 and N7 as described in Section 5.9.5 below.

Environmental Costs and Benefits

156. Because of their subjective nature it is not possible to assign firm values to environmental costs and benefits, and they are not included in the economic component of the model. It is intended to assess environmental values qualitatively as 'threshold' values required to achieve a positive cost/benefit ratio for any proposed program, given all other quantifiable costs and benefits.

5.5 Task N3 and R4 - Assessment of Transboundary and National Water Resources

5.5.1 Description of Task

157. Our interpretation of the Terms of Reference (paras 10-11, 33, 39, 41, 62-69, 71-74, 78-84, 95, 97, 99, 113-116, 135-137) for Tasks N3 and R4 is that:

- the National teams will prepare relevant data sets and assess for their respective States the quantity and quality of surface waters and groundwater and their variability in the short term and long term;
- the Regional team will provide guidance and support to the National teams, will designate 'transboundary' and 'national' waters, will compile the national data sets, and will evaluate data deficiencies at the regional level and establish a methodology to deal with them. The end result should be an acceptable regional data set that meets the needs of the present study.

Basic guidance for the implementation of Tasks N3 and R4 will be provided under Task R2 (Phase II Report). This relates particularly to definitions of 'transboundary' and 'national' waters.

5.5.2 Assessment of Surface Waters and Their Variability (Short Term and Long Term)

158. The following steps are proposed in the assessment of the available data at national level:

- Carry out preliminary water and salt balances, with sufficient cross-checks (using also climatic data) so that deficiencies can be identified;
- Evaluate deficiencies in the existing data sets (gaps, inconsistencies);
- Agree on a methodology to deal with data gaps and inconsistencies.

159. Detailed terms of reference will be agreed with the National teams for execution of these tasks. These will specify the formats for data presentation so that the results from the five States will be comparable. After acceptable data sets have been established at national level, the Regional team will evaluate deficiencies at the regional level, propose a consistent method to deal with these deficiencies, and establish data sets that meet the purposes of the present study. The modes of operation of reservoirs in the rivers and desert sinks in the drainage system may affect water and salt balances, and we will obtain details on the operation of these water bodies as an aid in interpreting the balances. The main output of this activity will be data sets that are acceptable to all parties and that meet the needs of the present study.

160. Forecasts of potential long term climate change prepared by several institutes in Central Asia, including Uzhydrometcenter, will be taken into account in assessing possible changes to precipitation patterns and discharges of the major rivers in the region. However, we will treat all quantitative forecasts with due caution because, although current models may adequately simulate climatic processes in regions with a flat topography and without land-water interfaces, they are less capable of simulating the complex climatic processes in mountainous regions, and most of the waters of the Syr Darya and Amu Darya originate in mountainous areas

5.5.3 <u>Assessment of Groundwaters and Their Variability (Short and Long Term)</u>

161. For planning purposes, assessments of the following components of the groundwater and salt balance are relevant:

- inflows to the groundwater from rivers, canals, reservoirs;
- percolation to the deeper aquifers from irrigated areas;
- groundwater recharge from local precipitation;
- lateral inflows and outflows of groundwater (national and transboundary);
- groundwater outflows to rivers and drains;
- groundwater abstraction for water supply, irrigation and vertical drainage;
- evaporation from capillary rise from shallow watertables outside irrigated areas;
- salinity of the various inflows and outflows.

162. An early task will be to review and describe the broad hydro-geological features of the Aral Sea Basin to provide a framework of understanding for the salinity studies in Tasks R7/N7. The critical areas identified in Tasks R7/N7 will then be analysed in detail to provide mapping of the underlying aquifer system(s) in terms of piezometric pressure (or depth of watertable below surface) and groundwater salinity. This will be done in close co-operation with, and using data from, the local research institutes. These analyses will be used to provide indications of the likely major areas of salt generation.

163. Terms of reference will be agreed with the National teams for preparation of information on these aspects for various areas, and for carrying out the assessments. Progress will be monitored and discussed during two regional working sessions.

5.5.4 Identify and Designate Transboundary and National Waters

164. Agreements reached in the workshop at the end of Phase II and laid down in Regional Report 1 will form the basis for this activity. These agreements may encompass definitions of the terminology 'transboundary' and 'national' waters, and a preliminary interpretation of these definitions. Task R3 will basically start where Task R2 stops. If agreement has been reached on the definitions, then the Regional team will elaborate on them. If no agreement has been reached, then the 'Helsinki Rules of International River Water Use, Article 1' of 1992 are proposed as the basis for this activity. Under Aral Sea Program 1.1, experts of the five States interpreted these rules at a workshop in Chymkent (1995). However, not all States endorsed the final conclusions of that workshop, and we will seek to develop an interpretation that all parties can endorse.

165. We recognise in particular the challenge of delineating transboundary groundwaters, due to the inherent complexity of hydrogeological conditions and the inadequacy of groundwater data. The difficulties associated with this activity were confirmed during the working session in September 2000. An additional factor is that water management questions in the region have traditionally focused on surface water. Addressing the management of groundwater will require more interaction between surface and groundwater experts than has traditionally been the case. A regional workshop of experts in both fields will be held to promote this. The outcomes will feed into National Report 1 and Regional Report 2.

5.5.5 Delineation of Transboundary and National Waters for Each Planning Zone

166. The first step in the delineation of transboundary and national water resources at the planning zone level will be to reach consensus among the relevant experts on a set of criteria to establish boundaries. The national and Regional teams will jointly develop these criteria. Work done under ASBP Program 1.1 may serve as a basis for this task. In selecting appropriate criteria, we will refer to approaches used in other international river basins. We propose to hold a regional working session, chaired by the team leader, with the water planners, legal experts, hydrologists and hydrogeologists of the National and Regional teams to achieve such a consensus. Terms of Reference will be agreed with the National teams for the preparation of such a working session.

167. The second step will be for the National teams to consistently apply these criteria and define where the network of transboundary waters starts and where the national network stops. We anticipate that this will involve an iterative process in which the interpretation of criteria will be refined in several stages. However, the various States have very different ideas on the definition of transboundary waters and the ownership of water. Consequently, at the working session in September 2000, the National teams expressed scepticism that the project would eventually produce a map

of transboundary waters. As an alternative, it may be feasible to produce maps that elaborate the separate criteria and that may serve as a basis for future agreements.

168. Although the Terms of Reference for Sub-component A1 call for mapping at a scale of 1:250,000, we were informed at the working session that a scale of 1:200,000 has always been used in the region. Other scales would introduce unnecessary complications, and it is proposed to utilise the WARMIS GIS to prepare maps per planning zone on a scale of 1:200,000. These will be included in Regional Report No. 2.

5.5.6 Implications of Variability in Time for National and Regional Strategies

169. The national and regional water and salt management policies and strategies should take into account variability of flow from year to year. As described in previous sections, the National teams agreed that flow conditions with 50% and 90% probabilities of exceedence are appropriate for this purpose. With regard to drought conditions, we will specifically address water shortage and salinity problems in the middle and lower reaches of the rivers related to:

- peak salinity of surface water sources for public water supply;
- competition for fresh groundwater resources between agriculture and public water supply;
- water availability for the wetlands in the delta and Aral Sea shore zone.

The outcomes of this evaluation will feed into Tasks N7/R7 (critical areas), N8/R8 (water and salt balances) and R9/N9 (policies, strategies and action plans).

5.6 Tasks R5 and N5 – Assessment of Basin and National Water Infrastructure and Management

5.6.1 Background

170. Irrigated agriculture is the main use of water resources in the Aral Sea Basin, accounting for 92% of overall water consumption. This water is delivered to irrigated crops through an extensive system of storages, canals and on-farm structures. Excess water is then removed from irrigated land through a system of drainage canals and disposal works. The operational condition of these irrigation and drainage (I&D) infrastructure systems has a major influence on the efficiency of water use, the quality of agricultural land, and the economic viability of irrigated agriculture.

171. Various estimates suggest that funding levels for management, maintenance and replacement of I&D in the Basin have fallen by over 70% in the last decade. As a result, much of the irrigation infrastructure is in poor condition. In many areas, parts of the system no longer function, or they operate at reduced technical and management levels. As a consequence there has been an increase in the extent of waterlogging and salinisation and a pronounced decline in crop yields.

5.6.2 Description of Tasks

172. Tasks R5 and N5 are described in paragraphs 138 and 139 of the Terms of Reference. Essentially the main objective of the tasks is to assess the condition of regional and national irrigation and drainage (I&D) infrastructure, and the quality of operational management. The assessment is to include current conditions as well as long-term forecasts over 25 years. Individual system components are to be examined as well as the overall system. The assessment is to consider rehabilitation of the infrastructure both to existing standards of service and to improved and expanded standards of service. Rehabilitation may be undertaken in phases, and these phases must be identified with each phase having precise objectives. Economic justification is to be provided for each of the phases.

173. Tasks R5 and N5 have links with several other Sub-component A1 tasks and provide outputs to a number of the Sub-component A1 reports. Information from the tasks will be used in Task R3 – Basin Modelling, specifically the investment analysis of measures to save water and control salinity. The condition of I&D infrastructure will also affect the river and soil salinity costs and reclamation options, to be examined in Task R7 – Assessment of Salinity Trends, Costs and Standards. The efficiency of irrigation distribution system will affect required water demands and therefore the condition of the delivery system needs to be considered in Task R8 – Basin Water and Salt Balances.

174. Outputs from Tasks R5 and N5 will be used in the detailed analysis of planning zones to be presented in National Report 1 – National Water Demands and Options for Demand Management. Cost and effectiveness data for I&D are required for the technical and economic screening of water saving and salinity mitigation options to be presented in this report. National Report 1 must also provide long term, phased and prioritised investment programs for I&D infrastructure.

5.6.3 Team Responsibilities

175. The Regional team will be responsible for assessing basin infrastructure, which includes 'carriers' or large canals that convey water across national boundaries or between oblasts e.g. Big Ferghana Canal, Kirov Main Canal, Karshi Main Canal, and Shavat Canal. The National teams will assess the main, inter-farm and on-farm systems. The term 'main' is taken to be systems that supply water directly to distribution canals.

5.6.4 Definition of Water Infrastructure

176. The proposed definition of the irrigation and drainage (I&D) infrastructure to be assessed covers all structures and equipment for the delivery of water to irrigation users and the disposal of return flows from irrigation fields. This definition includes items such as:

- water supply canals;
- drainage channels;
- pipelines;

- vertical and horizontal drainage systems;
- pumps;
- hydraulic control and metering structures;
- electrical and mechanical equipment, and associated buildings;
- communications and telemonitoring equipment, and associated buildings;
- housing and administrative offices;
- roads and access structures; and
- disposal basins.

The definition excludes infrastructure associated with other water uses including hydropower, domestic and industrial water supply, flood control, aquaculture, recreation and environment. Some elements of infrastructure are shared by a range of water users. In these circumstances it will be necessary to separate out costs using an allocation mechanism or, where irrigation is the dominant use, to ignore the contribution of the infrastructure to other uses.

177. Irrigation systems consist of combinations of many varied individual components (assets), and for the purposes of the condition assessment these components need to be aggregated into segments. Conventionally, the irrigation system is divided into main, on-farm and inter-farm segments, although with the change in the structure of irrigated farming in recent years some on-farm systems are now inter-farm systems. The National teams will make appropriate adjustments for these changes.

5.6.5 Data Collection Method

178. It is impractical to physically inspect all of the vast and varied I&D infrastructure in the basin, given the resources available for this study. The assessment data will therefore be compiled using a combination of methods which will include:

- field inspection of a sample of assets;
- interviews with field staff of the infrastructure management agencies;
- compilation from existing records, reports and databases;
- questionnaires sent to the management agencies; and
- workshops with staff of management agencies.

179. In the case of national infrastructure, the National teams will determine the most appropriate methods after discussions with the national management agencies. They will prepare a draft plan setting out in detail the methods, sampling proportions, questionnaires and workshops that they propose. This will be submitted to the Regional team for discussion and approval before implementation. The task will be documented comprehensively, and records will be kept regarding the data used, the organisations consulted and the assets inspected.

180. The Regional team will assume responsibility for assessment of the regional infrastructure. The team will consult with the Amu Darya and Syr Darya BVOs in assessing the appropriateness of the various methods, and on the basis of these

discussions will prepare an assessment plan. This will be the subject of a team workshop before it is finalised and then implemented.

5.6.6 Data to be Collected

Overall Condition Assessment

181. The assessment of overall condition of a specific segment will include all the assets (canals, pumps, structures, etc.) within that segment. This segmentation approach will apply specifically to the network components of the supply and drainage system, as the larger individual structures such as dams and pumping cascades will be evaluated individually by the Regional team.

182. For this study the condition assessments will be made using a condition rating or scoring system based on the remaining service life and capacity of components in a segment (see Table 5).

Table 5 Condition Assessment Criteria

Component	**Criterion**	**Variable**
Irrigation and drainage Canals	Existing capacity as % of design capacity.	c
Vertical and closed horizontal drainage	% of design life remaining (expected remaining service life/design life).	d
Mechanical systems	% of design life remaining (expected remaining service life/design life).	ms
Electrical systems	% of design life remaining	es
Hydraulic structures	% of design life remaining	hs
Pipelines	% of design life remaining	P

183. The overall ranking for a segment will be calculated as the sum of the scores for each component. The weights will be the book asset value of each component in the segment as a proportion of the total segment value. The formula to be used is:

$$CR = w_c \cdot c + w_d \cdot d + w_{ms} \cdot ms + w_{es} \cdot es + w_{hs} \cdot hs + w_p \cdot p$$

where: CR = condition ranking

w_i = weight for component i

The overall condition assessment will be a value between 0 and 1.

184. Data is required for predicting the future condition of the system as well as its present condition. The Base Case for such predictions is the no-change scenario in which the level of O&M and replacement expenditure remains at present or recent levels. For the time-based economic studies an estimate will be made of the annual rate of change in each of the component criteria.

Management Assessment

185. The quality of infrastructure management is judged in terms of the ability of the infrastructure system to deliver services to consumers reliably, cost-effectively and with the required standard of service. The basic aims of irrigation management are:

- to deliver water as required by irrigators to satisfy the needs of irrigated crops;
- to minimise losses of water to the system;
- to minimise the risk of loss of supply to irrigators.

It is proposed to use a mix of quantitative and qualitative assessments. The quantitative information will be used in the computer modelling for the purpose of estimating crop stress factors and water losses in the distribution system. The criteria are summarised in Table 6.

Table 6 Management Assessment Criteria

Measure	**Criterion**
Standard of service	% of crop water requirements met (average volume of water delivered/volume of crop water requirement)
Water Delivery Performance	% water use efficiency (water volume at the Intake/water volume delivered to farm outlet)
Loss of Supply Risk	Irrigated crop yield at risk (see below)

186. In evaluating the infrastructure, both the National and Regional teams will identify those structures whose malfunctioning will have an impact on the entire system or large portions of the system. This is likely to be a major component in the transmission system such as one of the cascade pumping stations, a river diversion structure or a major control structure. This will be used to develop a prioritised rehabilitation plan in which the critical items are given the highest priority. The risk of failure of the critical items will be estimated, and the area of irrigated crops or volume of water affected and outage duration quantified. A risk management approach, that uses the probability of failure and weights the costs of such an occurrence by its probability, will then be applied in the economic analyses to assess whether the rehabilitation work can be justified.

187. The National teams will prepare written assessments identifying the structure of water management in each planning zone, including staffing and

equipment levels, and funding and cost recovery measures. The assessment will highlight the main deficiencies in management operations and identify options for overcoming these deficiencies.

188. The RWG will assess the basin water management institutions (BVOs) in terms of their internal organisation structuer and functioning. The performance level of these institutions will also be assessed, including reliability of services provided, risk of loss of water supply, cost effectiveness and water use efficiency.

Investment Analysis and O&M Data

189. The investment analysis of the rehabilitation of I&D infrastructure will require a range of cost and benefit data. Where capital costs of rehabilitating typical elements are produced, the estimates will be based on the cost to bring the component from its current condition up to a condition equivalent to 100% of the relevant criterion. Detailed breakdowns of materials, labour and equipment will be produced in order to enable economic costs to be calculated by the National team economists. These will be converted to costs per kilometre for water conveyance systems, with equipment such as pumps and structures being converted to costs per kilometre. For vertical, sub-surface and surface drains, unit costs per hectare serviced or protected will be determined.

190. The rehabilitation assessment will be essentially a high level one in which large numbers of individual components will be combined to form investment 'packages'. Typically, however, some items will be of such scale and/or importance (e.g. the Amu-Bukhara Cascade) that they warrant consideration on an individual basis, and cost and benefit estimates will be prepared on that basis.

191. With regard to O&M costs, international best practice suggests that lifecycle costing is essential for long term viability, and O&M costs in the ‘high level development’ scenario will include an allowance for future replacement/refurbishment in addition to recurrent annual costs. The information required in this case will include annual costs of operation and recurrent maintenance, asset life, and the cost of refurbishment. It will be assumed in this scenario that preventive maintenance will be undertaken on a regular basis to ensure reliable operation of the system. In the lower level scenarios, less than optimum levels of O&M expenditure will be assumed.

192. The final element of the costing will be the expenditure required to upgrade systems to provide a service better suited to the evolving structure of farm ownership and water management. Such enhancements could include greater degree of control over flow, installation of measurement devices, and/or the provision of a greater number of outlets. In all cases economic rather than financial costs will be produced i.e. financial costs will be adjusted to reflect subsidies, tariffs and other economic distortions.

193. With regard to benefit estimates, most of these will be derived from the Basin models (Task R3). However, an item of additional information will be the rate of deterioration in water use efficiency for each segment of the delivery system if

there is no change to current (or recent) O&M funding. Estimates of this factor will be provided by the National and Regional teams.

5.7 Task N6 – Scenario Development

194. One of the activities required in Phase II of the project (Principles and Guidelines for Regional and National Planning) is the development of alternative scenarios for the irrigation sector in the five Central Asian Republics. These scenarios will be drafted initially by the National teams according to guidelines provided by the Regional team and in line with the goals defined in Task R2. The drafts will be assessed by the Regional team for consistency with the defined goals and between the various Nations, and agreement will be reached with each of the National teams on the scenarios to be finally adopted for the purposes of the study.

195. A scenario tries to take a glance into the future, in this case to depict a vision for the Aral Sea Basin over the period from 2001 to 2025. The scenario method is a qualitative process in which the emphasis is placed on describing the interdependence between individual parameters and sectors. It describes a complex end state, i.e. the imaginable conditions in the target year. Although scenarios are by their nature qualitative, they should be supported by quantitative forecasts. In particular, goal scenarios are written with regard to previously defined systems of goals, in this case salinity levels, irrigation efficiency, etc. In this study the goals will be defined in Task R2 and discussed and described in Regional Report No. 1.

196. The fundamental function of scenarios is to create an understanding and awareness among national decision makers that the future continuously offers a number of alternative courses of action. There is always more than one option open. Scenarios must be realistic and based on the analysis of the potentials and constraints of the current situation. The conditions described in the scenarios must be attainable with the known technical, institutional and organisational tools, and with the funds that are likely to be invested in the sector, including external donor funds.

197. Based on the analysis of current political and economic conditions, anticipated future opportunities for change will be developed and tested for each State. Apart from other factors, one of the key elements will be the annual amount of investment in the irrigation sector over the next 25 years. As suggested in the Terms of Reference, the three following scenarios will be developed to describe the possible future development of the irrigation sector:

- 'minimal change' scenario (or 'Base Case' scenario);
- 'low-level development' scenario;
- 'high-level development' scenario.

198. The minimal change or Base Case scenario will be based on the assumption that trends that have been observed in the past will continue within the forecasting period, especially with regard to policy reforms and annual investment in existing irrigation and drainage infrastructure. The assumption will also be made that irrigation efficiencies will remain (at best) at the current low level and that soil and river salinity levels will further increase. General agreement to the Base Case scenario will be essential, because all other alternative scenarios will be compared to

it to test their specific performance. The low-level as well as the high-level scenarios will differ in the extent and speed of the policy reform process, institutional reforms, reorganisation of the water management sector, investment levels, the pricing and incentive policies for cost recovery, water conservation, better water allocation systems, etc. The individual scenarios will be reflected in the results of the basin modelling, which will indicate the technical, economic, social and environmental implications of each alternative.

199. Key variables that will be considered in the development of scenarios will be:

- overall national development goals;
- political reform processes in the transition of all States to market orientation;
- performance of the national economies and expected growth, in total and by sector;
- public expenditure/investment potential in irrigated agriculture (national budget; international donor funding) for rehabilitation of existing irrigation and drainage infrastructure;
- population and population growth, migration trends;
- employment, in total and by sector;
- socio-economic development goals (food requirements, health standards for drinking water);
- domestic and industrial water demand and quality standards;
- energy production and demand, with special attention given to hydropower;
- sector-specific development goals for irrigated agriculture;
- agricultural development strategies:
  - political reform process,
  - legal framework (national, international),
  - institutional set up and water management reforms,
  - status of irrigation and drainage infrastructure,
  - pricing and price policies/cost recovery,
  - production and productivity,
  - land use,
  - irrigation efficiency,
  - soil and river salinity levels and their impacts on yield,
  - water conservation.

200. Relevant references for the above listed variables include the existing National Development Plans of each of the five States, although their time horizons vary between 5 and 30 years. The sectoral development plans for the agricultural and energy sectors will also provide source material. Additional statistical information is available from publications of the Ministries of Macroeconomics and Statistics (The Basic Indicators of Social and Economic Development) and the Ministries of Agriculture and Water Resources (The Annual Report on Land Reclamation and Water Use). Other sources of national and sectoral policy analysis are the World Bank country reports and recent publications/feasibility studies of current projects being planned or already implemented.

201. An example of possible development scenarios for the irrigation and drainage sector is one developed and agreed upon by representatives of all five Central Asian Republics during a workshop held in Tashkent in August 1999 entitled: 'From Vision to Action' (see Appendix C). This 'vision' is similar to that presented in the UNESCO-publication: 'Water related vision for the Aral Sea Basin for the year 2025' published in early 2000. These will be taken into account in developing the scenarios.

5.8 Task R6 – Assessment of Sanitary and Ecological Demands of Transboundary Rivers, Delta and Aral Sea Shore

5.8.1 Task Definition

202. Our interpretation of the Terms of Reference (section 10-11, 44-46, 83.c, 87.c, 115.c, 144) is that the task will propose and develop an initial framework, tools and methods to give adequate weight to regional sanitary and ecological concerns in the national and regional water resources planning process. These tools will facilitate the evaluation of the environmental sustainability of draft strategies, policies and action plans that are elaborated under Task N9/R9. Implementation of Task R6 will be guided by outcomes of Task R2. This guidance could relate to a definition of the concept of “sanitary and ecological water demands”, and/or a specification of the water objects that are to be considered under this task.

203. During the working session in September 2000, no consensus could be reached on a definition of sanitary and ecological water demands. In developing the approach to the present task we have used the following working definition:

'The sanitary and ecological water demands of transboundary rivers, delta and the Aral Sea are the requirements in terms of water quality and water quantity during various periods of the year in order to sustain their functions as:

- *sources of public water supply;*
- *sources of water, sediment and nutrients for floodplains and grazing areas;*
- *objects for recreation;*
- *objects that sustain biodiversity and fisheries;*
- *other relevant ecological functions.'*

This preliminary definition will be reviewed and agreed upon between the five States in the early stages of the task.

204. Under Task R6 the Regional team will:

- develop an initial framework;
- outline sustainable sanitary and ecological target situations and the associated hydrologic target regimes for relevant water objects and key points in the rivers;
- evaluate mechanisms for water allocation for sanitary and ecological purposes and for control of environmental sustainability.

5.8.2 Initial Framework for Environmental Sustainability of Rivers, Delta and Aral Sea

205. The initial framework will be used to develop initial guidelines for national and regional planning, to screen options and assess sanitary and ecological impacts of future changes in water use. As a first step in developing the framework, we will specify in more detail which water objects and key points in the rivers the framework will cover and what function they fulfil or may fulfil in the future. The water objects may include some or all of the following wetlands:

- upper, middle and lower river reaches;
- artificial reservoirs;
- lowland lakes;
- floodplains;
- desert sinks;
- deltas;
- Aral Sea shore zone.

206. The Terms of Reference do not specifically mention the wetlands that have developed in association with drainage and hydropower generation (desert sinks and escapes). However, water bodies like Arnasay, Sarikamish and Dengizkul may be considered to be of regional ecological significance, and their importance for biodiversity, migratory birds and fisheries is increasing as 'downstream' wetlands become more degraded. Also, they store hundreds of millions of tonnes of salt, and may constitute a considerable risk if not properly managed. It appears appropriate, therefore, to include them in any salt management strategy for the Basin, and we propose that consideration of them be included in this project.

207. The next steps will be to elaborate, for selected objects and key points in the rivers, the following initial framework:

- tentative sanitary and ecological objectives;
- tentative hydrologic criteria;
- tentative water resource parameters.

Tentative Sanitary and Ecological Water Management Objectives

208. Under Task R2, we will have sought agreement between the five States on broadly defined sanitary and ecological water management objectives. Based on the National Environmental Action Plans of the five States, and agreements that they have signed in recent years in the framework of the Aral Sea Basin programme, these objectives may include:

- protection of sources of drinking water;
- halting of the desertification process in the Aral Sea shore zone;
- restoration and stabilisation of wetlands in the delta and Aral Sea shore zone;
- erosion control in upper reaches of the basin;
- enhancement of the economic productivity of wetlands (fisheries, reeds);
- safeguarding of the biodiversity of terrestrial and aquatic ecosystems.

209. The objectives will be defined for the short term (five years) and long term (25 years). We recognise that it is important that these objectives adequately reflect the specific sanitary and ecological issues in different parts of the Basin.

Tentative Hydrologic Criteria for Ecological and Sanitary Water Management

210. Various studies undertaken in previous years provide an adequate basis for this activity. These include projects under WEMP component E (Wetlands Restoration), the Upper Watersheds Study under Component 6 of the ASBP, the environmental assessments under the Syr Darya Control and Northern Aral Sea (SYNAS) Programme, the EPIC Programme and the Uzbekistan Drainage Project (UDP).

211. Hydrologic criteria and parameters that reflect ecological and sanitary requirements at the basin level could relate to:

- water quantity: pattern and level of flood flows; annual pattern of water flows (inflow and outflow), water levels and water volumes;
- water quality: surface water salinity or salt load, treatment levels for industrial and domestic wastewater, concentrations of hazardous chemicals and sediment load.

In cooperation with the National teams, the list could be expanded to produce a long list. Subsequently that long list could be narrowed down to the parameters that are essential at the level of national and regional planning. In this process of narrowing down, the following considerations are relevant:

- data availability;
- representation of the specific sanitary and ecological issues in different parts of the Basin;
- possibility of simulating changes in the parameters in the Basin models (Task R8).

5.8.3 Sustainable Hydrologic Regimes: Sanitary and Ecological Target Situations

212. Once a limited set of hydrologic criteria and parameters has been selected, the next step will be to define the long-term targets (in terms of water quality, quantity and variability with time) for the relevant water objects and key points in the rivers. The following could serve as a basis for defining these hydrologic regimes:

- existing sanitary/hygienic norms in the five States;
- historic hydrologic regimes for the specific water objects;
- existing hydrologic regimes in healthy reference wetlands or rivers where environmental sustainability exists.

213. Terms of reference will be agreed with the Regional team to elaborate tentative long term sustainable hydrologic targets. It is noted here that specific water bodies may be identified as inherently unsustainable. Such water bodies will be evaluated in more detail under Task N7. Outcomes of this activity will also feed into Task R8/N8.

5.8.4 Mechanism for Water Allocation for Sanitary and Environmental Sustainability

214. Suitable quantities of water of appropriate quality must be allocated and delivered to the wetlands and to key points in the river at appropriate times and then properly controlled and managed. The five States currently operate in a framework for water allocation and sharing on a seasonal, annual or multi-year basis. Water allocation for public water has priority over all other water uses. Yet, the sustainability of sources of public water supply is at risk in the middle and lower reaches of the Basin. Significant bacteriological pollution occurs because wastewater treatment is inadequate. Locally, hazardous chemicals cause problems. Fresh groundwater sources at tail ends of the irrigation system are temporarily overdrawn in dry years, causing irreversible damage to the quality of local groundwater reservoirs.

215. Allocation of water to wetlands in the delta and the Aral Sea shore zone is at present dealt with basically as a residual allocation. Wetlands fed by drainage collectors receive relatively stable supplies from year to year, even under drought conditions, but wetlands that rely on fresh water sources may not receive any water. These are regional realities that are the result of national water management interventions which are not coordinated on a Basin scale.

216. Terms of reference will be agreed within the Regional team to:

- review existing allocation mechanisms and their effectiveness, including mechanisms to limit agricultural water use. This includes a review of laws, regulations and decrees at national level;
- review existing mechanisms for management of salt loads in drainage flows, their effectiveness as well as constraints;
- identify, assess and screen alternative mechanisms, taking into account existing agreements between the five States in the Basin, international water law and experience in other international river basins.

217. We recognise that practical inputs of water managers and water users in the Basin at different levels are crucial in reviewing existing mechanisms and developing meaningful alternatives. We also recognise that quantitative water allocation may require mechanisms other than salinity and pollution control. Therefore, we will seek the active participation of:

- interstate river basin organisations (ICWC and BVOs);
- Ministries responsible for Agriculture and Water Resources (including groundwater) and their branch offices at planning zone level;
- energy sector agencies;
- agencies responsible for nature protection and pollution control at national and at planning zone level;
- agencies responsible for fisheries;
- khokimiats.

Outcomes will feed into Task R9/N9.

5.9 Task R7 and N7 – Assessment of Salinity Trends, Costs and Standards

5.9.1 Basin-wide Salinity and Salt Load Studies

218. In the first part of this subtask we will review critically the existing water and salt balance studies already undertaken, together with any additional data not previously studied or gathered since. We will develop a detailed description of river salinity levels and salinity-flow relationships, covering the whole Basin, concentrating on key points along the two major rivers and their main tributaries. This in turn will be used to identify the river reaches in which major salt inflows occur, and to quantify where possible the salt inflows. The water and salt balances will be used also to quantify the gains and losses of water and salt from the Amu Darya and Syr Darya over specific reaches. The review will also provide an appreciation of the worst areas for soil salinisation and waterlogging. This review will be undertaken principally by the Regional team, with input from the National teams.

219. On the basis of this work, and taking into account previous studies and the local knowledge of the National team members, we will identify and map the major sources of salt generation. In doing so we will make use also of all available hydro-geological information and field data.

5.9.2 Identification of critical areas

220. We will then identify and delineate those areas that are typical of various combinations of conditions under which salinity and waterlogging have become critical problems and salt mobilisation is at a high level. Specific features that will be taken into account include:

- soil type;
- crop type;
- hydro-geological conditions, including type and size of underlying aquifers and groundwater salinity;
- drainage conditions;
- on-farm irrigation and drainage practices.

The WARMIS GIS system will be used to generate maps at a scale of 1:200,000 which will show soil salinity contours and thus indicate the most saline areas. As noted previously, mapping was previously undertaken at this scale in all States, and it is proposed to retain it rather than use the scale of 1:250,000 called for in the Terms of Reference so that the new and old mapping will be compatible.

221. It is not possible without closer examination of the Basin to specify how many typical areas involving various combinations of the above features will be selected for study. However, it is envisaged that, for the purposes of outline strategy development, adequate coverage will be provided by not more than eight areas. They may include some or all of the following:

Syr Darya Basin

- Fergana Valley;
- Hunger Steppe;
- riverside irrigation areas (Kazakhstan).

Amu Darya Basin

- one of the Vaksh, Pyandj, or Kafirnigan valleys;
- Surkandarya valley;
- riverside irrigation areas (Turkmenistan);
- Karshi irrigated area;
- Bukhara irrigated area;
- Khorezm, Karakalpakstan.

5.9.3 Analysis of salt mobilisation processes in critical areas

222. Using as a basis the broad description of the hydro-geological features of the Aral Sea Basin produced under Tasks R4/N3, more detailed consideration will be given to the irrigation areas and to other areas affected by irrigation infrastructure such as drainage water disposal areas or sinks. The mapping of piezometric pressures and groundwater salinity concentrations in the underlying aquifer systems also produced under Tasks R4/N3 will be used to provide indications of the likely major areas of salt generation.

223. Broad-based relationships will be developed to describe the salt mobilisation processes in each of the critical areas. Values for key parameters will be established from experience or by calibration against recorded salt exports or river salt loads where adequate data are available. These relationships (and relevant ones developed under Task R3) will be used to derive estimates of the current and future exports of salt to the surface water system from the irrigation areas. Estimates will also be made of the current and future salt contributions caused by seepage-induced high watertables under desert sinks and major drains and canals.

224. Finally, we will describe the salinisation processes likely to be critical in the future, and canvass in general terms the available options for reducing salt mobilisation and/or minimising the impacts.

5.9.4 Salinity Projections and Trends

225. The results of the previous tasks will be assembled to provide a picture of current and future salinisation of the Aral Sea Basin under the 'Base Case'.. The salinity picture will identify and delineate areas with different salinisation processes, and give estimates of the total extent of the areas affected by each process. The results will be presented in selected index years over the 25-year study period. The results will also be compiled so as to indicate, for each of the major regions of the Basin, the total areas (by crop type) with soil salinity levels in given ranges Estimates of river salinity levels at key points along the two main systems will also be derived for the same future index years under the Base Case scenario.

5.9.5 Study of Current and Future Costs of Salinity

226. Irrigation water salinity imposes costs on agriculture by lowering crop and pasture productivity and damaging infrastructure. Salinity may also impose costs on the rest of the community. This is particularly the case where drainage is inadequate and saline watertables rise towards the surface. The aim of this subtask is to establish the economic costs of various levels of salinity in the rivers and soils in the Basin. These costs will be used in the economic component of the Basin model developed under Task R3 for the evaluation of available options and/or measures for dealing with the salinity problems.

Agricultural Loss Functions - River Salinity

227. The first part of this element of the study will be to develop salinity-yield response functions for the major crops in the Basin. We will take into account local knowledge and any local research, together with the results of international research, in deriving Maas-Hoffman ('bent stick') relationships for the various crops. These will relate yield to the soil water salinity EC_e. For permanent plantings such as fruit trees or grapevines, we will take account also of long-term effects due to the accumulation of toxic ions in the woody tissues. The methodology to be applied is given in a separate ToR.

228. In order to assess the impact of irrigation water salinity on crop yields, representative values for the leaching fractions must first be determined. For each crop, therefore, we will then consider current irrigation technologies and agricultural practices in arriving at likely leaching fractions, which will differ between combinations of soil type and irrigation technology. Soils will be divided into three classifications: 'light soils' (sands and sandy loams), 'medium soils' (loams and clay loams) and 'heavy soils' (clays). We will obtain information on soil types and on-farm practices from the available reports and from the relevant government agencies. The leaching fractions will be used to derive soil water salinity levels from irrigation water salinities, and thus provide direct relationships between yield and irrigation water salinity (i.e. river salinity) for each combination of crop/soil type/irrigation technology/agricultural practice.

229. Soil salinisation does not generally begin until shallow watertables develop, which may not occur until many years after the commencement of irrigation. Once shallow watertables develop, soil salinity levels generally increase until an equilibrium level is established. Factors that influence the rate of salinity increase include the salinity of the groundwater, soil type, drainage conditions and on-farm practices. The various irrigation areas throughout the Aral Sea Basin are at different stages in the development of salinisation, and individual areas contain a mix of sub-areas at various stages in the salinisation process. To enable estimation of future economic costs of soil salinity, we will use the soil water/salinity model developed under Task R3 (see Section 5.4.5 above) to derive time-based relationships for development of soil salinisation with various soil types under different land uses, and hence time-based yield loss functions.

230. Land use information will be compiled for each of the two river basins to provide values at a number of critical points along the main stems of the areas of the various crops that are irrigated downstream of those points. These will be used with the yield loss relationships and gross margin data to give values for agricultural losses for each mg/l increase in river salinity at that point.

Domestic and Industrial Water Supply Cost Functions

231. Estimates of the impacts of river salinity on urban water supplies will be based on methodologies developed and used in a recent similar study of the Murray-Darling Basin in Australia. The basic methodology will involve a comparison of the costs associated with a number of water supply aspects in several towns/communities with different salinity levels in the water supply, and from these development of cost/salinity relationships. Aspects in which river salinity may have a cost impact in the Aral Sea Basin and for which individual salinity/cost relationships may be developed include:

- plumbing corrosion;
- hot water systems;
- cooling towers;
- commercial and industrial boilers;
- industrial process water treatment.

232. Using the Murray-Darling Basin results as a guide, we will develop salinity/cost relationships by comparing cost information from towns/communities with significantly different water supply salinity levels. The pairs of towns to be utilised in the comparisons will be finalised after further discussions with the National teams, but could include Tashkent/Nukus and/or Tashkent/Qyzlorda. Where comparative cost information cannot be obtained, we may adopt the form of the Murray-Darling relationships and modify the parameters in line with local costs.

233. We will seek from relevant government agencies data on urban water use throughout the Basin, and on all domestic and industrial consumers of water from the main stems of the two major rivers. Particular attention will be paid to the cities and towns along the lower reaches of the two rivers such as Nukus, Urgench and Qyzylorda. Information to be sought for each town/city will include:

- total water use;
- the division of water between domestic and industrial consumption;
- fluctuations in consumption over a year.

Where the division between domestic and industrial usage is not known, we will make estimates on the basis of town/city populations, per capita domestic consumption, the relative strength of industry and/or numbers of industrial plants, types of industry, and other factors.

234. The cost relationships will be combined with the consumption data to provide overall cost functions for each of the two river basins. These will be inserted in the economic component of the basin model described in Section 5.4.6 above.

Infrastructure Costs

235. Shallow watertables have a significant impact on road life and road maintenance requirements, and cause considerable costs in irrigated areas. The costs are due mainly to saturation of the road pavement, although the salinity in the groundwater can also have an effect. Road costs are usually the greatest infrastructure costs resulting from shallow watertables.

236. We will derive estimates of road costs using a similar methodology to that developed for the Murray-Darling Basin. It will involve comparisons of road construction and maintenance costs in areas with and without shallow watertables. These costs will be obtained by surveys of government ministries and road engineers to obtain estimates for several classes of road, e.g. local roads, regional roads and highways. The information that we will seek will include typical construction and maintenance costs, road standards, pavement materials, road life and reconstruction intervals. The data collected will be used to derive annualised costs per kilometre of road resulting from shallow watertables and from this the annualised benefits of constructing and rehabilitating surface and/or sub-surface drainage and hence eliminating waterlogging. The surveys and data analyses will be undertaken by the National teams.

237. The effects of waterlogging and/or salinity on other infrastructure, including the impacts in urban areas surrounded by irrigation, may also be significant. We will identify important items of infrastructure that might be affected by shallow watertables and/or the associated salinity, either now or in the future. These could include major water, gas or oil pipelines, railways, electricity transmission towers, or irrigation infrastructure itself. The National teams will obtain from the relevant government agencies estimates of the effects of salinity or waterlogging on the useful lives of these items, and their replacement costs. Towns and cities under which watertables have risen, or are likely to rise in future, will be identified, and costs will be placed on this occurrence based on estimates of reductions in useful life and replacement costs. The resulting cost functions will be used to estimate the current and future costs of salinity and waterlogging in each irrigated area, and the results will then be compiled for each of the two major river basins.

5.10 Task R8 and N8 – Determination of Basin Water and Salt Balances

5.10.1 <u>Use of the Basin Model</u>

238. The modelling approach to be used under Sub-component A1 will involve two principal steps – (i) calibration and verification, and (ii) scenario evaluation. In the first step the model(s) will be calibrated and then validated extensively, focusing on water-related data such as discharges, intakes, return flows and flows to depressions, as well as on energy produced. Salinity data will include the salinity levels of surface and ground waters and salinity of the (shallow) soils.

239. After validation, the model will be run using the 'Base Case' scenario. The results will form the basis for comparison of future scenarios.

240. Model runs simulating the effects of changes in future water management and other measures will then be undertaken. The results will be compared to those from the Base Case to indicate trends and directions of development. This modelling effort will focus on the river basins, and the results for all planning zones will be aggregated up to national values. This approach is illustrated in Figure 7. An example of the use of the model is presented in Figure 8.

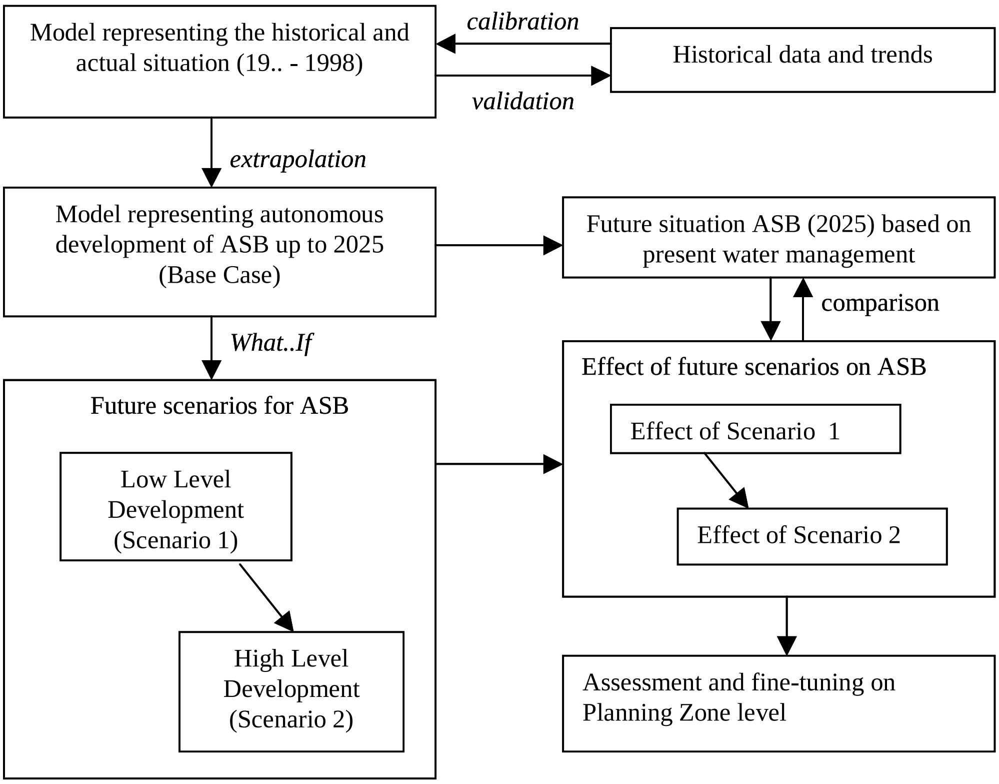

Figure 7 Schematic Representation of the Modelling Process

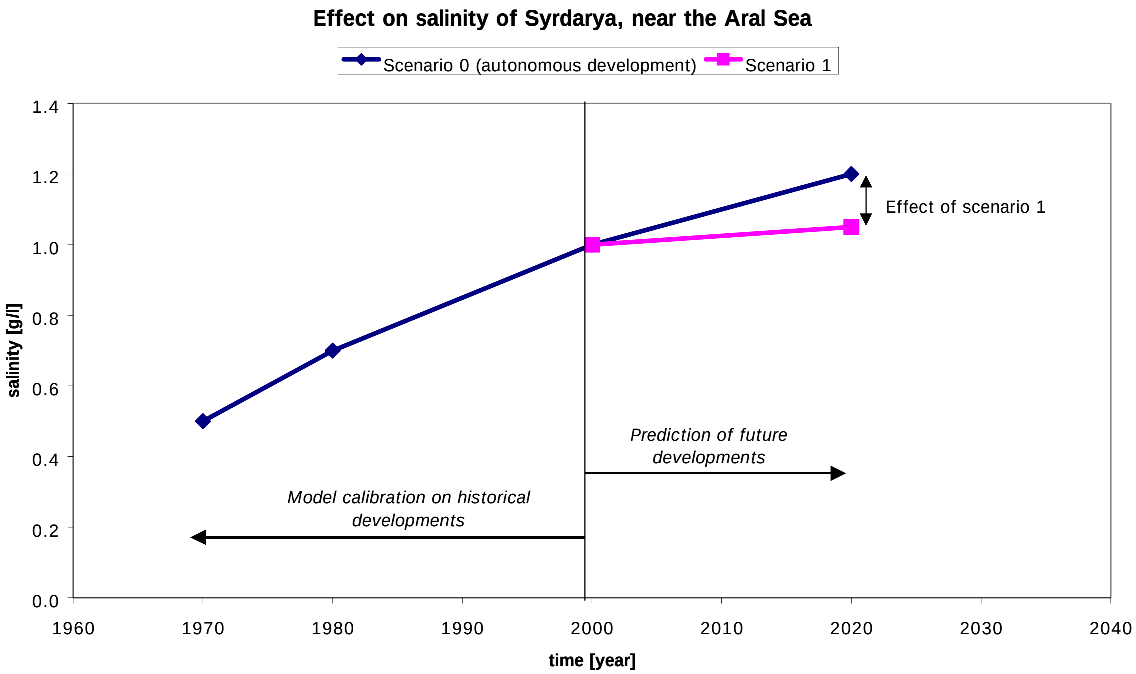

Figure 8 Typical Model Output

241. These approaches will be used in an iterative process to arrive at a comprehensive understanding of the complex processes that apply in the Aral Sea Basin. The results will provide a robust basis for the development of the strategies and plans. Using a “What..If” approach, the results will then be considered, and positive and negative effects will be highlighted. This “What..If” approach will focus on the regional level and not on small-scale fine-tuning (e.g. on the level of Planning Zones).

5.10.2 Model Studies and Outcomes

242. Based on the results of the previous phases, which will comprise the identification of regional needs and constraints (Phase III) and of national water demands and options for water demand management (Phase IV), the activities that will be undertaken in Tasks R8 and N8 (Phase V) will include the establishment of water and salt balances.

243. The water and salt balances will be studied from both the short and long-term perspectives for the various planning zones and for the basin as a whole. These analyses will identify the impacts of various water supply and demand scenarios under different assumptions made for river salinity and flow targets, different water allocations to rivers, deltas and the Aral Sea shore, and alternative development scenarios of the irrigation sector. The analyses will integrate the findings of specialist working groups on (i) water management and infrastructure; (ii) salinity, irrigation and drainage; and (iii) modelling. Constraints, limitations, criteria, requirements, and targets will be tested and evaluated.

244. Basin water and salt balances will jointly involve the regional and national project teams in order to verify and adapt national scenarios for water demand and to make them compatible with regional requirements.

245. From a regional point of view, the major objective will be to develop a framework that enables interstate co-operation on water and salinity management, based on the integration of national policies in a regional water policy, strategy and action program.

246. The results of the water and salt balances will be presented in Joint Report No. 2. This report will form the basis for a formal meeting with political decision-makers with the aim of obtaining guidance on a number of strategic choices presented in the report and on the proposed detailed planning guidelines for Phase VI. The strategic choices may include: the extent of environmental protection and improvement of water quality; sustainable irrigation water use and drainage disposal objectives; and flow regulation and water allocation. Key elements presented in Joint Report No. 2 will include:

- water and salt balances for all planning zones (using the basin simulation models) which will provide forecasts of salinity trends in critical areas and salt loads discharged to transboundary rivers;
- descriptions of future available national and transboundary water resources and regimes, and their variability in terms of quantity and salinity, and analyses of their impacts in the evaluation of alternative water allocation principles and criteria;
- alternative water and salt balances that meet sustainability criteria, and discussion of the implications for the availability of water to the States;
- discussion of alternative long-term salinity standards and their implications in terms of the costs of salinity;
- consideration of alternative sustainable hydrological regimes for water allocation to satisfy sanitary and ecological demands of the transboundary rivers and the delta areas;
- the results, in terms of transboundary water allocations to each state, of an evaluation of the application of (i) alternative principles and criteria for interstate water allocation and (ii) alternative regional salinity and environmental standards;
- a review of existing agreements for national and interstate water allocation;
- a critical analysis of alternative principles and criteria that might be adopted for interstate water allocation e.g.: 'priority rights', 'equitable rights', 'no significant harm', etc.

247. The report will include detailed recommendations to be adopted by decision makers on:

- principles and criteria for transboundary water allocation;
- transboundary river flow and salinity standards, sanitary and environmental flows;
- transboundary water allocations and total national water availability;

- measures to be implemented on both regional and national levels to arrive at a long-term sustainable water and salt balance in the Amu Darya and Syr Darya basins that meet regional salinity and ecological criteria.

248. The preliminary conceptual and economic framework for the formulation and evaluation of alternative regional and national policy and strategy options and trade-offs, which will have been developed in Phase II, will be further elaborated. In this context, regional and national policy objectives will be discussed and strategy options examined in the light of their technical, economic, political, financial and managerial feasibility, and prioritised as to importance and sequence in time.

249. Potential measures related to investments, finance, management, and the administrative and legal framework required for successful implementation, will be described as well.

5.11 Tasks R9 and N9 – Draft Regional and National Policies, Strategies and Action Programs

250. On the basis of the results obtained during Phases III, IV and V, and the guidelines of political decision-makers on the alternatives and recommendations presented in Joint Report No. 2, each of the five National teams will prepare a draft policy, strategy, and action program for their State (Task N9). The Regional team will prepare a similar draft on a regional basis (Task R9) which will be consistent with the draft national strategies.

251. The results will be presented in National Reports No. 2, which in principle will provide a further elaboration of the findings presented in National Reports No.1 (National Water Demands and Options for Water Demand Management) and Regional Report No. 3. These reports will remain as drafts, as further coordination and integration of the national and regional plans may be necessary during Phase VII. In order to facilitate this task, the PMCU will organise before the end of Phase VI a meeting with the political decision-makers from all States to seek: (i) their acceptance of the draft national policies, strategies, and action programs; and (ii) their appreciation of the draft regional policy, strategy and action program as a basis for the full coordination and integration of national and regional plans. The Draft National Reports will concentrate on the following:

Policy Issues

- national policy objectives with regard to social and economic development, environmental sustainability, and equity considerations with regard to water distribution among regions, sectors and target groups;
- principles with regard to priority setting for water use among economic sectors and inter-sectoral water allocation;

National Strategies for Water and Salt Management

- problem analysis, including trend forecasts for future development scenarios for irrigated agriculture;

- impact analysis of alternative strategy options to attain set objectives, including cost benefit analysis for short-, medium- and long-term perspectives;
- derivation of priority settings and strategic choices stemming from the results of the above analyses;
- identification of suitable instruments (economic incentives, legal framework, institutional set-up) to be developed or applied to implement the selected development strategy;

Action Programs

- action programs for the first 5 to 10 years in line with the chosen strategy, including:
  - concrete objectives and targets for water conservation, irrigation water use, rehabilitation of irrigation and drainage infrastructure, institutional and economic reforms;
  - a package to implement a consistent institutional and policy reform program;
  - an investment plan for the measures proposed; and
  - an implementation plan.

252. The structure of the Draft Regional Report will basically follow the one set up for the Draft National Reports, but will focus on those issues required for effective management of the Aral Sea Basin as a whole. The proposed strategies and action programs will provide for the regional balance of resources, taking into account existing and future regional allocations, and the need to establish sustainable management practices and to protect the natural environment.

6 PROJECT ORGANISATION AND MANAGEMENT

6.1 Project Organisation

253. There are three lines of organisation for the project - those of the decision making bodies at regional and national levels, those of the project management and co-ordinating bodies, and those of the Consultant. Setting up the organisations has taken considerable time; it commenced long before the start of the Consultant's contract and has continued during the Inception Phase.

6.1.1 Organisation of the Decision-making Bodies

254. As part of the Aral Sea Basin Program, the project comes under the auspices of the IFAS Board and its Executive Committee who established the Project Management and Co-ordination Unit for the implementation of WEMP. EC-IFAS and ICWC members who have decision-making power as authorised by their governments will participate in regional workshops, which will be organised to discuss the major intermediate and final outputs of the project.

255. On a national level the project involves National Governments, Vice Prime Ministers (who are members of IFAS Board) and the National Co-ordinating Council on the Aral Sea Basin. The member bodies of the National Co-ordinating Council for the five States are:

- Kazakhstan: 'Working group for legal documents preparation, related to the transboundary water management of the Aral Sea Basin' - decree of the Prime Minister of the Republic of Kazakhstan, K. Tokaeva, of November 10th, 1999, N-174.R
- Kyrgyzstan: 'National Commission on the Water Strategy Issues' under the Supervision of the President of the Republic of Kyrgystan, Mr. Akaev, of April 24th, 1998, n 157.
- Tadjikistan: 'Co-ordinated Commission on Improving and Implementing the Legal Documents Concerning the Water Management of the Aral Sea Basin', - the order of the Prime Minister of the Republic of Tadjikistan, Mr. A. Akilov, from February 12th, 1998.
- Turkmenistan: No Commission has yet been created.
- Uzbekistan: 'National Co-ordinating Council of the Republic of Uzbekistan on the considering and co-ordinating issues, connected with the GEF Project realization' - the Order of the Vice-Prime Minister of the Republic of Uzbekistan, Mr. B. Alimdjanov, of May 10th, 1999. N 03-3-148.

256. The Ministries that are responsible for realization of the Sub-component A1 project within the five States are:

- Kazakhstan: Committee on Water Resources of the Ministry of Natural Resources and Environmental Protection of the Republic of Kazakhstan;
- Kyrgyzstan: Water Department of the Ministry of Agriculture and Water Management;
- Tadjikistan: Ministry of Land Reclamation and Water Management;

- Turkmenistan: Ministry of Water Management;
- Uzbekistan: Ministry of Agriculture and Water Management.

6.1.2 Project Management and Co-ordination Unit

257. The WEMP, often also referred to as the GEF Project of IFAS, is implemented by the Project Management and Co-ordination Unit (PMCU) in Tashkent. The PMCU manages the five components of WEMP, and as such the Component A management team is responsible for the relationship between the Consultant and the National and Regional decision-making bodies. PMCU has an essential role to play in the process of review and appraisal of the outputs of the project (see Section 6.3 below).

258. At the State level, National Co-ordinators have been appointed who are responsible for the co-ordination and facilitation of the work of the Consultant in the States by liasing with the ministries of water, agriculture, energy, environment, finance and macro-economics. They also are crucial in disseminating the outputs to the appraisal government bodies and in organising the review and approval process.

6.1.3 Consultant's Team Organisation

259. The Project Terms of Reference point out the paramount importance of obtaining permanent interaction and co-ordination between the Regional team, or Regional Working Group (RWG), and the National teams, or National Working Groups (NWGs), and also between the five NWGs themselves.

Regional Working group

260. The RWG is headed by the Consultant's Team Leader and is composed of international consultants and experts from the five republics. A Steering Committee has been created within the RWG, composed of the Consultant's Team Leader and the five NWG Team Leaders. Senior advisors may be invited to the Steering Committee meetings depending on the issues under discussion. The senior advisors will be selected by the National Co-ordinators in consultation with the NWG Team Leaders and the Consultant. The RWG Steering Committee will convene every two or three months, depending on the phase of the project.

261. The objective of the RWG Steering Committee is to determine common lines of action for the various activities and steps in the project, particularly definition of the regional approaches taking into account the national and regional needs and constraints. These then become the guiding directives for the work of the RWG team and the five NWGs. The Steering Committee will also internally monitor the RWG in terms of progress and quality and will have the authority to adjust the activities of the RWG when deviations to the plan occur.

262. The RWG itself is composed of a balanced team of experts representing the various sectors in the project, with parity of input from the republics. Regional organisations may be invited to undertake specific tasks e.g. on inter-state water management issues. The distribution of the positions of the long-term experts was

proposed by the Consultant in consultation with the PMCU after assessment of the availability of specific experience in each country, and also after considering the candidates proposed by each State. The staffing schedule of the RWG is given in Appendix E. The Consultant has concluded individual contracts with the experts and as such they are integrated in the HASKONING team in Tashkent.

National Working Groups

263. The National teams have been drawn from the resources available in the five States and their composition was discussed extensively between the Consultant and the representatives of the decision making bodies mentioned above. Participation of the national experts in the project was subsequently approved by the governments. It is to be noted that the indicated staff can draw upon other staff from within their own organisations or from outside as needed, subject to the approval of the Team Leader. The staffing schedule of the NWGs is also given in Appendix E. The national lead organisations and the Consultant have successfully negotiated sub-consultancy agreements. Hence the NWGs are an integral part of the HASKONING team.

264. The Sub-consultancy agreements with each NWG cover all national tasks to be undertaken, with guidance and supervision by the International Consultant. The international members of the RWG will assist the NWGs on a number of tasks or sub-tasks.

265. The establishment of the National Working Groups, approved by the governments, allows the project to have the proper introduction to State organisations and institutions needed for consultation on national policy and strategy development as well as to have access to their sources of information. It is the responsibility of the leaders of the NWGs to formalise co-operation with various national bodies through e.g. protocols if needed.

6.2 Project Management

266. The team for Sub-component A1 comprises a total of about 30 professionals in the Regional team and about 75 professionals in the five National teams. The management and co-ordination of the activities of a team of this size over a period of about two years will present a major challenge. Project management techniques will be employed to ensure that tasks are correctly undertaken, and that the outcomes are produced to the desired standard and within the required time frame. These techniques include:

- provision of comprehensive and specific terms of reference for each task and sub-task, including accurate definition of the required outcomes (deliverables);
- detailed programming of tasks and subtasks, including allocation of time inputs;
- preparation of an overall project program showing the interconnection between tasks and subtasks and indicating project milestones;
- regular monitoring of output quality (QA/QC);

- regular monitoring of progress, in terms of both outputs and time inputs, by comparison with budgeted time inputs.

267. Given that the Regional team will provide the management and co-ordination, good links for liaison and communication between it and the National teams will be essential. These could be achieved in various ways, but the most relevant appear to be either State or discipline based. In the first (State-based) option, a National member of the Regional team would be assigned to provide the principal liaison with a particular National team. Desirably he/she would be from that State. Alternatively, (the discipline-based option) a Regional team member of a particular discipline would co-ordinate and liase with National team members of the same discipline. In view of the fact that most tasks will involve more than one discipline, the State-based approach is preferred. The project Team Leader will liase with the National teams through the NWG Team Leaders. The project management structure is shown in Figure 9.

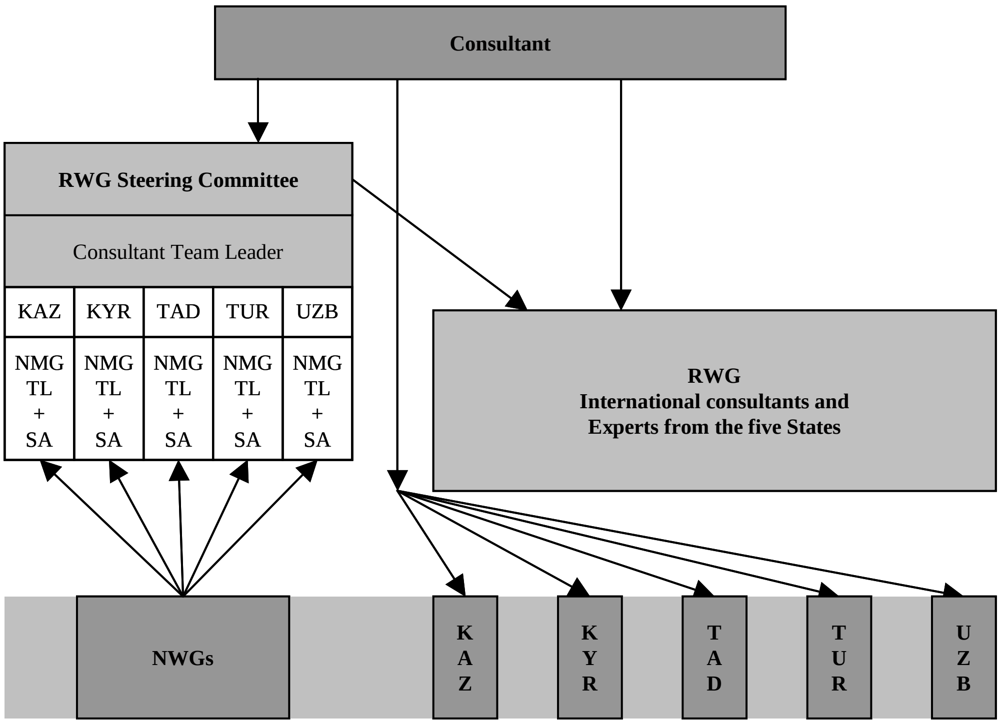

Figure 9 Project Management Structure

268. The first project management task, involves drafting detailed terms of reference for the National teams. The detailed terms of reference set out the objectives of the tasks, and define the categories into which the subtasks are divided. They identify the various subtasks, and allocate them between the RWG and the NWGs. Detailed descriptions of the subtasks to be performed by the NWGs are then provided. Each subtask is described in terms of:

- the subtask objectives;
- the underlying concept, where appropriate (such as where new methodology is involved);

- actions to be performed in executing the subtask, including where appropriate descriptions of the methodology to be adopted;
- expected outputs/deliverables, including nomination of the report number and title, and specification of the report content, report organisation and headings, and map scales where appropriate;
- indications of where the outputs form inputs to other tasks or subtasks.

269. In some cases the terms of reference for a task may differ between States because of differences in conditions in the States or in their location within the Basin. For example, in the upstream States water quality and ecological studies will assume much less importance than in the downstream States.

270. Terms of Reference (Drafts) of the detailed Terms of Reference for most of the tasks in Phase III and IV are attached as Appendix G. These Terms of Reference will be discussed with the Team Leaders of the NWGs and the experts concerned. This will take place through visits to the teams. Working sessions on major subtasks, involving all experts involved in the subtasks, will be organised where appropriate. The Terms of Reference specify the program for each task, setting target dates for subtasks and giving cumulative time input progressions and milestones for monitoring purposes.

271. In order to provide a common basis for the NWGs' activities, a brief QA/QC manual based on HASKONING's in-house manual will be produced for the project. It will amongst other things define supervision procedures, lines of communication, documentation standards (report and spreadsheet formats), translation requirements, and quality expectations. The manual (in English and Russian) will be provided to all team members.

272. Close communication between the Regional and National teams is seen as being an essential element for successful completion of the project. We have already well-established communication with the teams through telephone, fax and electronic mail. In addition, to provide the necessary personal interaction, we will hold co-ordination meetings in each State at two monthly intervals. It is envisaged that these will be attended by:

- From the Regional team, the relevant co-ordinator for that State, plus specialists from the international and/or National components of the Regional team as appropriate at the time.
- From the National team, the team leader and deputy leader, plus relevant specialists.

The aims of these meetings will be to review and monitor progress, deal with any queries and problems, and generally maintain a team image.

6.3 Reporting

273. During the course of the project, a considerable number of internal reports and working papers will be prepared by the NWGs and the RWG on various topics specified under their individual Terms of Reference. The content of these reports will

be reviewed and summarised for inclusion in the overall project output where appropriate.

274. The overall project output will comprise a series of major reports. The primary responsibility for the preparation of these reports will lie with different groups depending on the aims and content of the particular report. As required by the Terms of Reference for the project, the various reports will be as shown in Table 7.

Table 7 Project Reports

Report No.	**Primary Responsibility**	**Title**
Joint Report 1	RWG and NWGs	Inception
Regional Report 1	RWG	Principles and Guidelines for Regional and National Planning
Regional Report 2	RWG	Regional Needs and Constraints
National Reports 1	NWGs	National Water Demands and Options for Demand Management
Joint Report 2	RWG and NWGs	Basin Water and Salt Balances and Their Implications for National and Regional Planning
National Reports 2	NWGs	Draft National Policy, Strategy, and Action Program for Water and Salt Management
Regional Report 3	RWG	Draft Regional Policy, Strategy, and Action Program for Water and Salt Management

275. In the case of Joint Report No. 2, a draft will be produced by the RWG well in advance of the delivery date. The draft will be circulated to the NWGs, and will then be the subject of a workshop involving the RWG and all NWGs to arrive at a consensus regarding the final outcomes.

276. The reports will be submitted to the PMCU who will arrange distribution to the States through the National Co-ordinators, regional organisations and the World Bank in accordance with the delivery times shown in the Project Program in Appendix F.

277. The procedures for obtaining approval of the outputs are defined in the contract and are included in Appendix F. The procedures vary depending upon the report..It is important that approvals be given in a timely fashion, as tardy responses may affect the ability of the Consultant to complete the project in the specified time. The outlined procedures demonstrate that each step to be taken will require approval from the appropriate governmental bodies. When obtained, such approvals then imply that the governments are committed to proceeding with the next step and ultimately to achieving the proposed final outcome.

6.4 Document Control and Translation

278. During Phases III and IV, both the RWG and the five NWGs will be working on at least five tasks concurrently. Reports and working papers on various aspects will be continually produced during this time, and those produced by the NWGs will require review of the draft by the RWG, amendment as necessary, translation, second review, etc. before final production and submission. It will be a major task to program and control these activities so that they are carried out in accordance with the requirements of the overall program and so that output quality is not compromised. The detailed management program will identify and schedule all of these activities, and a computer system will be devised to keep track of the progress of each document as it passes from first draft stage through to the final product. It will be a major function of one staff member to program and operate this system.

279. All documents produced by NWGs and the National component of the RWG will be written originally in Russian, while those produced by the international component of the RWG will be in English. Accurate translation between the two languages will be essential to minimise misunderstandings. It is intended that all documents produced by the NWGs will be submitted to the RWG in Russian, and that all translation into English will be undertaken by interpreters attached to the RWG. Similarly, all documents produced in English by the RWG will be translated into Russian before they are issued to the NWGs and all ASBP and government agencies. We will incorporate in our QA/QC procedures a checking system to review draft translations for accuracy, sense and style before they are finally issued.

6.5 Workshops

280. The workshopping process will be an important means by which the RWGs and NWGs interact and arrive at a common understanding of problems and solutions. It will be an essential step in finalising the joint reports. Workshops will be held at three levels: (i) task level, (ii) team level and (iii) at high level when political guidance is to be obtained. Those in the first two categories will in fact be working sessionsto consider various aspects of individual tasks. These are described in the methodology sections.

281. As described in Section 5.2 above, a workshop at high level will be held near the end of Phase II to seek political guidance on major issues, and to agree on a basis for the execution of the rest of the project. The workshop will be held over a period of three days, with the project team leader acting as chief moderator. A similar workshop is scheduled at the end of Phase V after the water and salt balances have been established, to seek guidance by National Governments and IFAS on strategic choices to be made during Phase VI.

6.6 Project Program

282. The overall project program showing the major subtasks and the timing of the major reports and workshops is presented in Table 7. Detailed programs for each subtask will be developed during preparation of the detailed terms of reference.

When these are all completed they will be assembled to form an overall detailed program. A broad outline of activities in the coming year is presented in Figure 10.

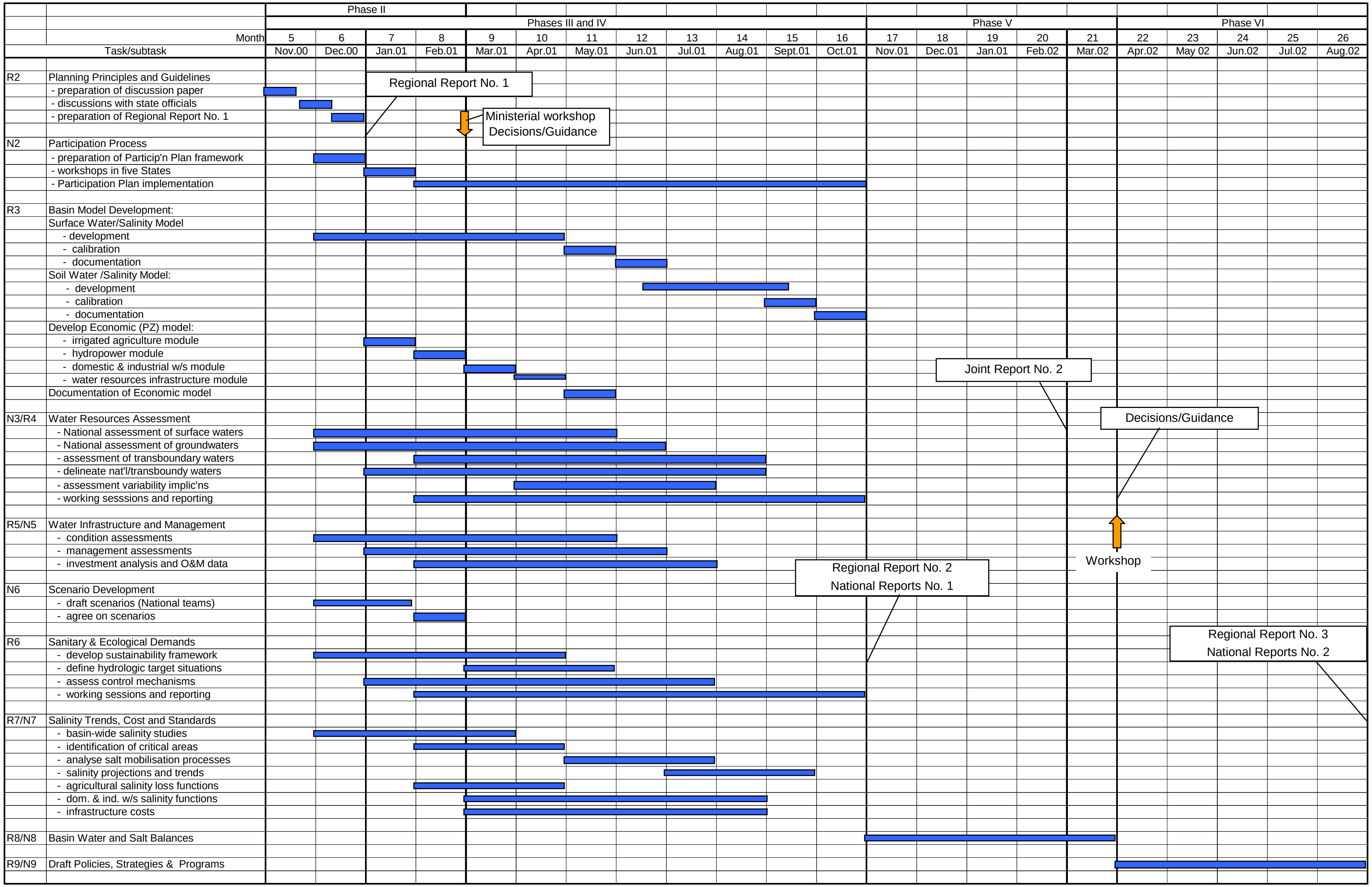

Figure 10 Aral Sea Basin Project Program

APPENDIX A

DOCUMENTS REVIEWED IN THE INCEPTION PHASE

The following documents have been reviewed in the inception phase:

1. ASBP: Developing a Regional Water Management Strategy: Issues and Work Plan, April 1996

2. ASBP WEMP: Project Document, May, 1998

3. ASBP 1.1: Basic Provisions for the Development of the National Water Management Strategies, 1996

4. ASBP 1.1: Developing a Regional Water Management Strategy, Comments of D.J.W. Berkoff on a Draft Paper, May 1996

5. ASBP 2.1: Hydrometeorological Survey Reports, 1996-1997

6. ASBP 2.1: Hydrometeorological Survey, Final Report , April 1997

7. ASBP 3.1: Agricultural Water Quality Improvement – Analysis of Water and Salinity Data , Final Report, June 1997

8. ASBP 3.1.b: Classification of Project Proposals in Themes for Improvement of Agricultural Water Quality, Final Report, June 1997

9. ASBP 6: Integrated Land and Water Management in the Upper Watersheds, national Reports, 1997.

10. ASBP 6: Development of Water Management and Sustainable Irrigated Farming in the Foot-hill Area of Uzbekistan, 1997

11. ASBP 6: Land of Water Resources Management in the Mountanious Area of Kazakhstan, 1997

12. ASBP 6: Afforestation, Erosion Control and Water Management in the Kyrgyz Republic, 1997

13. ASBP 6: Developing Land-use Practices and River Water Management in the Uplands of Tajikistan,1997

14. ASBP 6: Integrated Land and Water Management in the Upper Watersheds, 1997

15. WARMAP-1: Groundwater Resources Use in the Upper Watersheds Area of the Syr Darya and Amu Darya Catchments of the Central Asian Republics, July 1995

16. WARMAP-1: Project Preparation Reports. Executive Summary, September, 1995

17. WARMAP-1: Irrigated Crop Production Systems, January 1996

18. WARMAP-2: Formulation and Analysis of Regional Strategies on Land and Water Resources, July 1997

19. WARMAP-2: WUFMAS, Annual Report, 1997

20. WARMAP-2: Economic Modelling of Agriculture in the Aral Sea Basin, February, 1999

21. WARMAP-2: Sub-component A2. Participation in Water Savings. Regional Monitoring of the first stage of the competition , Report , 1999

22. MAWR Agricultural Sector Development Project TA 2798-UZB, Phase I, January 1998

23. MAWR, Construction of Drainage System in Uzbekistan, Project Report, September, 1998

24. MAWR, Improvement and Reconstruction of the Pumping Irrigation Infrastructure in Uzbekistan, Project Report, September, 1998

25. MAWR: Environmental Assessment of Irrigation and Drainage in the Amu Darya Basin, Final Report, June 1998

26. MAWR: Preparation Study of the Uzbekistan Drainage Project - Phase II, March 1999

27. Ministry of Macroeconomics and Statistics of Uzbekistan: Water Supply, Sanitation and Health Project. Inception Report, 1999

28. State Committee for Nature Protection of Uzbekistan: National Environmental Action Plan, 1998

29. Economic Trends Quarterly Issue, Uzbekistan, January-March 2000

30. EC IFAS: Aral Sea Wetland Restoration Project, Main Report, 1995-1996

31. ICWC, Regional Water Management Strategy in the Aral Sea Basin, 1997

32. SIC ICWC: Integrated Water Resources Management in the Aral Sea Basin, March-April, 2000

33. IMF, Output Decline and Recovery in Uzbekistan: Past Performance and Future Prospects, G.Taube and J. Zettelmeyer, September 1998

34. IMF, The Uzbek Growth Puzzle, J. Zettelmeyer, September/December 1999

35. IMF, Republic of Uzbekistan: Recent Economic Developments, March 2000

36. USAID: Pricing During the Transition to Paid Water Use and Market Relations in the Central Asian Republics, November 1996

37. USAID: Short-Term Forecasting of the Amu Darya's Flow Based on a "Reservoir" Model, October 1996

38. USAID: Central Asia Power Market: Issues and Options, Daud Beg, November 1999

39. WB: Country Study – KAZ,KYR,TAD,TUR,UZB, 1997

40. WB: The Agrarian Economies of Central and Eastern Europe and the Commonwealth of Independent States. Situation and Perspectives, 1998

41. WB: Uzbekistan. Social and Structural Policy Review Report, August 1999

42. UN: United Nations Convention on Sustainable Development of the Aral Sea Basin

43. UNESCO: Ecological Research and Monitoring of the Aral Sea Deltas, February 2000

44. UNESCO, Water-Vision for the Aral Sea Basin for the Year 2025, April, 2000

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APPENDIX B

DESCRIPTION OF WARMIS

THE WARMIS INFORMATION SYSTEM

1. Overview

WARMIS is an Information System for land and water resources management developed under the TACIS-sponsored WARMAP and WARMAP-2 projects by the Scientific Information Centre of ICWC (SIC). It is designed for the collection, storage, processing and analysis of various data about the historical and actual situation of the land and water resources of the Basin and their use. A detailed description of WARMIS is presented in Appendix B.

The underlying concept of WARMIS is to support planning at the national and supra-national levels in the area of land and water management of the Central Asian States within the Aral Sea Basin, i.e. Kazakhstan (partly), Kyrgyz Republic (partly), Tadjikistan, Turkmenistan (partly) and Uzbekistan. It is designed to provide an economic approach to land and water management through the provision of data and analysis tools.

When completed the system will comprise the following inter-linked components:

- Database Management System (DBMS), containing tabular data;
- Geographic Information System (GIS), containing spatial data and spatial analysis tools. Data include:
  - point objects; cities, hydrological objects, intakes, outfalls, transfers, climate stations,
  - linear objects; rivers, canals, collectors, administrative boundaries,
  - polygons; planning zones, reservoirs, lakes, irrigated areas, drainage zones, soil types, Aral Sea;
- Toolbox; comprising components for system maintenance, data verification, data exchange and security, user authorisation, etc.;
- User Interface for data input and output;
- Three modules for strategic analysis and/or decision support: Planning Zone Module, River Basin Module and Hydropower Module.

The structure of the model is shown in Figure A1.

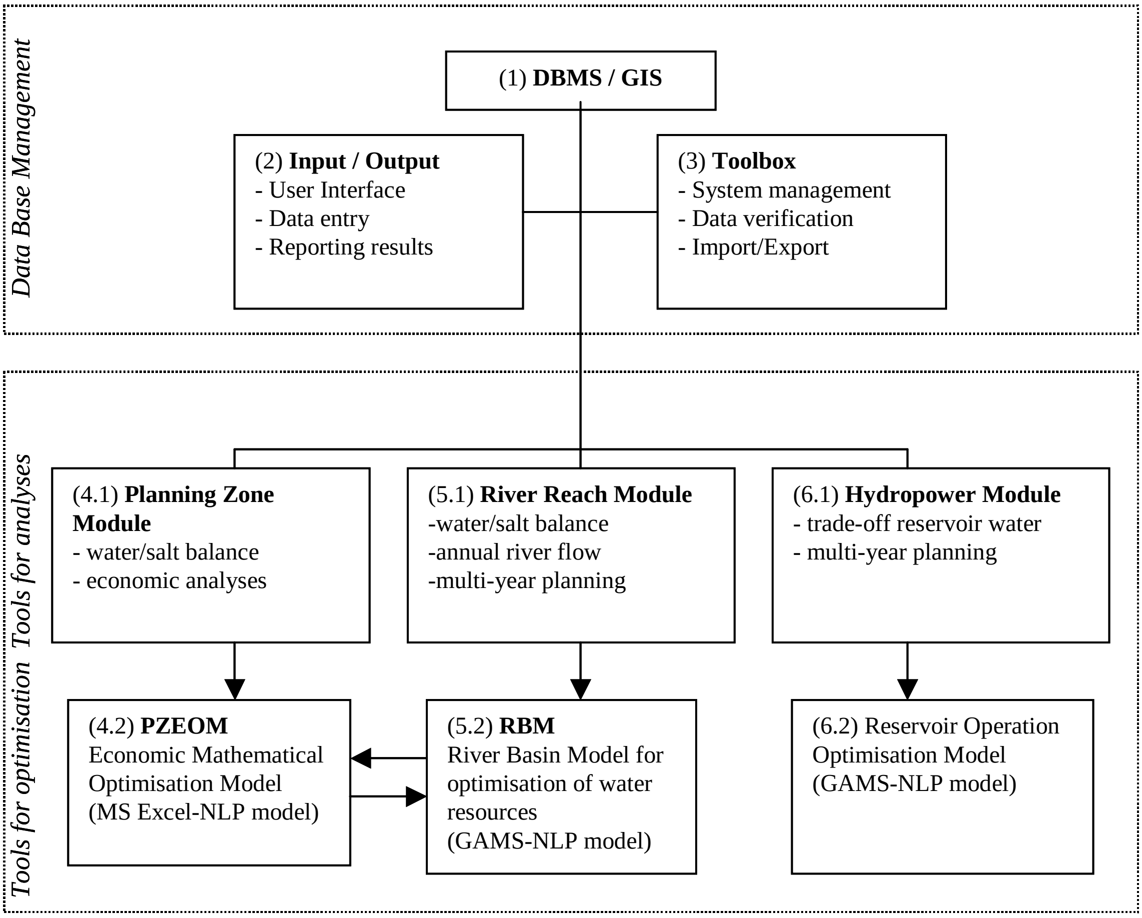


Figure A1 Envisaged Links Between the Various WARMIS Components

2. WARMIS Database Structure

The basic spatial unit of the (regional) WARMIS Database is the Planning Zone, and the basic unit of time is the month. The sub-databases in WARMIS version 1.0, and the information they contain, are described in Table A1.

Table A1 WARMIS Sub-database Content

Sub-database	Information Contained
Administration	Basic data and reference codes on administrative boundaries and planning zones.
Land	Periodical data on land capability, groundwater level, soil and groundwater salinity.
Water	Basic data and reference codes on rivers, lakes, reservoirs, hydrological objects, irrigation and drainage networks; monthly information on water flow/distribution and reservoir volumes.
Water Quality	Monthly information on quality of water in rivers, intakes, outfalls and wells.
Climate	Basic and multi-year average monthly data on weather and climate.

Sub-database	Information Contained
Industry	Basic data on non-irrigation water users and monthly data on water use.
Economy	Data on economic indicators, market prices for agriculture, water management costs.
Hydropower	Basic information on hydropower and thermal power plants and electricity production.
Agriculture	Secondary data based on analysis results and output from WUFMAS and agricultural models (CROPWAT), to provide information on water productivity in irrigated agriculture.
System	Information on clients and contracts, and on authorisation levels for users.
Meta Database	Information on the data itself: e.g. database structure, data source, object description, unit of measurement, validity, etc.

3. WARMIS Geographic Information System (GIS)

The WARMIS GIS contains maps and spatial information on objects stored in the WARMIS Database. Examples of spatial information in the WARMIS GIS are:

- cities, hydrological objects, intakes, outfalls, transfers, climate stations (point objects);
- rivers, canals, collectors, administrative boundaries (linear objects);
- planning zones, reservoirs, lakes, irrigated areas, drainage zones, soil types, Aral Sea (polygons).

4. Planning Zone Module

The Planning Zone module consists of two submodules, namely:

- The Planning Zone Water and Salt Balance model (4.1);
- The Planning Zone Economic Optimisation Model (PZEOM) (4.2).

In general, both submodules allow the user to evaluate the consequences of present and future water and land use policies at the Planning Zone level. The PZ Water and Salt Balance module focuses on the physical effects of water and salt management, while the PZEOM module helps the user to identify measures to optimise net annual agricultural benefit. During iterations the PZEOM can be linked directly with the River Basin Module which will give feed-back related to the availability of water on basin level and water quality.

Planning zones are defined as areas in which all water consumers are supplied with water from a single off-take in the river system. SIC has identified 44 planning zones in the Aral Sea Basin. In most cases they correspond to oblasts, although some oblasts are divided into multiple planning zones. The average size of a planning zone is approximately 250,000 ha. The PZEOM considers each planning zone separately. The zones are calibrated with data from the WARMIS and WUFMAS databases. The model requires a considerable amount of data on the physical and economic characteristics of the zone. A sample of the data used is set out in Table A2.

Table A2 Sample of the Data Required for a Planning Zone Model.

Category	Data	Category	Data
Zone Structure	a) Area b) number of inlets and outlets to the zone c) population d) current irrigated area e) potential irrigated area f) crops grown and area	Crops	a) start and end of vegetation season b) norm of water consumption and leaching c) expected crop yield d) impact of water stress on crop yield e) impact of soil salinity on crop yield f) impact on farm input levels on crop yield
Irrigation and Drainage Network	a) time of filling b) efficiency of main canals,inter-farm canals, on-farm canals and field application c) rate of efficiency decrease d) cost of restoring efficiency e) rate at which efficiency is restored f) capacity of canals g) collector and field drainage modulus h) cost of restoring field drainage	Hydro-logic Studies	a) soil porosity coefficient b) soil filtration coefficient c) slope d) depth of groundwater e) salinity of groundwater f) parameters of water and salt balance

The above is only a partial list of the data required for the PZEOM. It is anticipated that the collection of a complete set of data for all planning zones will be a major task ahead. Potentially, the 44 planning zones could be reduced to a smaller number by aggregating zones with similar characteristics or excluding those that do not have a major impact on basin level water management. This issue has been flagged by the SIC but has yet to be implemented.

The PEOZM is formulated as a stochastic non-linear optimisation model, implemented in the GAMS programming language and MS Access 2.0. GAMS is a optimisation software package developed by the World Bank and extensively used in water resource planning. GAMS-based water resource models have been used for the Indus River Basin (Pakistan), the Tarim River Basin (China), the Mahakali River Basin (India/Nepal), and the Mekong River Delta (Vietnam).

Generally speaking, optimisation models are used to find the allocation of resources that provide the 'best' or optimal outcome for a given set of constraints. In the case of the PEOZM the optimal planning outcome is the one that maximises net income from irrigated agricultural production within a planning zone over a 20-year period.

The model achieves this by finding the 'best' cropping pattern and use of capital given the available water and capital resources (see Figure A2).

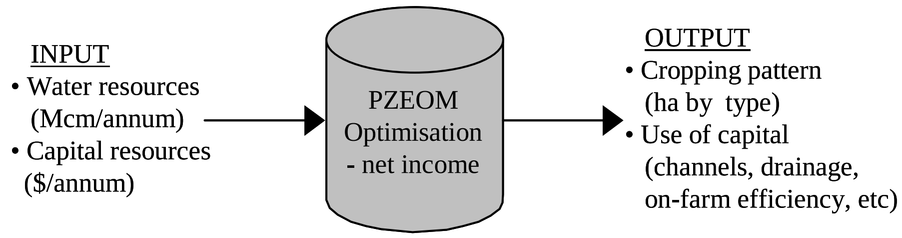


Figure A2. PZEOM – Overview

In finding the optimum outcome the model takes into consideration the hydrologic, infrastructure and agro-economic features of the planning zone. A relatively high level categorisation is used to differentiate features within a zone, and average values are derived for each feature. The key features of a zone are:

- soil salinity characteristics and groundwater depths;
- existing and potential cropping patterns and areas;
- length and efficiency of main, inter-farm and on-farm canal systems;
- crop yields – both achievable and actual yields and gross margins (economic values);
- costs of water from different sources;
- infrastructure operating and maintenance costs.

Within a zone the hydrologic and agro-economic processes are simulated using three sub-models: 1) salt balance; 2) water balance 3) agro-economic model. These sub-models simulate the:

- response of crop yield to water stress, soil salinity and the level of farm inputs (i.e. fertiliser, pesticides);
- rate of deterioration of irrigation and drainage systems;
- costs of rehabilitating irrigation and drainage systems and improving on-farm application efficiency; and
- generation of drainage water from the planning zone.

By varying these factors and the availability of resources, the PZEOM allows the analysis of the impact on net income from agricultural production of a range of planning and management scenarios. Scenarios can be modelled, for example, for expected future changes to the following:

- operation and maintenance expenditure, budgets for capital investments and options for distribution of funds over time;
- crop prices e.g. shifts in the relative prices of agricultural products;
- water allocation and availability e.g. changes to the allocation of water between planning zones, droughts, etc.; and
- water delivery costs e.g. increased cost recovery for national and regional water infrastructure (dams, river training works, etc.) or programs (hydrometric monitoring, BVO administration, etc.).

The proposed use of the PZEOM in conjunction with the high level River Basin Model (RBM) is to determine the optimal use of resources at a national and basin level. This involves optimising the PZEOM and then exchanging the output for all the planning zones with the RBM. The output variables exchanged between the models are:

- volumes of water received from transboundary sources;
- the quantity and quality of drainage water discharged to the river system;
- changes in the level and salinity of groundwater; and
- the value of land productivity losses or surpluses in irrigated farming.

The linkage between the models occurs at two levels: 1) water and salt balance; and 2) economic. Iteration with the RBM ensures that the water demands from the planning zones do not exceed the total allocations at a national level or *vice versa*. In addition, the economic values from the PZEOM feed to the economic optimisation segment of the RBM.

It is feasible to run the PZEOM as a salt and water balance model only. This requires defining future cropping patterns – *a priori* - for each of the planning zones. The advantage of doing this is that it avoids the use of some of the more contentious (subjective) aspects of the agro-economic model. Thus, the model is given a cropping pattern scenario (which may also include crop yields and salinity, water stress and input impacts on yields) and the required level of capital and water resources is determined.

To date the SIC has prepared prototype models for only four planning zones in the Ferghana Valley. As part of the WARMIS program the PZEOM model has been reviewed by a number of international experts in water resource modelling. They generally conclude that the model is of value for the development of management strategies in the Basin, although it is complex in its interactions between economic and hydrologic issues.

5. River Reach Module

This consists of two sub-modules for river water management and flow analysis:

- River Reach Water and Salt Model (5.1)
- River Basin Model (5.2)

The River Reach Water and Salt Module (5.1) can simulate for each river reach the past, present and future inflows and outflows of water, salt, and a number of other conservative water quality parameters. It takes into account interaction with Planning Zones and different types of water losses, such as evaporation, seepage outflows, groundwater inflows and riverbed storage. At present, only the lower reaches (Kelif – Samanbai) of the Amu Darya are modelled.

Although the Planning Zone can be considered as the basic unit for planning purposes, both with respect to sustainable water resources management and economy, a single overall model in which optimisation could also be undertaken was considered too complex. Thus two river basin models have been developed, one for the Amu Darya basin and one for the Syr Darya basin.

The River Basin Model (5.2.) can simulate multi-year availability (quantity and quality) of water. It will take into account national or basin-wide constraints (financial, social and environmental) for the economic sub-optimisation of each Planning Zone. The model generates input for the PZEOM and subsequently accepts the output to check for each year whether or if limits on drainage water quality and investments are exceeded. Furthermore, net benefits from agriculture are evaluated against benefits from hydropower and losses caused by discharge of water into depressions or by a lack of water flowing to the Aral Sea. If constraints cannot be met, the results of the River Basin Model are used as new input for the PZEOM for the next iteration.

There is also an annual river water flow model for the Amu Darya which is used by the BVO Amu Darya in water resource management.

6. Hydropower Module

The Hydropower module is in two parts:

- Hydropower production model (6.1)
- Reservoir operation optimisation model (6.2)

The hydropower production model is intended to assist in evaluating the economic trade-off between the use of stored water in reservoirs for power generation or for irrigation. A sub-database is being developed containing information on the costs of energy production through hydro-plants and thermal plants, and on the total demand for power over the year and over the five Central Asian Republics. As can be seen from Figure A1, there is no connection between the River Basin Model and the Hydropower module. This means that the optimisation of water management and the trade-off between hydropower and agricultural demand can only be done in two ways, namely:

- With the use of the connected PZEOM and RBM modules, where hydropower production has also been modelled.
- With the use of only the hydropower modules (6.1. and 6.2.), with the effects on agricultural production being calculated separately, for example by using the PZEOM module.

APPENDIX C

‘FROM VISION TO ACTION’

From Vision to Action

International Workshop

Water for Food Production and Agricultural Development in Central Asia» Organized by ILRI, ICID, IWMI, IFPRI and SIC ICWC

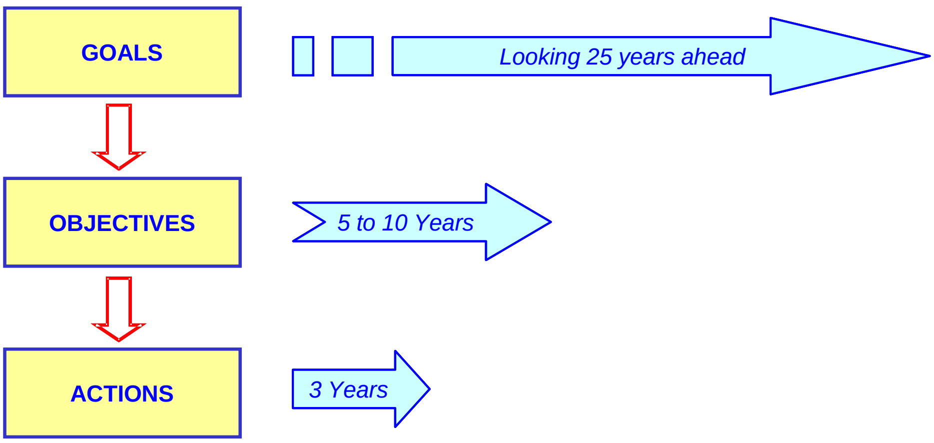
Tashkent, 16 - 19 August 1999

Introduction

Representatives of the five Central Asian States and of regional organizations participated in the workshop organized under the Program; '21 Century Vision on Water, Life and the Environment'. They discussed reports that were presented by national and regional teams on the problems of food production in the Aral Sea Basin using existing water and land resources.

Speakers from five Central Asia republics, three (vice-)ministers of water management of Kazakhstan, Tajikistan and Uzbekistan presented their visions. The vice-president of the International Commission for Irrigation and Drainage, the GEF Project Leader and representatives of UNESCO, the EU WARMAP Program, ILRI and of ICRISAT participated in the discussion

The 'vision on water for food' was structured along different time horizons as shown below:



Goals

The goal is to raise the standard of living of both the rural and urban population. Because the standard of living in Central Asia depends heavily on the production of irrigated crops, the related institutions and infrastructure must be optimized. This must be achieved through the efficient use of natural resources whereby the growing population and the environment are determining factors.

Objectives

As derived from the above goals, the objectives are partly related to institutional development and partly related to the improvement of irrigated agriculture.

Related to Institutional Development:

1. Development of an inter-state agreement on agricultural production on the basis of the most suitable agro-climatological zones for the major (food and fibre) crops in Central Asia (e.g. in terms of kg/m^3). This includes a trade agreement on agricultural products between the Central Asian Governments.

2. Establish a regional policy, and related actions, at government level on the joint management and efficient use of water resources.

3. Achieve a growth of the GNP. Tentatively it is anticipated that the 2010 GNP must be equal or better than its 1990 level.

4. Controlled restructuring of state farms thorough the development of capabilities of agricultural producers and the creation of a (regional) market for agricultural products.

5. Establish a financial and economic support system for agriculture to bridge the period until farmers will be able to pay for management, operation and maintenance of irrigation infrastructure. The related water charge should include a provision for the mismanagement of water resources.

Improvement of Irrigated Agriculture:

1. Implementation of a water conservation program that increases crop yield per cubic meter water diverted from the Amu Darya and Syr Darya. A gradual increase to potential yield levels is needed to provide water to non-agricultural user groups (urban, industrial, energy, environment).

2. Rehabilitation and modernization of rural infrastructure. This should create conditions for the more efficient use of local resources for economic development of rural areas.

3. Development of economic methods for encouraging water and land use with due regard to environmental factors and maximum stimulation of initiative of farmers and private farms working under the conditions of the market-oriented economy.

4. Revision of the evapotranspiration and leaching norms taking into account that water (not land) is the limiting resource in Central Asia.

Actions

The economic development (and thus agricultural development) in the five Central Asian republics is highly inter-related. This is partly due to their location relative to international markets, and to a large extend because life depends on the water from the

Amu and Syr Darya. Several 'actions' thus are valid for the entire region. Because of the difference in climate (and land and water resources) between upstream and downstream countries also actions on 'national level' are recommended.

Regional Level

1. Improve co-operation of governmental and non-governmental organizations on the management of trans-boundary river basins. In this context, rules and financial conditions for common water use and conservation should be adapted.

2. Develop common political approaches and measures for preventing trans-boundary water pollution. Water quality improvement is needed for effluent from urban, industrial and agricultural users.

3. Develop and implement (inter-state) regional investment projects, Attract funds from international and bilateral donors for a well balanced use of water in the Aral Sea Basin.

4. Gradually reduce surface water diversion and increase the water demand of the environment of trans-boundary rivers as natural consumers (water user).

5. Develop a plan for a common agricultural market in Central Asia. This plan should include the regulation of custom procedure's, import tax, etc.

National Level

1. Revise the currently used (USSR) food norms for the populations of each of the states, taking into account local traditions and customs.

2. Estimate the potential yield of main crops and compare it with the current yield level. Determine the relative order of constraints that need to be alleviated to approach potential yield levels.

3. Estimate opportunities and possible actions for raising the yield of non-irrigated (rain-fed) agriculture and of pasture stockbreeding.

4. Implement pilot projects on fish breeding. This includes breeding in natural and man-made lakes, in fishponds and in irrigation canals.

5. Improve the management and operation of the irrigation system in between the water source (usually a river) and the structure where water is delivered to the state farm or the 'water users cooperative'. In this context, the (service) agreement between the water supply institution and the water user(s) should be revised.

6. Determine the sequence of priorities in the rehabilitation and upgrading of irrigation systems. In this context, the following categories are proposed:

   – irrigation schemes with (high) lift pumping stations, lifting irrigation;

   – irrigated areas with high infiltration rate and a complicated relief of the surface;

- irrigation schemes with low water availability (saline water);
- upstream irrigation schemes that produce low quality drainage water.

7. Develop optimal forms of (Water) Users Cooperation. A transfer of the structure of state farms, in combination with international experience on ‘users cooperatives’, should be used to integrate activities of agricultural producers.

8. Improve the system for financing O&M of irrigation systems, guarantee access of state farms and newly formed users cooperatives to loans for the rehabilitation of on-farm irrigation systems.

9. Improve the extension service on; crop selection, recovery of seed stock, agricultural chemical and technical services to provide rural producers with fertilizers, chemicals and on-farm mechanization.

10. Transfer from the central planning system of water management to the River Basin (System) principle of water management.

11. Implement a regional program for land conservation and improvement, including conservation of degraded agricultural lands.

12. If payment for water is introduced, it is recommended to increase the charge progressively if water use exceeds biological and technological water requirements.

13. Control the implementation of the already existing Water Law in each state.

14. Set the fee for pollution as a function of the volume of discharged concentration of pollutants (the polluter pays for downstream damages).

15. Prepare proposals on the gradual introduction of water trade market.

16. Hold regular water conservation competitions at various levels: from a small farm to a rayon water management organization.

17. Develop the most favorable conditions to attract foreign and local investments into the development of agricultural production and rural infrastructure.

18. Create public awareness that *water has value*. Only if water is regarded as a valuable natural resource, water users will try to use it efficiently with minimal negative environmental effects.

Summary of three scenarios for the Development of the Irrigation and Drainage Sector

Institutional Changes and Investments	Minimal Change	Medium-level Development	High-level development
Allocate water to various user groups in each planning zone	Continue to use the current (1992) rules on water allocation	The right of main water users is agreed upon in an interstate treaty and in related national laws	Fully integrated river basin management system is used. Actual allocation is monitored by remote sensing (RS)
Up-dating of the service agreement between the water supply agency and all water users (state farms, etc.)	Supply water at the current schedule and at flow rates. The level of dependability remains as present.	Modern water law is passed to regulate all water use	Signed service agreements are available between water providing agencies and all water users.
Reform of state farms into (water) users cooperative	Most (state) farms operate at the verge of bankruptcy	Cooperatives are formed that handle the most basic resources	Cooperative enterprise handles the purchase and marketing of bulk resources (water, fertilizer, machinery, etc.)
Introduce system of service fee for supplied water	Virtually no service fee is paid for water	A service fee is paid on the basis of irrigable area	A service fee consisting of two parts is paid: Approximately $^{1}/_{3}$ for the irrigable area and $^{2}/_{3}$ for the volume of delivered water
Modernize key-structures in the conveyance system	Failure of key-structures is avoided	Key water division structures are modernized for accurate flow measurement	All flow division structures in the conveyance canals are capable to control and record measured flow accurately.
Improve information system on water supply to the (state) farms	Actual quantity and schedule of water supply to farms is not known	Schedule of water supply to farms is as intended in the service agreement	Actual flow to all farms is automatically recorded by use of a broad-crested weir and data logger
Modernize on-farm irrigation system	Up to 50% of water supplied to the farm gate does not reach the irrigated fields	On-farm operational losses and leakage from canals is reduced by half its present rate	Farms have technical and institutional capacity to deliver water to fields in accordance with water requirements
Rehabilitate drainage system	About 50% of the irrigated crop has reduced yield because of salinity	Yield reduction due to salinity is reduced to 25%	On farm drainage system is used to avoid significant salinity in irrigated fields
Rehabilitate the delta's of the Amu and Syr Darya	Both delta's receive too little water for sustainable development	High value agricultural and ecological areas are supplied with sufficient water	Dikes are in place that control the water level in both delta's for sustainable environmental and agricultural development
Reduce flow into depressions	Significant volumes of fresh water discharges into depressions and evaporate	The overall consumed ratio is increased so that drain discharge decreases	Interceptor drains are used to discharge drainage water back to the Amu and Syr Darya or to their delta's

APPENDIX D

INFORMATION ON DATA AVAILABILITY PROVIDED BY THE NATIONAL TEAMS

INFORMATION PROVIDED BY THE NATIONAL TEAMS

Information Type	Kazakhstan	Kyrgyzstan	Tadjikistan	Turkmenistan	Uzbekistan
Existence of Social Assessment Teams	Social research has been undertaken in projects for UNDP, USAID, JICA, WHO, UNICEF, and by consultants ELECTROCONSULT, GIBB, CES. Water user associations (WUAs) exist	Social research has been conducted within the framework of GEF Project "Public Awareness". NGOs are widely involved in state planning as well as national/ international institutions and projects.	Participatory planning is increasingly applied in new water supply and irrigation projects WUAs are currently created	No specific reply WUAs do exist	Social research has been undertaken in selected projects; participatory planning is not yet a common approach; involvement of the public started within 'Component C': Public Awareness No statement on WUAs
Availability of Planning Principles/Guidelines and Scenario Development	Special approval required for development plans Annual reports on agriculture available All reports and directives are in Russian.	National Development Plan up to 2010 is under preparation. Development plans and statistical data on economic and social development are available. National Strategy and Action Plan up to 2020 on rehabilitation of irrigation infrastructure is in under preparation.	National development plans and agricultural development plans and annual statistics are available	Social-Economic Development Program , sectoral development plans, annual agricultural statistics and various technical reports are available (in Russian)	Economic and agricultural development plans are available as well as annual economic and statistical data and reports (all in Russian)
Climate Data	10 meteo stations. Data include evaporation, precipitation etc. Map available from Hydromet	14 meteostations The meteorological precipitation map is available (1999)	45 meteo stations (1960-1998) Rainfall map available	9 meteo stations Map of annual rainfall (up to 1983) available	18 meteo stations, data available at Hydromet (1960-1998) Climatic maps are available
River Discharge Data	12 gauging sites	29 gauging stations	97 gauging stations	8 gauging sites	116 gauging. stations
River Mineralisation Data	Nothing provided	7 stations (data is available	44 gauging stations	6 gauging stations	114 stations, data are

Information Type	Kazakhstan	Kyrgyzstan	Tadjikistan	Turkmenistan	Uzbekistan
		only to 1991)			collected by different Ministries
Groundwater Data	Maps of shallow and deep groundwater (incl. electronic version) available from Hydrology Institute	The hydrological map is available (1999)	Maps available from hydrogeological meliorative expedition	Maps of shallow and deep groundwater available from Hydrology Institute	No specific reply
Basin and National Water Infrastructure	Data on all massifs available in project institutes and hydro-meliorative stations	The data on the whole irrigation infrastructure are available in different institutes and universities.	Specific technical reports on exploitation and maintenance of irrigation systems and constructions are available in Ministry of Water Resources	Specific technical reports and Feasibility Studies available	Data available in special department of MAWM
Salinity and Drainage	Data available in project institutes, expeditions, KSRIWR	Annual data on mineralisation of water and soil salinity are available in the Department of Water Resources of the Ministry of Water Man and Agric.	Data on soil and water salinity are available	Data on soil and (drainage) water salinity available in National Institute	Regional reports available in Russian and Uzbek Regional maps on soil and water salinity available at various scales
Other notes	Provision of departmental and departmental materials is only possible on payment basis. Access to depart-mental materials (> 1960) might be impossible due to reorganisation of government structures			Soil maps of different scale do exist for 5 planning zones Data on domestic and industrial water consumption do exist at Ministry	Data on domestic and industrial water consump-tion do exist at various Ministries Responsibilities differ for surface water and ground water sources

APPENDIX E

COMPOSITION OF NATIONAL AND REGIONAL TEAMS

The National Working Goups

#	Position	Name	Organisation
		NWG KAZAKHSTAN	
1	Team Leader	Sarsembekov T.T./ Dmitriev L.N.	Goskomvodresurs/ Institute “Kazgiprovodkhoz”
2	Economist	Mukhamedjanov V.	Institute of Water Economy
3	Water Resources Planning Engineer	Zemlynikov A.	Institute "Kazgiprovodkhoz"
4	Water Resources Management Engineer	Askarov K./Kipshakbaev N.K.	State Committee on Water Resources/SIC ICWC
5	Agronomist	Anafin M.	Taraz State University
6	Hydrologist	Funkner R.	Institute "Kazgiprovodkhoz"
7	Hydro-geologist	Silkina N.	Institute "Kazgiprovodkhoz"
8	Irrigation and Drainage Specialist	Mustafaev J.	Taraz State University
9	Salinity Control Specialist	Junusov M.	JSC "Yuzgkazvodproekt"
10	Energy Specialist	Kravtcov V.	Energy Company KEGOK
11	Participation Specialist	Kutzhanov A.	Kzyl-Orda Oblvodkhoz
12	Ecologist Water Pollution	Severskiy I.	Institute of Geography
13	Ecologist – Specialist in Soils	Rau A.	Institute of Water Economy
14	Institutional / Legal Specialist	Esinkulov S.	Taraz State University
		NWG KYRGYZSTAN	
1	Team Leader	Beyshekeev K.	MAWR
2	Economist	Abdurasulov I.	Kyrgyz State University
3	Water Resources Planning Engineer	Bekenov A.	AOOT "Kyrgyzsuudolbor"
4	Water Resources Management Engineer	Sarbaev T.	AOOT "Kyrgyzsuudolbor"
5	Agronomist	Kasymov Ch.	Institute "Kyrgyzgiprozem"
6	Hydrologist	Romanovskiy V.	Institute of Water Problems
7	Hydro-geologist	Ponomarev B.	SEZ "Bishkek" (offshore zone)
8	Irrigation and Drainage Specialist	Sizintzev A.	MAWR
9	Salinity Control Specialist	Gossu L.	KNII of Land Reclamation
10	Energy Specialist	Djailoobaev A.	MAWR
11	Participation Specialist	Cheban G.	Ministry of Nature Protection

#	Position	Name	Organisation
12	Ecologist Water Pollution	Kovalenko B.	KNII of Land Reclamation
13	Ecologist – Specialist in Soils	Djamgychiev A.	MAWR
14	Institutional / Legal Specialist	Mambetjanova S.	IFAS Branch Office
NWG TADJIKISTAN			
1	Team Leader	Nazriev M.	MWR
2	Economist	Valiev D.	Ministry of Economy
3	Water Resources Planning Engineer	Akhrorov A.	MWR
4	Water Resources Management Engineer	Kholmatov A.	MWR
5	Agronomist	Akhmadov Kh.	Committee of Forestry
6	Hydrologist	Komilov O.	MWR
7	Hydro-geologist	Rakhmonov B.	TadjNIIGIM
8	Irrigation and Drainage Specialist	Madaminov A.	MWR
9	Salinity Control Specialist	Pulotov Y.	TadjNIIGIM
10	Energy Specialist	Garibmakhmadov B.	PowerCompany "BarkiTochik"
11	Participation Specialist	Paishanbiev A.	Committee on Industry
12	Ecologist Water Pollution	Mukhabbatov Kh.	Academy of Sciences
13	Ecologist – Specialist in Soils	Kamolov S.	TadjNIIGIM
14	Institutional / Legal Specialist	Kamolitddinov A.	Ministry of Agriculture
NWG TURKMENISTAN			
1	Team Leader	Khatamov A.A.	MWR
2	Economist	Aganov S.E.	Institute "Turkmengiprovodkhoz"
3	Water Resources Planning Engineer	Berdiev A.A.	MWR
4	Water Resources Management Engineer	Annaev B.A./ Buslov N.A.	MWR
5	Agronomist	N/A	
6	Hydrologist	Nobatov A.A.	TurkmenGidromet
7	Hydro-geologist	Avanesov A.A.	TurkmenGeologia
8	Irrigation and Drainage Specialist	Golubchenko V.	Institute "Turkmengiprovodkhoz"
9	Salinity Control Specialist	Redjepbaev K.	Institute of Agriculture and Water Management
10	Energy Specialist	Orazmamedov O.	MWR
11	Participation Specialist	Gashaev D.G.	MWR

#	Position	Name	Organisation
12	Ecologist Water Pollution	Khanmedova A.O.	NGO "AVIS"
13	Ecologist – Specialist in Soils	N/A	
14	Institutional / Legal Specialist	Ataev M.A.	Ecological Fund of Turkmenistan
		NWG UZBEKISTAN	
1	Team Leader	Abdullaev U.	"Uzgipromeliovodkhoz"
2	Economist	Muminov A.	MAWR
3	Water Resources Planning Engineer	Agzamov M./Rakhimov Sh.Kh.	MAWR/SANIIRI
4	Water Resources Management Engineer	Rakhmatov Sh.	"Uzgipromeliovodkhoz"
5	Agronomist	Voronov A.	"Uzgipromeliovodkhoz"
6	Hydrologist	Gulyaev M.P.	"Uzgipromeliovodkhoz"
7	Hydro-geologist	Yusupov G.	TIIMSH
8	Irrigation and Drainage Specialist	Azizov A.	"Uzvodremekspluatazia"
9	Salinity Control Specialist	Yashin A.	MAWR
10	Energy Specialist	Ametov N.	Ministry of Energy
11	Participation Specialist	Talipov Sh.G.	State Water Inspection "Gosvodkhoznadzor"
12	Ecologist Water Pollution	Juraev Z.	MAWR
13	Ecologist – Specialist in Soils	Nerozin S.	SANIIRI
14	Institutional / Legal Specialist	Mukhamedov O.	MAWR

N/A – Name not yet available

The Regional Working Goup

#	Position	Name	Country
1	Water Resources Management Specialist	Kenshimov A.	KAZAKHSTAN
2	Economist	Bekniyazov M.	KAZAKHSTAN
3	Water Resources Planning Specialist	N/A	KYRGYZSTAN
4	Hydrologist	N/A	KYRGYZSTAN
5	Energy Specialist	Khisoriev Sh.	TADJIKISTAN

6	Agronomist	Kholov G.	TADJIKISTAN
7	Hydrogeologist	Niyazov O.	TURKMENISTAN
8	Soil (salinity) Specialist	Pirniyazov A.M.	TURKMENISTAN
9	Water Quality Specialist	Yakubov Kh.I.	UZBEKISTAN
10	Irrigation and Drainage Specialist	Ikramov R.K.	UZBEKISTAN

APPENDIX F

REPORT APPROVAL PROCEDURES

PREPARATION, REVIEW, ACCEPTANCE AND PAYMENT FOR REPORTS– NATIONAL AND REGIONAL WATER AND SALT MANAGEMENT (COMPONENT A1)

Report No.	Phase no. (see figure 1)	Primary Responsi-bility	Title of Report	Submission Date Draft Report	Level of Agreement	Period of Preliminary Agreement	Submission Date Final Report	Period for Acceptance and Payment
1	2	3	4	5	6	7	5	8
Joint Report 1	I	RWG and NWG of the Consultant	Inception	end of month 3	NC, NCC	1 month following submission	2 weeks following prel. agreement	2 weeks following subm., of final report
Workshop		Consultant, PMCU			IW	middle of month 3		
Regional Report 1	II	RWG of the Consultant	Principles and Guidelines for Regional and National Planning	end of month 5	NC, NCC, Gov.	1 month following submission	2 weeks following prel. agreement	2 weeks following subm., of final report
Regional Report 2	III	RWG of the Consultant	Regional Needs and Constraints	end of month 16	NC, NCC	1 month following submission	2 weeks following prel. agreement	2 weeks following subm., of final report
Workshop		Consultant, PMCU			RW	middle of month 17		
National Report 1	IV	NWG of the Consultant	National Demands and Options for Demand Management	end of month 16	NC, NCC, Gov.	1 month following submission	2 weeks following prel. agreement	2 weeks following subm., of final report
Joint Report 2	V	RWG and NWG of the Consultant	Basin Water and Salt Balances and Their Implications for National and Regional Planning	end of month 20	NC, NCC, Gov.	1 month following submission	2 weeks following prel. agreement	2 weeks following subm., of final report
Workshop		Consultant, PMCU			RW	middle of month 21.		
National Report 2	VI	NWG of the Consultant	Draft National Policy, Strategy, and Action Program for Water and Salt Management	end of month 26	NC, NCC, Gov.	1 month following submission	2 weeks following prel. agreement	2 weeks following subm., of final report
Regional	VI	RWG of the	Draft Regional Policy, Strategy,	end of month 26	NC, NCC,	1 month	2 weeks	2 weeks following

Report No.	Phase no. (see figure 1)	Primary Responsi-bility	Title of Report	Submission Date Draft Report	Level of Agreement	Period of Preliminary Agreement	Submission Date Final Report	Period for Acceptance and Payment
Report 3		Consultant	and Action Program for Water and Salt Management		Gov.	following submission	following prel. agreement	subm., of final report

Notes

* - in coordination with Joint Report 2

** - in coordination with Regional Report 3

Submission of National and Regional Reports to PMCU by the Consultant, their Review and Agreement

- The Consultant will submit the reports prepared by National Working Groups (NWGs) or the Regional Working Group (RWG) to the PMCU or in agreement with the PMCU to the National Coordinator.
- The number of copies of Joint Regional and National reports that have to be prepared is 20 in English and 40 in Russian.
- On behalf of PMCU the National Coordinator will submit the reports to the Government at the required level for review and agreement;
- After receiving the report from the Consultant through the PMCU the National Coordinator will organize a meeting of the corresponding National Coordination Council (NCC) for review of the report and produce a protocol of the meeting;
- The reports, which are to be agreed with the Government should be submitted by the National Coordinator to the Government on behalf of the PMCU. This should be at the level of deputy Prime Minister, who is also a member of the IFAS Board. The review of the report submitted will take place and corresponding decisions will be made.
- If during the agreement process the issue of report amendment and finalization occurs the National Coordinator will return the report to the Consultant through the PMCU for completion.
- Final payment will be made only when the report is satisfactory and approval received
- If national and regional reports are to be coordinated with each other, final payment will be made only after acceptance of the joint report.

- If the National Coordinator is unable to establish agreement in one of the Governments of the region the PMCU may be requested to assist in the solution of the difficulty.
- PMCU will regularly inform the World Bank about the implementation of sub-component and agreement of the stages.

The above Reports are those to be implemented under this Contract. These Reports cover only Phases I-VI of Subcomponent A1. The Contract with the Consultant could be extended for Phase VII, subject to satisfactory implementation of Phases I-VI.

The Reports projected for Phase VII figure below:

Report No.	Phase no. (see figure 1)	Primary Responsibility	Title of Report	Submission Date Draft Report	Level of Agreement	Period of Preliminary Agreement	Submission Date Final Report	Period for Acceptance and Payment
1	2	3	4	5	6	7	5	8
Final National Reports	VII	PMCU and EC-IFAS with support of the Consultant	Final National Policy, Strategy, and Action Program for Water and Salt Management		NC, NCC, Gov.			
Final Regional Report	VII		Final Regional Policy, Strategy, and Action Program for Water and Salt Management		NC, NCC, Gov.			
Integration into Joint Report 3	VII		Generalization		NC, NCC, Gov.	.		
Workshop	VII	Consultant, PMCU			RW			
Preparation of the Final Report	VII		Integrated Policy, Strategy, and Action		NC, NCC, Gov.			

Report No.	Phase no. (see figure 1)	Primary Responsibility	Title of Report	Submission Date Draft Report	Level of Agreement	Period of Preliminary Agreement	Submission Date Final Report	Period for Acceptance and Payment
			Program for Water and Salt Management		IFAS Board			
Delivery of the last version to the national governments, EC-IFAS and the World Bank		PMCU, Consultant						

Abbreviations

RWG and NWG — Regional and National Working Groups of the Consultant

IW — Initial Workshop with participation of National Coordinators, representatives from NWGs and RWG, and ministries and bodies responsible for project implementation in CA States

NCC — National Coordination Councils of CA States

RW — Regional Workshop with participation of National Coordinators, representatives from NWGs and RWG, and representatives from national governments authorized for decision making. In case of disputable questions the Consultant will be given time

	for revision;
NC	National Coordinators in CA States
PMCU	GEF Project Management and Coordination Unit
EC-IFAS	Executive Committee of the International Fund for Saving the Aral Sea
Gov.	national governments
IFAS Board	Board of the International Fund for Saving the Aral Sea

APPENDIX G

DRAFT TERMS OF REFERENCE FOR TASKS

TOR R4/N3

TASKS R4 AND N3: ASSESSMENT OF TRANSBOUNDARY AND NATIONAL WATER RESOURCES

TOR R5/N5

TASKS R5 AND N5: ASSESSMENT OF BASIN AND NATIONAL WATER INFRASTRUCTURE AND MANAGEMENT

TOR N 6

TASK N 6: SCENARIO DEVELOPMENT

TOR R7/N7

TASKS R7 AND N7: ASSESSMENT OF SALINITY TRENDS, COSTS AND STANDARDS

TOR ECON-1

TASKS R5 AND N5: ASSESSMENT OF WATER INFRASTRUCTURE AND MANAGEMENT; Sub-Task: Establishment of Uniform Calculation Approaches to Set-up Unit Costs for Investment in Rehabilitation of Irrigation and Drainage Infrastructure.

TOR ECON-2

For TASKS R5 AND N5: ASSESSMENT OF WATER INFRASTRUCTURE AND MANAGEMENT; Sub-Task: Establishment of Uniform Calculation Approaches to Set-up Unit Costs for Annual Operation and Maintenance Cost of Irrigation and Drainage Infrastructure.

TOR ECON-3

TASKS R7 AND N7: ASSESSMENT OF SALINITY TRENDS, COST AND STANDARDS; Sub-Task: Establishment of Uniform Calculation Approaches to Set-up Unit Costs to calculate Costs of Salinity to Urban and Rural Infrastructure and Estimation of Operation and Maintenance Costs.

TOR ECON-4

For TASKS R7 AND N7: ASSESSMENT OF SALINITY TRENDS, COSTS AND STANDARDS; Sub-Task: Calculation of Gross Margins for Major Irrigated Crops

(For details see separate files)