

**Report of the**

**FAO EXPERT CONSULTATION ON THE USE OF IRRIGATION SYSTEMS  
FOR SUSTAINABLE FISH PRODUCTION IN ARID COUNTRIES OF ASIA**

**Almaty, Kazakhstan, 25-29 September 2001**



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## **PREPARATION OF THIS DOCUMENT**

The FAO Expert Consultation was organized in close cooperation with the Kazakh Scientific Research Institute of Fisheries. The major objective was to review the present status of fisheries in irrigation systems of countries in the arid zone in Asia. Thirteen papers were presented, followed by discussions. This Report summarizes the presentations, discussions and recommendations for further action. The papers presented at the Expert Consultation are published as FAO Fisheries Technical Paper No. 430 "Fisheries in irrigation systems of arid Asia".

This report was prepared by T. Petr, FAO Consultant, and G. Marmulla, Fishery Resources Officer, FAO.

## **ACKNOWLEDGEMENTS**

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### **Distribution:**

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### **ABSTRACT**

The FAO Expert Consultation was attended by 19 participants, including national fisheries and irrigation experts from 10 countries: China, India, Iran, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Syria, Turkey, and Uzbekistan. The presence of irrigation experts made possible close interaction on common problems, especially in areas where fisheries interests in water resources have been in conflict with demands from irrigated agriculture. The presentation of thirteen papers was followed by discussions which addressed the following: the present use of irrigation systems, including drainage waters, for fish production; current fishery management practices in irrigation systems; constraints to improving fish production in these systems; fish biodiversity, fish stock enhancement, efficiency of the existing fishery laws and regulations, trans-boundary aspects of fish stock management, regional and sub-regional collaboration, and some other areas of interest for fisheries in irrigation systems of the arid zone of Asia. The Expert Consultation concluded with a set of recommendations and proposals for further action.

This Report is a companion to the FAO Fisheries Technical Paper No. 430 "Fisheries in irrigation systems of arid Asia".

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## SUMMARY OF RECOMMENDATIONS AND PROPOSALS FOR FURTHER ACTION

As a result of the Expert Consultation there was a broad consensus and the experts agreed on the need for the following activities:

While some countries in the Region are well advanced in the field of fish production from water bodies of irrigation systems in the arid zone of Asia, other countries experience major difficulties which have arisen from the recent changes in their political and economic systems. These are especially the countries of Central Asia and Mongolia. Such countries require major assistance.

The Expert Consultation therefore **recommended** that a study be urgently carried out to provide insight into the potential for fishery rehabilitation of irrigation reservoirs in particular, using regular stocking of seed/fingerlings produced in hatcheries, in countries of Central Asia and Mongolia.

The Expert Consultation stressed the **need** for evaluation of the effectiveness of regular enhancements of fish stocks in irrigation and multi-use reservoirs in the arid zone of Asia.

The Expert Consultation **encouraged** countries to promulgate the use of artificial breeding technologies for production of stocking material, where such technologies are not yet in a routine use.

The Expert Consultation **recommended** that each country prepare a review on the present status of indigenous fish. The information would then be collated by the FAO.

The Expert Consultation **recommended** that a regional review of the current use of irrigation and drainage canals for fish production be prepared. This to be based on reports of the individual countries.

The Expert Consultation **recommended** that pilot studies in Syria and other countries in the Region should test the potential of canals using one or more fish species, both indigenous and introduced and already well acclimatized to the Region.

The Expert Consultation **recommended** that countries in the Region with experience in optimizing fish production in irrigation reservoirs and in irrigation and drainage canals prepare an account of their management practices.

The Expert Consultation **requested** countries in the Region to collate information on residual (drainage) water bodies such as terminal lakes, their morphological, hydrochemical and biological characteristics, including fish species diversity and their current use for fisheries, and on organization(s) responsible for the fisheries and environmental management of such water bodies.

The Expert Consultation **recommended** that a review of the efficiency of the new type fish passes in high rainfall Asia and in Australia be prepared with suggestions for their modification for their use for the existing irrigation systems in the arid zone of Asia.



The Expert Consultation therefore **recommended** that fish passes could be constructed on a pilot scale.

The Expert Consultation drew attention to the **need** to minimize damaging trans-boundary impacts, using regional collaboration and discussions as a mechanism for solving such problems.

The Expert Consultation **recommended** that FAO initiate steps for the collection of information on the world-wide suitability and use of collectors/drainage water canals for production of fish, including fish of medical significance, i.e. for the control of vectors and hosts of water-borne diseases. The study could be prepared in collaboration with the World Health Organization (WHO).

The Expert Consultation stressed the **need** for more information on the fishery potential of water bodies storing drainage (residual) water.

The Expert Consultation **recommended** that FAO consider the preparation of draft guidelines for optimal utilization of irrigation water bodies serving agricultural production in arid zones.

The Expert Consultation, recognizing the urgent need for improved information, has **requested** FAO to include countries of Central Asia and Mongolia on distribution lists for inland fisheries publications, and to consider the possibility of establishing a free-of-charge information source, using Virtual Journal or Website, specifically devoted to fishery and agriculture aspects of irrigation systems.

The Expert Consultation recognized as urgent the **need** to standardize methods for monitoring fishery resources among the riparian countries in order to better assess the impacts on fish stocks of water resources manipulation for irrigation needs.

The Expert Consultation recognized the **need** for critical revision or reformulation of laws and regulations pertaining to inland fisheries in countries of Central Asia and Mongolia. The Legal Office of FAO, Rome, Italy, should be approached for advice on how to undertake such revisions.

The Expert Consultation **requested** that, in order to speed up the rehabilitation and further development of fisheries in irrigation systems in countries of Central Asia, each country government give full support to organizing a national conference on fisheries which would review the current situation, analyse achievements and problems, and identify the necessary steps for improvement and advancement. FAO has been **requested** to assist in the organization of a follow-up regional conference.

The Expert Consultation **requested** that assistance be given to specialists of Central Asia and Mongolia to participate in international workshops on the application of fishery in irrigation systems developed elsewhere in Asia, especially in India, Pakistan, Turkey and the countries of Southeast Asia.

The Expert Consultation **recommended** the Interstate Coordination Water Commission of Central Asia (ICWC) in Tashkent, Uzbekistan, as a suitable location for coordination of activities in fisheries management of irrigation water bodies in landlocked countries of Central Asia and Mongolia.

The Expert Consultation **recommended** that an FAO *ad hoc* Working Party be established as soon as possible to address critical issues related to fisheries in irrigation systems of arid Asia and to assist in the development of strategies for fisheries rehabilitation and further development.

The Expert Consultation **recommended** that other countries in the Region, which did not take part in the present Expert Consultation, be included in the follow-up activities initiated.

## INTRODUCTION

1. The FAO Expert Consultation on the use of irrigation systems for sustainable fish production in arid countries of Asia was held in Almaty, Kazakhstan, 25-29 September 2001. The meeting of Experts was organized with the close cooperation of the Kazakhstan Scientific Research Institute of Fisheries. The Expert Consultation was attended by 19 participants including national experts from 10 countries: China, India, Iran, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Syria, Turkey, and Uzbekistan. Among the participants were two irrigation experts and a FAO consultant. The presence of irrigation experts made possible close interaction on common problems, especially in areas where fisheries interests in water resources have been in conflict with demands from irrigated agriculture.

2. The major objectives of the FAO Expert Consultation were:

- to review the current achievements and identify constraints in managing fish stocks in irrigation systems of arid countries of Asia, and
- to assess the potential and to develop strategies for further improvement of inland fisheries production.

3. To achieve these objectives, the Expert Consultation addressed the following:

- the present use of irrigation systems, including drainage waters, for fish production in the respective river and lake basins,
- current fishery management practices in irrigation systems;
- constraints to improving fish production in irrigation systems;
- existing measures for protecting fish biodiversity in irrigation systems as well as in the river and/or lake basins affected by them;
- introductions and fish stock enhancements and their impact on fish yields;
- adequacy of the existing fishery laws and regulations and their enforcement;
- transboundary aspects of fish stock management in irrigation systems;
- regional and subregional collaboration.

4. The Agenda and List of participants are appended in Appendixes A and B. The List of papers presented at the Expert Consultation is in Appendix C. Full versions of the papers presented are produced as Fisheries Technical Paper No. 430 "Fisheries in irrigation systems of arid Asia".

## OPENING OF THE EXPERT CONSULTATION

5. In his Opening Address, the President of the Kazakhstan National Academy for Agricultural Research, Mr Azimkhan Satybaldin, highlighted the importance of water resources for irrigated agriculture, with currently over 2 million ha being irrigated in Kazakhstan, and increasing every year. He stressed the need for a more effective use of water resources, including for fish production, and encouraged the participants of the

Expert Consultation to come forward with concrete proposals and recommendations. Mr Khismet Ismukhanov, Director of the Kazakhstan Scientific Fishery Research Institute, in his introduction expressed appreciation that the organizers of the Expert Consultation selected Almaty as a venue for this very important meeting and wished the participants success with their deliberations. The UNDP Deputy Resident Representative, Mr Selvakumaran Ramachandran welcomed the participants and thanked the Director of the Kazakhstan Fisheries Research Institute for hosting this important meeting. Mr G. Marmulla, FAO Fishery Resources Officer and Technical Secretary for the Expert Consultation, Fisheries Department, Rome, then briefly reviewed the history of the preparatory work leading to the present Expert Consultation. The issue of the importance for freshwater fishery of water systems serving irrigated agriculture in the arid zone of Asia was raised for the first time in 1991 at the FAO Indo-Pacific Fishery Commission Fifth Working Party on Inland Fisheries, held in Indonesia. An attempt to hold the Expert Consultation in 1993 in Turkey failed, but the need for holding it was stressed again at the Sixth Working Party in 1994 in Bangkok. During the period 1995–2000, FAO prepared publications dealing with reservoirs in India and the former USSR, respectively, and also with fisheries in several landlocked countries of Asia, including those in the arid zone. Papers already submitted for the 1993 Expert Consultation in Turkey were also published. In 1999, the Twenty-third Session of the FAO Committee on Fisheries gave high priority to inland fisheries and aquaculture development and requested the Fisheries Department of FAO to take appropriate action.

#### SUMMARY OF REGIONAL AND COUNTRY REVIEWS AND AGRICULTURE ENGINEERING CONSIDERATIONS

6. The various Sessions were chaired by Messrs. K. Ismukhanov, B. Kamilov, N. Akhtar and B. P. Das, respectively.
7. In developing countries over 70% of water used is for irrigation. It is estimated than in the year 2010, approximately 45% of the total global food production will come from irrigated lands. To develop irrigation on such a large scale, many engineering works are needed. At the beginning of the 1990s there were over 36 000 dams in the world, with many of the resulting storages serving irrigation. Some rivers now have a cascade of reservoirs, with little or no free water in between them. Irrigation systems, which consist of dams, reservoirs, main irrigation canals and their distributary net, drainage canals, and often drainage water storages, offer a diversity of water bodies for fish production. On the other hand, such systems exercise a negative impact on fish stocks of the original riverine habitats, which are no longer available to them.
8. The arid belt of Asia extends from the Mediterranean to the Pacific, including the following countries: Turkey, Syria, Iraq, Iran, southern Russia, countries of Central Asia, i.e. Turkmenistan, Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan, and also Pakistan, India, Mongolia and China. For the purpose of this report all these countries are defined as Region. Much of the food production comes from irrigated agriculture, and all of them have inland water resources with harvestable fish stocks. While FAO and other organizations have been actively promoting the integration of fish production into irrigated small-scale farming systems in high rainfall areas of Asia and Africa, small-scale systems are less common in countries of the arid zone of Asia, especially north and west of India and Pakistan. In these countries large irrigation systems

predominate, with water distributed to these areas for production of food crops and cotton. Such systems include reservoirs, distribution canals, drainage canals, and storages of residual water. While many reservoirs have been used for fish production with varying success, other types of water bodies have been utilized much less or not at all.

9. Improved integration between fisheries and agriculture is an important means to achieve enhanced food security and fish production. The most direct interactions between agriculture and fisheries occur where these two sectors compete for the same kinds of resources, especially land and water, and where measures aimed at higher agricultural production can alter natural fish habitats. Physical and chemical changes to the aquatic environment arising from agricultural practices such as damming, water abstraction and transfer for irrigation, drainage and wetland reclamation are common where irrigated agriculture is a government priority. Fishery and irrigation experts from the ten countries which met in Almaty presented accounts on the status of irrigated agriculture and the use for fish production of water bodies serving irrigation. The presence of irrigation specialists was most welcome as it allowed inter-sectoral exchange of ideas. This also contributed to a better understanding by agriculture engineers of some problems facing fisheries managers when dealing with fish production in irrigation water bodies.

10. Xinjiang Uyghur Autonomous Region, situated in northwestern China, is arid, with very low precipitation. Rivers and lakes are fed predominantly by snow and ice meltwaters draining from high mountain ranges. Capture fishery, which rapidly developed after 1945, exhausted the available fish stocks, and the situation worsened when water from rivers started to be diverted for irrigation to increase crop production for the fast growing population. Discharges in the lower courses of rivers declined, and some rivers dried out completely before reaching terminal lakes or before their confluence with other rivers. Terminal lakes also started drying out. Fish introductions and species transfer were the first management measures aimed at increasing fish yields in reservoirs and lakes. More recently, fisheries management has concentrated on aquaculture development, which now produces 84.6% (47 760 tonnes) of the total fish production in the landlocked Xinjiang Region.

11. In India crop production from irrigated agriculture has kept pace with the growth of the population: from 51 million tonnes in 1951 (population 361 million) to 200 million tonnes in 1999 (population 1 billion). This has been primarily attributable to the implementation of irrigation projects, which today comprise 311 major, 944 medium and 40 000 minor schemes. India has the largest irrigated area in the world. Man-made reservoirs harnessing water for irrigation, flood control and hydropower have a combined area of around 40 000 km<sup>2</sup>, ranging from less than 1 km<sup>2</sup> to 740 km<sup>2</sup>. Fish production from Indian reservoirs has been steadily rising and contributes a significant percentage to the total inland fish production, which in 1997 reached 2.5 million tonnes. However, better management of water in reservoirs is still required to improve the natural fish productivity in those reservoirs with rapid and large changes in water level during the time of fish reproduction and nursing. India has shown promising results with pilot studies of fish production in irrigation canals, and has identified water bodies resulting from seepage and drainage waters as having good potential for pisciculture.

12. In Iran there are 3500 inland water bodies. Of these about 730, covering a total area of 508 000 ha, are used for fisheries. During the 1995-1999 the annual fish production from these water bodies averaged 30 000 tonnes, employing over 130 000 fishermen. It has been recognized that to keep the fisheries sustainable, regular stocking is necessary. Irrigated lands cover 8 million hectares, of which about 600 000 ha are allocated to rice farming. It is planned to further develop integrated rice-carp farming and trout farming during the post-harvest period. Farming in rice fields in 1999 resulted in a harvest of 126 tonnes of fish. The side benefits of this type of culture are fertilization of fields by fish and control of the rice stem borer by carp feeding on it.

13. In Kazakhstan about 70% of water is used for irrigated agriculture. Reservoirs in southern and western Kazakhstan serve mainly irrigation, while those situated in the northern half of the country are mostly multipurpose. By the beginning of the 1990s 2.3 million ha of land were irrigated, plus 1 million ha of irrigated pastures in the deltaic region adjacent to the Aral Sea. Apart from the large number of reservoirs, there are 96 400 km of irrigation canals and 14 900 km of drainage canals. The change from a centrally planned to a market oriented economy has had a negative impact on land use, resulting in a reduction of irrigated land by about 1 million ha. The system of irrigation canals has deteriorated in a number of places, and no new irrigation systems have been constructed. There has been a drastic reduction in the officially reported fish catches from reservoirs and other water bodies, in spite of the government maintaining its policy of regular stocking of reservoirs with hatchery-produced fingerlings, as fish hatcheries are still government-owned. It is believed that much of the fish is now fished illegally. But there are also losses of fish resulting from poor coordination of water management, for example in the Syr-Darya River basin, where untimely water releases from upstream reservoirs require the excess water, including fish, to be spilled in depressions without outflow. On the positive side, the reduced use of organochloride pesticides in agriculture has resulted in gradual lowering of their concentrations in water and subsequently in lower mortalities of fish, especially of silver carp.

14. As much of Kyrgyzstan is covered by high mountains, the predominant type of agriculture is livestock production on mountain pastures. Consequently, this Central Asian country has the least developed fishery of all countries in the subregion. The multipurpose Toktogul reservoir produces between 12 and 70 tonnes of fish per year, but recently its stocks have not been fully exploited. It has been suggested that with good management this reservoir could produce 120 to 150 tonnes per year in a sustainable manner. Due to large drawdown other reservoirs appear to be less suitable for development of commercial fisheries, but they could still be used by recreational and subsistence fishermen. There is a major scope for improving fish production on fish farms, some of which are connected to irrigation water supply.

15. At present Mongolia has no fish production in irrigation systems. In the 1990s 90 000 ha of land were irrigated, but there are no major reservoirs and irrigation canals which could be utilized for fish production.

16. In Pakistan, 14 million ha are irrigated. There are three major reservoirs, plus 19 barrages, 12 interlink canals and 43 independent irrigation command areas. The total length of main canals is 58 500 km. Farm production is dominated by crop production, especially wheat and rice, followed by cotton, sugar cane, and maize. About 79% of the total wheat crop comes from irrigated fields. None of the major dams are provided with

fish passes, but some barrages have fish passes, which, however, are largely non-functional. Migration of important economic fish species such as *Truncalosa ilisha* and *Tor putitora* can no longer take place. Most pumping stations have no fish protection devices and where these are present, they do not function well. In the year 2000, a total of 144 000 tonnes of fish were captured from rivers, reservoirs, natural lakes and irrigation canals; 36 000 tonnes were produced in aquaculture, and about 75% of these were produced in fishponds fed by irrigation canals. There is potential for enhancing fish production in irrigation and multipurpose reservoirs, and also in the at present largely unutilized brackish water bodies formed from drainage water. Abandoned irrigation canals are being brought under fish production and managed as fish ponds. Flood control compartments ranging from 10 to 5 000 ha are naturally stocked with fish during floods, but a few months later they are drained, which does not allow the fish to grow to market size. With proper management, these structures could be better utilized, perhaps for the production of stocking material.

17. Turkey has experienced intensive dam construction activity aimed at tapping as much of its water resources as possible, mainly for hydroelectricity and irrigation. Turkey has 8.5 million ha of economically irrigable lands and 151 dams which have been constructed to store irrigation water. The South Eastern Anatolian Project (GAP) is a multi-purpose project which comprises 22 dams and is expected to double the current hydropower and agriculture production of Turkey. Upon completion, the water storages will cover 2 200 km<sup>2</sup> and include 2 235 km of irrigation and drainage canals. In 1998, 1 828 tonnes of fish were captured in GAP water bodies, as well as 520 tonnes produced in aquaculture, this corresponding to 3.3% of the total inland capture, and 1.5% of the total aquaculture production. The major fish produced in water bodies of irrigation systems are common carp and trout, but Turkey intends to initiate breeding, stocking and production of other indigenous fish species. Turkey has a shortage of trained fishery specialists and needs assistance with the introduction of new and cheaper culture technologies suitable for fish production in water bodies of irrigation systems.

18. Uzbekistan uses about 85% of the total water runoff for irrigated agriculture, producing mainly cotton, rice and wheat. Water for irrigation is taken from the middle courses of rivers, and drainage water is returned to the rivers further downstream or collected in depressions in lakes without outflow. The total length of irrigation canals is 150 000 km, and that of drainage canals 100 000 km. Fisheries in numerous bodies of irrigation systems is now privatized, with the former state fishing companies now united under one private management enterprise. Today the major fish production comes from aquaculture from fish ponds established alongside irrigation systems. Twelve of these fish farms use irrigation water, eight use drainage water with salinities of up to 6 ppt. After a sharp decline in fish production in early 1990s, in 2000 the fish production in all types of freshwater bodies of Uzbekistan reached 9 200 tonnes, of which 6 200 tonnes came from aquaculture and the rest from capture fisheries. With better support from the government and more private investment which would assist especially small-scale producers, fish production could be substantially increased. In Uzbekistan's lakes and reservoirs in the Aral Sea basin fish production varies between 1.5 and 50 kg per ha per year. Prior to the major changes in economy, state-owned hatcheries produced stocking material which was regularly released into reservoirs and lakes. The hatcheries/fish farms still exist and have sufficient capacity to provide enough seed to farmers and for stocking, to achieve total fish production of up to 100 000 tonnes per year. But changes in the economic system have resulted in a two thirds decline in fish catches from

reservoirs. Training of fishery specialists stopped, and research was dismantled. Today, Uzbekistan has no specific programmes, national or international, assisting fishery development. The fishery potential of irrigation reservoirs is grossly underutilized. The current fish food consumption in Uzbekistan is only 1 kg/person/year.

## SUMMARY OF DISCUSSIONS

19. All countries in the region covered by the Expert Consultation use numerous irrigation reservoirs for fish production. Among the water bodies of irrigation systems in the arid zone of the Region, usually only irrigation reservoirs are used for fish production. Irrigation canals, drainage/residual water canals, water bodies formed by seepage, and water bodies storing residual water are utilized much less. Fishery management is best developed in irrigation reservoirs of India and Pakistan, where for many years irrigation systems have been a valuable source of fish. Enhancement of fish stocks by stocking, practiced in most countries of the Region, has resulted in steady increases in fish production, providing a growing fish supply to the markets. But while in the countries of Central Asia fish stocks in reservoirs are at present underutilized, in the Xinjiang Uyghur Autonomous Region of China, and in the large reservoirs of Syria, fish stocks appear to be over-exploited.

20. In countries of Central Asia and in Mongolia fishery management in irrigation and other types of reservoirs has been declining since the dissolution of the Soviet Union. These countries are still partly isolated from the rest of Asia and from the Western world, not only by linguistic barrier (until recently their *lingua franca* was Russian), but also by the historical influence exerted on them for many years by the former Soviet Union. Radical changes which have taken place in these countries over the last 10 years have resulted in the dismantling of the centrally planned economic system, in which many coordinating centers had been located in Moscow. The countries have now entered a phase in which not only the whole economy but also the organizational structure of the major sectors, such as irrigated agriculture and fisheries, are being subjected to rapid changes. The introduction of new structures goes in parallel with the dismantling of the old structures. This has been accompanied by drastic cuts in financing, departure of professionals, and some other changes, which together have resulted in neglect of the existing infrastructure, decline in the previously well-functioning fishery management, and consequently in a drastic decline in fishery production.

21. In major water storages in Central Asia and Mongolia organized fishing activities have declined as fishing and fish stock enhancement activities which were formerly coordinated by the government have been scaled down. In some water bodies poaching of fish is now widespread and may have contributed to the sharp decline in the officially declared fish catches. Fish production continues to be allocated a lesser priority than irrigation, hydropower production and clean water supply for towns and industries. Fishery laws and regulations, valid in the old era, need to be updated or rewritten. The recovery and rehabilitation of the fishery associated with the major irrigation systems in these countries requires a major effort. Only in this way can fish regain status as an important food source and contribute to the food security and income generation in these countries.



22. In countries of Central Asia and Mongolia the lack of finances for private investors has been a major obstacle to initiating or restarting fishery activities. This has slowed down the process of recovery. It is recognized that a more forceful representation of fisheries managers and specialists in government forums, as well as their involvement in fund-raising through international assistance, is needed to overcome the stagnation. Free market economy has been sometimes misunderstood as a competition for meager money sources. It is in the common interest of the presently fragmented fisheries organizations and enterprises in countries which have changed to a market-oriented economy, to join in the effort of obtaining assistance, especially foreign funds.

23. In Mongolia until now little attention has been paid to the fishing potential of irrigation systems. These systems appear to be in need of rehabilitation and, in connection with that, their potential for fish production needs to be evaluated. Priority should be given to water bodies close to major centers of habitation, especially those close to Ulaan Baatar.

24. Adequate water supply during the critical reproduction and growing periods is a precondition for maintaining fish stocks in irrigation reservoirs. However, due to the priority given to irrigation and often also hydropower production, a satisfactory water supply for fish cannot always be safeguarded. Then other fish stock management methods may have to be applied. The most commonly used method is regular stocking of reservoirs with hatchery-produced fingerlings. The Expert Consultation showed the need for evaluation of the effectiveness of regular enhancements of fish stocks in reservoirs. Information available for Indian reservoirs indicates that proper stocking of reservoirs significantly contributes to incremental fish production. A similar experience is available for several reservoirs in Turkey. But information is still needed on the benefit of stocking reservoirs with fish of various sizes and species, especially for large reservoirs. Close monitoring of stock enhancement measures will lead to rationalization of such measures. At present, the dearth of information hampers efforts to improve management of fish stocks in numerous irrigation water bodies. Only a good knowledge of the fish standing stock will allow the right scale of enhancement to be chosen, or the conclusion that no enhancement is needed. This has important economic implications.

25. The Expert Consultation recognized the problem of large losses of fish at high water discharges which require the excess water to spill over dams. This is particularly true in Kazakhstan and for large dams in India. At present very little can be done to avoid this. It has been suggested that one way of mitigation is to allow fish to migrate back upstream into the reservoir. The Expert Consultation therefore recommended that fish passes could be constructed on a pilot scale. Appropriate technical solutions can be selected from the already available wide range of fish passes, with the possibility of adapting them to the migratory habit of individual fish species. For this purpose field trials are needed which would test the behaviour of the relevant species. Careful monitoring of fish yields in the reservoirs should accompany each modification, so as to evaluate each new design. The Expert Consultation further recommended that a review of the efficiency of the existing fish passes serving non-cyprinid fish in Asia and Australia be prepared with suggestions for their modification. The review should include considerations of new designs of fish passes which have already been tested in trials in other parts of the world, and their evaluation for suitability for dams and barrages serving irrigation and other uses in the arid zone of Asia.

26. During periods when no water is being used for irrigation excess water is sometimes be discharged by spilling into depressions. An example was given of a discharge from an upstream-situated reservoir which provides water for hydropower production during winter. At that time the river is frozen, and the water releases have to be diverted into a depression so as not to cause ice breaking and consequently formation of ice barriers which would result in flooding of inhabited floodplains. Such large winter releases from an upstream reservoir situated in a neighbouring country waste not only water, but also fish. The Expert Consultation drew attention to the need to minimize damaging transboundary impacts, using regional collaboration and discussions as a mechanism for solving such problems. International river basin commissions or other appropriate bodies need to address fisheries considerations and concerns and to involve fisheries specialists and managers in discussions on water resource allocation and on water distribution timing.

27. The Expert Consultation has drawn attention to the low level of utilization of irrigation canals for fish production in the arid zone of Asia. Syria has demonstrated in pilot scale experiments that active canals (i.e. those which contain water permanently or most of the time) can be managed for fish production. This being an isolated experience, the Expert Consultation recommended that further pilot studies in Syria and other countries in the Region should test the potential of canals using one or more fish species, both indigenous and introduced and already well acclimatized to the Region. The Expert Consultation also recommended that a regional review, including constraints, of the current use of irrigation and drainage canals for fish production be prepared.

28. The Expert Consultation also noted that a pilot study in India showed that flow-through components of irrigation systems could be effectively utilized for intensive aquaculture, particularly below dams, where part of the water can be diverted through this system. A similar experience is also available from Iran. After being used for aquaculture, the water can again be utilized for irrigation. The Expert Consultation also highlighted the potential of seepage water from canals and dams for fish production. In Pakistan seepage from a major irrigation canal taking water from the Chashma barrage on the Indus River has been ponded and used for fish pond culture.

29. Assistance in the development of new aquaculture technologies and their application to semi-intensive fishery production systems, particularly for high value fish species, including those endemic to the region, is also needed. This would lead to a better utilization of the presently underutilized, or non-utilized components of irrigation water bodies, such as irrigation canals, which could serve, for example, for raceway fish production. For enhancing fish stocks in irrigation water bodies the Expert Consultation encouraged the countries to promulgate the use of artificial breeding technologies for production of stocking material, where such technologies are not yet in routine use.

30. In some countries of Central Asia fish hatcheries cum fish farms have been constructed alongside major canals as well as reservoirs. Such fish farms have been producing fish predominantly for stocking reservoirs, but some of them also have produced fish for marketing. While most of them are still functioning, their production capacity has declined due to the rapidly increasing cost of fish feed, spare parts for pumps and water conveyance, labour cost, etc. This has led to a reduction in the stocking rate in reservoirs. Privatization of hatcheries may be the only way for overcoming the current problem. The necessary investment capital for privatization may have to come in

the form of government or foreign assistance as local capital is still scarce. An economic study of potential returns from a regular fish stocking management programme is essential for any further initiative in this direction. The Expert Consultation recommended that a study be urgently carried out to provide insight into the potential for fishery rehabilitation of irrigation reservoirs in particular, using regular stocking of seed/fingerlings produced in hatcheries. The study, which should be prepared in one country of Central Asia, possibly in Kazakhstan, should include a section on marketing. A draft outline of such a study is presented as Appendix D.

31. The general crisis of sturgeon fisheries in the Caspian Sea requires the intensification of the production of stocking material for regular releases into the sea. Kazakhstan, with its irrigation systems adjacent to the Ural River, has the potential for an increase in production of sturgeon fingerlings. Major irrigation canals, such as the Kushumsky, are a suitable environment for growing spawn to the size suitable for release into the Caspian Sea. The River Ural is the only river which has not been dammed and therefore adult sturgeons can still reach their spawning grounds situated in this river. However, irrigation water uptake from the river represents a danger for the spawn. The Expert Consultation recognized the urgent need for the rehabilitation of sturgeon stocks and gave full support to the Kazakhstan proposal to develop technology for reducing high spawn mortalities resulting from the sturgeon spawn entering irrigation systems, as well as to carry out pilot studies on growing sturgeon in irrigation systems of the Ural and Volga Rivers. This idea, when fully formulated, should receive full support of donors for its implementation.

32. Only a few countries use drainage/waste water canals for fish production. Some results have been obtained from a pilot study in Syria, and drainage waters have been also used for fish production in some parts of India. The issue of regular maintenance of these canals needs attention. The Expert Consultation gave support to initiatives in some countries of the Region, such as Syria, India and Uzbekistan, and recommended that FAO initiate steps for collection of information on the worldwide suitability and use of such waters for fish, including those of medical significance, i.e. for the control of vectors and hosts of water-borne diseases. The study could be prepared in collaboration with the World Health Organization (WHO).

33. The Expert Consultation stressed the need for more information on the fishery potential of water bodies storing drainage (residual) water. Such water bodies have usually elevated salinity and are often polluted and contaminated with agrochemicals and heavy metals. A decline in the use of agrochemicals, including those containing heavy metals, in irrigated agriculture, has been noticed in many countries of the Region. This may eventually lead to gradual reduction of harmful substances not only in reservoirs and the rivers to which the water is eventually returned, but also in residual water bodies. Levels of agrochemicals in fish and fish food organisms, water pollution levels, as well as the general health status of fish stocks in water bodies of irrigation systems need to be regularly monitored. Depending on the results, fisheries managers could use for fish production those residual water bodies with an already improved water quality.

34. The Expert Consultation requested countries in the Region to collate information on residual water bodies, such as terminal lakes, which are used for fish production in only a few countries so far. The information should include morphological,

hydrochemical and biological characteristics, including fish species diversity and their current use for fisheries, and on organization(s) responsible for the fisheries and environmental management of such water bodies. The information should be sent to the FAO Secretariat in Rome, Fisheries Department, for further analysis and for preparation of a synthesis for the next meeting on the management of fish stocks and fisheries in water bodies of irrigation systems in the arid zone of Asia.

35. The participation of irrigation specialists from Uzbekistan and India in the Expert Consultation assisted in better understanding of the complexity involved in manipulating a water resource in order to satisfy both irrigation demands and fisheries requirements. The Expert Consultation agreed that a pilot model study on methodologies for increasing fish production in various types of irrigation water bodies, including those established from discharged waters, is needed. The Expert Consultation therefore recommended that countries in the Region with experience in optimizing fish production in irrigation reservoirs and in irrigation and drainage canals prepare an account of their management practices. The studies could be carried out by the existing lead centres in inland fisheries: the Aquaculture and Fisheries Research Institute (AFRI) in Pakistan; the Inland Fisheries Research Institute (CICFRI) in Barrackpore, India; the Kazakhstan Scientific and Research Institute of Fishery Industry, Almaty; the Interstate Coordination Water Commission of Central Asia (ICWC) in Tashkent, Uzbekistan. These centres are also suitable places for training in fisheries management, including enhancement technologies, for various types of water bodies serving or arising from irrigated agriculture.

36. With the ever increasing demand for water resources, more care must be taken to satisfy all uses, especially for irrigation, hydropower production and fisheries. The discussions showed that it would be possible to achieve the same crop production with less water. Engineering measures for this purpose are well known and should be applied wherever feasible. Reducing water demand for agriculture would have a positive impact on fish stocks and fisheries, especially where at present large seasonal agricultural demands cause a major drop in water level which damages the spawning and nursery areas. Regular dialogues between irrigation and fisheries specialists and implementation of guidelines for economical water use should become an established practice. The Expert Consultation recommended that FAO consider the preparation of draft guidelines for optimal utilization of irrigation water bodies serving agricultural production in arid zones.

37. The ICWC in Uzbekistan is a suitable institution for training specialists from countries where Russian remains the language of international communication. The ICWC, which has been already involved in a number of international programmes on the rehabilitation of the Aral Sea and its basin, also uses both Russian and English for communication among its member countries. The Centre is well equipped and has a broad knowledge of the situation in Central Asia. The Expert Consultation recommended the use of this Centre as a suitable location for further activities in fisheries management of irrigation water bodies in landlocked countries of Central Asia and Mongolia. The training unit of the Centre would be an appropriate coordinator for the implementation of subregional projects such as a project for better utilization of selected irrigation water bodies through small-scale aquaculture, proposed for three countries in the subregion, i.e. Uzbekistan, Kazakhstan and Kyrgyzstan (Appendix E).

The ICWC could also assume responsibility for coordination in developing strategies for better management of fisheries in transboundary waters in the Aral Sea Basin.

38. The complexity of irrigation systems and their considerable potential for fishery production require that in the future the existing training centres be strengthened to correspond to the future demand for training. The Expert Consultation highlighted the importance of all irrigation reservoirs, i.e. large, medium and small-sized, for fish production. While the CICFRI in India should be strengthened to become the lead centre for training in large irrigation reservoir fisheries management, the AFRI in Pakistan should be strengthened to take over as lead training centre for the utilization of small and medium-sized reservoirs for fisheries. Another centre could be established in Syria in the Department of Fisheries Resources, Damascus, to specialize in training for irrigation canal fish production.

39. Large-scale river system modifications involving dams in the arid zone of Asia have led to blockage of migratory paths of fish, flooding of spawning and nursery grounds, changes in the dominant type of fish food organisms and, consequently, changes in fish species composition. Natural spawning areas in the rivers need to be identified and protected. As species diversity of indigenous fish has declined, and a number of excellent food quality fish have either disappeared or became rare in catches, the enhancement strategy has centered on introductions of adaptable fish species, which now dominate most fish catches. The Expert Consultation recognized the need for the rehabilitation of at least some important indigenous fish species, and recommended that each country prepare a review on the present status of indigenous fish. The information would then be collated by the FAO. The next step should be the rehabilitation of the most threatened economically important indigenous fish species. This could be realized through the development of technologies for artificial propagation of native fish where such technologies do not yet exist. The produced stocking material then should be released in protected areas, until self-propagating stocks are established.

40. Global warming may have already impacted on the rainfall in the arid zone of Asia, and there is a grave concern in some countries such as Pakistan, India and Syria that the increasing irregularity of monsoon and drought periods may cause a serious problem for any new irrigation projects required for increasing land crop production. The impact of prolonged droughts may also impact on fish stocks and fisheries dependent on them. Hence, a more efficient use of water is essential to satisfy the rising demands of both sectors. The deliberations showed a great support for several areas where a TCDC approach or other development or cooperative programme would be appropriate. Countries, such as India and Syria, with well developed capability in a particular field of fishery management in one or more components of irrigation systems, could assist those countries where improvement is needed.

41. The Expert Consultation requested that in order to speed up the rehabilitation and further development of fisheries in irrigation systems in countries of Central Asia, each country government give full support to organizing a national conference on fisheries which would review the current situation, analyze achievements and problems, and identify the necessary steps for improvement and advancement. Country conferences should be followed by a regional conference which would focus on developing strategies for regional cooperation. The Expert Consultation strongly supported a suggestion that both the national and regional conferences be attended by specialists from countries

outside the region, such as northern America, Australia and Africa, and that international organizations such as FAO be also involved. FAO has been requested to assist in the organization of the regional conference.

42. The Expert Consultation also requested that further assistance be given to specialists of Central Asia and Mongolia to participate in international workshops on the application of fishery in irrigation systems developed elsewhere in Asia, especially in India, Pakistan and the countries of Southeast Asia. These countries, situated in a climatic zone either with a monsoon rainfall pattern, or in the high rainfall tropical area, have considerable experience not only in extensive fisheries but also in enhancement methods. Their technologies could be transferred either directly or modified to suit countries with arid climate. Assistance could be provided in the form of TCDC, and/or in collaboration with international organizations such as ICLARM, NACA, Mekong River Commission, and Asian Institute of Technology.

43. International assistance is much needed in many fields of fisheries. Until recently the countries of Central Asia and Mongolia were isolated not only from Western information but also from that available in the rest of Asia, mainly in the Indo-Pakistan sub-continent and Southeast Asia. While much of the effort of international organizations focused for many years on fisheries development in the high rainfall and monsoon countries, including India and Pakistan, countries of Central Asia and Mongolia remained isolated from the advances in the rest of the world. Information was unavailable and contacts were very limited. The Expert Consultation, recognizing the urgent need for improved information, has requested FAO to include countries of Central Asia and Mongolia on distribution lists for inland fisheries publications. FAO has also been asked to consider the possibility of establishing a free-of-charge information source, using Virtual Journal or Website, specifically devoted to fishery and agriculture aspects of irrigation systems.

44. The Expert Consultation recognized the need for critical revision or reformulation of the policy pertaining to inland fisheries in countries of Central Asia and Mongolia. In order to do that, fishery laws may have to be amended to correspond to the changes in the economy and the privatisation trend in the fisheries industry. In some countries (Mongolia) there is free access to fishing while elsewhere, due to the lack of enforcement of the existing fishery laws and regulations, inland fisheries have entered the grey economy, as the government may not pay sufficient attention to fisheries, resulting in an increase in illegal fishing. New or amended fishery laws and regulations should have a section specifically directed toward fish production in the diversity of water bodies serving irrigated agriculture and resulting from it. The Legal Office of FAO, Rome, Italy, should be approached for advice on how to undertake such revisions. The existence of appropriate laws and regulations would assist in the dialogue of fishery experts, managers and decision makers with other water resource users on planning for, management and rehabilitation of irrigation systems. This need is a burning issue particularly in countries of Central Asia and Mongolia.

45. Further development of inland fisheries in several countries of Asia with arid climate suffers from poor coordination and monitoring of water resources. A number of river basins are shared by several riparian countries. The action of one country may lead to destabilisation of the existing fishery activities and even harm fish stocks in another country. The Expert Consultation recognized as urgent the need to standardize methods

for monitoring fishery resources among the riparian countries to better assess the impacts on fish stocks of water resource manipulation for irrigation needs. (Appendix F).

46. Fishery specialists in all countries participating in the Expert Consultation expressed the need to take part in discussions dealing with water resource allocation, management, etc. Representation of fishery specialists in planning, management and decision-making would mean that the interests of fisheries are presented and discussed at a high level. This has not always been the case. Such an approach would contribute to better understanding of fishery problems by other users of the same water resource. As irrigation demands determine the quantities and timing of water discharges, close collaboration is imperative in decisions regarding water allocation and releases.

47. Where transboundary river/lake basins exist, collaboration among the riparian countries is essential for achieving optimal conditions for fisheries development under constraints of multiple-use of water resources. The Expert Consultation highlighted the importance of international river/lake basin coordinating bodies for international collaboration in aspects of fishery resources development in irrigation water bodies in the Region. Where a basin coordinating body does not exist, it should be established.

48. The Expert Consultation provided a mechanism for increasing awareness, highlighting needs for development and bringing expertise in the region together to achieve the single most important goal of optimum utilization of irrigation system water bodies for fish production to contribute further to food security in the relatively less developed and developing part of the arid world. The Expert Consultation brought forward the problem of a sharp decline over the last 10 years in fish catches from irrigation and multi-use reservoirs in a number of countries of Central Asia and in Mongolia. The Expert Consultation noted that in most countries in the Region fish stocks in irrigation reservoirs remain underutilized, but that a clearer picture of the situation is needed to better understand the situation and to put forward measures for improvements. The Expert Consultation therefore recommended that an FAO ad hoc Working Party be established as soon as possible to address critical issues as related to fisheries in irrigation systems of arid Asia and to assist in the development of strategies for fisheries rehabilitation and further development. It stressed the need to invite irrigation specialists, such as crop production specialists and engineers, to the meetings of the ad hoc Working Party, as cross-sectoral discussions are essential for the successful outcome of such meetings. The Expert Consultation also recommended that other countries of the Region be included in activities initiated by the present Expert Consultation.

49. The Report was unanimously adopted on 29 September 2001.

**APPENDIX A****Agenda**

1. Opening of the Session
2. Adoption of the Agenda and Timetable
3. Election of Chairmen and Rapporteurs
4. Introductory presentation
  - T. Petr, Consultant
5. Presentations of technical country papers and discussion
  - India (B.P. Das)
  - Kazakhstan (K.H. Ismukhanov)
  - Kyrgyzstan (D. Djancharov)
  - Pakistan (N. Akhtar)
  - Turkey (R. Celebi)
  - Mongolia (D. Ganbaatar)
  - Uzbekistan, engineering aspects (P. Umarov)
  - Uzbekistan, fisheries aspects (B. Kamilov)
  - Iran (M. Foghi)
  - India (P.V. Dehadrai)
  - Syria (I. Krouma)
6. Preparation of Draft Report
7. Discussion and Approval of Draft Report



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**APPENDIX C****List of Presentations<sup>1</sup>**

Petr, T.: Fish stocks and fisheries in irrigating systems of arid Asia.

Guo Yan: Fishery development in the Xinjiang Uygur Autonomous Region, China.

Das, B.P.: Case study on the use of irrigation systems for sustainable fish production in India.

Ismukhanov, K. and Mukhamedzhanov, V.: The use of irrigation systems for sustainable production of agriculture and fishery products in Kazakhstan.

Djancharov, D.: The use of irrigation systems for sustainable fish production in Kyrgyzstan.

Akhtar, N.: The use of irrigation systems for sustainable fish production in Pakistan.

Celebi, R.: The use of irrigation systems for sustainable fish production in Turkey.

Ganbaatar, D.: The use of irrigation systems for sustainable fish production in Mongolia.

Umarov, P.: The use of irrigation water bodies for fisheries in Uzbekistan in the context of subregional demands for irrigation water.

Kamilov, B.: The use of irrigation systems for sustainable fish production in Uzbekistan.

Foghi, M.: The use of irrigation systems for sustainable fish production in Iran.

Dehadrai, P.V.: The use of irrigation systems for sustainable fish production in India.

Krouma, I.: The use of irrigation systems for sustainable fish production in Syria.

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<sup>1</sup> order as presented

## **APPENDIX D**

### **Draft outline proposal for a review of the Kazakhstan fisheries**

#### **BACKGROUND**

Kazakhstan includes parts of the catchments of the Aral and Caspian seas, the large lakes Balkhash and Markakol and the Alakol lakes system, eight large river basins including those of rivers Irtysh, Ural and Syr-Darya, and 85 other permanent rivers and streams, many of which supply water for irrigation. The total discharge in the territory of Kazakhstan amounts to 101 km<sup>3</sup>. Water is also stored in 475 mostly multi-purpose reservoirs. The fishery potential of waters associated with irrigation is underutilized. The reason for this is a general decline of fisheries over the last 10 years, after Kazakhstan initiated the transfer of its economy from a centrally-planned system to a market-oriented one. The impact of a decrease in government financial support has been dramatic, resulting in decline in the management and scientific base and in deterioration of the existing infrastructure, such as hatcheries and fish farms producing stocking material for regular releases into reservoirs. The decline in the fishing industry, formerly state owned, has been accompanied by an increase in illegal fishing. Fish consumption in the country has declined by two thirds to 2.5 kg per caput per annum. Currently the fisheries in Kazakhstan is lacking legal and economic mechanisms for rehabilitation and development.

#### **OBJECTIVE**

To develop a management strategy for the rehabilitation of Kazakhstan fisheries, especially in the reservoirs and other water bodies of irrigation systems.

#### **To be achieved by**

Evaluation of the state of fish stocks and fisheries in reservoirs and other water bodies of Kazakhstan. This to cover production, economical, legal and social aspects

#### **Expected results**

- Establishment of an information data bank on fish stocks, their level of exploitation, and current enhancement practices;
- Economical analysis of fisheries;
- Identification of legal constraints;
- Analysis of social impacts of the current situation in fisheries;
- Recommendations for improvements in fish production;
- Suggestions for economic, legal and social improvements.

The results will represent an important step towards improving decision-making on national and local levels for the implementation of enhancement strategies, introduction of new technologies, as well as for the preparation of programmes of work. The project will also address the profitability of investment into fishery development and this should result in attracting private investment. On the whole the project would be a major

stepping stone in the direction of rehabilitation and development of fisheries in Kazakhstan.

**Executive agency**

Kazakhstan Scientific and Research Institute of Fishery Industry, Almaty. The Institute has a team of economists, lawyers and ichthyologists, who have already initiated the collection of data, especially on fishery resources in large reservoirs of the country. Shortage of funds at present does not allow the expansion of data collection and analysis for the whole territory of Kazakhstan. This would be the major objective of the project, as outlined here.

## **APPENDIX E**

### **Draft outline proposal for pilot studies of small-scale aquaculture in irrigation systems of Central Asia**

#### **BACKGROUND**

Fish production in countries of Central Asia has recently declined sharply, from 10-12 kg to 1-4 kg per person per year in the year 2000. The main cause has been the change from a centrally-planned economy to a market-oriented one. While the old structures of management have largely disappeared, new structures have not been put in place, or have not started functioning well. The potential fish producing capacity of numerous water bodies of irrigation systems in Central Asia is at present underutilized. To improve the fish supply to the people it is proposed to execute several small-scale pilot studies on aquaculture utilization of these water bodies.

#### **OBJECTIVE**

To test in pilot studies the existing methodologies, and to develop new specific methodologies where appropriate, for small-scale aquaculture production from various types of irrigation water bodies of Central Asia.

To disseminate the information through training programmes and in the form of manuals.

#### **To be achieved by**

Several pilot studies, e.g.:

- warm water carp pond polyculture in the Yushnogolodno Step irrigation system in Uzbekistan;
- trout culture in irrigation canals of the Osh Oblast, Kyrgyzstan;
- fish culture in rice fields of the Kyzyl Orda Oblast, Kazakhstan.

The implementation of the project would require formation of a group of specialists who would be responsible for the technical and scientific supervision and execution of the project. The specialists would be recruited from Uzbekistan, Kazakhstan and Kyrgyzstan and the group would be based in Tashkent in the Interstate Coordination Water Commission of Central Asia (ICWC). When established, the group, with the assistance of technical organizations such as FAO, NGO or other specialized agencies would prepare a detailed project proposal. In the project implementation the local experts of the group would be assisted by specialists from other countries of Asia with advanced aquaculture experience.

#### **Executive agency**

Interstate Coordination Water Commission of the Central Asia, Tashkent, Uzbekistan.

## **APPENDIX F**

### **Draft outline proposal for monitoring fishery resources in transboundary river systems modified for irrigation and other demands**

#### **BACKGROUND**

Some river basins extend over several countries. Water resource manipulation in an upstream country may affect a downstream country or countries. Furthermore, fishery management measures, such as species introductions, stocking and control of unwanted fish species, may impact transboundary fish stocks, and in some cases result in reduced fish production or in intrusion of unwanted fish species. A wanted species introduced upstream may become unwanted downstream for reasons such as competition with indigenous fish, or being a vector of a new fish disease. To avoid this, all riparian countries in the same river basin need to participate in regular monitoring of the situation, using standardized methods. The absence of river or lake basin cross-boundary coordination and monitoring is one of the major obstacles for achieving sustainability of fish yields and hence of fisheries in some irrigation and multipurpose reservoirs in Kazakhstan. At present, fishery management efforts in one country may be nullified by action in another riparian country sharing the same water resource.

#### **OBJECTIVE**

To establish unified methods of monitoring fishery resources in all riparian countries sharing the same river or lake basin.

#### **To be achieved by:**

- unification of data collection and regular monitoring;
- well-functioning exchange of information on fish stocks and fisheries and of fishery methodologies, such as hatchery techniques of propagation of seed and stocking material, unification of enhancement practices for various types of water bodies serving irrigation and drainage.

#### **Expected results**

- Improved management of fish stocks, i.e. enhanced fish production resulting in higher yields, and maintaining biodiversity.
- Establishment of a common database on fishery resources for transboundary water bodies, such as rivers.
- Establishment of regulatory mechanisms for minimizing or prevention of fish losses resulting from the action of one riparian country.
- Regular dissemination of information among all riparian countries on the status of fish stocks and fisheries.
- Development of a system of rapid response to emergencies so as to prevent major losses to fisheries.

**Executive agency**

Kazakhstan Scientific and Research Institute of Fishery Industry, Almaty.

The Institute already has a database on fishery resources and fisheries of Kazakhstan and some neighbouring countries. It has contacts with fishery specialists of the neighbouring countries sharing the same catchment rivers. The Institute also has specialist manpower experienced in monitoring of irrigation systems, especially their irrigation components.



The FAO Expert Consultation was attended by 19 participants, including national fisheries and irrigation experts from ten countries: China, India, the Islamic Republic of Iran, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, the Syrian Arab Republic, Turkey and Uzbekistan. The presence of irrigation experts made close interaction possible on common problems, especially in areas where fisheries interests in water resources have been in conflict with demands from irrigated agriculture. The presentation of thirteen papers was followed by discussions that addressed the following: the present use of irrigation systems, including drainage waters, for fish production; current fishery management practices in irrigation systems; constraints to improving fish production in these systems; fish biodiversity; fish stock enhancement; efficiency of the existing fishery laws and regulations; transboundary aspects of fish stock management; regional and subregional collaboration; and some other areas of interest for fisheries in irrigation systems of the arid zone of Asia. The Expert Consultation concluded with a set of recommendations and proposals for further action.

This report is a companion to FAO Fisheries Technical Paper No. 430 *Fisheries in irrigation systems of arid Asia*.

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