DRAFT REPORT

THE FISHERIES SECTOR OF THE ARAL SEA: DESK REVIEW

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Contents

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EXECUTIVE SUMMARY

The Aral Sea was once the fourth-largest lake in the world with a thriving fishing industry. The expansion of irrigated agriculture, hydroelectric schemes and general demand for water drastically reduced water inflow and increased salinity. Causing a collapse of the fishing industry, devastating the livelihoods of local communities, and the fragmentation of the sea into the still productive North Aral Sea (NAS) in Kazakhstan and the hypersaline South Aral Sea, primarily in Uzbekistan.

Drawing on mainly recent secondary sources of information, the report provides an understanding of the decline and degradation of the Aral Sea and the current situation, with an eye on the future. The report lays a foundation for primary data collection including a value chain analysis and stakeholder mapping. The report not only highlights micro level issues related to the current NAS fishery value chain and aquaculture but also macro level needs related to regional water management and climate change. Recommendations to support future sustainable development initiatives focus on the North Aral Sea fishery, aquaculture and water management.

Key issues include the need to increase fish production or the availability of fish to consumers to just maintain current levels of per capita consumption. Securing the water supply to the NAS is key to ensuring its sustainability and development. Solutions exist and are proposed but complex regional, national, environmental, political and economic factors and processes are at play. Notably climate change which is predicted to impact negatively water availability as well as weather patterns and agriculture. As well as regional coordination over water management.

Implementation of the KAZAKHSTAN: North Aral Sea Development and Revitalization Project will likely boost fish production and trigger various important sustainable development initiatives. This may provide an opportune moment to revisit fisheries management considering different approaches. Precluding this would be efforts to update data on the sector, although this could be undertaken as part of a value chain analysis and stakeholder mapping process.

INTRODUCTION

The Aral Sea was once the fourth-largest lake in the world with a thriving fishing industry. The expansion of irrigated agriculture, hydroelectric schemes and general demand for water drastically reduced water inflow and increased salinity. Causing a collapse of the fishing industry, devastating the livelihoods of local communities, and the fragmentation of the sea into the still productive North Aral Sea (NAS) in Kazakhstan and the hypersaline South Aral Sea, primarily in Uzbekistan. See Figure 1. The Aral Sea example, although extreme and complex, is an example of a natural disaster that may provide lessons for other inland water systems that experience fluctuations in water level and biodiversity.

Drawing on mainly, secondary sources of information, this report, phase 1 in a regional World Bank project development process, provides a “stocktake” and understanding of the decline and degradation of the Aral Sea and the consequences of this event. It describes the NAS fishery and its value chain as well as aquaculture in the context of Uzbekistan, the development of which was spurred on by the Aral Sea decline, and the development of which may provide guidance as to how aquaculture in Kazakhstan maybe similarly supported. The report introduces key stakeholders involved at regional and national levels and makes reference to stakeholder mapping and value chain analysis which includes a gap analysis as being important next activities to include in World Bank phase 2. It is anticipated that this report will inform future primary data collection as well as the development of an upgrading strategy and/or the identification of interventions. Numerous recommendations associated with the sustainable development of the NAS, aquaculture and general water access issues are also provided based on secondary sources.

Figure 1 Regional map showing current Aral Sea area

METHODOLOGY

The main source of data and information presented in the report are secondary sources: reports, scientific papers and a book. A number of secondary sources were identified, however, only those from the last 10 years (2014-2024) were consulted. This was because it appeared that historical data and consistent statements are repeated and appear in these more recent references and as the objective is to consolidate the current understanding and development opportunities, the more recent references are seen as the priority. Some references have been translated from Russian into English using Google translate. Annex 1 summarises the key references that have been consulted for this study. The original intention was to also engage with key stakeholders to build on the information gleaned from literature. Whilst efforts were made, this was not possible to the extent envisaged and is recommended to be done as a key component of a next phase, which would include stakeholder mapping and value chain analysis. However, one key informant that provided useful information was Zhannat Makhambetova, formerly of the Kazakhstan fisheries NGO, Aral Tengizi. She was interviewed online.

ARAL SEA FISHERY BACKGROUND

The environmental and socioeconomic rises and fall of the Aral Sea fishery (once the fourth largest freshwater lake in the world) have been well documented. Due to man-made environmental consequences the sea is now fragmented and much reduced with a productive small North Aral Sea (NAS) concentrated in Kazakhstan and an unproductive South Aral Sea (SAS) area in Uzbekistan. In its heyday, during the early to mid 20th century the Aral Sea fishery, which spanned both Kazakhstan and Uzbekistan, was producing an estimated 40 to 70,000 tonnes of fish per annum. After its dramatic decline due to the diversion of the Amu-Darya (feeding the south of the sea) and Syr-Darya river (feeding the north of the sea), which supplied water to the sea, for irrigation and hydroelectric schemes, the sea shrank and the water became extremely saline causing an environmental disaster and fish production to plummet. Now, following efforts to dam the outflow of water from the NAS in Kazakhstan, water levels have risen, salinity levels have dropped and fish production returned to this much smaller water body, to an estimated and modest 7000 tonnes of fish per annum. Once famous for its ship sturgeon (*Acipenser nudiventris*) catches, the NAS fishery is now focussed on pikeperch/zander (*Sander*

lucioperca) and other freshwater fish species (pike, carp, asp, crucian carp, roach, sabrefish and bream). The fishery supplies domestic, regional and international markets. The SAS, part of which is in Uzbekistan, remains highly saline with no fish present. Aquaculture production has increased in Uzbekistan, partly driven by the decline of the Aral Sea fishery.

There are numerous political, social and environmental happenings associated with the history of the Aral Sea and its fishery. Table 1 provides a timeline of some of the key events. This is followed by an overview of the Aral Sea's decline and partial rejuvenation.

Table 1 Aral Sea timeline of key historical events

Date	**Event**
Neogene period (23 to 2.6 mill years ago)	Aral depression forms in central Asia
10,000 to 20,000 BC	Amu Darya river changes course and Aral depression starts to fill with water and Aral Sea (sea of islands) is formed.
1000 BC	Advent of irrigation in region
Early 1400s	Aral sea dries up (not clear why but could be related to: climate, earthquakes, irrigation, wartime destruction of dykes)
Up to 1570	Aral sea fills up and returns to original size
1700s	Displaced Kazakhs arrive at the northern shores of the lake
1800s	Russian incursion into the region and settlement.
1860s	American civil war starves global market of cotton stimulates interest in cotton production by Russia in Central Asia.
1875	Tsarist authorities deported rebellious Ural Cossacks to the region. They brought new technologies for catching, smoking and curing fish, especially ship sturgeon.
Late 1800s	Kazakhs began to fish for the market, and fish were exported overland by caravan in winter to the railhead at Orenburg. Integration into imperial space, and thus value, depended on infrastructure that could overcome the perishability of fish, so Russian industrialists opened ice houses and plants for smoking and curing Aral fish, taking advantage of nearby salt deposits. Those Kazakhs who were dispossessed of livestock had little choice but to subscribe to this vision of fish as value, and were increasingly hired to fish for Cossacks.
1886	Access was regulated by permits; there was a banned zone around the Syr Dariya delta and bans on fishing during spawning season. Cossacks mediated the generation of environmental knowledge: science-backed regulation focused on sturgeon, the key fish of interest to the Cossacks, while Kazakhs and Karakalpaks were pushed into 'cognitive irrelevance'.
1905-6	Crucial moment in the fishery's development was the construction of the Orenburg–Tashkent railway. Aralsk established near rail station as port in sheltered Saryshyghanaq bay. The railway opened new markets, and catches rose rapidly. The railway also dramatically expanded the fishing population, facilitating widespread immigration from western parts of the empire, especially the Danube delta and the Sea of Azov.
1914	15,000 people were working in the industry, and 44,000–50,000 tonnes of fish were caught and exported from the region annually.
1925	Aral State Fishery Trust, Aralgosrybtrest, established to harness the natural wealth of the sea and emancipate local people. Aralgosrybtrest provided credit for cooperatives to create independent fishermen, albeit bound to the state by debt. These cooperatives also engaged in salting and cottage production of smoked fish.
1929	Completion of the Turksib railway meant Central Asia was provisioned with Siberian grain, allowing more irrigated land to be devoted to cotton.
1930	Catches were approaching their pre WW1 peak.
1930s	Arl'sk becomes an important fish processing centre and point of collection and distribution for processed fish. It is also an important port for the transport of cotton and grain.

Date	Event
	KazNIIRKh (established in 1928) as well as promoting increased production also regulated the fishery, introducing new rules to guarantee reproduction of stocks. Spatial and temporal bans were expanded to protect spawning grounds. Inputs were regulated, as were sizes of fish caught. Further management measures included amelioration works such as clearing spawning grounds, dredging channels to connect lakes and clearing reeds which choked water of oxygen.
1930s?	Stellate sturgeon introduced from the Caspian Sea, while failing to reproduce, brought with it a parasite which proved fatal to the local ship sturgeon, which died off in large numbers.
1939-45	World War 2 leads to collapse of fishery.
1954	Work begins on the construction of the Karakum Canal which spearheaded the development of irrigation for agriculture in the region using water from the Amu Darya River.
Late 1950s	Catches return to near peak levels. Fishery mechanised and refrigerated vessels introduced. Industry fraught with financial woes.
1960s	Aral sea is an important focus of economic production. Soviet plan initiated for water intensive cotton production in Uzbekistan desert and diversion of Amu Darya and Syr Darya rivers.
1965	In 1965 the Presidium of the Council of Ministers of the USSR made a resolution, 'About measures for the preservation of the fishery significance (rybokhoziaistvennogo znacheniia) of the Aral Sea.'35 An integrated plan (kompleksnaia skhema) was to be drawn up for the rational use of the water resources of the whole Aral basin, taking into account the interests of the fishery. However, the integrated plan was slow to materialise, and water withdrawals continued to grow.
1967	Lakeshore residents in the town of Tastubek, Kazakhstan, notice sea level dropping as water recedes.
By 1973	Some wetlands and deltas had vanished and turned into desert
By 1980	Rivers feeding the sea were running dry in summer months
1980s	Shoreline recedes at pace leaving communities long distances from the waters edge. Aralsk 150 km from sea edge. Uzbekistan becomes one of largest cotton producers in world.
1979-87	Salt tolerant flounder introduced
1987	Aral sea splits into two: North and South Aral sea and salinity of water increased leading to fish kills
1991	USSR collapse
1992	Total surface area of two seas reduces to 33,800 m2 (from 68,000km2)
1992	Aral Sea Basin Programme (ASBP) initiated
1996	Danish project providing fishing gear and development of flounder fishery. Demonstration fishing started in Tastubek. Cooperatives concept introduced.
1997	Basin countries approach UNESCO for advice
1998	Scientific Advisory Board on the Aral Sea Basin (SABAS) formed
1999-2000	Danes establish fish receiving stations. NGO Aral Tenizi, based in Aral'sk established.
Early 2000s	Kazakhstan present plan to save North Aral Sea to World Bank
2001	Syr Darya Control and Northern Aral Sea (SYNAS) project was eventually confirmed. funded by a $64.5 million World Bank loan, was designed by international consultants together with Kazgiprovodkhoz, once a prestigious arm of Minvodkhoz, but now a nonstate, underfunded cooperative. The aim was to stabilise the Small Aral at 42 m asl.
2002	South Aral sea splits into East and West
2000s	People leave area and those remaining suffer economic hardship. Salinity of water begins to drop and freshwater fish such as zander feature more in catches.
Early 2000s	With the help of Danish, processing plant in the former state bakery in Aral'sk. Kambala Balyk established to help fishermen process and market their catch, and to provide sustainable financing for Aral Tenizi. Fisheries Committee (the former ministry now subordinated to the Ministry of Agriculture) preparing a new legal framework for Kazakhstani fisheries.

Date	Event
	Problems with fisheries management noted. Most fishermen unregistered, and actual catches, up to four times higher than declared catches. A report presented to the Fisheries Committee in 2003, blamed the verticality of the system: quotas were allocated to small companies and sold on to individual brigades. expensive, fishermen would buy a quota for one tonne and then fish as much as they could. Efforts at enforcement only alienated fishermen further. Moreover, total quota sizes were arbitrary: research into stocks was only carried out on two lakes in the whole country. The report made recommendations for the new law about fisheries management, including piloting co-management on the soon-to-be-restored Aral. The Japanese Social Development Fund (JSDF) project responded directly to the report. Its centrepiece was to be co-management. Cooperatives would become co-management organisations, which would register legally and work with KazNIIRKh and inspectors. They would help decide how much could and should be caught. Fish would be bred in growing ponds, and village processing workshops would be developed.
2005	12 km Kokaral dam (dike) under ASBP completed by Kazakhstan with funds from World Bank to prevent water from leaving North Aral Sea to South Aral Sea. The fall in salinity levels accelerated, and freshwater fish – including carp, bream and zander, roach – migrated downstream from the Syr Dariya, rapidly re-establishing populations in the freshening sea. Not all indigenous species returned: shemaya and barbel remain very scarce, while ship sturgeon, on which the World Bank (2001) had premised the economic benefits of the project, remains absent, because its migration routes along the Syr Dariya are blocked by dams. Flounder negatively effected by low salinity levels.
Late 2000s	Owing to the SYNAS-1project's rapid success, the World Bank willing to fund a second phase, involving further restoration of delta lakes. World Bank mobilised a parallel $1.9 million grant from the JSDF. 'Community-based Aral Sea fisheries management and sustainable livelihoods' was drafted by foreign consultants in collaboration with Aral Tenizi and managed by the SYNAS team. The project involved infrastructural measures, including investments in roads and quays; radio communication for fishermen; an ambulance for one village; a water lorry for another village; medical supplies; and sleeping quarters near the sea. It also involved sub-grants for local businesses to diversify incomes. But the project's main goal was to create a sustainable fishery.
2008-2011	JSDF project implemented but seems to have failed to deliver and did not trial co-management.
2009	ASBP 3 begins
2010	Overall surface area had decreased by over 80%. East Aral sea 1/5th size it had been in 2002
2010	Fish species reintroduced into North Aral Sea by Kazak government
2010 onwards	Fishing increases in North Aral sea
2011	Kambala Balyk, processing plant, built to guarantee Aral Tenizis financial viability, went bankrupt
2014	East Aral Sea dries up
2018	Aralsk (Aral) 17km from North Aral sea (1980s it was 150 km away).
2021	16 species of fish in commercial catches (Ref 6)
2023	NAS fishery stabilised. Producing approximately 7000 tonnes of fish per annum (ref 1)

Sources:

Wheeler, William. Environment and Post-Soviet Transformation in Kazakhstan's Aral Sea Region: Sea changes (Economic Exposures in Asia) (p. 279). UCL Press.

Tairov M 2023 The Aral Sea and Fisheries – A Revival Strategy. Society. mysl.kazgazeta.kz/news/16011

Fact Spark video: https://www.youtube.com/watch?v=cGXdTEypnso

The Aral Sea: The Toxic Soviet Sea video: https://www.youtube.com/watch?v=xEIt4OojA3Y

Aral Sea fishery decline

Until the 1960s the water level of the Aral Sea was relatively stable (Ref 6). However, Central Asia's agricultural expansion and population growth resulted in increased diversion of water from the Aral Sea basin's rivers (Ref 9). The "Plan for the Transformation of the Aral Sea Basin" (Aral Plan) developed and implemented in the USSR from the 1960s to the 1980s led to accelerated rates of water diversion or discharge (withdrawal) from the Amu Darya and Syr Darya rivers, away from the Aral Sea, to expand irrigated areas in the cotton-growing regions of Uzbekistan, Tajikistan, Turkmenistan and, partially, Kazakhstan (Ref 1).

However, due to less water inflow and evaporation, in the mid-1960s the salinity of the Aral Sea increased from 10 g/l to 12–14 g/l. This affected the state of commercial fish populations - having a detrimental effect on the development of eggs, and increasing the mortality of fingerlings (Ref 6).

By the mid-1970s. the average salinity exceeded 14 g/l, and the reproduction of freshwater fish in the sea became impossible. Fishing declined greatly and in the early 1980s at salinities above 18 g/l, adult freshwater fish began to die and then disappeared. It is estimated that 20 of 24 native Aral Sea fish to revive fishing saltwater flounder were introduced , and flounder fishing began to develop. For the next two decades it remained the only fishery in the Aral Sea (Ref 6). As well as flounder there has been a number of well-intentioned species introductions aimed at boosting fish production which have altered the Aral Sea ecosystem. These are summarised in Box 1.

By 1988–1989 the sea level had dropped by 13 m (to +40 m) (Ref 6). The surface area of water had decreased from 67,499 km2 in 1960 to only 39,734 km2 in 1990 (Ref 10). This loss of water led to the division of the sea into two: the SAS and NAS (Ref 1)(Ref 9). The SAS eventually split into western and eastern sea basins, of which the eastern one remains dry in most years (Ref 9). At present, water flow into the SAS is intermittent and the waters are mostly hypersaline, without any fish (Ref 10). See Figures 3, 4 and 5. The SAS situation is complicated by the occasional presence of a channel, probably formed by erosion, that enables some exchange of water between eastern and western parts, creating conditions that are unpredictable. All remnants of the former SAS anoxic conditions in the deep layers, including the presence of H2S. Methane also has been detected and its release to the atmosphere surpasses levels of most other lakes (Ref 10).

The shrinking of the sea has also caused the local climate to become violent and unhealthy and seriously affect the economy, health and livelihood of the surrounding population (Ref 10). Pesticides, herbicides from agriculture and other types of pollution also present a looming problem. In the nearby Lake Sarygamysh, the fish are now so contaminated that they are unsuitable for human consumption. An increase in sulfates has been detected that may be the result of run off from the Syr Darya (Ref 10).

species disappeared between 1950-1980 (Ref 5). Fishing had ceased by the end of the 1980s. In an effort

Box 1 Species introductions

To compensate for the loss of native fish species, and in an effort to sustain the fishery and adapt to changing environmental conditions some non-native fish species were introduced:

Common carp (*Cyprinus carpio*) - known for its adaptability to various water conditions and is often farmed in aquaculture settings.

Pike-perch / zander (*Sander lucioperca*) - a predatory fish introduced to the Aral Sea to help control the populations of smaller fish species. Its introduction was intended to stabilize the ecosystem by balancing the fish population dynamics.

Silver Carp (*Hypophthalmi c h thy s mol i t r i x*) and Bighead Carp (*Hypophthalmichthys nobilis*) - introduced to address the decline of native fish and promote fishery. However, the introduction of these carp species can sometimes have unintended ecological consequences, as they are known for their rapid growth and potential competition with native species.

Grass carp (*Ctenopharyngodon idella*) - another herbivorous fish often used for weed control in aquatic ecosystems, as it feeds on aquatic plants. However, the introduction of grass carp can also impact native plant and animal communities (Ref 5)

Salt-tolerant fish species were intentionally or inadvertently introduced during the 1960s when hydropower and irrigation projects reduced the flow of fresh water thereby increasing salinity. These include the Baltic herring (Clupea harengus membras), big-scale sand smelt (Atherina boyeri caspia), black-striped pipefish (Syngnatus abaster caspius), Caucasian dwarf goby (Knipowitschia caucasica), monkey goby (Neogobius fluviatilis), round goby (N. melanostomus), Syrman goby (N. syrman), bighead goby (Ponticola kessleri), tubenose goby (Proterorchinus marmoratus), grass carp (Ctenopharyngodon idella), silver carp (Hypophtalmichthys molitrix), bighead carp (H. nobilis), black carp (Mylopharyngodon piceus), and northern snakehead (Channa argus warpachowski).

Amur snakehead (*Channa argus*) was unintentionally introduced into the Aral Sea basin in early 1960-1963. This species is considered one of the most dangerous invaders.

The herring, sand smelt, and gobies were the first planktivorous fish in the lake, leading to a collapse of the lake's zooplankton population. This in turn caused a collapse of the herring and sand smelt population from which neither species has recovered. All introduced species aside from the carp, snakehead, and (possibly) pipefish survived the lake's shrinkage and salinity increase, and during this time the European flounder (Platichthys flesus) was introduced to revive fisheries. The extirpated species (aside from possibly the pipefish) returned to the North Aral Sea following its recovery. Herring, sand smelt, gobies and flounder persisted in the South Aral Sea until increasing salinity extirpated all but the gobies (Wikipedia https://en.wikipedia.org/wiki/Aral_Sea?variant=zh-cn)

Other species introductions include various failed attempts to introduce sturgeon species. These are described in Ref 6.

Sources:

Alieva D, Usmonova G, Shadmanov S and Aktamov S (2023) Fishery culture,sustainable resources usage an transformations needed for local community development: the case of Aral Sea. Front. Mar. Sci. 10:1285618 (Ref 5).

FISHES OF THE MODERN ARAL SEA © 2024 A.O. Smurov (AuthorID: 93107), I.S. Plotnikov (spin: 1581-5135) (ref 6).

https://en.wikipedia.org/wiki/Aral_Sea?variant=zh-cn

Despite the general Aral Sea degradation water from the Syr Darya has been sufficient to maintain the lowered level of the NAS. In 1992, the flow of water from the NAS was blocked by a dam and in 2005 by the permanent World Bank funded Kokaral dam was completed. See Figures 3, 4 and 5. As a result of the dam the level of the NAS increased, and the water began to desalinate which allowed some

species of freshwater fish living in the river to return to the NAS (Ref 6). These included carp, pike perch, roach, bream species of fish (Ref 1). Up until now the restored NAS has remained relatively stable, with conditions resembling the original brackish water lake (Ref 10). It is generally recognized that the creation of a full-fledged Kokaral dam with locks, as well as the regulation of the river flow of the Syr Darya, has significantly stabilized the environmental situation in the NAS and stopped further degradation of the entire region (Ref 1).

Figure 2 Map showing North Aral Sea (also known as the Small Aral sea) circa 2014 (Ref 2)

Figure 3 Aral Sea changes over time

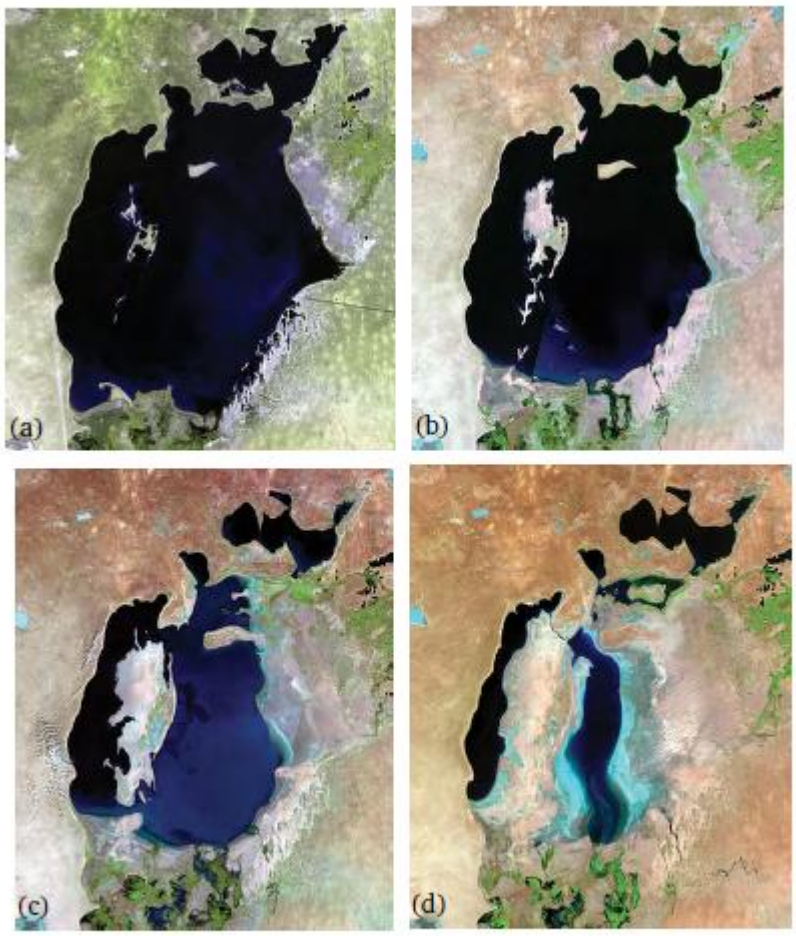


Figure 0.1 The Aral Sea from space: (a) 1977, (b) 1987, (c) 1998, (d) 2010. Source: US Geological Survey, https://eros.usgs.gov/image-gallery/earthshot/aral-sea-kazakhstan-and-uzbekistan#earthshot-stories, accessed 18 May 2021.

Maps ref: Wheeler, William. Environment and Post-Soviet Transformation in Kazakhstan's Aral Sea Region: Sea changes (Economic Exposures in Asia) (p. 404). UCL Press. Kindle Edition.

Figure 4 Aral Sea regression

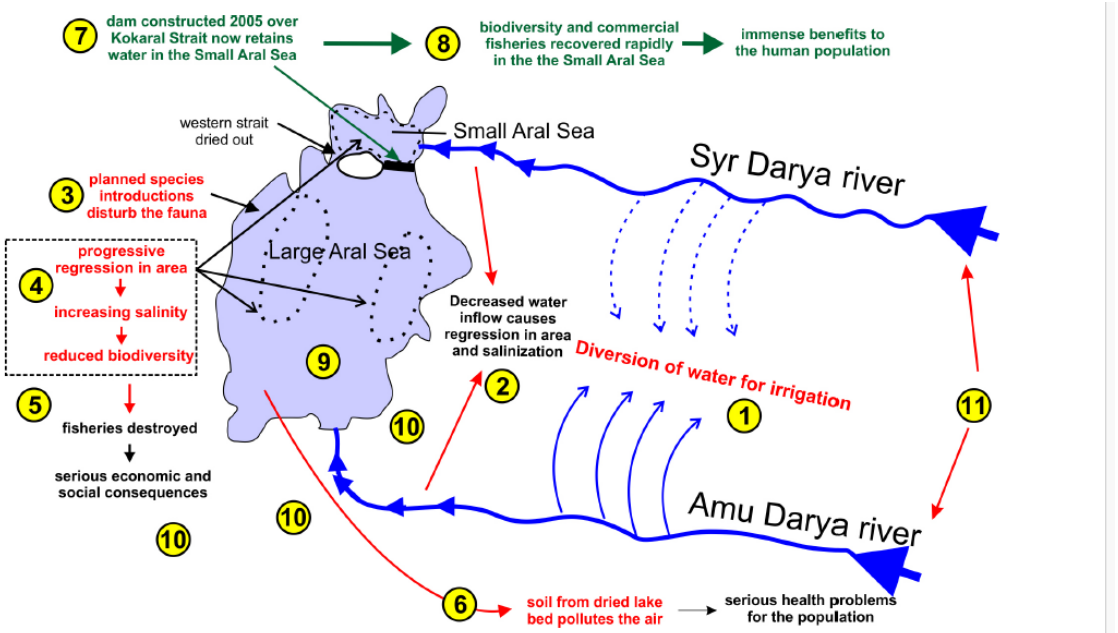


Fig. 12. Causes and effects in the Aral Sea crisis. Hatched outlines show the extension of the sea after the regression had split it into two main bodies in the south and the Small Aral Sea in the north. (1) Diversion of water for irrigation resulted in (2) disastrously reduced inflow to the sea from ca.1960 onwards (3) Almost simultaneously planned species introductions seriously disturbed the native fauna (4) The reduced water inflow caused area regression, increased salinity and therefore serious reduction in biodiversity (5) Almost all fish disappeared with serious economic consequences for the human population (6) Sediment form the dried out sea bottom was blown into the air, causing very serious health problems for the human population (7) At the height of the area regression in 1990, the northern Small Aral Sea was connected to the vanishing Large Aral only through eastern Berg Strait, since the western Auzy-Kokaral Strait had dried out; a dam constructed in 2005 across the Berg Strait now retains inflowing water from the Syr Darya (8) Water level in the Small Aral Sea rapidly increased and salinity decreased; the fauna was reconstituted from refugial populations and fisheries recovered, where it again became an important commercial asset. (9) The larger part of the original Aral Sea continues to degrade into hypersaline water bodies and dried out salt flats with little or no metazoan life (10) The surrounding arid steppe now suffers from more extreme weather oscillations, since Aral waters no longer act as a buffer to temperature (11) In the future, climate caused, decreased precipitation at the sources of the two rivers will add to the shortage of water.

Map: Ref 10

Environmental and socio-economic consequences, vulnerabilities and associated adaptation capacity in relation to the Aral Sea decline

This section introduces socio-economic, environmental and political issues associated with the depletion and degradation of the Aral Sea. A depletion which has significantly affected the climate, agriculture, and biodiversity of the region, exacerbating water scarcity and socio-economic challenges for countries like Kazakhstan, Uzbekistan, and Turkmenistan (Ref 11). Key issues going forward include: climate change, melting glaciers, negative impacts of the dried sea bed, increasing usage of water resources and deteriorating water quality, degrading land resources and increasing desertification, population growth as well as insufficient food and energy security (Ref 4).

Food security and livelihoods

Historically Aral Sea, had a potential to cover the essential nutritional fish needs of the population in Central Asia region. Fishing and consumption of fish and seafood were part of the culture of the population living around the sea region. In Uzbekistan, where the main source of fish was the Aral Sea and its deltas, the consumption of fish and fish products per capita decreased almost ten times, from 4.5-5 kg/year in late 1980s to 0.4kg/year in 2000s. Although aquaculture growth has increased per capita consumption to approximately 2.8 kg/ year in recent years, but still it is lower than World, Asian and landlocked developing countries' averages (Ref 5).

The collapse of the fishery in the Aral Sea has had significant economic impacts on the communities and regions that once relied on it for livelihoods. No accurate value is given to the total economic consequences of Aral Sea, but some reports in the former USSR show estimates of 1.5 to 2 billion rubles as the annual losses in 1985 (estimated at USD 3 – 4 billion in 2024). The decline of fish populations led

to the loss of jobs for those engaged in fishing, processing, and related industries. This loss of employment and income affected both local communities and the wider regional economy. A reported 60 000 workers explicitly or implicitly employed in Aral Sea fishery had to leave their jobs in 1950s and more than 40 000 had to leave the northeast regions of Aral in search for jobs. The collapse also affected businesses that provided equipment, transportation, and other services to the industry (Ref 5) (Ref 1)..The collapse of the industry disrupted traditional ways of life and eroded cultural identity, as generations of knowledge and skills related to fishing were no longer relevant (Ref 5).

Importance of water

Embracing an integrated water management approach that accounts for the requirements of all stakeholders, including upstream and downstream nations, is critical. Prioritizing sustainable water utilization, ecosystem conservation, and climate resilience is paramount (Ref 11).

Many aspects of socio-economic development across Central Asian countries are determined by the availability of water resources (Ref 4). Large-scale development of irrigation and other uses of water, (hydropower), created serious socio-ecological problems: the drying up of the Aral Sea and destruction of its ecosystem; desertification of vast areas around the Sea, deterioration of water quality and impact on public health; local climate change, etc. Yet, water resource use in Central Asia is set to increase substantially due to demographic factors, industrial and agricultural development, mainly irrigation (Ref 4). Countries such as Kazakhstan and Uzbekistan, in the middle and lower reaches of transboundary rivers will face depletion of available water resources and increased water scarcity as water quality, including groundwater degrades. This will primarily affect the population's access to quality drinking water (Ref 4). Water scarcity can contribute to conflicts and tensions within communities over access to limited water resources. Competition for water can strain social relationships, exacerbate inequalities, and create additional stress on already vulnerable populations (Ref 11). Thus far, Central Asian nations have successfully averted overt water related wars; but, there exists a potential for the issue to escalate beyond manageable proportions in the coming years (Ref 5).

Water must be viewed from a regional as well as national perspective. Box 2 provides an overview of regional water management issues. The Syr Darya basin has complex water trade offs: the energy-poor yet water-rich upstream countries are keen to use water for hydropower production in the winter, while the downstream states consumptively use water during the summer irrigation season. About 22 million people in the region depend on irrigated agriculture for their livelihoods, and 20 to 40 percent of the economic output of these countries is derived from agriculture, most of which is irrigated (Ref 9). See Box 2 for more information.

Kazakhstan's Ministry for water resources was established in late 2023 and has implemented measures to encourage more rational use of resources within the country, including bringing "irrigation systems and hydraulic structures into compliance with the standards," and facilitating the "automation and digitalization of water supply processes. " To see in real time where and how water is being used and also working on developing a system to use groundwater more efficiently. As only use a small percentage of groundwater is currently being used. https://eurasianet.org/kazakhstan-prioritizing-water-management-measures-in-2024

Crop area in the Aral Sea basin has actually decreased since 2000. But unfortunately much of the water diverted for irrigating the existing cultivated land is lost before being used. This is due both to evaporation from the irrigation canals, from poorly maintained systems in general, and by inadequate management of irrigation techniques. Integrated water management aimed at reducing evapotranspiration and unproductive water losses are crucial to future restoration projects in the area. The hotter summers caused by global warming and the disappearance of the Aral Sea entails less precipitation, leading to drier soils and an increasing demand for irrigation of agricultural fields. Furthermore, less water is coming to the two rivers from their sources due to shrinking snow cover and glacier size in the Tien Shan and Pamir mountains. The International Fund for Saving the Aral Sea reports that by 2050 the volume of river runoff in the Amu Darya and Syr Darya rivers will probably be reduced by

10–15% and 2–5%, respectively. Altogether, this means a future with less flow in the rivers, while the demand for water will increase. Predictions are that 5% more water will be needed in 2030, 7–10% in 2050 and 12–16% in 2080. These predictions raise the fear that even the inflow to the reconstituted Small Aral Sea could eventually suffer. According to the Agency of IFAS a full reconstitution of the Aral Sea would require an annual supply of 65 km3 of water. Since the demands for agriculture will necessarily continue or are likely to increase, this is clearly impossible. The best hope is for a better use of the available water such as reducing loss from seepage or evaporation in the supply canals and better administration of dosage at the individual plants. In addition, modern agricultural technology using more drought resistant crops is also an option (Ref 10).

Farmers depend on water for irrigation to cultivate crops, and limited access to this vital resource can result in reduced yields, crop failures, and livelihood insecurity. This situation often leads to food shortages, income losses, and increased dependency on external assistance (Ref 11). The situation is compounded by the inefficiency of irrigation systems and future demand for water.

Water scarcity also affects access to clean and safe drinking water. In rural communities facing contaminated or scarce water sources, residents may be forced to travel long distances to fetch water or resort to unsafe alternatives. This can lead to waterborne diseases and health complications,. Furthermore,women and children, who typically bear the responsibility for water collection, are particularly vulnerable (Ref 11).

The social and environmental consequences of the extreme use of the water resources of the Aral Sea have been ignored. Poorly treated or untreated municipal and industrial wastewater, and drainage water often containing heavy metal salts and other highly toxic ingredients, is discharged into the Amu Darya and Syr Darya rivers and their tributaries because of the lack of any environmental and sanitary restrictions (Ref 4).

At the national level, Kazakhstan’s long-term economic development, and its water, food and energy security, could depend to a great extent on how effectively it manages its water resources, especially under the increased pressures from climate variability, economic growth and population expansion. Economic losses related to water risks are estimated to amount to US$ 6-7 billion a year by 2030, while the cost of transition to a water resource efficient economy remains smaller at about US$ 0.5-1 billion a year. Continuing population growth is expected to significantly increase demand for water services by 2050, while climate change is expected to make Kazakhstan “drier” on average and to lead to a diminished overall water availability after 2050 (Ref 9).

There are already several water supply programs in Kazakhstan that aim to address water scarcity and improve access to clean and safe drinking water. Drinking Water, Ak Bulak, and Nurly Zhol, aim to enhance water infrastructure, promote sustainable water management practices, and improve water supply services for communities nationwide. Official statistics indicate that coverage has now reached 90-95% (Ref 11).

Box 2 Overview of regional water management issues

Before their independence, under overall integrated basin water management protocols, the energy-rich downstream countries (Uzbekistan, Turkmenistan, and Kazakhstan) traded winter gas against the upstream countries' (Kyrgyz Republic and Tajikistan) summer irrigation water, thus allowing both sides to satisfy their respective energy and irrigation needs.

After the countries gained their independence, water sharing and management in the Syr Darya basin became more contentious despite the emergence of regional water management frameworks. With the institutional breakdown of a unifying hand in river basin management, Kyrgyz Republic, the upstream state that controls Toktogul, the largest reservoir in the Syr Darya basin, opted for a hydropower regime, because of a lack of other energy resources. Kyrgyz Republic's hydropower is most required in winter, so large water volumes are released downstream during a season in which they are not needed for irrigation (a summer activity) and in which the reduced capacity of frozen watercourses greatly increases the severity of flood events. With climate change it may be that warmer winters will reduce upstream energy needs and hence average winter flows, but the risks of high rainfall/runoff and flash flood events may increase. Higher summer water demands everywhere may lead to disproportionately greater water stress in the downstream regions. Starting in 1992, the Central Asia Interstate Commission for Water Coordination (ICWC) developed a common but incomplete strategy for transboundary water management in the Aral Sea basin, determining water allocations and reservoir operations in the Amu Darya and Syr Darya basins. The International Fund for Saving the Aral Sea (IFAS) was established in 1993 and an interstate council was created to coordinate and manage financial resources and programs in the field of ecological and socioeconomic development in the Aral Sea region. Declarations on water sharing were signed in 1995 (Nukus) and in 1997 (Almaty). In the Ashgabat (Turkmenistan) declaration of April 1999, the five heads of states again expressed their concern on the quality of life in the Aral Sea region. They acknowledged the need for an integrated and joint regional strategy based on an ecosystem approach and integrated water management. IFAS continues to coordinate and manage financial resources and programs for ecological and socioeconomic development in the Aral Sea region, including within Kazakhstan through its IFAS Kazakhstan branch (IFAS-KZ) (Ref 9).

Water resource management and interstate cooperation on transboundary rivers is a top Kazakhstan governmental priority.

In early 2024 a resource-management framework agreement (2024-2030) was being negotiated to establish a system for joint management of river traffic and water flows between Uzbekistan and Kazakhstan, as well as fix volumes for water allocation for agricultural and other purposes by China and Kazakhstan.

Beyond working with Tashkent and Beijing on river management, Kazakhstan intends to use its chairmanship of the International Fund for Saving the Aral Sea (IFAS) to promote a sustainable system for sharing water resources. The organization is one of the few that brings together all five Central Asian states. It is one of the most important institutions for regional cooperation in the issues of transboundary water resources sharing, as well as solving environmental and socio-economic problems and the organization needs to play a more active role in regional water-management issues. A major aim is to encourage Kyrgyzstan's closer engagement with the organization. Authorities in Astana are also keeping a wary eye on Afghanistan, where the Taliban government is pressing ahead with the construction of a canal that could divert a significant amount of water from the already stressed Amu Darya River. The project, if completed as envisioned, could upset Central Asia's delicate water balance.

Sources:

International bank for reconstruction and development project appraisal document on a proposed loan in the amount of us$ 213 million to the republic of Kazakhstan for a north aral sea development and revitalization project. (Ref 9)

Past, Present and Future of the Aral Sea - A Review of its Fauna and Flora before and during the Regression Crisis Igor S. Plotnikov1 , Nikolai V. Aladin1 , Lubov V. Zhakova1, Jens Mossin2, and Jens T. Høeg3,* 1Zoological Institute, Russian Academy of Sciences, Universitetskaya nab. 1, St. Petersburg 199034 (Ref 10)

Desertification and health

The uncovered drylands largely comprise desertic, unpopulated sandy seabed areas that generate extensive dust and salt storms which negatively impact human health and agricultural lands. The population living around the sea suffers from acute health problems. Some of these are direct consequences of the sea's recession (e.g. respiratory and digestive afflictions, and cancer from inhalation and ingestion of blowing salt and dust and from poorer diets due to the loss of Aral Sea fish, a major food source). All of these challenges are further aggravated by an ageing infrastructure in the basin, whose management is also increasingly compromised by a declining capacity for monitoring of crucial environmental variables. In addition, the noted main relevant climate changes, particularly increased heat and aridity, will worsen the region's land and water environment situation and conditions (Ref 9).

Climate change

As can be seen climate change is associated with many the issues discussed above. The Aral Sea basin countries lying in the arid zone are most exposed to high risks and threats as a result of global and local climate change (Ref 4). The increasing unpredictability of climate will impede prosperous development with temperatures in the Aral Sea basin are projected to increase by 3-5°C by 2080 (Ref 9) The cumulative negative effects of climate change will increase competition for water among the countries in the region with long-lasting and significant implications for political, food, energy, sanitation, and environmental security in the region (Ref 4).

Climate change impacts in the region are aggravated by the dried-out Aral Sea which, having lost its role as a climate and geochemical runoff regulator, has turned into a source of aeolian salt transport to the surrounding area (Ref 4). Climate change or warming is also linked to:

- accelerated glacier melting and reduced snow cover (Ref 4). Melting glaciers and reduced snowpack in the Tien Shan and Pamir Mountains decrease the long-term availability of water for rivers like the Amu Darya and Syr Darya (Ref 11).
- higher evaporation rates, reducing water levels in rivers and lakes resulting in decreased soil moisture levels and reduced water availability for agricultural activities and ecosystems (Ref 11).
- rice cultivation (water-intensive irrigated crop sensitive to temperature fluctuations) (Ref 9).
- accelerated desertification
- land degradation and salinization
- loss of biodiversity
- increased deforestation
- increasing frequency of dangerous and extreme hydrometeorological phenomena (hail, drought, extremely high or low temperatures, heavy showers, mudflows, landslides, avalanches, floods, and droughts) (Ref 4).
- changes in precipitation patterns (Ref 11).

Box 3 highlights some of the issues associated the NAS area.

Box 3 Climate change issues

The project area is highly exposed to extreme temperature, drought and strong winds. River floods are mostly caused by ice jams and occur in spring in the Syr Darya river. The average annual wind speed is 3.2-4.9 m/s and hurricane wind speed can reach 28 m/s. Dust storms are observed in the warm season up to 64.1 days per year. Despite a downward trend in the wind speed from the 1970s, the number of dust days per year increased to up to 100 days in some years. The annual duration of steady heat waves is 45 days in the northern part of Kyzylorda region and is expected to increase by 7-8 days by 2050. In the southern part of Kyzylorda region, within the Kyzylkum desert, the duration of heat waves is expected to increase from 70 to 80 days per year by 2050. These extreme weather events will contribute to the already existing water stress. The challenge, therefore, is to address these increasing climate risks and enhance adaptive capacity and resilience in relation to climate change and other region-specific environmental vulnerabilities, especially those affecting the poorest sections of society (Ref 9).

Source:

International bank for reconstruction and development project appraisal document on a proposed loan in the amount of us$ 213 million to the republic of Kazakhstan for a north aral sea development and revitalization project. (Ref 9)

Given the ramifications of climate change on water availability, countries must integrate climate adaptation measures into their water governance strategies. This may involve the development of resilient infrastructure, diversification of water sources, and advocacy for water conservation practices (Ref 11).

Solutions suggested include new approaches to irrigation development and water management in the region, especially in the transboundary context. Practical adaptation measures must be put in place especially in large water-using and water-consuming sectors such as agriculture, hydropower, industry, and public utilities. In these sectors, step-by-step comprehensive reconstruction of water infrastructure is needed, with universal transition to water-saving technologies and waste-water reduction. In the agricultural sector, it is important to promote cultivation of more drought-resistant crop varieties on a larger scale, improve the technical level of engineering irrigation systems and equip them with automated means of water distribution and monitoring for condition of irrigated lands. In the industrial sector, low-water technologies and water recycling systems need to be implemented. In the public utilities sector, technical condition of water supply and sewerage systems should be improved while reducing their water losses, and new technologies for wastewater treatment should be adopted (Ref 4).

OVERVIEW OF FISHERY AND AQUACULTURE SECTORS

This report is based on secondary data and whilst it provides an insight Into the background and key aspects of the Aral Sea history and current status there are still gaps in the current understanding particularly in relation to the value chains. Hence there is an opportunity going forward to carry out a robust value chain analysis study as a precursor to formalising an upgrading strategy or plan.

This section forms the basis for a more rigorous analysis focussed on primary data collection. It relies on secondary data to describe the current situation regarding the NAS fishery and the situation in Uzbekistan which relates to aquaculture.

Table 2 provides a summary of key national fisheries statistics along with a general outlook in terms of 2030. It highlights the large deficits in terms of fish production, population growth and maintaining per capita fish consumption going forward. The emphasis is on increased aquaculture production in both countries to make up the shortfall in supply in both countries.

Table 2 Overview of national fisheries statistics

	Year	Capture fisheries (tonnes)	Aquaculture (tonnes)	Fish imports (tonnes)	Fish exports (tonnes)	Per capita consumption (kg/capita/yr)	Outlook 2030
Kazakhstan[1]	2017	31157	1563	43641	25175	4.78 (2013) 2.9 (2017)	Capture fisheries production declined from 36 620 tonnes in 2000 to 31 157 tonnes in 2017. The share of diadromous fishes declined from 8.9 percent to 0.8 percent. Given the 4.78kg baseline per capita fish & seafood consumption, 98696 tonnes of fish & seafood will be needed to satisfy the demand of Kazakhstan's 20.639 million population in 2030, which is 12237 tonnes higher than the 86459 tonnes of baseline fish & seafood demand. Kazakhstan's aquaculture production would need to grow **18.2percent** a year between 2017 and 2030 in order to generate enough fish supply to cover fish demand driven by population growth. If Kazakhstan would like to increase its per capita fish & seafood consumption in 2030 to10kg (i.e. half of the world average at the baseline), then the **shortage** would be 117087 tonnes. Kazakhstan's aquaculture production would need to grow **39.8 percent** a year between 2017 and 2030 inorder to generate enough fish supply to cover fish demand driven by population growth together with the increase in per capita fish consumption to half of the world average at the baseline (i.e.10kg).
	2019	45645	6933				
Uzbekistan[2]	2019	40000	81,717	9343	859	2.8	Given the 2.78 kg baseline per capita fish and seafood consumption, 104 180 tonnes of fish and seafood will be needed to satisfy the fish demand of Uzbekistan's 37.418 million total population in 2030, which is 12 353 tonnes higher than the 91 828 tonnes of baseline fish and seafood demand.

[1] Aquaculture growth potential in Kazakhstan WAPI factsheet to facilitate evidence-based policy-making and sector management in aquaculture March 2020 https://openknowledge.fao.org/server/api/core/bitstreams/ffd27880-deed-418f-95cd-620d45ce877a/content

[2] Aquaculture growth potential in Uzbekistan WAPI factsheet to facilitate evidence-based policy-making and sector management in aquaculture March 2022 https://openknowledge.fao.org/server/api/core/bitstreams/f7543a39-63df-4eda-bf72-0be27316191e/content

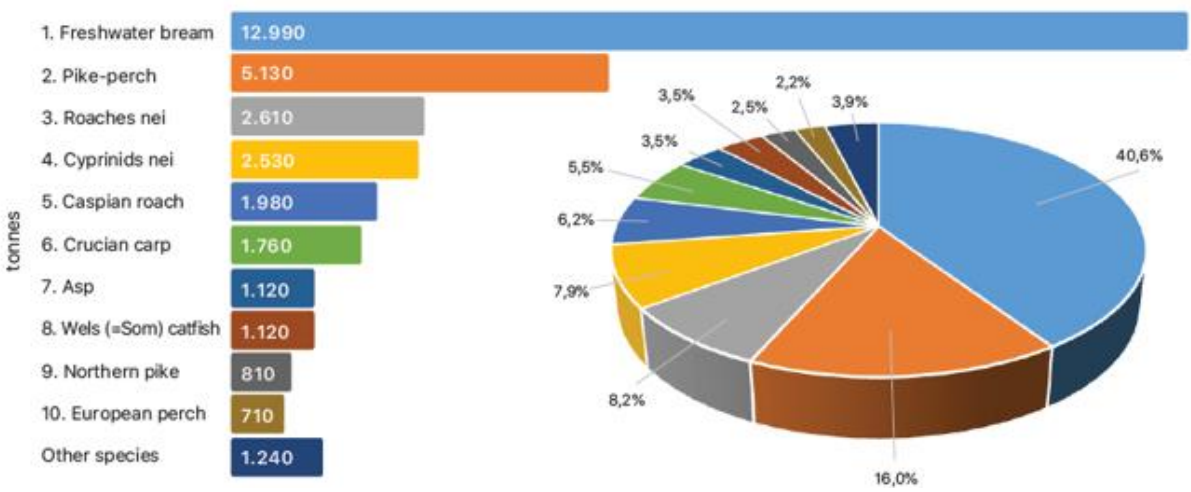
	Year	Capture fisheries (tonnes)	Aquaculture (tonnes)	Fish imports (tonnes)	Fish exports (tonnes)	Per capita consumption (kg/capita/yr)	Outlook 2030
							• If Uzbekistan would like to increase its 2030 per capita fish and seafood consumption to 20.26 kg (i.e. the baseline world average), then 666 162 tonnes of extra fish and seafood supply are needed to satisfy the extra demand generated by the population growth and the higher per capita consumption. • Uzbekistan's farmed fish and seafood production increased from 36 896 tonnes in 2015 to 81 717 tonnes in 2019. Following the linear trend during 2015-2019, farmed fish and seafood production in Uzbekistan would reach 194 961 tonnes in 2030, which is 113 244 tonnes higher than the baseline level. • The 113 244 tonnes of extra fish and seafood supply generated by the trend aquaculture growth would be sufficient to cover the 12 353 tonnes of extra fish and seafood demand driven by population growth only (with a surplus of 100 891 tonnes), yet it would be insufficient to cover the 666 162 tonnes of extra fish and seafood demand driven by population growth and the higher per capita consumption (with a shortage of 552 918 tonnes). • Uzbekistan's aquaculture production would need to grow 22.3 percent a year between 2019 and 2030 in order to generate enough extra supply to cover the 666 162 tonnes extra demand driven by both the population growth and the higher per capita consumption.

Kazakhstan is underperforming in fish production, producing only 0.0032% of the world's inland aquaculture while having 5.14% of the total surface area of inland water bodies. Kazakhstan's overall fish production has declined to about half of what it was under the USSR's subsidies structure. The main causes of decline in capture fisheries are: unregulated fishing, decline of government stocking programs, and reduction of flows in rivers due to diversion for irrigation and blockage for hydropower. Unused government hatchery infrastructure is available for stocking valuable fish species for income and conservation. There are abundant natural aquatic resources that could be more intensively managed for the benefit of local communities and gross domestic product (GDP). However, the cost of modifying infrastructure to recover lost fisheries and aquatic bio-diversity is said to be high compared to expected national returns on investment (Ref 7).

In 2018, Kazakhstan had a slightly positive trade balance for seafood. According to UN Comtrade statistics, the country exported 108 different types of fish and fishery products to 36 countries/territories in 2018, for a total value of $116 million. Europe was the largest market accounting for 85% of the total. The country imported 205 different types of fish and fishery products worth $96 million in 2018. Based on projected population growth and per capita income growth adjusted to the impact of the Coronavirus Disease 2019 (COVID-19), **domestic fish demand is expected to increase by 27% between 2018 and 2030.** Using the same approach**, export market growth is expected to increase by 13%.** The domestic and export market growth potential for carp is the largest (30,379 tons), followed by roach (6,422 tons) and perch/pike/pikeperch (6,267 tons). The relatively low export market growth potential reflects the lack of population growth and the relatively low income-driven growth in per capita demand in most export markets of fish and seafood products from Kazakhstan (Ref 7).

At the national level, Figure 1 shows the main commercial fish species of Kazakhstan and national production for 2018. Most of these species are also caught currently in the NAS.

Figure 5 Kazakhstan fish production by main fish species 2018



From: Ref 7

NAS fishery

This section provides a current understanding of the NAS fishery and associated value chain. Statistics show that fishing in the rejuvenated North Aral Sea in Kazakhstan has been developing steadily since the 2000s. By 2016, production reached 7500 tons per year. However, in recent years, the catch has stagnated, not exceeding about 7000 tons annually (Ref 9). This is thought to be due to the fishing quota being set at 7000 tonnes and the production capacity from the volume of water in the North

Aral Sea (Ref 1). In terms of the future, under a proposed revitalization project which would involve further dam building, production is anticipated to increase to 18,775 tonnes per annum (Ref 9). Anecdotal evidence suggest that NAS fish catches are low and unpredictable and the size of fish is reducing. A key issue though appears to be a lack of real data and information on many aspects of the fishery sector and why catches maybe declining. There is also no understanding of how many people are involved in the sector and the role of fish from outside the NAS in the NAS processing sector and value chain (Zhannat Makhambetova).

The current important commercial species of the NAS are: freshwater bream (*Abramis brama*), pike-perch / Zander (*Sander lucioperca*), northern pike (*Esox lucius*), Aral asp (*Aspius aspius*), roach (*Rutilus rutilus*), common carp (*Cyprinus carpio*), sabrefish (cyprinid sp) (*Pelecus cultratus*) and crucian carp (*Carasius auratus*). Other species occasionally captured are: silver carp (*Hypopthalmichthyxmolitrix*) rudd (*Scardinius erythropthalmus*), catfish (*Silurus glanis*), snakehead (*Channa argus*), shemaya (*Alburnus chalcoides*), ide (*Leuciscus idus*), perch (*Perca fluvatilis*), white-eyed bream (*Ballerus sapa*) and flounder (*Platichthys flesus*) (Ref 3).

Pike-perch/zander is a valuable fish mainly exported It is popular in Europe for its leanness and unpopular among Kazakhs for the same reason: fat and oil are rated highly in Kazakh diet. Fishing is seasonal. Catches tend to be frozen in containerised refrigeration units at the lake shore before being taken to processing factories. Many of which are in Aralsk. After processing the fish are distributed by road usually in refrigerated vehicles. Frozen zander fillets and salted dried roach (vobla) are exported. Other species are sold in the domestic or regional (CIS) market. Table 3 provides available data on species, product, price and market(Ref 2).

Key value chain actors in the NAS are:

- Fishers/fishing units or brigades
- Fish receivers/middlemen
- Processing factories (plant managers/owners)
- Processing labour
- End marketeers

A representation of the NAS value chain is provided in Figure 2.

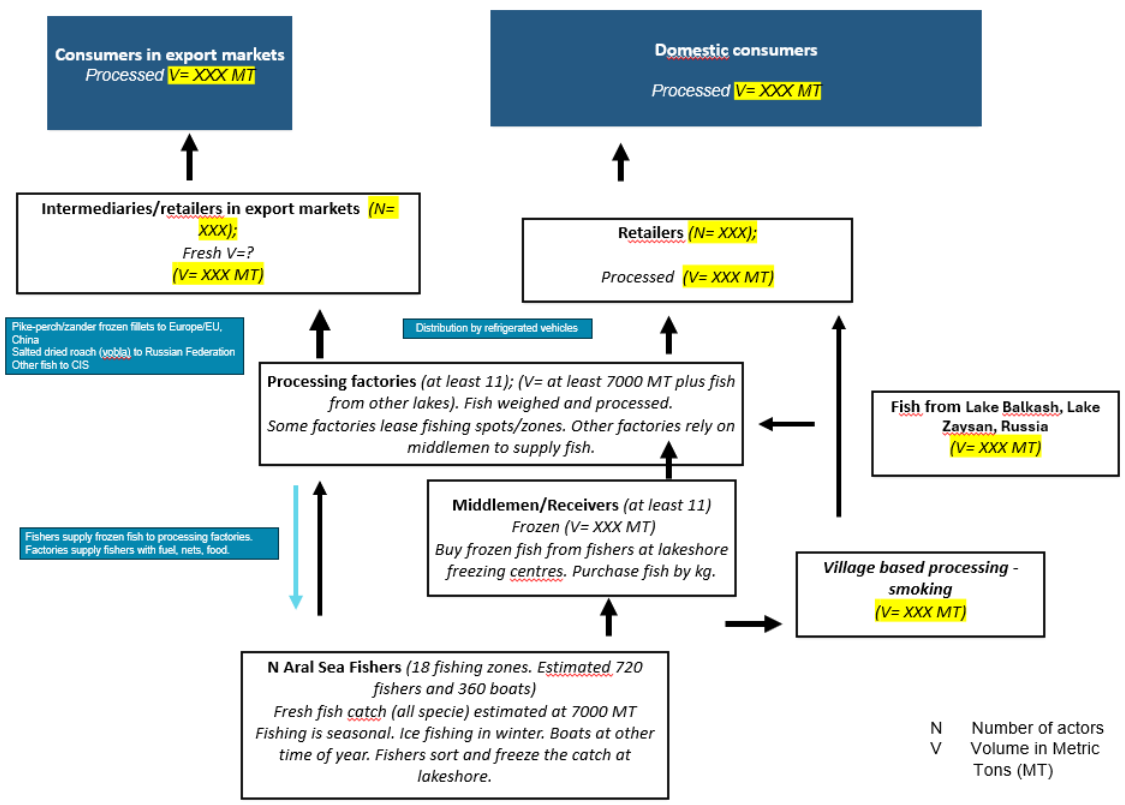
Table 3 Species, products and markets

Species	Price[3]	Product form(s)	Market
Freshwater bream (*Abramis brama*) – mass commercial species, dominates both net and non-aquatic catches.	NA	Frozen Smoked?	Domestic
Pike-perch / Zander (*Sander lucioperca*) - valuable commercial species	Zander 1200 T/kg price to middleman paid by factory Zander from Lake Balkash/Zaysan 1500 T /kg. Fishers 1st point of sale 1000 T / kg Zander fillet price paid by wholesale buyer in Europe Euro 7 – 12 /kg depending on quality and size of fillet	Frozen fillet	Europe/EU (e.g. Poland, Germany), China,
Northern pike (*Esox lucius*) - valuable species	NA	NA	NA
Aral asp (*Aspius aspius*) – valuable species	NA	Frozen	Domestic

[3] (Zhannat Makhambetova Makhambetova pers comm).

Roach (*Rutilus rutilus*) – dominant species in abundance	Roach 300/400 T/kg factory/middleman Dried & salted roach 350/370 Roubles / kg wholesale price in Russia	Dried & salted (vobla) Frozen	Russian Federation Domestic
Common Carp (*Cyprinus carpio*) is one of the most valuable fish species in inland water bodies of Kazakhstan	Carp 1st point of sale 700 T / kg Carp 700/800 T /g factory to middleman or price to fisher Carp retail price local market 1200 T /kg	Fresh/frozen	Domestic
Sabrefish (cyprinid sp) (*Pelecus cultratus*)	NA	NA	NA
Crucian carp (*Carasius auratus*) – significant share in the catches	NA	NA	NA

Figure 6 North Aral Sea value chain summary



Fishing

Fishing is seasonal and conducted by over 700 fishers using small boats and monofilament nets, except in winter when ice fishing is practiced.

There are estimated to be 10 active fishing villages/communities that are now (due to receded water level) located 20 to 30km from the sea (Zhannat Makhambetova Makhambetova pers comm).

The NAS is divided into 18 fishing "spots" or areas which are leased to five fish processing factories. A processor in Shymkent (about 800 kilometres away south east from the sea) has eight spots another factory in Aralsk has five spots another has three spots. The Shymkent processors brings his own fishers to the lake (Zhannat Makhambetova Makhambetova pers comm).

Each spot has a quota limit of fish which can be caught. Leaseholders are legally required to employ a brigade of up to 20 small outboard engine powered fibreglass fishing boats (2 fishers per boat) for each spot. The processor/leaseholder will usually provide the fishers with nets, fuel and food. The fishers who come from the nearby communities or are brought in from outside the region operate from lakeshore camps (Zhannat Makhambetova Makhambetova pers comm). Fishermen once employed different types of nets, hooks, and fishing methods to target different types of fish that have returned to the Aral Sea (ref 5). Monofilament gill nets from China are now commonly used.

The legal maximum number of boats is 360 and the maximum number of fishers permitted is 720. It is not clear how many fishers there are however (Zhannat Makhambetova Makhambetova pers comm). There appears to be a general lack of data on the number of fishers and other key stakeholders: fish receivers, processing factories. This may necessitate aframe survey, baseline research studies.

According to law, fishers are to receive a salary of 85,000 Tenge (USD 180) per month from the spot leaseholder. Fishers tend to be paid per kilogramme of fish caught (Zhannat Makhambetova Makhambetova pers comm). Fishing is considered more lucrative than many other local income generating activities (Ref 2). Nevertheless, fishing is seasonal and fishers often also engage in agriculture and or livestock keeping e.g. camels, cattle (Zhannat Makhambetova Makhambetova pers comm). From the information available, fishing is important but seasonal. It's not clear though who benefits most and least and how important fishing is in relation to livestock and crops.

Due to environmental/weather and fisheries management measures, NAS fishers are not able to fish all year round. There are winter, spring and autumn fishing seasons and in May or June/July, fishing is said to be banned for 46 days as it is spawning time. The peak fishing seasons are autumn (Sept to December). When ice has formed in winter there is ice fishing and the spring season is from March to May. For some weeks in spring and autumn, fishing is impossible while ice is melting or forming. In summer the temperatures are high and fish tend to be in deeper water. The high temperatures in summer were linked to fish spoilage, which restricted fishing activity then. Although cold chain technology is now used and may be enabling summer fishing. Fishing continues in August though mainly for carp to supply the local market. Fishers have other income streams from other work, agriculture, livestock e.g. camels, cattle (Zhannat Makhambetova Makhambetova pers comm).

Ice fishing: winter

Nets of 45–50 mm are preferred for catching zander, although monofilament nets are not particularly discriminating. The process of hauling nets in (au qarau, 'to look at the nets') is more straightforward than laying them. Two holes are made in the ice, heavy work by junior fishermen. The net is retrieved with a hook and attached to a piece of string, which pays out down the first hole as the net is hauled through from the second. Fishermen extract the fish from the net, trying not to tear the net (not easy with low-quality monofilament nets). Once all fish have been removed, the net is pulled back through from the first hole with the string (Ref 2).

Spring and autumn fishing

In spring and autumn fishers set their nets from boats in the evening and then haul in the morning. They then go ashore and extract the fish from the nets, put them in sacks and clean their nets. In the afternoon they take the catch to the receiving station either by vehicle (UAZ) or by boat, before going out to lay their nets again in the evening. Some of the catch is taken for household consumption (Ref 2).

Receiving/landing

Catches are brought to receiving stations or landing points. Each fishing spot has a receiving station. Receiving stations now have cold stores/freezers to freeze and store fish before they are taken to the factories. Previously the fish were not frozen. See Box 4 There are no ice plants in the region and ice is not used by fishers or during distribution. Ice plants are said to be difficult to manage.

And ice demand is seasonal, the volume of catch plus relative remoteness of fishing locations probably renders ice production unprofitable. Fishers who are in a processor's brigade may also sell to a middleman if the middleman is offering a better price. Or the middleman is present before the factory representative arrives at the receiving station (Zhannat Makhambetova Makhambetova pers comm).

Box 4 Fish receiving in 2012-14

Previously fish receivers (middlemen) were based at receiving station which consist of a set of weighing scales and a truck (Soviet-era ZiL). They can be busy all day receiving fish. It is not practical to check that every sack contains what fishermen claim it contains. Zander are generally obvious, their pointy heads tearing the sack and sticking out of the sides. But a sack of bream will almost certainly also contain some flounder and other non commercial varieties (Ref 2).

The fishermen unload the sacks of fish and pile them onto the scales. The receivers ask what is in each sack, but may not check. But fish which is damaged or of low quality or the wrong size maybe rejected or devalued. The receivers' capacity to exploit their position is limited by their need to maintain trust. While there are social pressures on the receivers, there are limits too on what fishermen can get away with. Informal rules, albeit backed up by the formal authority of the camouflage uniform, shape relations between receivers and fishermen. For example juvenile fish should not be caught or sold. Factories will not take zander under 400 g and zander under 38 cm should be put back (Ref 2).

Receivers pay fishermen, before being reimbursed at the factory. The sacks of fish are loaded onto the receivers lorry by the fishers. The cost is calculated, and deductions are made for fuel or nets purchased from the receiver. The money is handed over to a senior member of the fishing unit (not necessarily the owner of the UAZ) (Ref 2).

Source:

Wheeler W 2021 Environment and Post-Soviet Transformation in Kazakhstan's Aral Sea Region. UCL Press. London. (Ref 2)

Processing / freezing

The fish are in frozen form when delivered to the processing factory. There are now 11 processing factories at least, the number is said to have grown over the last 10 years. Three have leases for fishing spots and supplied by fishers at those spots. Those that don't have leases buy fish from middlemen. There are at least 11 middlemen or receivers (Zhannat Makhambetova Makhambetova pers comm). Most factories are in Aralsk. But there are also factories in Kazaly and Shymkent. The Shymkent processor also rents a facility in Aralsk. Some processors have quotas for the amount of fish that can be bought and processed, other factories do not have quotas.

Eight fish processing plants in the Aral region, have a processing capacity of up to 20,000 tons of fish per year. One of the largest fish processing plants in Aralsk has been exporting zander fillets to China, Poland, and Germany for the second year. Frozen vobla (roach), bream, and asp are sent to the domestic market and the Commonwealth of Independent states (CIS) countries (ref 3). Different processors now specialise in supplying certain products to certain markets: 5 factories are supply zander fillets to Europe. Other factories specialise in providing dried roach (vobla) to Russia. The quality of fish is said to be improving due to the standards required by the export markets.

The volume of zander from the Aral Sea is insufficient. So factories supplement with fish from elsewhere. There is a perception that fish is imported from other lakes and processed but sold as Aral fish (Zhannat Makhambetova Makhambetova pers comm). In 2024 catches are low so processors were buying fish from other lakes such as Lake Balkash, Lake Zaysan. These two lakes are closer to Shymkent. They also import fish from Russia to process (Zhannat Makhambetova Makhambetova pers comm).

Distribution

Most of fish is distributed from processing factories by road in refrigerated vehicles. There is now an electronic system for exports making the process of obtaining permission much easier for processors

and traders supplying international markets. It is said to be difficult to distribute fish without the relevant paperwork (Zhannat Makhambetova).

Retail marketing and consumption

Pike perch/zander, a predator with lean, white meat, is popular in filleted form in Europe, making it far more valuable to Aral fishermen than other fish (Ref 2). Carp is popular on the local market.

Fisheries management

Management of the NAS fishery is overseen by the Fisheries Inspectorate with spot leaseholders responsible for the implementation of certain management measures such as abiding by catch quotas, fishing gear mesh size specifications and restocking with fingerlings. Spot leaseholders have certain obligations: to attract local residents to their seasonal fishing teams (brigades), provide and maintain fishing equipment, pay the tax on biological resources, carry out reclamation and recreational (including stocking) work, pay for monitoring scientific research by third-party organizations. A natural consequence of this situation is that natural resource users are trying to get the maximum profit from fishing. In particular, by protecting "their fish plots" from poaching, by strengthening protection by private inspectors and attracting hired "shift workers" from other regions or even migrants from neighbouring countries to fishing (Ref 1).

In practice fishing effort is not restrained: everyone acknowledges that above-quota fishing is pervasive. For inspectors tasked with implementing management regulations and scientists, the problem is inadequate enforcement of the current system (Ref 2). See Box 5.

The local fishing population are basically hired workers. There is sense of "alienation" of the local population from the reservoir, which has become "someone else's property". This, in turn, encourages uncontrolled fishing by fishermen in order to maximize their profits. A natural consequence of this situation is the intensification of poaching and the formation of a "black market" of fish products, which, according to estimates, is already at least 50% in relation to the catch allowed - 7000 tons of fish per year. There is complete disregard for long-term planning for the conservation of the resources threatening the sustainability of the NAS(Ref 1). Box 5 provides a perspective on some of the management issues from 2014/15 highlighting what may be current problems.

Excess production capacity of fish factories owned by natural resource users (spot leaseholders) may be stimulating demand leading to overfishing. For example, only 9 factories have the capacity to process 20,000 tons of fish, with a permitted catch of about 7,000 tons from the entire NAS. . Intensive seasonal fishing may also be encouraging overfishing (Ref 1).

The current moratorium on tax audits of small enterprises in the Republic of Kazakhstan – and local fish factories belong to this category – creates additional difficulties in controlling fishing effort (Ref 1).

Box 5 Fisheries management issues

Inspectors agree that regulation is inadequate, but blame lack of funding. Aral Tengizzi (NGO) representatives conversely, advocate for co-management, and blame the fishery's hierarchical structure, which excludes fishermen from resource management. Were ordinary fishermen included, they argue, they would have an incentive to conserve the resource. cheap Chinese nets have made fishing too easy, resulting in a 'tragedy of the commons'. monofilament nets are illegal. Being cheap, they are readily discarded, left in the sea or on the shore. If fishermen cannot find them, it is not a major loss, and the nets get tangled on the seabed. Once stuck, they do not decompose. So abandoned nets go on catching fish. Because they are illegal, if unknown vehicles ever approach the shore, fishermen hastily throw all their nets into the boat and cast off; but otherwise there is no attempt to conceal their use. although their import is banned, they can be imported as nets for catching birds, and, while in Aral'sk they are sold covertly, in Qazaly they are sold openly in the market. Chinese nets, which can be laid by just two or three people, have led to a downsizing in fishing units. Moreover, the need for cooperation between households has also declined as rising incomes have enabled more households to acquire UAZ jeeps, facilitating access to the sea. In 'the time of flounder' (kambala kezïnde), most access to the sea was by camel, and people would camp in groups by the shore. This matched wider trends in early post-socialist Central Asia where the maintenance of wide social networks was a crucial survival strategy amid economic breakdown. Today households are becoming more self-sufficient and less dependent on networks of friends and relations. According to inspectors fish caught above quota is not reported at the factory level. With just 10 inspectors, equipped with three UAZ jeeps, one Niva and two boats, they stress the difficulties of regulating reporting. Keeping two sets of records, one by the shore and one at the factory for the inspectors, is routine (Ref 2).

Source:

Wheeler W 2021 Environment and Post-Soviet Transformation in Kazakhstan's Aral Sea Region. UCL Press. London. (Ref 2)

There appears scope to review and consider updating the current management regime and associated legislation. Consideration could be given to the development of an overall fisheries management plan in conjunction with all parties. At the same time strengthening the capacity of research stakeholders to be able to better understand the resource, value chain, production potential and plan for the fishery. This may involve twinning Kazakhstan institutions with international or regional/neighbouring institutes not only with regard to fisheries but also hydrological research to better understand water supply issues (author/Zhannat Makhambetova pers comm).

Aquaculture and Kazakhstan

Aquaculture is discussed as it could be associated with the future development of the NAS. Kazakhstan has adopted a strategy to increase fish production by boosting fish farming, setting ambitious targets for aquaculture development by 2030. Currently, aquaculture production represents 13% of Kazakhstan's total fish production. Most of the aquaculture production comes from extensive/pasture aquaculture that relies on natural productivity to grow hatchery-produced fry or fingerlings stocked into artificial and/or natural water bodies and harvested, either commercially or through fee-based recreational fishing (Ref 7). In Kazakhstan, although efforts have been made, aquaculture has not taken off as it has in Uzbekistan. In the Aral Sea region the weather is very harsh/extremes of hot and cold. Common carp maybe a species for culture for the local market. Collaboration between Kazakhstan and Uzbekistan in connection with aquaculture development is suggested as a way forward (Zhannat Makhambetova pers comm).

The following are some recommendations/observations taken from Ref 7.

At its current stage of development, it may be difficult for Kazakhstan to rapidly increase aquaculture production. Species with great market potential (for example, pikeperch) face technical constraints on production, while species with relatively mature farming technology (for example, carp, rainbow trout,

and sturgeon) are subject to limited domestic demand, competitive international markets, or both. A volume-oriented development strategy may not yield desirable outcomes due to a highly competitive global market (Ref 7).

Extensive/ pasture aquaculture can be turned into a marketing advantage by selling fish grown as wild fish (or naturally farmed fish) for premium prices, as many consumers are willing to pay for such 'wildness.' Under this strategy, the focus of farming is on creating and adopting an environment- and fish-friendly farming practices to produce high-quality fish and turn this into economic value through proper marketing strategies (Ref 7).

Developing and implementing of a strong regulatory framework for aquaculture development that prepares the industry for expansion and increased levels of scrutiny in markets. Such a framework would include carrying-capacity modelling, zoning, surveillance, and biosecurity. Ongoing consultation with stakeholders would also be needed to ensure clear messaging about the importance of sustainability as a prerequisite to accessing seafood markets of the future (Ref 7).

Aquaculture is highly innovative. Best practices are constantly evolving, including in Kazakhstan. Strong engagement with adaptive research, including hiring international experts to work with local scientists and industry operators, can rapidly bring Kazakhstan's fish farmers up to speed. Marketing information and support through awareness-raising could position the country's seafood as a high-quality, environment-friendly product for European as well as high-end domestic and Asian markets (Ref 7).

Aquaculture should develop in the context of sustainable watershed management. It can take many forms and can be conducted in a wide range of natural and artificial ecosystems, including cages in reservoirs or natural water bodies, raceways along river courses, and indoor 'fish plants' as well as traditional ponds. Stocking programs can support capture, recreational fishing, or both. Each ecosystem has a different carrying capacity that determines how much of each kind of aquaculture it can support. The government can use new and existing technologies and natural resource management science to support aquaculture mechanisms that encourage integration into sustainable landscapes (Ref 7).

Uzbekistan and aquaculture

This section summarises aspects of the aquaculture or fish farming value chain in Uzbekistan. Whilst this VC is not directly related to the Aral Sea, it is related to the decline of the Aral Sea and at the same time indicates what may be possible for fish farming in Kazakhstan, which is relatively under-developed.

Although total fish production (from landings and aquaculture) has increased from 59 000 tonnes in 2015 to 120 400 tonnes in 2019, an impressive average annual production growth rate of 20 percent,fish consumption in Uzbekistan is below the recommended level and the role of the fisheries sector in the overall general economy remains insignificant (in terms of contribution to GDP). The sector does however have a role as an important source of fish supply and seasonal food security for the population, in addition to meat products (livestock and poultry) and the industry is also an important source of employment and livelihood in the rural economy of some regions.

The fisheries sector of Uzbekistan is comprised of industrial and small and small-medium sized enterprises (SME) engaged in capture fisheries, fish farming (aquaculture) and the production of feed products, as well as a limited number of small enterprises and individuals engaged in the processing and marketing. The sector is supported by an un-quantified variety of upstream and downstream businesses by SME (and micro) businesses engaged in the repair of fishing gear, construction of packaging material and auxiliary services (material supply, sales, communications, construction, etc.). As of the 1 January 2020, according to data provided by NFA, there were 60 fish feed producers in the country with an annual production capacity of 385 200 tonnes (Ref 12).

In Uzbekistan, in order to compensate for the loss of fish landings from the Aral Sea, large-scale work was launched to build pond facilities for fish farming in the 1970 – 80s with more than 8 000 hectares (ha) of artificial pond areas built and the technology of extensive cultivation of carp fish in polyculture

mastered (Ref 12). Aquaculture was developed through various tax incentives and benefits in almost all regions of the country with significant success. At the start of the 1990s no more than 20 fish farms were operating in Uzbekistan, with 10 000 ha of feeding ponds and less than 2 000 ha of grow-out ponds. These farms focused exclusively on the extensive polyculture of carp in large-sized earthen ponds. Although the ponds met the biological and technical standards necessary to be productive, they were generally cumbersome to manage and had high input costs (water, compound feed, mineral fertilisers, etc.). Reforms initiated by the Council of Ministers within the fisheries sector between 2009 and 2016, with the construction of more, and smaller, ponds have resulted in more than a two-fold increase in pond production capacity (Ref 12).

Newly built ponds are generally small in area at 0.5 – 3.0 ha compared to ponds 10 – 100 ha in size built during the planned economy period. These small, intensively managed, farms use modern technology throughout the hatchery, nursery and grow-out stages to significantly increase productivity and thereby the economic returns. Farmers who grow in extensive systems produce 1.0 – 2.5 tonnes/ha (75-85 percent silver carp and 15-25 percent carp, grass carp and bighead carp), compared with production rates of +10 tonnes/ha for intensive systems (Ref 12).

Aquaculture has become the main source of fish with a production amount of more than 80,000 tonnes and making 67% of total fish catch Fish farming operations were set up to cultivate fish species that could thrive in the altered conditions of the Aral Sea ecosystem(Ref 5).There are currently three main types of fish farm in Uzbekistan:

- Fully integrated farms, with a hatchery (incubation units), nursery to produce stocking material (nursery), and grow-out fishponds (producing fish to market size).

- Nurseries, which produce stocking material only. These farms buy larvae from hatcheries, which are then grown to stocking size (10 – 50 gram dependent on the species) and sold to other farms for grow-out.

- Grow-out fish farms (using fingerlings purchased from nurseries).

Most of the fish that is farmed (or harvested from the wild) are sold in a live or fresh chilled form. The largest fish and fish products market in the country is located in the Chinaz district (*rayon*) of the Tashkent region. Sellers and buyers come from all over the country to sell and buy fish at this market and the supply/value chain can be briefly described in a number of ways as follows:

1. Fish are brought to the market by a variety of merchants (farmers, fishers, tenants of the lake, plus illegal fish catchers etc.) and handed over to the major wholesale traders, who are all private individuals (individual sellers). There are no dominant players (merchants) in the market.
2. The wholesale traders sort the fish by size and type and sell it (with a mark-up) to merchants.
3. These merchants (functioning as distributors) deliver the fish to the areas where they intend to sell (in/around Tashkent and other regions).
4. These merchants (functioning as retailers) then sell the fish (with a mark-up) to the end consumer, as well as to restaurants and cafes.
5. Some fish raised in small artificial ponds may be sold in large wet central (and regional) markets in areas dedicated to the sale of live fish, where the fish farmer sells their product directly to consumers.
6. In addition, large fish producers supply directly (wholesale) to large supermarkets like Makro, Korzinka, Havas and other multiple retail outlets.

When fish products are brought to the market and sold by individual middleman, the farm gate price of fish increases by an average of 45 – 50 percent. On average, 40 – 45 percent of all fish farmed in the country is sold in the markets by individual middleman and 45 – 48 percent is sold directly by farm farmers To date, 240 outlets have been opened by fish farming enterprises to sell fish directly to consumers. The remaining 8 – 10 percent of the total volume of farmed fish is sold for PHVA by various enterprises (processing and freezing)(Ref 12).

There is limited value added sales in the domestic market, with roughly 25 percent of all fish sold live and the remaining 75 percent sold chilled. The principal points of sale are the bazar markets, where the fish farms (enterprises) have market stalls. Although the National Fisheries Association (NFA) helps its members get a place to sell fish in central markets (as this is a significant problem in the markets in Uzbekistan), staff from the NFA however do not record fish sales in Bazar markets in the summer.

Supermarket sales of fish are limited, where it is also sold live but mainly as chilled fish. At the point of sale fish is typically culled (if alive), cleaned, butchered (into fillets or steaks) and then packaged for the customer. The largest multiple retail outlets in the country where fish are sold are the trading networks Makro and Korzinka (Ref 12)

Some of the key limitations however, to economic fish production and job creation include:

- A lack of collateral to use as guarantees for bank loans (noting the constraint that in Uzbekistan land cannot be used as collateral to secure a bank loan).
- Public infrastructure is not well developed (poor roads to farms).
- The introduction of new technology is problematic, partly due to a lack of capacity in the sector (trained staff).
- Distribution logistics within the industry are poorly developed, with problems regarding the transportation and storage of fish during the main fishing winter season (September until March).
- The low per caput consumption of fish, as fish consumption is generally seasonal (mainly in the autumn and winter).
- The marketing system for small fish farmers is not well established and fish market prices are relatively elastic.
- Poor environmental controls (in relation to the natural lakes/reservoirs) and IUU fishing.
- Lack of funding of applied fisheries and aquaculture research.
- Lack of reliable economic data across the sector (Ref 12).

STAKEHOLDERS AND STAKEHOLDER MAPPING

This section provides an understanding of key stakeholders associated with the Aral Sea fishery value chain. It is designed to inform a more advanced stakeholder analysis process. As this was a stocktaking activity relying on secondary data, and it was not possible to organise a participatory activity, it is proposed that during phase 2 a more thorough stakeholder analysis is undertaken as an activity involving stakeholders identified in this section.

This section is based on the understanding gained from secondary sources. It provides an overview of the main stakeholders identified. It does not include the current views and thoughts of stakeholders. It may also not include all key stakeholders such as donor organizations. Tables 4, 5 and 6 summarise regional stakeholders, public, private and other stakeholders associated with the NAS VC and the fish farming VC of Uzbekistan then the subsequent text provides more detail.

Table 4 Regional stakeholders

Stakeholder	**Involvement/Influence in Aral Sea VC**
Interstate Commission for Water Coordination	Joint management, use and protection of interstate sources of water resources including river basins which supply Aral Sea.
International Fund for Saving the Aral Sea (IFAS)	Coordinating research to improve ecological and socio-economic status of Aral Sea basin and its stakeholders. Has national branches also.
Basin Water Management Association	Multi-agency multi-sectoral advisory and consultative water basin body.
United Central Asia Professionals (UCAP)	Network of young scientists, water specialists, and experts with links to locations in Aral Sea basin.

Table 5 Kazakhstan stakeholders

Stakeholder	**Involvement/Influence in Aral Sea VC**
Fishers	Seasonally employed by fishing spot leaseholders to carry out fishing operations in SAS.
Fishing lot leaseholders	Responsible for harvesting fish and management of 18 fishing spots in SAS.
Collectors/receivers	Middlemen often based in lakeshore fish receiving stations. Buy fish from fishers and sell to processors. They often freeze the fish.
Processors	Process fish and sell to the national, regional and international markets. Some are spot leaseholders.

Retailers	Sell fish to consumers.
Fisheries Inspectorate	Oversee management of the SAS fishery.
Ministry for Water Resources and Irrigation	Strategic, regulatory, implementation and supervisory functions regarding use and protection of water resources.
Ministry of Ecology and Natural Resources (MENR)	Implementation of state policy, coordination of management regarding environmental protection, development of the "green economy", waste management (excluding municipal, medical and radioactive waste).
Ministry of Agriculture	Management of agro-industrial complex, irrigated agriculture and melioration, land resources.
Fisheries Committee	Under the Ministry of Agriculture. Management and development of fisheries resources and fish farming.
National Agrarian Science Educational Center (NASEC)	Innovative agriculture development, increasing the yields. Includes Fisheries Research Institute (below).
Fisheries Research Institute (KazNIIRKh)	Ichthyology, hydrology, hydrochemistry, aquaculture, toxicology and hydrobiology. There is an Aral Branch of the institute in Aralsk.
Association of Environmental Organizations of Kazakhstan (AEOK)	Environmental protection
Akimat of Kyzylorda Oblast	Local regional government concerned with most of Aral Sea region. Oversees regional social and economic development.
Kyzylorda region district akimats.	Kyzylorda region has a number of Districts where local SAS communities are represented. For example Aral district and Kazaly district.
The Executive Board of the International Fund for saving the Aral Sea in the Republic of Kazakhstan	National branch of IFAS.
Aral Tenizi Association PF	Fisheries NGO operating in SAS region.
Al-Farabi Kazakh National University	Water security research and water management issues and regional cooperation mechanisms related to Aral Sea.

Table 6 Uzbekistan stakeholders

Stakeholder	**Involvement/Influence in Aral Sea VC**
Fish farmers	Grow and produce fish.
Fish hatcheries	Supply farmers with fish seed/fry for growing on.
Collectors/wholesale traders/middlemen	Intermediaries between fish farmers, fishers and retailers/end market. Some sell direct to consumers.
Processors	Process fish for national, regional, international market.
Retailers/supermarkets	Supply fish to consumers.
Fish feed producers	Supplying feed to fish famers.
Equipment manufacturers	Makers of aquaculture equipment.
Ministry Agriculture and Water	Water resource management and irrigation sector development.
Ministry of Ecology, Environmental Protection and Climate Change of the Republic of Uzbekistan	Environmental protection
Uzbekbaliksanoat Association (National Fisheries Association)	Development of the fishery, increase fish production using water-saving industrial technologies. 1,200 companies involved in fish culture, harvesting, processing, production of pelletized fish feed, and sale of fish are members.
Research Institute of Fisheries of Uzbekistan	Research in support of sustainable fish farming.
Commodity and Raw-Material Exchange	Provision of mineral fertilizers, materials and equipment for fish famers.
Scientific Research Institute of Fishery	Improve the management system of the fishing industry. Fish farming, restocking etc.
Universities	Seven higher educational establishments (Tashkent Agrarian University, Nukus Branch of the Agrarian Institute, Samarkand Veterinary Institute, Uzbek National University, Bukhara, Namangan, and Fergana State Universities) educate personnel for the industry.

Regional

Interstate Commission for Water Coordination

On February 18, 1992 five Ministers of Water Resources of Central Asian states (N. Kipshakbayev, M. Zulpuyev, A. Nurov, A. Ilamanov, R. Giniyatullin) signed in Almaty “Agreement on cooperation in joint management, use and protection of interstate sources of water resources”. Actually, this agreement founded a united body Interstate Coordination Water Commission (ICWC). This Agreement was confirmed by the Decision of the Presidents, Kzyl-Orda, March 26, 1993 and their “Agreement on joint actions on resolving the problems related to the Aral Sea and its coastal zone on environmental sanitation and social-economic development in the Aral Sea region”, and later by Agreement of the region's five countries of April 9, 1999 “On status of IFAS and its organizations”.

The Interstate Commission for Water Coordination (ICWC) is a parity collective body of Central Asian States acting on the basis of equity, equality and consensus. According to the Decision by the Heads of State of March 23, 1993, ICWC was included in the International Fund for saving the Aral Sea (IFAS) and has the status of an international organization. http://www.icwc-aral.uz/index.htm

International Fund for Saving the Aral Sea (IFAS)

The International Fund for Saving the Aral Sea (IFAS) was established by a decision of the Heads of CA states on the 4th of January 1993 with the aim of developing and funding environmental and applied research projects and programs in order to improve ecological situation in the areas affected by the Aral Sea catastrophe and address the socio-economic issues in the region.

Another key cooperation mechanism is the International Fund for Saving the Aral Sea (IFAS). Established in 1993, IFAS is a major regional organization that aims to address the Aral Sea’s environmental crisis and improve water management practices. Kazakhstan is chairing the IFAS in 2024.

In recent years, water issues have gained the upper hand in discussions among Central Asian leaders, including during their regular consultative meetings. http://www.icwc-aral.uz/ifas.htm

Basin Water Management Association

A basin-level multi-agency multi-sectoral advisory and consultative body. Under the Interstate Commission for Water Coordination of Central Asia. https://bwosyrdarya.org/

United Central Asia Professionals (UCAP)

A network of young scientists, water specialists, and experts. With the support of the Friedrich Ebert Foundation, the German Embassy and Perspectivity Enterprise of the Netherlands, the network organized talks and discussions with youth in Shymkent, Oskemen, Karagandy, and Taraz http://www.icwc-aral.uz/ifas.htm

Kazakhstan

Public sector

Ministry for Water Resources and Irrigation

The Republican state institution "Committee on water resources of the Ministry of ecology, geology and natural resources of the Republic of Kazakhstan" is a state body and department within the competence of the Ministry of ecology, geology and natural resources of the Republic of Kazakhstan, which performs strategic, regulatory, implementation and supervisory functions in the field of use and protection of water resources assigned to it by the Constitution, laws, other regulatory legal acts of the Republic of Kazakhstan.

The Committee operates in accordance with the Constitution and laws of the Republic of Kazakhstan, acts of the President of the Republic of Kazakhstan and the Government of the Republic of Kazakhstan, and other regulatory legal acts.

The Committee is a legal entity, subordinated to the Ministry, in the legal form of public institution, has seals and stamps with its name in state language, forms of the established sample in accordance with the legislation of the Republic of Kazakhstan accounts in the Treasury bodies.

The Committee takes decisions on issues of its competence in accordance with the procedure established by law, issued by the orders of the Chairman of the Committee and other acts provided for by the legislation of the Republic of Kazakhstan.

The structure and staff size of the Committee is approved by the Executive Secretary of the Ministry of ecology, geology and natural resources of the Republic of Kazakhstan after approval by the Minister of ecology, geology and natural resources of the Republic of Kazakhstan.

Full name of the state body is the Republican state institution "Committee on water resources of the Ministry of ecology, Geology and natural resources of the Republic of Kazakhstan" https://www.gov.kz/memleket/entities/water/about?lang=en

Ministry of Ecology and Natural Resources (MENR)

The Ministry of ecology and natural resources of the Republic of Kazakhstan is the central executive body of the Republic of Kazakhstan, carrying out leadership in the areas of formation and implementation of state policy, coordination of management processes in the fields of environmental protection, development of the "green economy", waste management (excluding municipal, medical and radioactive waste), protection, control and supervision of the rational use of natural resources, state geological study n edr, use and protection of the water fund, water supply, sanitation, forestry, conservation, reproduction and use of the animal world and specially protected natural territories (hereinafter referred to as regulated areas) https://www.gov.kz/memleket/entities/ecogeo?lang=en

Ministry of Agriculture

The Ministry of Agriculture of the Republic of Kazakhstan is a state body of the Republic of Kazakhstan that manages in the following areas agro-industrial complex, irrigated agriculture and melioration, land resources, also, within the limits provided for by law, intersectoral coordination of state bodies in the field of activity within its competence https://www.gov.kz/memleket/entities/moa?lang=en

Fisheries Committee

The Fisheries Committee of the Ministry of Agriculture of the Republic of Kazakhstan is an agency within the competence of the Ministry of Ecology and Natural Resources of the Republic of Kazakhstan performing strategic, regulatory, implementation and control functions in the field of protection, reproduction and use of fish resources and other aquatic animals.

Main areas of activity:

fishing – fishing of fish resources and other aquatic animals;
fish farming is the artificial reproduction and cultivation of fish for the purposes of entrepreneurial activity.

Committee carries out its activities in accordance with the Constitution and Laws of the Republic of Kazakhstan, legal acts of the President and the Government of the Republic of Kazakhstan, other regulatory legal acts, as well as this Regulation.

The MPR Fisheries Committee was established by the Decree of the Government of the Republic of Kazakhstan dated December 31, 2020 No. 955. General information (www.gov.kz)

Association of Environmental Organizations of Kazakhstan (AEOK)

The Association of Environmental Organizations of Kazakhstan (AEOK) is a large public organization that brings together over 140 environmental entities in Kazakhstan, each operating as a legal entity and addressing various issues related to environmental protection. Its activities span across almost all regions of Kazakhstan, addressing concerns at both city and district levels, depending on the specific issues at hand. The scope of work ranges from addressing emissions affecting the atmospheric air, water and land resources to implementing initiatives like separate garbage collection, recycling, biogas and humus production, and tackling various other challenges faced by local communities.

National Agrarian Science Educational Center (NASEC)

National Agrarian Science Educational Center (NASEC) is a single operator of sustainable interaction of scientific and educational institutions of the agrarian sphere of Kazakhstan with the state and business.

NASEC's mission is to contribute to the innovative development of the agro-industrial complex of Kazakhstan, including the introduction of innovative approaches in agriculture for increasing the yield of breeds, the creation of demonstration sites on the basis of pilot farms for the approbation and the introduction of new technologies, the local and foreign research for the development of the agro-industrial complex of Kazakhstan, the strengthening and further development of the scientific environment in the agrarian sphere.

Fisheries Research Institute (KazNIIRKh)

The Fisheries Research Institute of NASEC was founded in 1959. It has been registered in the system of the Kazakh Ministry of Agriculture since 2002. The issues of ichthyology, hydrology, hydrochemistry, aquaculture, toxicology and hydrobiology. There is an Aral Branch of the institute in Aralsk. Facilities include a Scientific Production Center, the Kamyshlybash Fish Hatchery and Aral-Syrdarya Interregional Basin Inspection of Fishery team.

http://www.kazniirh.kz/

Akimat of Kyzylorda Oblast

Kyzylorda region is located in the south of the Republic of Kazakhstan. It borders in the north with Ulytau region, in the north-west with the Aktobe region, in the south-west and south with the Republic of Uzbekistan, in the east - with the Turkestan region. See Figure ?

Figure 7 Map of Kyzlorda Region

https://www.google.com/search?client=firefox-b-d&q=Kyzylorda+region+map

The region was formed on January 15, 1938. The administrative center is the city of Kyzylorda.

The state institution "The Office of akim of Kyzylorda region" is the state body of the Republic of Kazakhstan, providing information-analytical, organizational, legal and logistical support for the activities of the akimat and akim of Kyzylorda region.It includes an Entrepreneurship and Industry Division, Natural Resources and Regulations Division and Agriculture Division.

In accordance with the Regulations of Kyzylorda regional administration, as per approved decree No. 1154 on June 22, 2018, Agriculture and Land Administration department enforces state agrarian policy and provides food security of the population in order to increase competitiveness of agro-industrial complex on a qualitatively new level in the region and the promotion of economic growth implements mechanisms of stabilization of prices for socially significant food products. Increase of export opportunities of agro-industrial complex under conditions of market relations development, providing support the production of raw materials conducts the unified state policy in the sphere of agriculture. In addition, it performs the functions of land management, land development organization and approval of land administration projects for land formation.

Kyzylorda region district akimats.

Kyzylorda region has a number of Districts where local communities are represented, relevant to the Aral sea. For example Aral district and Kazaly district.

Private sector

See value chain description.

Other

The Executive Board of the International Fund for saving the Aral Sea in the Republic of Kazakhstan

In order to overcome the ecological crisis and improve the socio-economic situation in the Aral Sea basin, recognized by the world community as one of the largest catastrophes of the 20th century, the Heads of Central Asian States established the International Fund for Saving the Aral Sea (IFAS) in 1993 and approved the Statute of the Fund, according to which the Executive Board of the Fund was established in Almaty, as well as decided to establish the Interstate Council on the Aral Sea basin problems with a permanent Executive Committee in Tashkent.
In February 1997 Heads of the states adopted new principal scheme of IFAS management, according to which Interstate Council was abolished, Board, Executive Committee, ICSD and ICWC were transferred to IFAS, Executive Board of the Fund was transformed into a branch of Executive Committee of IFAS in Kazakhstan. EC IFAS on a rotational basis began to be placed in the country chairing IFAS.

Aral Tenizi Association PF

An NGO established with Danish support in 1990s to support Aral Sea fishers. NGO workers would tour villages, gathering data about catches, nets and vessels. The NGO also acted as an umbrella organisation, agreeing prices, seasons, amounts to be caught (Ref 2).

Al-Farabi Kazakh National University

Al-Farabi Kazakh National University has a significant scientific and educational potential and further aims to transform into a world-class research university By a Government decree dated on July 25, 2022, KazNU was granted the status of a research university and the KazNU Development Program for 2022-2026 was approved. It is engaged in water security research and water management issues, the legacy of the Aral Sea crisis, and regional cooperation mechanisms. https://astanatimes.com/2024/07/kazakh-researcher-discusses-water-scarcity-regional-cooperation-mechanisms/

https://farabi.university/university/about

Uzbekistan

Public sector

Ministry Agriculture and Water

Uzbekistan consistently develops relations with Central Asian countries on water issues both at multilateral level - within the framework of the International Fund for Saving the Aral Sea and the Interstate Commission for Water Coordination, and at bilateral level - within the framework of intergovernmental working groups on use of water resources. As a result of mutual cooperation and agreements reached in recent years with Kazakhstan, Tajikistan, Kyrgyz Republic and Turkmenistan, successes in improving water availability in the Syrdarya and Amudarya basins are being achieved.

Meanwhile, Uzbekistan shows its initiative among Central Asian countries in adopting water-saving technologies and expanding opportunities to use modern technologies in water management in order to reduce water shortages.

The Water Resource Management and Irrigation Sector Development Strategy of Uzbekistanis adopted for 2021-2023 and the Water Sector Concept for 2020-2030 was approved in order to improve land and water resources efficiency use, sustainable water supply to population and all sectors of economy of Uzbekistan, improve reclamation of irrigated lands, broad introduction of market principles and mechanisms and digital technologies in the water sector, and ensure reliable operation of water facilities.

https://gov.uz/en/activity_page/agriculture

Uzbekbaliksanoat Association

According to decree, the national “Uzbekbaliqsanoat” Association was created in 2017 to improve the fishing industry. The association comprises of 13 regional enterprises of LLC "Baliqsanoat". The "Uzbekbaliksanoat" Association employs 18 specialists (excluding service personnel), 6 of them have higher ichthyological education. The association has developed a strategy for the development of the fishery industry by the year of 2030. The strategy aims to strengthen food security by increasing fish production using water-saving industrial technologies. In addition, the strategy envisages the:

a) improving the reproduction juvenile of fish:

assistance to organizations and enterprises of the fishing industry in organizing the reproduction of valuable fish species for further stocking of natural and artificial reservoirs;

creation of new incubation farms for the release of larvae, an increase in the production juvenile of fish, the modernization and expansion of existing ponds for the cultivation of fish seed;

b) rational use of resources of natural and artificial reservoirs:

ensuring effective interaction with the relevant local executive authorities in the provision of lands area for the creation of reservoirs;

increasing the volume of fish catch due to the widespread introduction of modern intensive technologies, including the cage method of growing fish, and increasing the yield of natural and artificial reservoirs;

strengthening the fish feed base by creating new and modernizing existing production facilities for the production of balanced and high-protein fish feed;

c) dynamic development of the fishing industry:

coordination of the implementation of program measures for the development of the fishing industry, consistent implementation of a unified scientific and technical, technological, investment and export policy, as well as monitoring prices in the domestic and foreign markets;

participation in the development of a regulatory framework that ensures the rational use of fish resources of natural and artificial reservoirs, the introduction of mechanisms to stimulate the development of aquaculture in the republic;

assistance in the provision of state support to organizations and enterprises of the fishing industry by providing benefits and preferences, attracting funds from international financial institutions and donor countries;

conducting marketing research to expand sales markets, developing proposals and recommendations on the formation of an optimal pricing mechanism for fish products, increasing the volume of export of fish products;

introduction of modern methods of quality management system, certification and standardization of manufactured products, industrial processing and packaging of fish products in accordance with international requirements;

carrying out research work for the further implementation of the developed innovative technologies in the process of fish production and processing.

As of today, more than 1,200 companies are members of the association. They specialise in fish culture, harvesting, processing, production of pelletized fish feed, and sale of fish products. These enterprises are located mainly in rural areas and partly in regional centers.

The Association, appeals to state bodies, and implements programs to provide material and technical resources, the allocation of bank loans and subsidies for intensive fish farming.
It provides market information and lobbies for the allocation of the sector in projects and programs as well as loan schemes from the relevant banks.

It unites private enterprises and represents their interests to state bodies and brings to the attention of fish farms the requirements of state bodies on the established parameters of the development of the fishing industry. At the same time, all the problems of the members of the association are monthly submitted in writing to the Cabinet of Ministers, ministries, government bodies for their solution.

Ministry of Ecology, Environmental Protection and Climate Change of the Republic of Uzbekistan

The main tasks and activities of the State Committee of the Republic of Uzbekistan on Ecology and Environmental Protection:

State administration in the field of ecology, environmental protection, rational use and reproduction of natural resources;

Ensuring a favorable ecological state of the environment, the protection of ecological systems, natural complexes and individual objects, the improvement of the ecological situation;

Implementation of state control over compliance with legislation in the field of waste management, the organization of an effective system for the collection, transportation, disposal, recycling and disposal of household waste, in close cooperation with the local authorities and the self-government of citizens;

State environmental control over compliance with legislation in the field of protection and use of land, mineral resources, water, forests, protected natural areas, flora and fauna, protection of atmospheric air;

Coordination of work on ecology and environmental protection, ensuring interdepartmental cooperation in the development and implementation of a unified environmental and resource-saving policy;

Maintaining a state cadastre in the field of ecology and environmental protection, as well as state registration of nurseries for the breeding and maintenance of wild animals, wild plants, zoological and botanical collections;

Organization of environmental education, propaganda and education, as well as retraining and advanced training of specialists in the field of ecology and environmental protection.

Research Institute of Fisheries of Uzbekistan

Research in support of sustainable fish farming.

Commodity and Raw-Material Exchange

fish farms can buy mineral fertilizers, materials and equipment produced in Uzbekistan. Many types of equipment and materials (e.g. boats, outboard motors, nets, chemicals, medicine and preparations) are not being produced in Uzbekistan. They are imported by private firms on the basis of orders placed by the consumer. As the orders pass through several intermediaries and wholesale companies, prices increase two to four times before the equipment reaches the final consumer.

Scientific Research Institute of Fishery

Scientific Research Institute of Fishery was established on the basis of the Decree of the President of the Republic of Uzbekistan dated May 1, 2017 No PP-2939 "On measures to improve the management system of the fishing industry." (Pers comm. Nat Cons). It conducts research in the field of intensive aquaculture development (Eurofish 2020).

In accordance with the Resolution of the President of the Republic of Uzbekistan dated March 28, 2019 No PP-4254 "On the organization of the State Committee for Veterinary and Livestock Development of the Republic of Uzbekistan" Scientific Research Institute of Fishery was transferred to the State Committee for Veterinary and Livestock Development (Pers comm. Nat Cons).

The main tasks of the institute are: Developing intensive technologies in fish farming, laboratory analysis of hydrochemical composition of water, detection of fish diseases, scientific research in the field of selection and breeding in fisheries, study of biological properties of fish, development of new fish species in local climates and development of recommendations for breeding and nutrition, cooperation with leading research institutes of foreign countries on the development and introduction of new innovative technologies won expansion (Pers comm. Nat Cons).

The scientists of the institute are implementing innovative projects on the acclimatization of promising fish species in Uzbekistan, studying the reproductive indicators of local fish species, testing methods of artificial breeding of new fish species, as well as developing a technology for their feeding, using recipes from local ingredients (Pers comm. Nat Cons).

Compliance with technological discipline, the unconditional fulfillment of regulatory requirements will significantly improve the work of pond farms and lake-commodity farms, increase the output of marketable products (Pers comm. Nat Cons).

Restocking of fish in natural and man-made water bodies is carried out with the participation of employees of the Department of Ecology and Environmental Protection (from the State committee on ecology and environmental protection), Ministries of Agriculture and Water Management, Land Resources and State Cadastre (from the State Committee for Land Resources, Geodesy, Cartography and State Cadastre) and the State Tax Service, representatives of the regional LLC Baliqsanoat and fisheries enterprises.

Private sector

Easy Fish

A domestic company producing aquaculture equipment, also contributed to the establishment of the laboratory, which is fully supplied with modern equipment.

Only a few hatcheries sell fish seeds to other fish farms: the State Regional Fish Hatchery, the Balikchy Fish Farm (both in the Tashkent region) and the Khorazm Fish Farm (the Khorazm region) (FAO 2009).

However, with the increasing demand from intensive fish farms for specialised feeds, indigenous modern fish feed production has grown. As of late 2020 there were 58 companies producing about 45,000 tons of feed. Some companies are producing specialized feeds for cold water species such as trout. For the last 4 to 5 years there has been easier to access foreign currency and hence for businesses to import modern manufacturing equipment for feed production the feed ingredients such as fishmeal.

The following enterprises were commissioned in 2018 -2020:

• an enterprise with the participation of Vietnamese investors in the Arnasay district of the Jizzakh region of FE MTT "Sea Food" with an annual capacity of 15 thousand tons.

• an enterprise with the participation of Chinese investors in the Fergana region of the Hualong Silao JV with an annual capacity of 15 thousand tons.

• an enterprise with the participation of domestic investors, LLC BDK, with an annual capacity of 25 thousand tons.

Aquaculture feed producers

In addition, large aquaculture producers have established their own feed production units. For example Khorazm balik sanoat agro LLC, Sof Khavzalar LLC, Ok Amur LLC and more than 10 other enterprises. There is also collaboration with a German feed company, VILOFOSS.

Trout and sturgeon producers in Tashkent, Fergana, Namangan and Surkhandarya regions however, rely on feed imported from Asia and Europe (Aler Aqua, Coppens and enterprises from Iran).

If domestic producers of feed mainly sell products at a price of 3600 - 4600 - 5300 sums for kg, then imported costs at least 1.5 dollars.

The quality of fish meal from the Baltic states is preferred by some companies. Compared to fishmeal from Russia. Some feed ingredients such as calcium phosphate are imported from China. This is said to be cheaper.

Universities

The Government has taken steps to improve fisheries education in the country. Seven higher educational establishments (Tashkent Agrarian University, Nukus Branch of the Agrarian Institute, Samarkand Veterinary Institute, Uzbek National University, Bukhara, Namangan, and Fergana State Universities) educate personnel for the industry.

SWOT analysis of the fisheries sector of the NAS

Based on the information available the following SWOT has been developed by the author focussed on the NAS for which most information is currently available.

Strengths

a. Multi-species fishery catering for domestic, regional and international markets.
b. Electronic system for facilitating market access/fish distribution.
c. Seasonal small-scale fishing affording some natural protection of resource.

d. Cold chain technology (freezing, refrigerated transport) enables quality control and market access.
e. Fisher households also engage in agriculture, livestock and other income generating activities.
f. Ability of processors to utilize fish from other lakes in order to maintain production.
g. Access to domestic, regional and international markets.

Weaknesses

a. Lack of data for management and decision making…socio-economic, catch per unit effort, biological resource status, markets etc
b. Information on the impact of leaseholders restocking policy.
c. National research capacity.
d. Prevalence of monofilament nets (illegal?).
e. Abandoned nets causing ghost fishing.
f. Alienation of local fishers who are hired labourers and not involved in management process and look for short term financial reward from the fishery.
g. Illegal, unreported and unregulated (IUU) fishing and black market fish trade linked to under resources monitoring, controls and surveillance (MCS), strong demand for fish by processing factories.
h. Weather extremes and other factors conspire against the development of aquaculture in Kazakhstan.
i. Poor access to financial resources for investment.

Threats

a. Regional water infrastructure developments affecting the Syr Darya, Amu Darya rivers outside of those agreed by concerned countries.
b. Water scarcity, regional water demand and management.
c. Climate change.
d. Health impacts of desiccation and poor infrastructure.
e. Pollution

Opportunities

a. Review of current management regime and associated legislation.
b. Development of an overall fisheries management plan in conjunction with all parties.
c. Strengthen the capacity of research involving international or regional/neighbouring institutes not only with regard to fisheries but also hydrological research.
d. Collaboration between Kazakhstan and Uzbekistan in connection with aquaculture development.
h. Regional cooperation agreements on water management.
i. Experience of Uzbekistan in aquaculture development.
j. Development/donor/govt interest e.g. North Aral Sea Development and Revitalization Project

RECOMMENDATIONS

This section presents the main recommendations from the various sources of information reviewed for this report. The recommendations are grouped according to whether they relate to the North Aral Sea (NAS) or South Aral Sea (SAS) themes. There is also recommendations which relate to aquaculture and water access and the need for a more rigorous value chain analysis. From the

sources consulted it can be seen that there is much more guidance on the way forward in relation to the NAS, aquaculture development and regional water management. And less guidance in relation to the SAS.

North Aral Sea

Developing the domestic market. Increasing domestic fish consumption should be a priority for policy and planning. Strengthening the domestic fish market is an effective way to facilitate aquaculture development in the long run (Ref 7).

Promoting export markets. Although the NAS already supplies export markets, improving the quality of fish production (in terms of freshness, cleanliness, and safety), identifying and exploring niche markets through proper marketing/branding strategies and innovation in value-added products could strengthen export market access, if this was desired. . One suggestion is to bring together the private sector, public agencies, and academia and link them to a publicly financed capacity-building program and promotion campaign (Ref 7).

Strengthening monitoring, policy, and regulations. There is an urgent need to strengthen data and statistics in aquaculture and fisheries generally but specifically for the NAS. Evidence-based policy and planning are impossible without reliable data and information. An effective legal and regulatory framework is also needed to ensure food safety, environmental integrity, and social license to operate. (Ref 7).

Access to finance. The transition from a centrally planned economy to a market oriented one in the Aral Sea region has indeed been a complex and protracted journey, marked by numerous challenges that have not unfolded seamlessly. As the transition to a market economy has progressed, the reduction in government subsidies and funding has placed a heavier financial burden on industry participants. This has included expenses related to the upkeep of fishing boats, processing facilities, and storage units, all of which require ongoing investments to remain competitive in a market-driven environment. One of the primary challenges faced by the fisheries sector is the presence of economic restraints, characterized by a dearth or limited provision of financial assistance from the government and insufficient private investments. There are no specific credit lines available to ensure the financial support of local initiatives (Ref 5). With this is mind it can be deduced that facilitating the fisheries sector's access to finance is a key priority.

The modernization of the principles of fisheries management is necessary as is the need for a more in-depth discussion of standards, rules and legal regulation of fisheries, as well as issues of nature exploitation in the context of the environmental crisis as a whole(Ref 1).

Co-management or greater involvement of local stakeholders in fisheries management is seen as a way of improving fisheries management. For example, wide involvement of the local riparian population in the control and regulation of biological resources and their exploitation. In particular, the local aul akimats received the right to set fishing quotas for part of the fish resources (even at the currently leased fish sites) on the basis of the "historical or natural right" of the coastal population. With such involvement in production, village administrations will be more actively interested in the preservation of fish resources of water bodies and the development of fishing standards as a profitable part of local self-government. The aim is, to create a modern, sustainable, environmentally sound fisheries management system (Ref 1).

Establish community-based networks that include fishermen, local residents, and community leaders. To facilitate participatory decision-making in managing fishing resources and ecological restoration efforts. Forge networks between scientific institutions, universities, and local experts to support data collection, research, and the development of sustainable fishing practices, offering evidence-based solutions for governance (Ref 5). Another ype of networks should be policy and

advocacy oriented. It is recommended to create advocacy networks comprising NGOs, environmental organizations, and local advocates. These coalitions can collaborate to influence policy decisions at local and national levels, advocating for sustainable resource management and ecological restoration (Ref 5). The establishment of research networks involving academic institutions and policy think tanks is also needed. These networks can conduct research on the Aral Sea crisis's socio-economic and environmental impacts, providing data-driven insights for policy formulation (Ref 5).

Protecting juvenile and spawning fish. One of the technical limitations that arise in water management is the inability to maintain an appropriate water supply for fish spawning and nursery grounds due to competing priorities such as irrigation demand and hydropower production. To mitigate against this protective measures should be considered to prevent the discharge of young fish with irrigation water onto irrigated fields, develop interconnected pathways between water bodies such as floodplains, river reaches, and canals to facilitate the migration of fish and fish fry to and from spawning areas, reproductive habitats, and other essential environments, as well as create fish passes (Ref 5).

Ageing infrastructure in the basin, whose management is also increasingly compromised by a declining capacity for monitoring of crucial environmental variables. Monitoring of environmental parameters/indicators such as water quality, pollutants, heavy metals, fertilizers and chemical levels for ecological and food safety perspectives.

Strengthening the capacity of research stakeholders to be able to better understand the resource, production potential, value chain and plan for the fishery. This may involve twinning Kazakhstan institutions with international or regional/neighbouring institutes not only with regard to fisheries but also hydrological research to better understand water supply issues (Zhaanat pers com).

Capacity building. There is a notable scarcity of fisheries experts and a dearth of fisheries training programs (Ref 5). The government should organize information exchange and capacity building. Development of digital platforms or online networks will allow the exchange of information among fishermen, government agencies, NGOs, and scientific organizations. These platforms can disseminate updates on regulations, market trends, and environmental monitoring data. Organization of capacity building workshops within the network to enhance the knowledge and skills of fishermen and local communities. Training programs can cover topics such as sustainable fishing practices, resource conservation, and conflict resolution (Ref 5).

Pescatourism. The government can contemplate the foundation of cultural tourism centers in fishing communities along the Aral Sea, where tourists can learn about the rich history and traditions of the local fishing culture. These centers can include interactive exhibits, storytelling sessions, and hands-on activities like net making or traditional fishing techniques demonstrations. Another approach might encompass the development of heritage tours that take tourists on journeys through the region's fishing history. These tours can include visits to historic fishing villages, local markets where fresh catches are sold, and opportunities to interact with fishermen and their families. Tourists can gain firsthand experience of the daily life of local communities. Another way of engagement might be focused on the opportunity to engage in recreational fishing activities under the guidance of local fishermen. This not only provides a memorable experience for visitors but also generates additional income for the local fishing communities (Ref 5).

In addition, the government could evaluate the possibility of the organization of cultural festivals and events celebrating the fishing heritage of the Aral Sea region. These festivals can feature music, dance, art exhibitions, and storytelling sessions, creating a vibrant atmosphere that showcases the cultural richness of the area. Moreover, to increase the levels of awareness, it is recommended to conduct educational workshops on topics such as sustainable fishing practices, environmental conservation, and the importance of preserving the Aral Sea ecosystem. These workshops can be targeted at both tourists and local communities, fostering a sense of environmental stewardship. They can encourage storytelling sessions where local fishermen and elders share their stories and experiences with tourists.

These personal narratives can provide deeper insights into the history and challenges faced by fishing communities (Ref 5).

Health and well-being of the affected communities around the Aral Sea is a crucial aspect that needs to be prioritized. Access to healthcare services, clean drinking water, and sanitation facilities is essential to mitigate the health risks associated with the Aral Sea crisis. Providing these basic necessities can help address respiratory health issues and reduce the strain on the healthcare system. Furthermore, raising awareness about the health risks and providing necessary support to affected individuals is important for their overall well-being. By focusing on these aspects, efforts can be made to improve the quality of life and promote the recovery of the communities affected by the Aral Sea disaster (Ref 5). One can assume that this recommendation extends to the people associated with the SAS region also.

North Aral Sea Development and Revitalization Project

Subcomponent 2.1: Fisheries (US$ 20.0 million) of the KAZAKHSTAN: North Aral Sea Development and Revitalization Project highlights the intention to undertake the following NAS related development initiatives. And add-value to the hydraulic and environmental enhancement and stabilization of the NAS, delta lakes and Kok-Aral wetlands, not only through socio-economic revitalization but also through the improved control of increasingly disruptive drought and flood flow variabilities (Ref 9):

- Hatchery development to help the restoration of viable fish populations, through the breeding and release of fingerlings of various high-value fish species. This is to meet demands of private sector enterprises involved in both capture- and culture-based fisheries in the NAS and the Syr Darya delta lakes area (Ref 9).

- Habitat creation and conservation, water body resources management and protection, fish population health monitoring, and restocking of signature species.

- Facilitation of farming of brine shrimp (*Artemia salina*) for production of fish and fowl feed in saline sea areas below the NAS

- Intensive fish farming (aquaculture) systems in the Syr Darya delta lakes or on the NAS shorelines.

- Explore the potential for fishmeal and other fish product production which are in high demand and provide potential for the creation of more jobs, including female ones.

- support for further upgrading if warranted could be considered for the Aralsk private sector fish processing sector (although these have already been largely restored, are operational, and currently have excess capacity).

- Support for needed improvements to harbor facilities and support services (e.g. for ship repair and building), and other value chain support, could also be warranted.

- Develop localized medium- or small-scale community or individual household fishery-related income-generating ventures, if appropriate e.g. intensive duck-fish farming systems (Ref 9).

South Aral Sea

Measures to "green the Aral Sea" should lead to a decrease in the level of dust storms and air pollution, which lead to a deterioration in the quality of life of the local population and their health. It also implies the restructuring of degraded areas to preserve and increase biodiversity (Ref 1). This may also apply to areas associated with the NAS.

Aquaculture Kazakhstan

Pursuing a value-oriented (as opposed to volume-oriented) aquaculture development strategy. At its current stage of development, it may be difficult for Kazakhstan to rapidly increase aquaculture production. Species with great market potential (for example, pikeperch) face technical constraints on production, while species with relatively mature farming technology (for example, carp, rainbow trout, and sturgeon) are subject to limited domestic demand, competitive international markets, or both. A volume-oriented development strategy may not yield desirable outcomes due to a highly competitive global market (Ref 7).

Promoting a positive national image for Kazakhstan's fish. The global drive to build a healthy and profitable seafood and fishing sector builds synergy between catch and conservation. From an analysis of markets and trade for Kazakhstan's seafood, pikeperch is established in existing marketing channels, minimizing the need to make adjustments in the value chain. Social media have provided a powerful platform to propagate attractive images of Kazakhstan fish to every corner of the world. Yet all sub-sectors (fishing, farming, recreational fisheries, processing, fish markets, food catering services, and so on) need to live up to Kazakhstan's new 'Very Nice' public relations campaign being promoted by the country's Ministry of Tourism. A long-term, systematic mechanism is needed to coordinate these efforts toward a campaign promoting and publicizing high-quality fish from Kazakhstan (Ref 7).

Developing and implementing a strong regulatory framework for aquaculture development that prepares the industry for expansion and increased levels of scrutiny in markets. Such a framework would include carrying-capacity modeling, zoning, surveillance, and biosecurity(Ref 7).

Fostering adoption of production systems and value chains that are demonstrably 'blue'—that is, environmentally sustainable. Aquaculture is highly innovative. Best practices are constantly evolving, including in Kazakhstan. Strong engagement with adaptive research, including hiring international experts to work with local scientists and industry operators, can rapidly bring Kazakhstan's fish farmers up to speed. Marketing information and support through awareness-raising could position the country's seafood as a high-quality, environment-friendly product for European as well as high-end domestic and Asian markets (Ref 7).

Integrating aquaculture into sustainable landscapes. Aquaculture should develop in the context of sustainable watershed management. It can take many forms and can be conducted in a wide range of natural and artificial ecosystems, including cages in reservoirs or natural water bodies, raceways along river courses, and indoor 'fish plants' as well as traditional ponds. Stocking programs can support capture, recreational fishing, or both. Each ecosystem has a different carrying capacity that determines how much of each kind of aquaculture it can support. The government can use new and existing technologies and natural resource management science to support aquaculture mechanisms that encourage integration into sustainable landscapes (Ref 7).

Aquaculture Uzbekistan

The growth of aquaculture has been a response to the decline of the Aral Sea. By 2022 more than 10 presidential and government resolutions had been made regarding the development of the sector. Most importantly, the fishing industry has been given recognition by the Government of Uzbekistan as an important sector to help ensure food security in the republic. At the present stage of development of the sector the most important issues to be addressed are largely technological and economic. It is recommended that the following priority actions are necessary to support the sustainable development of the sector over the next 5+ years. At this stage these actions are in no specific order of importance, as their relative importance/priority will be defined in conjunction with stakeholders in developing the sector strategy and plan:

Increases in the level of efficiency of the functioning of intensive aquaculture enterprises in natural water bodies will largely be determined by the level of use of the water area of brackish water bodies.

Development and implementation of a guaranteed water supply system for the aquaculture industry is needed through improvements to the legislation on water allocation.

Investment in innovative technology is required to up-scale (commercialise) aquaculture production in natural brackish water bodies, focusing on cage farming – with the added benefit of income diversification to reduce the pressure on capture fisheries in these lakes.

Implementation of a research programme to identify new and promising fish species for aquaculture development.

Increased focus on the production of export-oriented aquaculture products (freshwater shrimp, crustaceans and value-added products) plus the development of a state support programme for fish exporters.

Improvements to the production and management of high-quality fish feed for the production of farmed fish for both the domestic and export market.

Development of new standards of farmed fish for yearlings of carp 100 grams, for two-year-olds 500 grams and for three-year-old fish over 2kg. Establishing norms (standards) for the cultivation of herbivorous fish are also recommended.

Implementation of a national fish marketing campaign to promote fish consumption and development of a marketing information system for farmers and fishing enterprises.

Strengthening of the single cluster system for enterprises, with vertically integrated fisheries management, farm production, fish processing and marketing facilities.

More detailed economic analysis of the fisheries and aquaculture sector, including strengthening of data collection and an evaluation of the efficacy of recent investments in the sector (particularly the expansion in extensive ponds), functioning of business enterprises and the performance of NFA implemented development projects in general since 2017. Preparation of a transparent business plan for the NFA is also recommended.

Investigations into the role of the state in the sector, legal framework for the development of the natural lakes, public-private partnerships for specific sub-sectors and options for the development of a network of fish hatcheries for stocking the fish lakes.

Strengthening of cooperation and partnerships with relevant international and regional organisations (including the Central Asian and Caucasus Regional Fisheries and Aquaculture Commission) (Ref 12).

The fish output potential of lakes, rivers, and reservoirs in Central Asia, particularly in the catchments of the Syr-Darya and Amu-Darya Rivers, is estimated to be approximately 100 kg per hectare per year. This has the potential to yield an annual fish supply of 200,000 tons for the market. Of all the countries in the region, Uzbekistan exhibits the highest potential for the utilization of irrigation systems in fish production. The implementation of aquaculture within irrigation systems has the potential to significantly augment the availability of fish in markets (Ref 5).

Currently, there is a lack of a regional network dedicated to addressing the utilization of irrigation systems for the purpose of fish production. The possibility of addressing this matter could be explored by the Ministry of Natural Resources, an organization headquartered in Tashkent, Uzbekistan. The Ministry in question has already been involved in addressing many facets of regional collaboration pertaining to water resources within the Aral Sea basin (ref 5)

Government sector partnership with NGOs could be considered the most appropriate structure for facilitating information support and the establishment of a regional network focused on utilizing irrigation systems for fish production. This is primarily due to the existing institutional framework for water management at the regional level, as well as the potential for consistent engagement with

governments, relevant ministries, and the general public. Community should continue playing a crucial role in overcoming obstacles created by the Aral Sea shrinking. Ties within it can help to progress further in development of solutions needed for helping locals. It is required to encourage active participation and involvement of the local community in decision-making processes and initiatives related to the Aral Sea catastrophe. This can be done through community meetings, workshops, and forums where individuals can voice their concerns, ideas, and suggestions for mitigation and adaptation strategies (Ref 5).

Access to water

Cooperation on water issues among Central Asian countries features bilateral and multilateral agreements and regional organizations. Several fundamental agreements on water management exist in Central Asia, including the 1992 Agreement on Cooperation in the Joint Management of the Use and Protection of Water Resources of Interstate Sources and the 1998 Framework Agreement on the Syr Darya Basin. The 1992 agreement established the Interstate Commission for Water Coordination, a regional body managing and coordinating the use of shared water resources. It recognized "equal rights to water use and responsibility to ensure rational use and protection of water." The 1998 agreement involved Kazakhstan, the Kyrgyz Republic, and Uzbekistan and was later joined by Tajikistan. The agreement sets protocols for annual water release schedules from reservoirs, primarily managed by the Kyrgyz Republic, to ensure downstream countries—Kazakhstan and Uzbekistan—receive adequate water for irrigation. It also envisions a compensation mechanism where downstream countries provide financial or energy resources to upstream Kyrgyzstan to regulate water releases and maintain reservoirs.

The ministers representing the top-level management organizations of the five nations in the Aral Sea basin convene at the quarterly meetings of the International Commission for Water Coordination (ICWC). These meetings serve as a platform to debate the prevailing conditions pertaining to water distribution and utilization, as well as to develop a water strategy for the upcoming period. The ministry should expand its focus to encompass the concerns of other stakeholders in water resource management, such as the fisheries sector. The objectives of the initiative should focus on addressing and overcoming administrative obstacles by actively engaging many stakeholders, including the general public, private sector, nongovernmental organizations, and water consumers. This approach seeks to promote integrated water resources management at both national and regional scales (Ref 5).

Another key cooperation mechanism is the International Fund for Saving the Aral Sea (IFAS). Established in 1993, IFAS is a major regional organization that aims to address the Aral Sea's environmental crisis and improve water management practices. Kazakhstan is chairing the IFAS in 2024.

In recent years, water issues have gained the upper hand in discussions among Central Asian leaders, including during their regular consultative meetings. Nevertheless, the current mechanisms of cooperation between Central Asian countries concerning transboundary water sources have shown varying degrees of effectiveness. Despite these mechanisms, issues related to implementation and enforcement persist. Disputes surrounding water rights, infrastructure projects, and the impacts of climate variability have, at times, strained inter-country relations. Deficiencies in trust, transparency, and data exchange have impeded effective collaboration on water governance, There is a need for enhanced trust and communication. Countries also need to reinforce existing legal frameworks and agreements, such as those under the auspices of the IFAS (Ref 11).

By 2030-2050, the countries of the region will reach the limits of irrigated land expansion. Despite the depletion of water and irrigation resources in the region, in their national strategies and programs, each country notes increased water use for irrigation and hydropower in the future. Hence, a coordinated regional water policy is required which must seek to balance the water resources use and improve the ecological situation in the region (Ref 4).

Embracing an integrated water management approach that accounts for the requirements of all stakeholders, including upstream and downstream nations, is critical. Prioritizing sustainable water

utilization, ecosystem conservation, and climate resilience is paramount (Ref 11). Given the ramifications of climate change on water availability, countries must integrate climate adaptation measures into their water governance strategies. This may involve the development of resilient infrastructure, diversification of water sources, and advocacy for water conservation practices (Ref 11).

Key Recommendations for Central Asian countries:

- Developing a regional water policy aimed at the balanced use of water resources and improvement of the ecological situation in the region.
- Developing new mechanisms and instruments for cooperation in transboundary river basins, based primarily on deep economic integration of countries in the region.
- Accelerating gradual and a holistic reconstruction of water management infrastructure with a widespread transition to water-saving technologies and reduction of wastewater.
- Promoting cultivation of drought-resistant crop varieties.
- Introducing green and low-water usage technologies, water recycling systems, and developing new wastewater treatment technologies.
- Improving the accuracy and efficiency of regional hydrometeorological services for climate change adaptation and disaster risk management in Central Asian countries.
- Creating sub-regional mechanisms for adaptation to climate change, risk assessment, early warning and prevention systems for transboundary hazards in the Aral Sea basin.
- Strengthening efforts to achieve the Sustainable Development Goals, in particular SDG 13 'Take urgent action to combat climate change and its impacts' and SDG 14 'Conserve and sustainably use the oceans, seas and marine resources for sustainable development'.
- Organizing a network on the ESCAP platform inclusive of the existing networks of experts on water resources, ecology, climate and socio-economic sector in the region with the aim of strengthening regional cooperation and attracting investment for implementation of projects concerning the Aral Sea and related ecosystem.
- Involving educational institutions and students on the issues like water resources management and environment protection in order to ensure participation of youth in solving present day challenges and threats. (ref 4)

Climate change impacts in the region are aggravated by the dried-out Aral Sea which, having lost its role as a climate and geochemical runoff regulator, has turned into a source of aeolian salt transport to the surrounding area. The resulting ecological, social, economic problems require new approaches to irrigation development and water management in the region, especially in the transboundary context. Hence, practical adaptation measures must be put in place especially in large water-using and water-consuming sectors such as agriculture, hydropower, industry, and public utilities. In these sectors, step-by-step comprehensive reconstruction of water infrastructure is needed, with universal transition to water-saving technologies and waste-water reduction. In the agricultural sector, it is important to promote cultivation of more drought-resistant crop varieties on a larger scale, improve the technical level of engineering irrigation systems and equip them with automated means of water distribution and monitoring for condition of irrigated lands. In the industrial sector, low-water technologies and water recycling systems need to be implemented. In the public utilities sector, technical condition of water supply and sewerage systems should be improved while reducing their water losses, and new technologies for wastewater treatment should be adopted (Ref 4).

Value chain analysis

A fisheries/aquaculture value chain (VC) consists of the full range of actors from capture/production to consumption and their coordinated value adding activities that transform raw materials into food products. A value chain development approach is a holistic method, which examines all the elements, actors, their complex interlinked behaviour, and their technical, economic, social and environmental performance in order to devise an upgrading strategy for a sustainable food value chain. A value chain

analysis is a process intended to collect and analyse the information needed to make strategic decisions for sustainable development goals (SDG)-compliant value chain upgrading. Sustainability is underscored by the triple-bottom line, analysing economic, social and environmental impacts. The main outcome from a VC analysis is a concrete action plan for value chain development[4].

It was originally envisaged that the World Bank Fisheries Sector Assessment Toolkit (FSAT) would be used as a guide to the design of further data collection and a value chain analysis5. Despite numerous attempts and research it was not possible to gain an understanding of FSAT and how it may be used.

Eventually the World Bank PROBLUE programme6 provided recent guidance on rapid value chain assessments. The guidance is primarily based on the FAO Sustainable Food Value Chain Framework (FAO, 2014), the work of the FISH4ACP project7 and more specifically on the FAO work on selecting agricultural value chains (Walker et al., 2021) for the screening process. Also, the USAID MarketLinks web-based materials8 are a valuable source of information on screening and assessing agricultural value chains. This guidance is designed to assist World Bank Group task team leaders (TTLs) and their teams of experts to (i) identify which value chains should be targeted in the design of projects in the fisheries and aquaculture sectors, and (ii) provide a scope for the interventions needed to upgrade fisheries and aquaculture value chains. Taking into consideration the triple bottom line of sustainable development – economic, social and environmental. An Excel-based workbook is used in conjunction with a guidance document. The guidance assumes that a screening process will be needed to select the value chain for investment.

The rapid assessment is, as the name suggests, a "quicker than usual" assessment of the selected value chain to provide an outline assessment of the key markets, performance and the subsequent opportunities for upgrading the value chain. This defines the "scope" of a project and highlights steps in the value chain where significant opportunities to add value exist.

The performance data can also be used to assess performance improvements during the World Bank Group project implementation.

The length and depth of the screening and rapid-assessment process depends on available time, budget and resources and the project's size. This can thus dictate whether the screening process is done entirely using secondary data and correspondence with the government counterparts or includes primary data collection and one or more workshops with relevant stakeholders. It is strongly recommended that primary data collection is included during the screening process. The rapid-assessment phase will definitely require primary data collection and close cooperation with the government-nominated representative(s) to collect appropriate secondary and primary data.

A screening process was applied in general to the Aral Sea value chain based on the understanding presented in this report (secondary data). The results of this screening are presented in Annex ? This highlights whether a decision is needed to focus on individual species VCs rather than multi-species. It also suggests main gaps in the current understanding described in this report, which require addressing via a rapid assessment and further data collection/stakeholder engagement. Key knowledge gaps have been identified as the following. More information can be found in Annex ?:

- end markets especially to identify likely future demand, consumers and market requirements.
- support services
- fisheries management effectiveness and opportunities

[4] https://www.fao.org/fileadmin/user_upload/FISH4ACP/documents/FISH4ACP_VCAD_MethodologicalBrief.pdf

[5] https://www.fao.org/fishery/services/storage/fs/fishery/documents/CWP/presentations/2023/CWP_IS_2023_Pr.6.4.pdf

[6] https://www.worldbank.org/en/programs/problue

[7] https://www.fao.org/in-action/fish-4-acp/en/

[8] https://www.marketlinks.org/good-practice-center/value-chain-wiki/how-information-those-designing-or-implementing-vc-project

- downstream VC stages
- water quality and its impact
- economics of the value chain activities
- aquaculture growth in Kazakhstan
- food safety and nutrition
- socio-cultural norms
- social institutions
- biodiversity
- enhanced workers' rights & safety

It is envisaged that the next steps to be undertaken, if the WB guidance is to be followed, will consist of the following:

- Data collection
- Initial evaluation of feasibility and impact
- Stakeholder meeting
- Final evaluation of feasibility and impact
- Market analysis
- Value-chain mapping
- Performance assessment
- Opportunities from value-chain analysis
- Validation stakeholder meeting
-

A VC analysis phase should also seek to develop an overview and analysis of the current policy framework (international, Kazakhstan, Uzbekistan).

CONCLUSIONS

Drawing on mainly recent secondary sources of information, the report provides an understanding of the decline and degradation of the Aral Sea and the current situation, with an eye on the future. The report lays a foundation for primary data collection including a value chain analysis and stakeholder mapping. Annex 2 provides a gap analysis and a start point for these processes. A SWOT highlights some of the positive and negative factors identified in terms of the NAS that can be validated in future and used to guide intervention design. The report not only highlights micro level issues related to the current NAS fishery value chain and aquaculture but also macro level needs related to regional water management and climate change. Recommendations to support future sustainable development initiatives are consolidated, particularly in relation to the NAS, aquaculture and water management. It is anticipated that the report will help inform the next phase of the WB project identification process.

Annex 1 List of key reports and studies

Ref	Title	Overview of existing studies (institution, focus, date)
1	TAIROV M 2023 THE ARAL SEA AND FISHERIES – A REVIVAL STRATEGY. Society. mysl.kazgazeta.kz/news/16011	This article attempts to analyze the problems of fisheries management and present our general vision of the current situation. "We", in this case, refers to the collective opinion of the NGO "Aral Tenizi" of the Aral region and an international group of ecologists working in the region since the 1990s
2	Wheeler W 2021 Environment and Post-Soviet Transformation in Kazakhstan's Aral Sea Region. UCL Press. London.	Detailed socio-economic timeline and analysis. Anthropological research. Book.
3	Berdiakhmetkyzy S et al 2021 CURRENT STATE OF POPULATIONS OF THE MAIN COMMERCIAL FISH SPECIES OF THE SMALL ARAL SEA	This paper analyzes the current composition of the ichthyofauna of the Small Aral Sea. A brief assessment of the state of populations of the main commercial fish species is given. According to the research of the current year, the commercial ichthyofauna of the Small Aral Sea was represented by 16 species of fish, of which 9 species (Abramis brama, Cyprinus carpio, Aspius aspius, Esox lucius, Silurus glanis, Sander lucioperca, Rutilus rutilus, Channa argus, Pelecus cultratus) form the basis of the fishery,
4	Narbayep, Marat and Pavlova, Vera. The Aral Sea, Central Asian Countries and Climate Change in the 21st Century. United Nations ESCAP, IDD, April 2022. Bangkok.	The Aral Sea, Central Asian Countries and Climate Change in the 21st Century is a research study that advocates joint solution of environmental and resource problems in transboundary river basins, implementation of multilateral investment projects, enrichment of latest scientific knowledge and upgradation of technical skills. The study argues that cooperation between water management bodies and water-using and water-consuming economic sectors (land-water-energy nexus) is the basis for integrated water resources management. It is important to strengthen cooperation between the hydrometeorological services of the region – at the local, national and regional levels. It argues full-fledged strengthening of the basin authority (at the national and regional level) to maintain sustainability of water resources management and to develop

Ref	Title	Overview of existing studies (institution, focus, date)
		policy coherence to strengthen the national and regional basin authorities – Syr Darya Basin Water Management Associations (BWMA) and Amu Darya BWMA.
5	Alieva D, Usmonova G, Shadmanov S and Aktamov S (2023) Fishery culture, sustainable resources usage and transformations needed for local community development: the case of Aral Sea. Front. Mar. Sci. 10:1285618. doi: 10.3389/fmars.2023.1285618	his scientific article uses primary and secondary data to explore the history and current status of fishery culture in the Aral Sea region, the connection between the fishery culture and community. The interviews with local residents, eco-activists and students help to understand different perspectives on the matter and evaluate the challenges faced by the fishery industry due to the shrinking of the sea, including declining fish populations and changes in fishing practices. Potential solutions for sustaining fishery culture in the Aral Sea region or for transforming it in another source of income for the local community, such as promoting sustainable fishing practices, community-based tourism activities, festivals and developing alternative economic opportunities for local communities, are discussed in connection with network-based interventions. Overall, this article provides insights into how to support sustainable resource use in the region, and how the local communities are affected by disappearance of Aral Sea.
6	QUESTIONS OF FISHERIES, 2024. Volume 25. No. 2. pp. 33–50 PROBLEMS OF FISHIRIES, 2024. Vol. 25. No. 2. P. 33–50 FISHES OF THE MODERN ARAL SEA © 2024 A.O. Smurov (AuthorID: 93107), I.S. Plotnikov (spin: 1581-5135), N.V. Aladin (spin: 8047-5003) Federal State Budgetary Institution of Science Zoological Institute of the Russian Academy of Sciences (ZIN RAS), Russia, St. Petersburg, 199034 E-mail: igor.plotnikov@zin.ru	The purpose of this review article is to describe changes in the ichthyofauna of the Aral Sea in the 20th and 21st centuries. and comparison of the structure of fish catches in the Aral Sea of the 20th century. with those in the Small Aral of the 21st century, as well as a generalization of data on the biology of fish species newly introduced into the Small Aral. In the first half of the 20th century. 20 species lived in the sea, of which carp fish predominated. After a series of acclimatization measures were carried out in order to enrich the ichthyofauna, 17 new species of fish appeared in the Aral Sea, but the composition of commercial species changed little. Until 1960, the Aral Sea was in a quasi-stable state.
7	“The World Bank and the Food and Agriculture Organization of the United Nations/ World Bank	This study was subsequently carried out on behalf of the Ministry of Ecology’s

Ref	Title	Overview of existing studies (institution, focus, date)
	Cooperative Programme, 2022. Market Growth Potential for Kazakhstan Fisheries and Aquaculture Products. © World Bank."	Committee for Fisheries to explore national, regional, and more distant international market trends and opportunities for species and product forms currently being produced or contemplated under the NFDP. The information, knowledge, and insights provided by this report are intended to help the Government of Kazakhstan and other investors/ donors in the private and public sectors make informed decisions on potential investments and other support to the country's fisheries and aquaculture sector.
8	KAZAKHSTAN: North Aral Sea Development and Revitalization Project Preparation Mission October 3 - 14, 2022 Aide Memoire	A World Bank Mission9 (the Mission) visited Kazakhstan on October 3-14, 2022 to provide preparation support for the North Aral Sea Development and Revitalization Project. To improve the Aral Sea water environment, provide local livelihood-enhancing conditions and opportunities, strengthen the integrated management of water resources in the Aral Sea-Syr Darya basin, and enable improved holistic natural resources planning and development in the Kyzylorda region. The Mission visited Shymkent, Shardara, Turkestan, Kyzylorda, Aralsk and Astana cities, conducted detailed review of the Feasibility Study and the proposed design of the project components, as well as discussed other project preparation activities with key stakeholders, including the Committee of Water Resources (CWR) of the Ministry of Ecology, Geology and Natural Resources (MEGNR) and its Project Management Unit (PMU), Kyzylorda Regional Administration (Kyzylorda Regional Akimat), Akimat of the Aral Rayon, Kazvodkhoz organization (KVK), the Executive Board of the International Fund for Saving the Aral Sea in Kazakhstan (IFAS Kazakhstan), as well as consultancy firms for the project Feasibility Study (Yekom Engineering Ltd) and Environment and Social Impact Assessment Study (Eco-Spectri Ltd/IE

[9] The Bank mission team included: Bakyt Arystanov (Task Team Leader, Water Resource Management Specialist), Abdulhamid Azad (Lead Water Resource Management Specialist, co-Task Team Leader), Robert Wrobel (Senior Social Development Specialist, co-Task Team Leader), Asferachew Abate Abebe (Senior Environmental Specialist), Harjot Kaur (Senior Social Development Specialist - remote), Ximing Zhang (Dam Safety Specialist – remote), Jamal Abdulla Abdulaziz (Senior Procurement Specialist – remote), Anara Akhmetova (Procurement Assistant - remote), Aliya Kim (Financial Management Specialist - remote), Togzhan Alibekova (Water Resources Management Analyst), Katerina Engelgardt (Operations Analyst), and Azat Alkeyev (Program Assistant).

Ref	Title	Overview of existing studies (institution, focus, date)
		"Diamond"). The list of people met is in the Annex 1. The Mission would like to thank the Government of Kazakhstan for the hospitality and cooperation extended to the Bank team during the Mission. The key findings presented in the Aide Memoire (AM) were discussed at the wrap-up meeting with Mr. Serikaliy Mukatayev, the Vice-Minister of MEGNR and other counterparts. The final version of the AM was subsequently endorsed by the Bank management.
9	INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT Project Appraisal Document ON A PROPOSED LOAN IN THE AMOUNT OF US$ 213 MILLION TO THE REPUBLIC OF KAZAKHSTAN FOR A NORTH ARAL SEA DEVELOPMENT AND REVITALIZATION PROJECT {RVP/CD CLEARANCE DATE}	WB Proposal 2026 to 2030 The Project Development Objectives (PDOs) are: (1) to improve water resource and environmental conditions and management; and (2) to provide associated local livelihood-enhancing and community-improving opportunities and facilities; all in Aral Sea and adjacent basin areas of Kazakhstan. Achievement of the PDO is to be effected through (a) infrastructure provisions for further increases in NAS water volume, area and level, (b) infrastructure provisions and complementary measures for wetlands conservation, seabed stabilization and environmental enhancement in the SAS areas below the Kok-Aral dike, (c) complementary targeted and inclusive local socio-economic and socio-environmental developments in fisheries, tourism, afforestation, agriculture, livestock, and basic infrastructure and services, (d) technical and institutional water management developments for basin-based decision-supporting data management and water balance assessment systems, and (e) dam safety enhancements. PDO Level Indicators Increased NAS water surface area (km2). Land area under sustainable landscape management practices (core results indicator (CRI)) (ha). Persons benefitting from improved livelihood opportunities supported by the project (total overall / total female). Persons benefitting from improved access to basic infrastructure and services supported by the project (total overall / total female) Basin-based water management decision support system, incorporating climate change considerations, and

Ref	Title	Overview of existing studies (institution, focus, date)
		corresponding stakeholder forum, established and institutionalized for routine and sustainable operation. Investments under the project are expected to generate substantial incremental benefits in terms of: (a) improved fish production; (b) guaranteed supply of fish stocks; (c) improved crop and forage production; (d) improved livestock production due to improved pasture productivity and rangeland management; (e) improved tourism in the region; (f) increased afforestation activities; and (g) improved basic infrastructure and services for the region's communities.
10	Past, Present and Future of the Aral Sea - A Review of its Fauna and Flora before and during the Regression Crisis Igor S. Plotnikov1 , Nikolai V. Aladin1 , Lubov V. Zhakova1, Jens Mossin2, and Jens T. Høeg3,* 1Zoological Institute, Russian Academy of Sciences, Universitetskaya nab. 1, St. Petersburg 199034, Russia. E-mail: Igor.Plotnikov@zin.ru (Plotnikov); Nikolai.Aladin@zin.ru (Aladin); Lubov.Zhakova@zin.ru (Zhakova) 2Gentoftegade 76, DK-2820 Gentofte, Denmark. E-mail: jmobranch@gmail.com (Mossin) 3Section of Marine Biology, Department of Biology, University of Copenhagen, Universitetsparken 4, DK-2100 Copenhagen, Denmark. *Correspondence: E-mail: jthoeg@bio.ku.dk (Høeg). Phone: +45 28 75 12 47 Received 21 July 2022 / Accepted 28 January 2023 / Published 12 May 2023 Communicated by	review the past, present and possible future of the Aral Sea system in context of the human caused regression crisis that resulted in the drying out of the larger part of this original brackish water sea. The results are put into the context of other threatened saline lakes and the general water crisis in the world due to overexploitation of water resources and climate change. We cover the geographic history and hydrology from the origin of the sea 17,000 years ago to the present. The original biota including animals, higher plants and algae are covered in full detail, and tracked through the regression crisis. We put special emphasis on fish and fisheries because of their economic importance for the surrounding populations. We also review the side effects of the regression in terms of human health and changes to the terrestrial environment and local climate. We explain the dramatic improvements to the fauna in the northern Small Aral Sea following the construction of dams to retain its waters and discuss future options to further improve this restored water basin. We contrast this with the progressing hypersalinization of the remnants of the southern Large Aral Sea, which faces conditions that will eventually render a "Dead Sea" condition hostile to all metazoan life. We end by highlighting the partial restoration of the Small Aral Sea as an example of how much restoration can be achieved for relatively little financial expense and in a short period, when good ideas, kind hearts and hard work operate together for the benefit of the environment and our human society.

Ref	Title	Overview of existing studies (institution, focus, date)
11	Kazakh Researcher Discusses Water Scarcity, Regional Cooperation Mechanisms By Assel Satubaldina in Central Asia, Editor's Picks on 16 July 2024 https://astanatimes.com/2024/07/kazakh-researcher-discusses-water-scarcity-regional-cooperation-mechanisms/	The future of water in Central Asia may look grim – rapidly growing population, climate change, and add inefficient water use to that. But regional cooperation, though varied, gives hope. In an interview with The Astana Times, Zhaniya Khaibullina, a water security researcher at the Al-Farabi Kazakh National University, discusses water management issues, the legacy of the Aral Sea crisis, and regional cooperation mechanisms.
12	Diffey, S. and Kurbanov, A. 2022. Aquaculture Sector Situational Analysis of Uzbekistan. Tashkent, FAO. https://doi.org/10.4060/cb8803en	Uzbekistan has abundant inland water resources, namely rivers and lakes, which are suitable for freshwater aquaculture. However, the production of fish is generally low compared to the resource potential due to the collapse of collectivized farms, a lack of interest in commercial operations and producer associations by local farmers, and the limited capacity of government extension and research facilities to promote fish production. Growing interest by the Government in fish production has led to an increase in investment in the aquaculture sector. This has resulted in significant gains in fish production in recent years. Government land distribution schemes for smallholder fish farmers to establish individual fishponds to produce carp are a major contributing factor to these gains. There is no existing national fisheries or aquaculture sector specific development policy or plan, and reference to government policy towards the sector are through a number of existing presidential decrees. Given that the sector has witnessed a significant increase in fish production over the last years, addressing this issue (using other country fisheries policy and legislation as a potential model) was seen as an important first step for any coherent strategic plan for the sector. The report was compiled in 2020 as one of the outcomes of the TCP/UZB/3703 project focusing on

Ref	Title	Overview of existing studies (institution, focus, date)
		national review and strategy for aquaculture sector and fish value chain in Uzbekistan. Due to the COVID-19 pandemic, this report was based solely on data sourced from the internet, academic papers and field data provided by the national consultant, including aquaculture value chain mapping and analysis of the project. The report includes a description of the Uzbek aquaculture sector, analyses its problems and opportunities, and presents options for its development.

Annex 2 World Bank Value Chain Screening Matrix and Data Gaps

Key criteria	Questions to answer to help decide score (these are suggestions - delete or add others to suit the project objectives)	Notes based on stocktaking report

I	FEASIBILITY		
A	**Economic feasibility**		
1	Unmet or growing **market demand**	* What is the current market demand for the species (specifying, where possible, market segments, market share, trends and seasonality)? * Is there growing and/or unmet demand from local, national, regional and/or international markets, considering all product forms (e.g. fresh, packaged, frozen and processed)? * Are there opportunities to expand to new markets (national or international)? * What are the trends in production volumes compared with consumption volumes? * What are the trends in import volumes compared with export volumes? * Are there any limitations in the VC to meet the market demand/access the new markets * Confirm population growth see world bank data * Confirm middle income growth see world bank data .	Info on end markets is available for different species and the WAPI profiles are helpful in terms of current situation and possible future demand. Some production data is available for Kaz but not for Aral Sea specifically. More info on end markets required especially to identify likely future demand and market requirements. It is highly likely that the demand for some species will remain strong due to population growth and the difficulties farming some species e.g. zander, roach. Carp is an important domestic / regional species. Aquaculture has not taken of in Kaz but has in Uz. Should there be a focus on carp and Kaz and aquaculture? Questions: Should the multi-species fishery be drilled down to understanding the main species/products in more detail and therefore rapid analysis of the zander, carp, roach VCs? Export vs domestic vs regional VCs?
2	**Competitive advantage** in terms of price advantage, efficiency and product differentiation;	* Are there opportunities to reduce costs (e.g. strategies, practices, technologies) compared with competing products (including imported)? * Are there opportunities to increase efficiency or scale up operations (e.g. through improving the skills of value chain actors, introduction of new technologies)? * Are there opportunities for product differentiation and value addition (e.g. strategies, practices, technologies to differentiate product and/or substitute imports in terms of quality, nutritional value, origin, taste, compliance with standards, certifications)?	A more detailed value chains and market analysis is required.
3	Engagement of **Private Sector**	* How many businesses are currently operating in this value chain (what is the currentnumber of VC actors), and at what scale?* What is the gauged interest from VC actors (i.e. producers, aggregators, processors,etc.) to invest and engage in developing this value chain (considering perspectivesfrom both men and women involved in the chain)?* What are VC actors' attitudes towards change, innovation and investment?* What is the availability of labour, by skills and education (compare available andrequired skill levels swwfor value chain upgrading, as there may be labour shortages dueto skills mismatches)?* see global competitiveness report/ world economic form	Some data available on numbers, but required validation. Stakeholder engagement required to address most of these issues e.g. interviews, inception workshop.

4	Potential to manage **market & logistical risks**	* How vulnerable is this value chain to market shocks (e.g. volatility of inputs availability or prices, ability to repay loans, changes in consumer preferences, changes in consumers' purchasing power, changes in quality and food safety requirements)? * How vulnerable is this value chain to logistical risks associated with access to reliable and affordable transport, communications, energy and information (e.g. investments in and maintenance of transport, storage, energy infrastructure, logistics planning, information services and technology)? * What is the potential of the businesses in this value chain to manage these risks at each VC stage (e.g. market and product diversification, adaptability, research and development, price regulations, information services and technology, safety nets, credit and savings)?	Not enough data available. Stakeholder engagement required. Focussing on one species may make data collection and analysis easier. See above re narrowing down the focus.
5	**Governance** - the level of stakeholder coordination	* What are the current governance mechanisms, i.e. formal and informal horizontallinkages (e.g. cooperatives, associations) and vertical linkages (e.g. contractualarrangements) among VC actors and with support service providers?* To what extent do all actors (including small-scale actors) have a say in the overallgovernance of the value chain?* What is the quality of pre-existing cooperatives, associations, etc. and what are themembership benefits?* What are the current power structures and how concentrated is market influence orcontrol? How dependent are producers on middlepersons and intermediaries?* What is the level of trust between actors, in terms of the flow of information andreliability of transactions among VC actors?	There is relatively more information available on these issues. It would be prudent to validate it. Key issues are: 18 fishing spots/areas exist and are leased to mainly processing factories. They are responsible for management of the fishery and investment and hence have the greatest power. One factory has 5 fishing spots. Fishers have little say in decision making. Associations appear weak. There appears to be overfishing/lack of enforcement of management regulations.
B	**Societal feasibility**		
6	**Government support**	* How does the government support this VC – e.g. have there been any governmentsupport projects (past, current or planned) and has this value chain been prioritized as astrategically important national VC (e.g. is this value chain named in national strategies)?* What policies, regulations and laws are applicable to this commodity, and how arethey conducive (or not) to VC upgrading (e.g. support to trade, access to inputs,collective action, ease of doing business, labour conditions)?* Are the policies, regulations and laws well enforced?* How well do available public services (e.g. extension, research, education)and physical infrastructure (e.g. road networks, electricity, information andcommunications technology) support VC upgrading?* How well do relevant governing ministries and agencies coordinate for the benefit ofthe sector?* How well do the public and private sector collaborate?* What is the ease of doing business (e.g. in terms of reducing the time and resources ittakes for business registration, delays, paperwork, fees)?	Government interest in developing Aral Sea basin. Regional collaboration is important in terms of water required for the fishery. Management regulations are in place. Perhaps require reviewing. Information suggests enforcement could be more effective. Basic services at production level are said to be weak. Over capacity at processing level. Some issues will require stakeholder engagement.

7	**Donor and partner support**	* What are the current contributions by donors and partners (e.g. international organizations, NGOs) to the sector in terms of funds and services? * What are the opportunities for support from donors and partners? Are donors interested in supporting this value chain (e.g., provision of relevant project reports)? * What is the level of coordination between donors and partners, government and local stakeholders (e.g. joint initiatives)?	Donor interest e.g WB, USAID, GIZ International Fund For Saving the Aral Sea (IFAS) …not sure where funding comes from? They seem to have a coordination role.
8	Availability of and access to **support services**	* What is the state of the existing support services (e.g. provision of finance, inputs,extension, transport, storage, business development services)?* What training do VC actors receive and what is their technical capacity to improvetheir knowledge?* What is the willingness and availability of financial resources (traditional orinnovative) to finance any VC upgrading?* How easily can VC actors access these support services and inputs?* Are there targeted services for disadvantaged groups (e.g. smallholders, youth andwomen)?	Evidence suggests that these issues are under developed and require support but this needs to be validated with stakeholders.
9	Potental to manage **socio-political risks**	* How might sociocultural norms (e.g. traditions, religious beliefs, codes of conduct, gender norms) support or impede VC upgrading? * What is the potential to overcome adverse sociocultural norms that impede value chain activities (e.g. gender discrimination)? * How does or might the sociopolitical situation impact this value chain (e.g. political instability within a country or with neighbouring countries, social unrest, involuntary resettlement and displacement, upcoming elections, or corruption issues)? * How vulnerable is this value chain to sociopolitical risks, and what is its ability to manage political and institutional risks?	Due to the regional importance of water resources, scarcity and their management, socio political vulnerability to negative change is high.
C	**Environmental feasibility**		
10	Suitability of **natural resources** in terms of availability and quality	* What is the availability and quality of natural resources and elements (e.g.ecosystems, land, water, fish stocks) at each value chain stage, and is this sufficient to make the end products?* What is the current status of the wider natural resource environment (e.g. pollutionand hazardous waste, algal blooms) and how does it impact the value chainactivities?* How suitable and effective are the governance and management mechanisms foruse of and access to natural resources (e.g. resource monitoring, participatoryapproaches, access rights)?	Evidence suggests governance at the production level could be improved. It appears IUU is evident. The fisheries management approach could be reviewed and made more inclusive or community based? Downstream VC stages not so well understood. But there appears to be an oligopoly controlled by processing companies. Water quality is researched and more needs to be understood on how this impacts sustainability.

11	Potential to manage **weather-related, environmental & biological risks**	* How vulnerable is this VC to weather-related risks (e.g. deficit and/or excess rainfall or temperature, climate change and extreme weather events such as floods, droughts, storms)? * What is the potential of this value chain to manage weather-related risks (e.g. through insurance, capacity development, early warning systems)? * How vulnerable is this VC to environmental and biological risks (e.g. pests and diseases, contamination and degradation of natural resources)? * What is the potential to manage environmental and biological risks (e.g. pest management, research and development, capacity development)?	To a certain extent the VC is already shaped by extreme weather events such as very cold winters and hot summers which effect fishing activities and hence the VC as a whole. Long term climate change is seen as a threat as is general demand for water within the CIS region. Pollution from agriculture is a biological threat. Regional mechanisms to combat threats such as IFAS exist.
II	**IMPACTS**		
A	**Economic impacts**		
13	Increase in **wages and** paid **jobs**	* Based on the current number of actors involved, and comparing the sector with othersimilar VCs in-country, regionally or internationally, what is the potential for jobgrowth and job creation through VC upgrading (consider formal and informal jobscreated along the core and extended VC and mentioning gender, age and skill level,where possible)? Also, consider the alternative – What is the potential for job losses(e.g. by introducing more efficient and labour-saving technologies: mechanization atfarm level, machines for processing and packaging)?* What is the potential for increasing salaries (e.g. increased labour productivity,capacity development, technology adoption, or efficiency)?	Historically the RLC Fishery employed many thousands of people at the fishing and processing stages. Since the fishery has shrunk major job losses than migration have occurred. At the moment it's not clear whether a significant jobs could be created at the phishing level since the results appears to be fully exploited and is only seasonally accessible. Hence fishing is more of a part time activity. Likewise at the processing level it's unlikely that significant job increases could be created because processing relies on production and volume of fish caught. More efficient processing is likely to lead to job losses EG the use of mechanised processing equipment will reduce the need for manual labour. More needs to be understood about wage structure and opportunities for increasing value before any conclusions can be made about salary increases.
14	Increase in **Profits** and number of enterprises	* What is the potential to increase profits (e.g. through increased productivity, technology adoption, access to financial services, capacity development, waste management or reduced food loss and waste, improved energy efficiency)? * Would consumers be willing to pay higher prices for better quality products (e.g. safer, better packaging)? * What is the potential for growth for new entrepreneurs/enterprises through VC upgrading (consider growth created along the core and extended VC)?	Not enough information is available on these issues at the moment. VC analysis required.
15	Increase in **tax revenues**	* What is the potential to increase in tax revenues through VC upgrading (e.g. formalization of agribusinesses; increase in licences, permits and certificates related to ownership/use of inputs and resources; fees/levies on imports and exports)? * What would be the potential tax generation through agribusiness formalization – based on an estimated number of businesses that could be created or formalized through value chain development and current fees associated with the formalization of businesses (e.g. Occupational Safety and Health Administration, business registration)?	Not enough information is available on these issues at the moment. VC analysis required.

16	Increased **consumer benefits**	* What are the potential consumer benefits from VC development (e.g. improved taste,nutritional value, safety, convenience, branding, social standards (such as fair trade),environmental standards (such as eco-labelling or organic))?	It's not clear what consumer benefits are achievable. More information is required on the market for fishing fish products and the consumer. Unless production is increased whether it be from the capture fishery or aquaculture it is likely that the price of fish will increase and therefore the consumer will be worse off going forward having to pay higher prices. Uzbekistan has significantly increased production through aquaculture and made fish more available to consumers. Kazakhstan may wish to explore a similar line of investment.
B	**Social impacts**		
17	Equitable **distribution of value-added**	* Based on the benefits that are currently distributed across the value chain, what is the potential to improve the distribution of economic benefits (i.e. wages, profits) among various actors along the VC, so as to be more equitable, particularly for marginalized or disadvantaged groups?	More info required. Disadvantaged groups could be fishers.
18	Increased **food security, safety and nutrition**	* What is the potential to increase the availability, affordability and consumption of nutritious and safe products (e.g. improved inputs or technology, processing, compliance with standards and regulations, reduction of food loss and waste)? * What is the potential to improve food safety (e.g. improved regulations or enforcement)? * What is the potential to increase demand for nutritious and safe food through this VC (e.g. consumer awareness, direct provision through vouchers and school feeding programmes)?	Increasing production volumes would contribute to food security. It appears the fishery is producing its maximum. Its likely demand will increase naturally due to population growth. Not enough info available on food safety and nutrition. Developing aquaculture in Kazakhstan would increase availability.
19	Enhanced **workers' rights & safety**	* What is the potential to improve working conditions and promote decent work (e.g.prevention and reduction of discrimination at work; ensure an adequate living income;enforcement of working hours; occupational safety and health measures; improvedemployment security and stability)?* What is the potential to build capacities of workers (e.g. through creation ofopportunities for improving skills and education)?* How will value chain development prevent, reduce or eliminate child and forcedlabour?* What social protection mechanisms are available to compensate for job risks (e.g.unemployment, injury)?* What is the potential to improve worker's rights, including freedom of associationand collective bargaining?* How could the VC protect or enhance human health (e.g. safe handling practices,minimization of harmful chemicals)?* Confirm ILO office presence and any relevant ILO reports	Not enough info.
20	Enhanced and more inclusive **socio-cultural norms**	* What is the expected impact on sociocultural norms (e.g. gender norms, inclusion, entrepreneurship, consumer preferences, animal welfare, and food loss and waste)? * What is the potential to avoid/mitigate socially unacceptable outcomes (e.g. tensions, social conflict, human rights violations)? * What is the potential to enhance positive attitudes towards jobs and entrepreneurship in this sector, especially among women and youth?	Not enough info available.

21	Strengthened **social institutions**	* What is the potential impact of value chain development on policies and institutions('rules of the game', including policies, laws, regulations and business practices) –(e.g. through creating, amending or removing policies)?* What is the impact on organizations (e.g. organizations, cooperatives, associations)?* What is the potential to increase coordination and reduce transaction costs along theVC? How likely would it be to implement these changes?* How would VC development impact related policies, laws, regulations, businesspractices, government coordination and public-private partnerships (policies may berelated to markets and trade, input provision, business registration, natural resourcemanagement protection)?	Not enough info available.
C	**Environmental impacts**		
22	Reduced **carbon footprint**	* What is the potential impact on greenhouse gas (GHG) emissions, such as carbon dioxide and other hazardous gas emissions? * Which potential practices, regulations and knowledge could be improved to reduce carbon and hazardous gas emissions along the core and extended value chain, including food loss and waste management? * What is the potential impact on energy efficiency and increased use of renewable energy (e.g. electricity, cold chain, transportation)?	Not enough info.
23	Reduced **water footprint**	* What is the potential impact of the value chain upgrading activities on the water footprint? * Are there potential practices, regulations and knowledge that could be improved to reduce water use or water pollution (e.g. wastewater treatment)? * What is the potential to improve water management and water-use efficiency (e.g. improved irrigation or reduction of food loss and waste)?	Certainly water is a core and controversial issue. It is rather a regional water management issue rather than a VC issue. Higher level focus.
24	Improved **biodiversity**	* Considering the current risk of biodiversity loss, either through overexploitation oftarget or non-target resources or production practices (including genetic dilutionor introduction of diseases or invasive species), what is the potential impact onbiodiversity (e.g. endangered or threatened species, improved agrobiodiversity)?* How could practices, regulations and knowledge for the conservation of naturalhabitats, species and genetic diversity, endangered or threatened species andecosystem services be improved through VC development?	More info required on this.
25	Improved **ecosystem management**	* What is the potential impact of the value chain, including the equipment, tools and practices employed (e.g. gear, fishing practices, processing technology) on the supporting or surrounding ecosystems (e.g. habitats, soils, forests, water or air quality, waste management)? * What is the potential impact of value chain upgrading on habitats, ecosystems or ecosystem services (e.g. controlling pests and diseases, toxicity, air pollution, solid inorganic or organic waste disposal)? * How could practices, regulations, resource management and knowledge support ecosystems ?	This first question is not clear. Either there is an impact or not…what is the current impact would be more appropriate. In this case it is rather the impact of the external factors on the VC that is the issue. Without defining what upgrading will look like it is difficult to suggest how it may have an environmental impact.