THE PROBLEMS OF FISHERMEN IN THE SOUTHERN ARAL SEA REGION

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Key words: Fish farming, sustainable development, environmental problems, Karakalpakstan,
Decision support modeling

Abstract

The main objective of this paper is the presentation of problems of fishery and fishermen in the southern Aral Sea region connected with water scarcity and water quality. We tried in the past to inform interested people about our suggestions how to rehabilitate the situation, how to produce relatively enough fish for the functioning of local fish processing industry and to give people jobs, but we were unable so far to convince decision makers about innovations needed. It is essential therefore to reiterate some of the well-known problems of the region, called the Aral Sea crisis, but we concentrate mostly on the problems for the fishermen. While we do this, we understand, however, that the problem requires solution within the concept of a socioeconomic sustainable development for which we suggest the development of a decision support system based upon a computer simulation model providing optimal solutions.

Introduction

The expected several million increases in population in the lower Amudarya region over the next 10 years require more food, much of which is to come from the expansion of irrigated land. The demand on fish products will be also greater than at present. But fish production has decreased after the Aral crisis first of all and sank below the subsistence level for the fishermen. Within a favourable ecological regime of the sea (until the end of 1960's) Uzbekistan caught from the sea annually about 25.000 tons of valuable fish. By the 1980s the Aral Sea ecosystem had lost its importance as a fishery resource, mainly because of the absence of fish reproduction (Fig.1). As a result of degradation it has today minor fishery importance mainly because of the extreme high salinity in the Aral Sea (more than 60 g/L). Commercial fishery is not conducted and predominantly the acclimatized euryhaline baltic flounder is caught. The total amount of fish caught in other water bodies of the Republic Uzbekistan makes only 3.000 tons/year. Besides that about 6.000 tons/year of fish is produced by fish farms.

The present level of consumption of fish products per capita of the population makes less than 1 kg/year. It is possible to consider, that the maintenance of the population with fish products at a level recommended by medicine will have social and economic importance. Besides it will be one of options to partially compensate the problems created by the Aral crisis.

Historical perspective

According to a hydroecological and fishery point of view the recent history of the Aral Sea may be divided into the following periods:

1. 1933-1965, is considered as a normal hydroecological regime for fisheries and other economical activities. Although at the beginning of 60s began in the Aral

Sea basin intensive irrigation constructions, was the reduction in the water flow to the delta zone insignificant (Fig.2).

2. 1965-1983, is considered as a period of permanent deterioration of hydroecological regime and reduction of fishery activities in the sea. In 1983 only about 50 tons of fish were caught from the sea. All further commercial fishery activities ceased. The cessation of the Sea ecosystem was especially accelerated after the construction of Takhiatash hydro-node in 1974.
3. 1983-present, ceasing of commercial fishery in Aral Sea and transference of fishery activities into deltaic and internal water bodies. Beginning of rehabilitation of hydroecosystems: creation of Muynak and Sarbas water reservoirs on the former same named sea bays and further reconstruction of Mejdurechye reservoir (initiated in 1968, Fig.3).

In April 2003, within the framework of INTAS Project 1039 visited the senior author together with some French scientists Muynak city in the Amudarya delta. We went to the street and asked people who were sitting on the street bench: how is life nowadays in Muynak. They all said the same: “the situation is bad and getting worse from day to day. In spite of attempts of a few republican and international organizations we still have no fish.”

NO FISH - NO LIFE IN MUYINAK…”.

So, fish means for the Amudarya delta people everything. They are used to catch fish and to process it in the Muynak fish-canning factory. They traditionally had mainly two types of employment, fishermen and fish cannery workers. According to R.T. Tleuov (1981) there were about 1.200 fishermen involved in 12 fishery collective farms. They had 113 fishing ships and caught about 75% of total fish in the country.

Another big part of the population was engaged in Muynak fish canning factory (MFCF). It was a rather big fish-processing factory of All Union significance build up during 1933-1941. It had included 5 other smaller fish processing plants. During the years of favorable hydroecological conditions, MFCF alone produced about 20 mlns of valuable fish cans and other fish products as well. However, already in 1974 production was cut in half. Other plants ceased their existence at the end of the 70s. Until the cessation of the Soviet Union, MFCF was able to function owing to the frozen oceanic fish imports from Russia. After the disappearance of the common soviet economics it became unprofitable. Today the factory is practically out of operation.

It worth noting that many people worked in ships maintenance plants, the Aral shipping company or in other branches of local industry engaged in fishing or for fish processing. A small part of the population was also involved in recreation, working at the guesthouses and health resorts situated on the sea cost.

In the delta region existed earlier large areas of pastures and tugais (forests alongside the river), where small parts of the population were involved in cattle breeding. However, the area of reed and other aquatic plant thickets was reduced already during the 80s from 550.000 to 20.000 ha, i.e. more than 30 times (Tleuov, 1981). There was also a catastrophic reduction of the areas of tugai forests. In the early 1930s the total area of tugais in the lower reach and delta of the Amudarya was about 300.000 ha. At present it is reduced to not more than 33.000 ha. Thus, in the course of the last 50 years, 90% of the tugai forests were lost, at an annual rate of 2% (Treshkin et. al., 1998). The cattle-breeders of the delta zone have used and still using only natural vegetation resources in connection with the tugai forests. It is clear that under above stated conditions such cattle breeding cannot be developed in large scales. Fodder production with irrigation, possibly with saline water and feed lot maintenance need to be developed.

Because of the present situation of extreme fluctuations of volume and the runoff pattern, causing formation of the landscape structure of the delta during historically reported times, the changes in hydrography of Amudarya delta occurred almost annually.

We find, therefore, in different reports different information about the areas of water bodies across the delta. By different estimations, within a favourable hydrological regime in the delta of the AmuDarya existed from 40 up to 80 lakes with the total area from 40.000 (Barkhanskova et. al., 1963) up to 100.000 ha (Akramov, Rafikov, 1990). According to our accounts, in the beginning of 90s in the delta existed only 21 lakes with a total water surface of about 115.000 ha (Karimov, 1995). Some recent increase of lake area is explained by the restoration of the areas of historically existing large lakes (Sudochje, Eastern Karateren, and Khodjakul-Karajar systems of lakes, Shegekul, etc.). On isolated gulfs of the dried up Aral sea, also a number of reservoirs were formed, filled only by river water in the flood periods, e.g. Muynak and Sarbas reservoirs by river water, and Adjibay and Jiltyrbas by collector-drainage water (CDW). Other categories of lakes of new types were formed on peripheries of irrigated territories, as a result of diversion of CDW into natural depressions (Sarikamish, Ayaskala, Shorkul and others). Besides with the purpose of the accumulation of high-quality river water and the increased concern for the security of drinking water provision from river water of the delta, major reservoirs were constructed, e.g. reservoirs Mejdurechenskoe and Dautkul.
In total, were in the 1990s in Karakalpakstan used for fishery more than 30 water bodies with the total area of 200.000 ha (Karimov, 1995). However, it is necessary to mention, that during the last dry years several reservoirs fell dry and many large lakes and reservoirs dried up almost completely. Especially during the vegetation period of 2000 and 2001 Karakalpakstan and Khorezm viloyat (Lower Amudarya) endured one of the worst droughts in recent memory. Until May 2002 there was no water even in Mejdurechye Reservoir. It caused severe drinking water scarcity.

Enhancement of lake and reservoirs fish production has become a priority after the collapse of the Aral Sea fishery. Fishery in the region has concentrated on fish production from 3 types of water bodies: major irrigation canals, reservoirs and lakes fed from them, and newly established terminal lakes, such as Lake Sarikamish, Ayazkala, Akchakul, etc. Freshwater lakes situated in the delta region have been endangered by the diminished inflow of freshwater from upstream and by the regulation of flow rates, which either completely eliminate the annual cycle in water discharges, or change them so that they do not coincide with the demands of fish for reproduction and early life stages.
In Khorezm region, situated in the lower reach of Amudarya and one of the oldest agricultural areas in the world there are more than 50 water bodies suitable for fisheries. The average fish catch reported from these lakes amount to about 32 t/year. Since 1974 the main fish production was concentrated in Khorezm fish farm. Till the early 1990s Khorezm fish farm with 1.484 ha of ponds, has been producing about 3.000 t pond table fish. However, during the last dry years it produced only about 1.000 t of fish, which can be explained with the well-known economic difficulties and water scarcity.
The negative effect of the regulation of Amudarya flow and its use of for irrigated agriculture, on fishery became more critical after the construction of Takhiatash hydro node in 1974. The construction of the Tuyamuyun hydro node and reservoir in the middle of 80s had a major negative impact as well on the local fish fauna, which require floodplains for their reproduction. Dams have also blocked the migratory ways of fish. Due to the sharply reduced outflow from the rivers into the delta zone a large number of Aral Sea fish species were denied the opportunity to migrate into the freshwater of inflowing rivers in order to spawn. Recent reports from the investigations of fish populations in contact with the Tuyamuyun reservoir indicate, however, that the reservoir might have saved some species thought to have become extinct.
The water quality was and still remains one of the main problem for Amudarya lower reach hydroecosystems and fishery. The quality of water available for aquaculture is as important as the quantity. Depending on the comparative resistance of various fish species, when the

composition of dissolved salts and pollutants in the water exceeds maximum tolerable levels, fish biodiversity and production decreases with increasing concentrations. Salinization of surface waters resulting from reintroduction of drainage water from irrigated fields is a common problem in Uzbekistan. Salinity of the southern Aral Sea region changes in wide ranges, from 0.7 to 15 g/L, depending on the season and water volumes (Fig.4). While water with salinity over 1 g/L is considered unsuitable for usual crops, less is known about water salinity levels harmful to especially the reproduction of the native fish of the lower Amudarya (Karimov and Keyser, 1998).

It is not surprising that under such conditions fish reproduction is impaired. Indeed, even in Sarykamish ans Arnasay, the two biggest lakes in the Central Asia, unsuccessful fish spawning was reported (Salikhov and Vundzettel, 1986; Sanin et al., 1991). The water mineralization in these aquatic ecosystems varied between 5 and 15 g/L (Kamilov et al., 1994).

In order to find threshold levels of salinity for the early life stages of fishes in the Aral Sea basin, we studied the effect of highly mineralized artificial brackish water with the specific ionic composition of the Aral Sea basin. The outcome of the study provides sound scientific indications for the raising of cyprinid fish in the Aral Sea basin as well as other arid areas where an extreme deficit of freshwater exists. The fertilization and swelling phases may be performed in freshwater or water up to 4g/L salinity; if necessary under artificial conditions. Further development can then take place in natural water bodies at about 6g/L or even higher salinities. The obtained results reveal that the mortality of the eggs in this case would be not more than 10%, the mortality of larvae not more than 20%.

Above stated results confirm the possibility to avoid negative impacts of water pollution with mineral salts in higher concentrations. Of course, in most cases the resolution of the problem is possible only with human intervention into the reproduction process. The next scientific problem in this direction is to study possible adaptations to salinity of wild fish populations.

The next human induced problem for the region is pollution. Defoliants, pesticides and fertilizers used in irrigated areas and around them in high quantities eventually washed away into the rivers, reservoirs and drainage lakes. According to Ataniyazova et al. (2001) only from Karakalpakstan is annually 17,1 t of pesticides washed away into the water bodies. During the dry season tons of polluted sand are blown from the fields into the water bodies. The situation is known to be critical especially on the lower Amudarya, but also much further upstream. The use of defoliants in orchards and on cotton plantations of the middle Amudarya river basin leads to their high concentrations in soils, from which the agrochemicals are washed away into rivers. The hydroecosystems of both of Khorezm region and Karakalpak republic of Uzbekistan and Tashaus region of Turkmenistan, which all are taking water from the lower Amudarya river have been exposed to high doses of agrochemicals for over 40 years. No doubt, the same agrochemicals are concentrated in the compartment fish. The worst concentrations appear in the fish in terminal water bodies, which are maintained by collector-drainage waters from irrigated fields.

Regular large-scale ecological and toxicological investigations on quality of water and various abiotic and biotic components of natural ecosystems deltas of the Amudarya river were for the first time initiated by group of scientists of the Central Asian scientific research institute of Irrigation (SANIIRI) in 1987. One of the primary goals of the research, where one of the junior authors participated, was the investigation of the ecological and toxicological situation in lakes and residual reservoirs in the Amudarya Delta region that had not been covered within the network of OGSNK (Nation-wide service of supervision and the control over a condition of the surrounding natural environment). For some years we received a unique data set (Razakov et al., 1988; Karimov, Borodin, 1990, et al.), giving detailed information on the level of pollution of various components of water

ecosystems. This research was continued later within the framework of « UNESCO Aral Sea Project ” during 1992-1996 (Borodin, Karimov et al., 1998). However, after the end of the mentioned projects the study of ecological and toxicological parameters of water ecosystems in the delta and their influences on aquatic organisms have been practically stopped; first of all for the lack of financing. At the same time is it necessary to take into account the missing relevance of the data because of the change of environmental conditions.

The present situation

Since last year we resumed such investigations within the INTAS 1039 Project. (see www.usf.uni-osnabrueck.de/projects)
The data we obtained was analyzed and compared with official water quality standards and literature data. On the base of our results (see Figures 5-7) it can be concluded that the level of pollution of the water ecosystems in the delta area has considerably decreased during the past years. This applies especially to pesticide pollution levels.
We carried out previously investigations of the accumulation of pesticides in fish species in the region (Karimov, 1990, 1995) and found that the levels of pesticides accumulation, though high, lay within limits found by the various investigators for other hydroecosystems of the world (Rovinsky et al., 1990, Chevreuil et al., 1995, et al.). Our new investigations showed, that during the last years the pollution rate of biota has dropped considerably (fig.8-10). Agriculture has in conditions of market economy either no money to buy large quantities of chemicals or had to save their use because it was banned for international ecological or medical regulations.
Generally, comparing obtained hydrological and ecotoxicological parameters with the environmental and water quality standards may estimate ecological situation in ecosystems. However, we should take into account that most of these norms are developed without enough consideration of regional peculiarities. Therefore, at this stage their use should have limited character and mainly for the orientation.
Comparative analysis of retrospective and recently obtained data shows that a present the ecological and toxicological situation may be locally assumed to be acceptable. However, it is necessary to carry out further investigations in order to give more detailed and statistically reliable answers.

We carried out special toxicological experiments with the aim to solve the particular problem of synergistic peculiarities of increased water mineralization together with pesticides and heavy metals, because these are the major pollutants of the aquatic environment of these areas. Our main conclusion is that the toxicity of the pollutants is lower for carp during early life stages in brackish water than in freshwater. This result probably, explains why cyprinid fish populations are still able to reproduce in the mineralized (between 3 and 6 g/L) Aral Sea basin hydroecosystems at this relatively high level of chemical pollution. A more detailed answer on toxic action peculiarities of water pollution would allow us more successfully to develop fishery in polluted waters by the way of differentiated and target oriented water quality management. Such data will essential for decisions about where and how fish farms can be allocated in the region.
According to the opinion of the most local scientists and fishery managers of the region the most effective way to increase the fish production in conditions of water scarcity and the modern economic situation in the lower reach of Amudarya is the introduction of innovative technologies of intensive aquaculture in small and average reservoirs. During the last 10 years fishery yields have remained at an unsatisfactory level. The fishery yields depend today fully on the quantity of water inflow into the deltaic water bodies. So was, in

the dry year 2001 in total only 552 t of fish harvested from the 26 water bodies with a water surface of about 200.000 ha, which means that the productivity was only about 2,8 kg/ha. This fact indicates the necessity to find out another, more effective ways of fish production system under modern hydroecological and economical situation, which we assume is only possible with the development of fish farming.

The potential of fish farming

The decision makers of the present Government in the region should focus on the most effective use of water resources reaching Amudarya delta. At present is the majority of the surplus water and the drainage water lead to the Aral sea or to evaporation. This must be changed. It should not be diverted directly to the Aral Sea, but used for the rehabilitation of rivers and terminal lakes with the aim of improvement of water quality and of maintaining stable water level in lakes. It could also be used to increase the regional environmental conditions, including tugai rehabilitation. Such a strategy is welcomed by fishery managers as it allows them optimizing fish yields under more stable conditions. All water bodies have considerable potential for raising fish yields. Judicious application of the available fish farming and fishery management methods would easily increase the current freshwater fish yields in the region by ten-fold within a not to distant future (Kamilov et al., 1994). Of course this only under an estimated 5 km^3 stable water inflow to the delta region (Kurbanbaev, 2001). However, the experience of 2000-2001 and other years shows that this is a very difficult task.

We are convinced, therefore, that together with the identification of the best ways to produce and harvest fish from the diversity of water bodies the most attention must be paid to the development of industrial aquaculture. The climatic conditions of the delta are highly suitable for fish farming. The development of small fish farms in small sized fishponds should have the priority in conditions of present market economy.

Some preliminary experience exists in this respect. Following the recommendations of scientists and fishery managers some efforts in this direction were undertaken. Two fish farms were constructed. The Nukus fish farm was built in 1974 especially for breeding sturgeon and Aral barbel. The Muynak fish farm was established in 1979. It had the orientation to breed common carp and acclimatized plant-eating fishes in order to produce stocking material for lakes of the Amudarya delta.

The Nukus farm never bred the migratory fish species, as originally intended, instead it has been used for production of cyprinid fish for stocking lakes in order to increase fishing yields in lakes. The Muynak fish farm was the only full system fishery enterprise in Karakalpakstan which produced both stocking material and marketable table fish. The small part of produced fish was used also for the canning factory.

However, the Muynak fish farm never reached the capacity originally intended. The main reason for this was the shortage of the Amudarya water, which resulted in only partly using the hatchery and its fattening ponds. The other very important reason was low quality of aquacultural activities and the lack of modern fishery equipment. Inadequate planning as well as the low qualification of fish farmers was another reason for failures. E.g. the large size of the fattening ponds invited flocks of cormorants which consumed a large portion of the fish population.. As a consequence the fish productivity of ponds was only about 1000 kg/ha in opposite to 2760-3730 in other fish farms of the Republic Uzbekistan (fig.11). They produced only 459 t of table fish in 1990. Since 1996 the fish farm has ceased fish production (fig.12). Altogether require equipment choice, planning and installations a complete new start.

At present hydroecological economical and sociological conditions the successful fish farming in the delta of Amudarya can be guaranteed only by the joint efforts of local and

federal governments. It should be elevated from its subordinate position to an equal partner in discussions and the decision making process. Above stated collapse of Muynak fish farm would not have taken place if it had been supported in due time by the appropriate authorities. Taking into account the nature of people in this region, fishery and fish farming should have almost everywhere priority. In particular, the needed water volumes should be guaranteed via the accumulated water in Mejdurechye and even if necessary, Tuyamuyun reservoirs.

In the latter case, the fish farming gives the opportunity to use even limited water resources in the delta to produce enough quantity of table fish. The present potential productivity of fish ponds in fish-farms of Uzbekistan is equal to about 3000 kg/ha in opposite to 5-10 kg/ha in water bodies. This means that only Muynak fish farm with his about 500 ha fish fattening ponds can afford at least production of 1.500 t of table fish. Compairing this with the 552 t of harvested in 2001 fish from the 26 water bodies of Karakalpakstan with the area of about 200.000 ha it warrants easily a decision for industrial fish farming. The intensification of aquaculture in the Nukus fish farm will give the possibility to produce not less than 3000 t of valuable fish. The produced fish may be used to supply the Muynak canning factory with the necessary raw fish. There are also other possibilities to develop small fish farms along the irrigation canals and drainage water collectors. All above stated will allow us to formulate a modern motto for the fisheries development in Southern Aral Sea Region as following:

„From unpredictable fishery in unstable water bodies to industrial fish farming which gives constant fish yields and jobs for the local population“. This idea should be largely distributed among the population and fish managers.

Proposal for future actions and research

As we have explained, exists a great potential for the development of aquaculture and fish production in the Amudarjev Delta region. With the demands of irrigation agriculture in the same region, the unpredictable use of agrochemicals and the socioeconomic and ecological demands of the region, is it essential that all parameters for and components of production developments require simultaneously careful assessment. The region will in the future only become selfcontaining if its development will occur within the context of the economic development of entire Usbekistan. Pilot projects with obiviously positive effects should be undertaken immediately. Relevant research projects should be continued as well.

But in order to achieve the best combination of land use, ecology, industrial development and optimal socioeconomic conditions it appears essential to construct a decision support system similar to the one constructed for the reduction of nitrate pollution in the county of Vechta, north of Osnabrueck which had gone out of control under the extreme development of battery farming in that region (see Arbeitsgruppe Systemforschung, University of Osnabrueck 1991). A similar model type can help to solve the present accumulation of problems in Karakalpakstan. The presently conducted spotlight type of admittedly important research projects must be incorporated into a model structure containing all important parameters for regional development. This will allow computer simulations for various development and management options within a regional and republican context. We hope to obtain funding for such a research project in the future in order to make the best possible use of our present research results.

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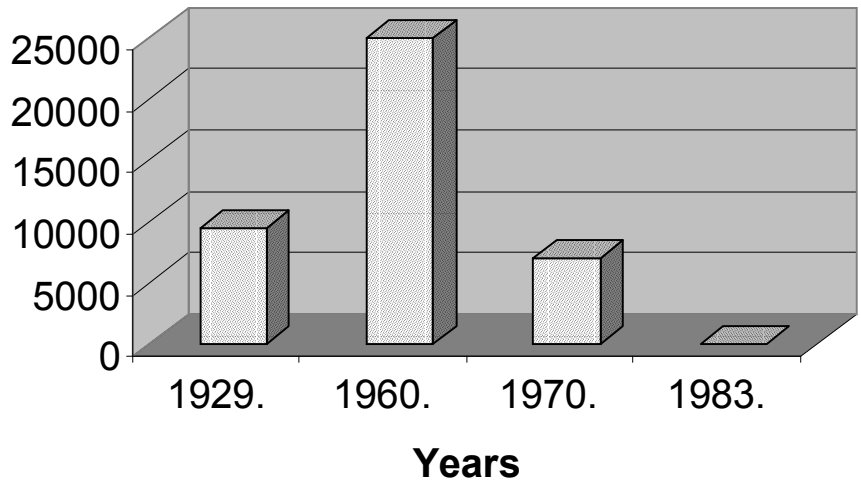
Fig.1. Fish catch in the southern Aral Sea, thousand tons



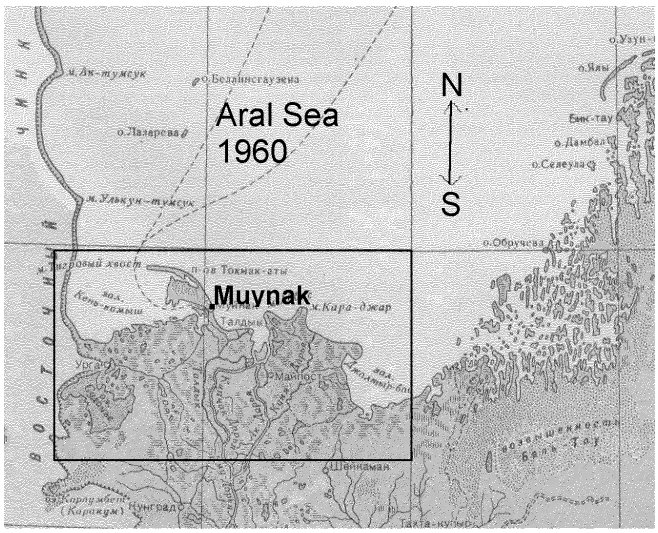


Fig.2. Southern Aral Sea Region in 1960s
(source: The big Soviet Encyclopaedia, Moscow, 1950, v.2, p.610)

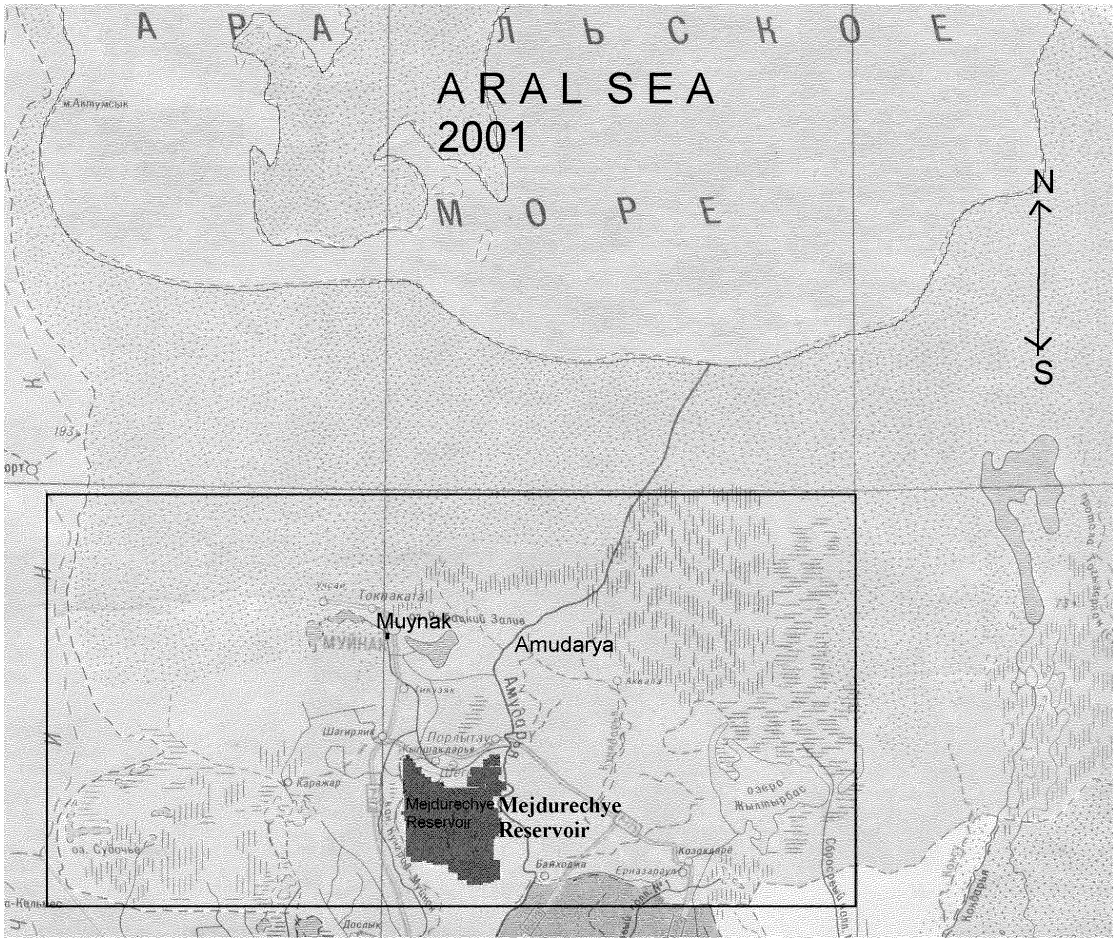


Fig.3. Southern Aral Sea Region in 2001 (source: Map of "Uzgeodezkadastr", 2001 with modifications)

Fig.4. Water mineralization in main water bodies of Amudarya delta during last years

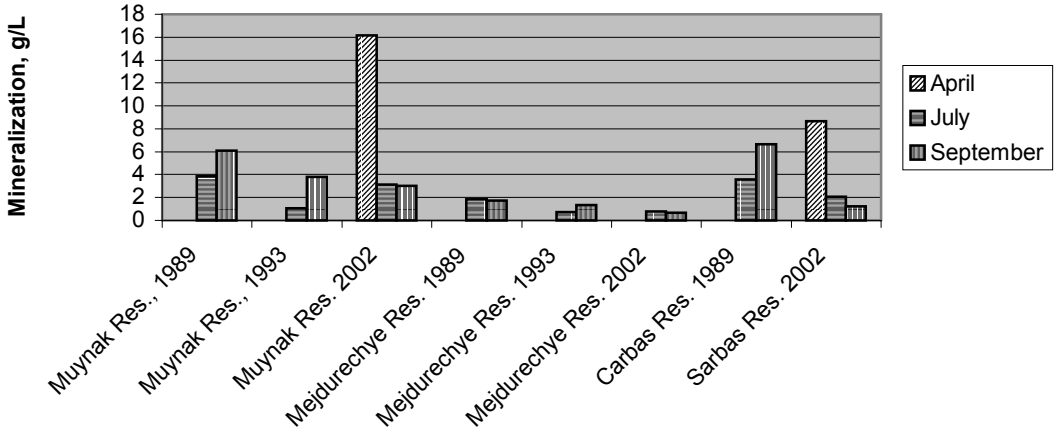


Fig.5. The dynamics of HCH concentrations in the water of Amudarya delta water bodies in 1989.1993 (Karimov, 1995) and 2002

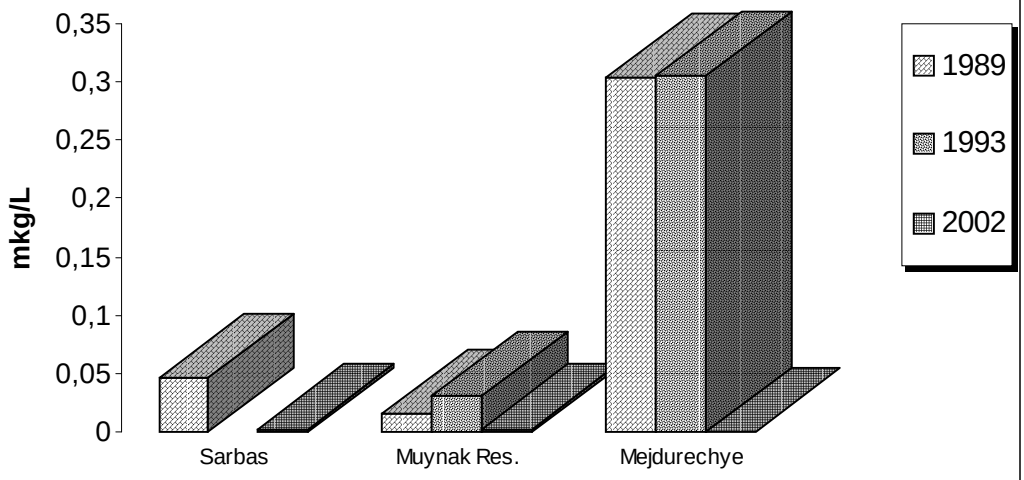


Fig.6. The dynamics of DDT concentrations in water of Amudarya delta water bodies in 1989. 1993 (Karimov.1995) and 2002

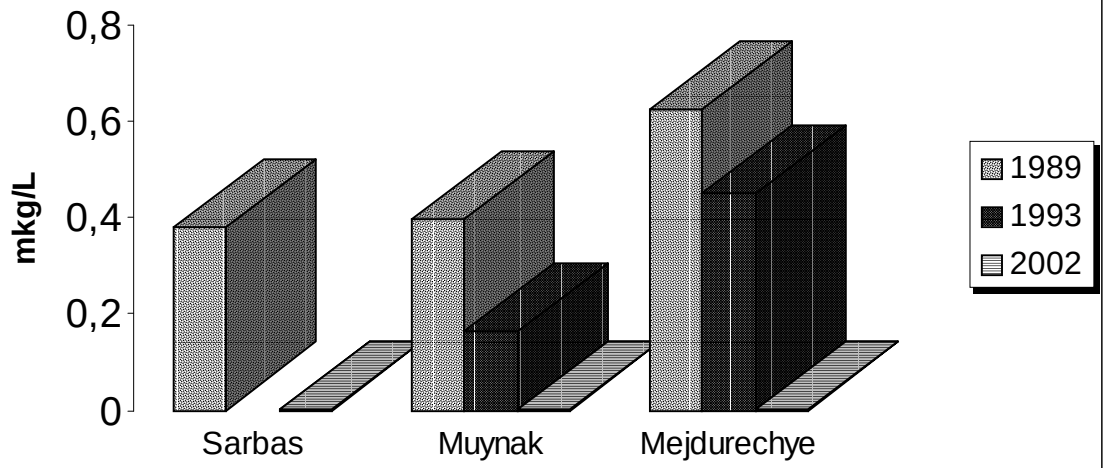


Fig.7. Mean values of pesticide concentrations in bottom sediments of Amudarya delta water bodies in 1989, 1993 (Karimov, 1995) and 2002

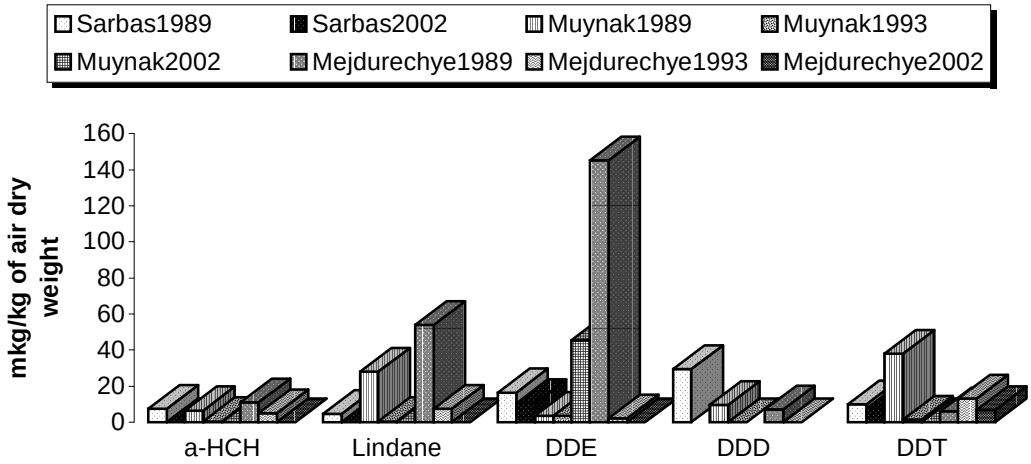


Fig.8. Average annual concentrations of some chlororganic pesticides in muscles of crucian carp (Carassius auratus gibelio) in 1989 (n=3, Karimov, 1995) and 2002 (n=2) in Muynak reservoir

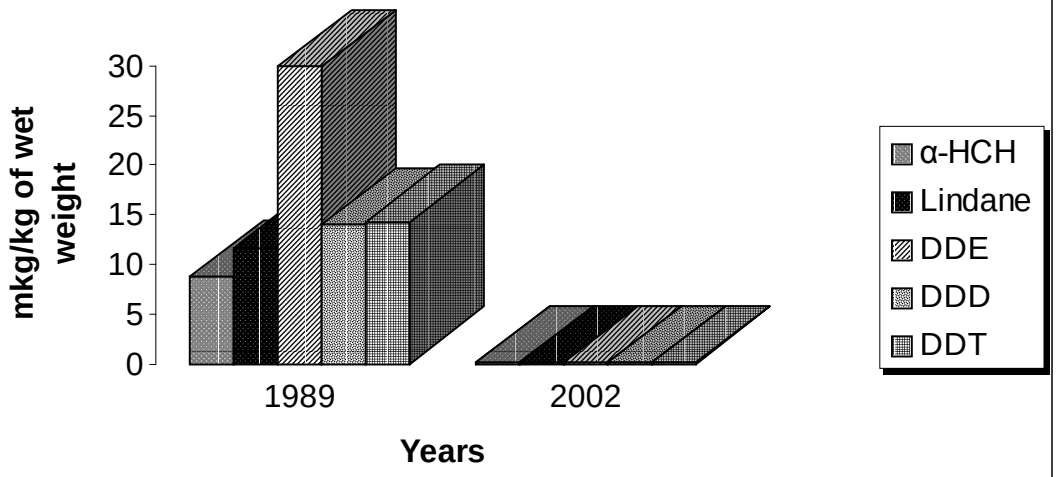


Fig.9. Mean concentrations of some chlororganic pesticides in muscles of Eastern bream (Abramis brama orientalis Berg) from Mejdurechye Reservoir in 1989 (n=2, Karimov, 1995) and 2002 (n=3)

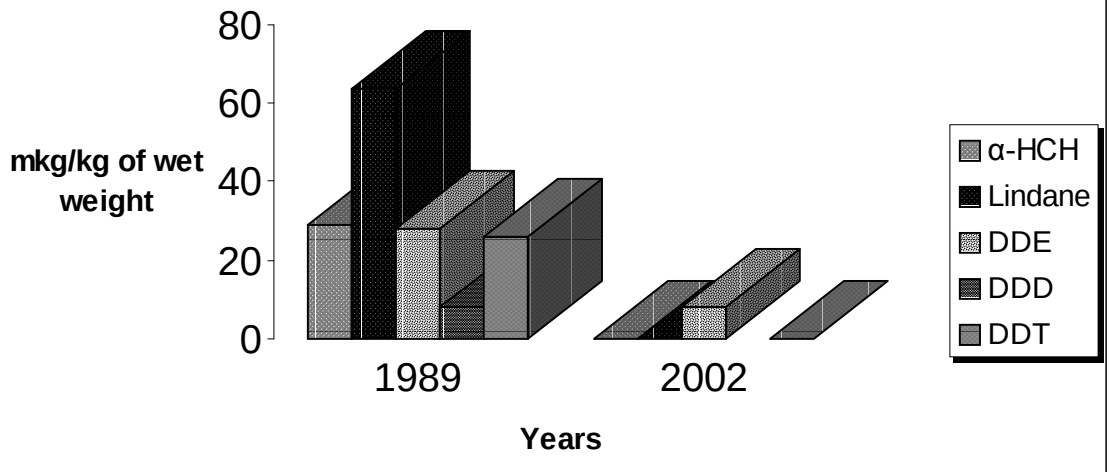


Fig.10. Mean concentrations of some chlororganic pesticides in muscles of carp (Cyprinus carpio L.) from Mejdurechye Reservoir in 1989 (n=2, Karimov, 1995) and 2002 (n=2)

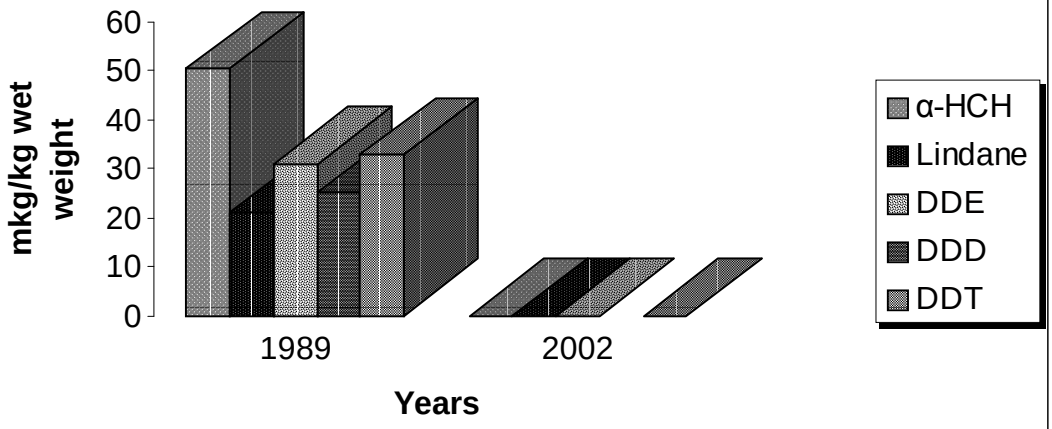


Fig.11 . Mean productivity of fish ponds in different fish-farms of Uzbekistan in 1991-1995, kg/ha