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Virtual workshop report

Climate change adaptation in fisheries and aquaculture

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About the Workshop

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Scope, objectives & participants

The virtual workshop was formulated under the project "Capacity Building for Sustainable Fisheries and Aquaculture Management in Central Asia, Azerbaijan, and Turkey (FISHCap): - GCP/SEC/013/TUR" implemented under the FAO-Turkey Partnership Programme on Food and Agriculture (FTPP II) funded by the Government of the Republic of Turkey.

The event was organized from 23–24 June 2020 in two sessions in cooperation with Bogazici University's Center for Climate Change and Policy Studies, a research centre conducting interdisciplinary research on the impacts of climate change in regions such as the Eastern Mediterranean, the Middle East, and Central Asia.

The virtual workshop aimed to provide an overview of the status and impacts of climate change on aquaculture and fisheries in Central Asia and the Caucasus and to discuss potential adaptation and mitigation activities. The agenda of the workshop is provided in Appendix 1. The workshop was conducted in English and Russian with

simultaneous interpretation. The event was originally scheduled to be held physically in Istanbul, Turkey from 30–31 March 2020 but was postponed due to the COVID-19 pandemic, which has caused substantial delays in the delivery of national and international activities.

The following countries were invited to nominate up to seven participants each: Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkey, Turkmenistan, and Uzbekistan. The target audience of the virtual workshop included government staff, decision-makers in fisheries and aquaculture management, academicians and researchers involved in climate change issues as well as fish farmers and representatives of fishery/fish farming organizations. The workshop was attended by more than 60 experts from the project's target countries. The list of participants is included in Appendix 2.

Climate change is an increasing global challenge which requires urgent, coordinated, and consistent action. There are several international instruments for combating climate change. Included is the 2015 Paris Climate Agreement, which recognizes the need for effective and progressive responses to the urgent threat of climate change through mitigation and adaptation measures while taking into account the particular vulnerabilities of food production systems.

Fisheries and aquaculture are important contributors to the food supply, food security, and livelihoods at both the local and global levels. Climate change affects fisheries and aquaculture via acidification, changes in sea temperatures and circulation patterns, the frequency and severity of extreme events, and sea-level rise and associated ecological changes. Both direct and indirect impacts include changes in targeted populations' range and productivity, habitats and food webs as well as impacts on fishery and aquaculture costs and productivity and fishing community livelihoods and safety. Fish feeding, migration, and breeding behaviours are directly affected and changes in their physical environments indirectly affect growth, mortality and reproduction.

Inland waters are particularly vulnerable to climate change and, in the short term, it is anticipated that climate change will affect inland fisheries through incremental changes in water temperature, nutrient levels, and lower dry season water levels. In addition, climate change could have either positive or negative impacts on aquaculture, which might arise from direct and indirect effects on the natural resources that aquaculture requires, i.e. land, water, feed, seed, and energy.

As fisheries play a significant role in providing feed and seed inputs, productivity and profitability of aquaculture systems could also be directly affected by climate change. Thus, dependency on natural resources and exposure to extreme weather events will give rise to the vulnerability of aquaculture-based communities. Climate change could lead to increased physiological stress on the cultured stock. This would not only affect productivity but also increase susceptibility to diseases; this, in turn, would result in higher risks and reduce profitability for farmers.

Climate change is expected to have direct and indirect impacts on the aquaculture sector. The significant socio-economic role of aquaculture in terms of job and income generation as well as food security and economic development calls for a proactive approach to the development of adaptation and mitigation policies towards climate change and aquaculture interactions. Awareness raising and understanding the perceptions of aquaculture stakeholders regarding the impact of climate change on aquaculture are important pillars for developing adaptation and/or mitigation policies.

Central Asia is particularly vulnerable to climate change. Among the 28 nations of Europe, the Caucasus, and Central Asia, the World Bank has given the highest vulnerability ranking to four of the five Central Asian countries, with the most vulnerable being Tajikistan and Kyrgyzstan (Zoi Environment Network, 2009). The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report states that climate change poses serious threats to Central Asia's environmental, ecological, and socio-economic systems, particularly because of the arid nature of the region (IPCC, 2007).

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A technical cooperation project titled "Strengthening the Adaptation of Aquaculture and Culture-based Fisheries for Climate Change" was conducted between 2013 and 2015 with the participation of Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan. The project generated a regional action plan for managing climate change-related risks in aquaculture and culture-based fisheries in the region. The plan, however, has not yet been implemented.

Technical highlights

FIRST DAY OF THE WORKSHOP

The first day of the workshop started with opening remarks from Viorel Gutu, Sub-regional Coordinator for Central Asia and FAO Representative in Turkey. Gutu stated: "*The FISHCap is one of the significant projects developed and implemented under the FAO–Turkey Partnership Program (FTPP-II). Fisheries and the aquaculture sector became a priority area in FTPP and even among countries across the region. Aquaculture, which is an important sector that globally provides food and income, is extremely vulnerable to climate change, so we need to pay attention to its sustainable management, development, and resilience to climate change. We need advanced collaboration, policy development, and investments in fisheries and aquaculture*".

Thereafter, M. Altuğ Atalay, Director General for Fisheries and Aquaculture in the Turkish Ministry of Agriculture and Forestry, took the floor and outlined key points for consideration, goals, and pathways for sustainable development of the sector: *"Especially in the aquaculture sector, it is aimed to cultivate fish species by developing methods to minimize the vulnerability of these species to climate change. Adequate conditions for resource conservation should be developed; examples of best practices should be identified and further applied. Conserving resources will affect our aquaculture policy in the future. As for the subject we work with, the effects of climate change on invasive species, local species, and carrier species will be determined, and mapping of biodiversity sensitivity of the seas will be improved*".

Finally, Levent Kurnaz, Manager at Iklimbu (Bogazici University Center for Climate Change and Policy Studies), delivered a welcome speech underlying the relevance and importance of the topics covered in the workshop for the Central Asia and Caucasus region.

Main topics of the first day:

- **physical drivers of climate change impacting aquatic ecosystems;**
- **impacts of climate change on fisheries, aquaculture, and water resources in Central Asia;**
- **the impacts of climate change on inland fisheries.**

Technical sessions were moderated by Haydar Fersoy, Senior Fishery and Aquaculture Officer at FAO. The main topics discussed on the first day were the physical drivers of climate change impacting aquatic ecosystems; impacts of climate change on fisheries, aquaculture, and water resources in Central Asia; and the impacts of climate change on inland fisheries. The objectives and expected outputs of the Virtual Workshop were introduced by Ramazan Çelebi, National Fisheries Expert at FAO.

Dursun Yıldız, Water Resources Engineer at the Hydro Politics Academy, stressed the following projections and threats:

- physical drivers of climate change create significant threats to the species composition and function of aquatic ecosystems;
- as climate change alters ecosystem productivity and species composition, many unforeseen ecological changes are expected;
- these changes may threaten the goods, services, and systems that help secure human well-being;
- management priorities should include these emerging threats.

Serik Timirkhanov, Head of Aqua Alliance LLP (Kazakhstan), made a detailed presentation covering the basic geographical and climatic characterization of the region. The presentation also provided information on observed/reported effects of global warming in the Central Asia region:

- an increase in water temperature and evaporation;
- an increase in total runoff over about half a century (due to glacier melt) and the subsequent complete dependence of runoff on precipitation with unpredictable changes in volume and distribution;
- an increase in the energy and frequency of adverse events (wind, storms);
- sharp fluctuations in water availability and water temperature in adjacent years.

Levent Kurnaz briefed the workshop about the work of IklimBU on the impacts of climate change on water resources in Central Asia and the Caucasus region. He also shared with the participants the experience of BU/CORDEX as the domains of Central Asia, under the International Coordinated Regional Climate Downscaling Experiment (CORDEX). Displayed climate change maps indicated a clear warming trend in the region over the last few decades.

SECOND DAY OF THE WORKSHOP

The second day was devoted to the topic of the international response to climate change, economic instruments for combating climate change, perceptions of Turkish aquaculture stakeholders on climate change-aquaculture Interactions, and climate-smart fisheries and aquaculture. The presentations each day were followed up by an open discussion.

Haydar Fersoy, Senior Fishery and Aquaculture Officer at FAO and the Lead Technical Officer of the project, delivered a presentation titled "International Action on Climate Change: International Governance Instruments for Climate Change". He underlined the targets of the international instruments (i.e. The United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement) as well as key achievements and challenges in the implementation of

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these instruments. He underlined the apparent impacts with immediate consequences due to an unprecedented level of increasing climate change. Along with these adverse impacts on livelihoods, disasters and extreme weather events such as drought, floods and cyclones, and their impact on productive sectors, including fisheries and aquaculture; and the 20 warmest years on record over the last 22 years were discussed. Fersoy stated that the 2018 Special Report of the IPCC projects that global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate. Although the Paris Agreement sets out a global framework to limit global warming to between 1.5°C and 2°C, Fersoy asserted that such an international commitment requires urgent action. IPCC warns that exceeding 1.5°C warming compared to pre-industrial levels will lead to catastrophic consequences, as the global average temperature is already more than 1°C higher than the pre-industrial era.

Main topics of the second day:

- **international response to climate change;**
- **economic instruments for combating climate change;**
- **perceptions of Turkish aquaculture stakeholders on climate change-aquaculture Interactions;**
- **climate-smart fisheries and aquaculture.**

Evetta Zenina, Natural Resources Officer (Climate Change) at FAO gave the presentation on economic instruments for combating climate change, noting the following:

Adaptation can be planned or autonomous (i.e. a spontaneous reaction to environmental change or a planned action based on climate-induced changes). Autonomous adaptation in fisheries may be changing the timing or locations of fishing as species arrive earlier or later or shift to new areas. Planned adaptation in fisheries may be securing research funding for finding species resistant to salinity and temperature fluctuations for aquaculture. Although adaptation is context-specific, there are a number of adaptation activities that can be applied in most fisheries and aquaculture contexts. These include:

- reduction of external stressors on natural systems;
- identification and protection of valuable areas;
- investments in safer harbours and landings and early warning and forecasting systems;
- promotion of disaster risk management;
- capacity building;
- financial mechanisms;
- market-based instruments (price-based or quantity-based);
- monitoring; and
- international trade.

Zenina gave detailed information on the FAO Adaptation Toolbox for fisheries and aquaculture, which comprises a set of climate adaptation tools and methods recommended and currently available to governments, industrial bodies, and individual fishers and fish farmers.

John Jorgensen, Fishery and Aquaculture Officer at FAO, gave a presentation on the overview of the impacts of climate change on inland fisheries. He started his presentation by introducing the 2018 FAO Review, *Impacts of Climate Change on Fisheries and Aquaculture: Synthesis of Current Knowledge, Adaptation and Mitigation Options* (available at http://www.fao.org/3/i9705en/i9705en.pdf). Jorgensen continued with an explanation of the distribution of the earth's freshwater resources. He elaborated on the impact of climate change on the structure and functioning of aquatic ecosystems, such as pollution, over-exploitation, flow, changes in flood patterns, water abstraction, fragmentation, and temperature changes with examples.

Ferid Rad, Professor at Mersin University Department of Fishery, shared his experiences related to the *Perceptions of Turkish Aquaculture Stakeholders on Climate Change-Aquaculture Interactions*, a study funded by the European Union's Horizon2020 research and innovation programme under grant agreement No678193 (CERES, Climate Change and European Aquatic Resources). He gave detailed information on the project's key findings as follows:

- There is a relatively high level of awareness about climate change (CC) and aquaculture interaction among Turkish producers.
- Producers regard climate change and its impact on aquaculture as a long-term challenge.
- The policy and strategy development on CC adaptation measures the responsibility of public authorities.
- There is an urgent need for a proactive approach by public authorities to assess the risks associated with climate change on aquaculture at the national level and to develop appropriate adaptation and mitigation policies.
- This requires a "bottom-up" and a co-constructive approach through involvement of all aquaculture stakeholders.

The last presentation, on climate-smart fisheries and aquaculture, was given by Binhan Ganioğlu, a freelance consultant (Turkey). Ganioğlu presented the Climate-Smart Agriculture Basics produced by FAO and gave detailed information on the ecosystem approach to fisheries (EAF) and the ecosystem approach to aquaculture (EAA) as approaches for developing climate-smart fisheries and aquaculture.

The workshop noted that climate change is posing considerable risks to aquatic ecosystems and to social and economic systems in the Central Asia and Caucasus region as well as in Turkey. Levent Kurnaz presented examples of future projections of temperature, precipitation, drought and aridity over these areas. He stressed that the lack of long-term historical data in these areas in most cases makes it difficult to make climate change predictions. He highlighted a need to implement a holistic approach to address climate change at the local, national, and regional levels. Fersoy concluded that despite serious challenges, certain opportunities and encouraging signs of increased political commitments and general public awareness about climate change exist in the region.

Situation overview of the impacts of climate change in the Central Asian region

A. The impact of climate change on water resources

There have been several studies on the impact of climate change on water resources in the Central Asian countries. The United States Agency for International Development summarizes the situation as:

> Central Asia is a land-locked region with wide-ranging climate regimes, from arid deserts to mountains with heavy precipitation, contrasts observed both within and across the region's individual countries. For example, while much of the Kyrgyz Republic is considered a moderate climate zone, with 70 percent of land above 2 000 meters (m) in elevation receiving heavy rainfall, the country overall is also highly drought-prone. By contrast, Tajikistan is mostly subtropical and semi-arid, with half of the country sitting at elevations above 3 000 m, while 80 percent of Turkmenistan is flat desert. Generally, across the region, the summers are warm to hot, with mean temperatures ranging from 20°C to 40°C, and winters are moderate to cool, with mean temperatures ranging from -3°C to 20°C. Summer daily maximum temperatures can be as high as 50°C in the deserts, while winter daily minimum temperatures can drop as low as -45°C in some mountainous areas and as low as -18°C in northern parts of the region. Annual average precipitation across highly mountainous Tajikistan is around 500 millimetres (mm), largely during spring and early summer, while Uzbekistan receives less than half as much. Heavy winds are at times prevalent across the region, leading to dust storms in many areas, especially during the months of September and October. Floods and mudflows occur frequently across the region, and droughts are also relatively common (USAID, 2018).

Water resources in Central Asian countries are under the threat of climate change as a result of an increase in water temperature and evaporation, in total runoff over about half a century (due to glaciers melt) and the subsequent complete dependence of runoff on precipitation with unpredictable changes in volume and distribution, an increase in the energy and frequency of adverse events (wind, storms), and sharp fluctuations in water availability and water temperature in adjacent years.

The virtual workshop underlined how the climate system works and that hydrologists are able to evaluate the impact of climate changes on water resources. Climate change is expected to exacerbate current stresses on water resources created by population growth and economic and land-use changes. The impact of climate change on water resources in Central Asia is summarized by Punkari et al (2014):

> The region has two main rivers in Central Asia, the Syr Darya and the Amu Darya, which play a prominent role in the region. People depend on their water for domestic use, farmers rely on it for irrigation, the environment alters if water resources change, and hydropower requires it to supply the region with energy. Besides ongoing economic development with associated changes in water requirements, it is clear that climate change is an additional challenge to the planning and management of water sources. Currently, most water in the region is generated in the upstream mountainous areas. Water flows from smaller streams into bigger streams and finally into the

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Amu Darya and Syr Darya rivers. Increasing evaporation, increasing water usage, and increasing irrigation needs trigger environmental instability in the region.

In Central Asia, mountain snowpack, glaciers, and small ice caps play a crucial role in freshwater availability. The glacial retreat and snow cover reductions observed over recent decades are projected to accelerate throughout the 21st century. The consequences will be a reduction in overall water availability, lower hydropower potential, and changing seasonality of flows in regions supplied by meltwater from the Tien Shan and Pamir mountains. Besides projected changes in precipitation, rising temperatures are an important factor for Central Asia. The large-scale irrigation systems are already suffering from water shortages, and higher temperatures will increase the volume of water required by the irrigated crops. Moreover, higher temperatures will also have an impact on the natural vegetation, and evaporation from these areas will increase so that less water will be available to flow into the streams and rivers (Punkari et al., 2014).

It is also reported in the same study that there are hundreds of proglacial lakes in Central Asia and that many of them have been classified as dangerous. Recent ice surges, outbursts of glacier-dammed lakes, and flooding caused by glacial rivers have caused major disasters. The increasing incidence of glacial lake outbursts can be related to climate warming because receding glaciers generate proglacial lakes. Thawing of an ice core in a terminal moraine damming a lake may cause a breach, leading to the sudden release of a mudflow down to the valley. Government institutions in Central Asian countries map and manage emergency situations. Flood protection interventions and early warning systems are needed in areas that are found to be vulnerable to glacial instability and lake outbursts.

Another issue raised in the virtual workshop was flood hazards resulting from glacier melting. Flood hazards are also noted in *Climate Change in Central Asia: A visual synthesis based on official country information from the communications to the UNFCCC, scientific papers and news reports (Zoi Environment Network, 2009)*. The report underlined that the flood hazards should be very carefully examined for perception in the future. The report summarizes the situation as follows:

There has been a series of glacial outburst floods in the mountains of Tajikistan, Uzbekistan and Kyrgyzstan, making it even more urgent to monitor these hazards. With glaciers melting, glacial lakes appear every summer in the mountains. Some of them grow significantly and, if contained by unstable moraines, they occasionally burst to release large amounts of water in destructive flash floods, sometimes with serious impacts on life and property. Annually, more than 200 potentially risky glacial lakes appear in the mountainous regions above Almaty and Bishkek cities, around Issyk-Kul Lake and the densely populated Ferghana Valley, and in the narrow Pamir and Hissar-Alai valleys. Experts suggest that this number is

> likely to grow with climate change. There have already been deadly floods in the past decade, including the Shahimardan (Uzbekistan and Kyrgyzstan, 1998), Dasht (Tajikistan, 2002) and Issyk-Kul (2008) floods. Some large mountain lakes, such as Sarez Lake in Tajikistan which formed in 1911 as the result of a rockslide in the central Pamir Mountains, represent a serious risk. Situated at an altitude of 3 000 meters, the lake is over 60 km long, almost 500 meters deep and contains 17 km3 of water. If there were a new rockslide into the lake there are fears that a high wave could form, and depending on its volume, the season and the location of the slide, this could cause a destructive flood. In spite of declining precipitation, the water level in the lake is increasing, which is likely due to intensified glacier and permafrost melt caused by climate warming. Other lakes, such as Karakul, show similar increases in water level and surface area due to the more intense glacier and permafrost melt and water inflow (Zoi Environment Network, 2009, p. 29).

In contrast to other parts of the region, some cities have been facing dramatic challenges with rising water levels in glacier lakes when most of the earth is experiencing severe water shortages because of climate change. This threat should be considered in the short term by governments and other international institutions. Effective and implementable measures including sustainable control of accumulated water should be developed to ensure the safety of thousands of communities.

B. The impact of CC on fisheries and aquaculture

Intergovernmental Panel on Climate Change (IPCC) maintains that climate change poses serious threats to Central Asia's environment and ecological and socio-economic systems, particularly because of the region's arid nature (IPCC 2007a, b, c, d). The following summarizes some of the major conclusions and projected impacts of climate change of relevance to fisheries and aquaculture in Central Asia and the Caucasus (CAC) countries as given in the IPCC Fourth Assessment Report (IFAD undated): Fishery industries are important in some CAC countries, but overfishing and marine pollution have led to decreased catches. Recent evidence shows that the fishing sector in Central Asia is close to collapse and that climate change will further exacerbate and accelerate this process, mainly affecting the rural poor.

Lastly, the implications of climate change for global fisheries and aquaculture were explored during the FAO Expert Workshop on Climate Change Implications for Fisheries and Aquaculture, held from 7 to 9 April 2008 in Rome, Italy. It was projected that

> Climate change poses multiple additional risks to fishery-dependent communities that may limit the effectiveness of past adaptive strategies. Adaptation strategies will need to be context- and location- specific and to consider both short-term (e.g. increased frequency of severe events) and long-term (e.g. reduced productivity of aquatic ecosystems) impacts. All three levels of adaptation (community, national, and regional) will clearly require and benefit from stronger capacity building through awareness raising on climate change impacts on fisheries and aquaculture, promotion of general education, and targeted initiatives in and outside the sector (FAO, 2008).

At the third meeting of the Technical Advisory Committee (TAC) of the Central Asian and Caucasus Regional Fisheries and Aquaculture Commission (CACFish), held in Baku, Azerbaijan in 2015, the big picture of climate change impacts in the Central Asian and Caucasus region were outlined as follows:

- Extreme weather and climate events are also increasingly being observed in the CACFish area.
- There is clear evidence indicating that the geographical distribution of fish stocks, life cycles of fish, and dynamics of aquatic ecosystems at the global level are being affected by climate change, most of which could be attributed to human activities. It was stated that growing evidence points to such changes in the CACFish area.
- Climate change would pose remarkable risks to fisheries and aquaculture in the CACFish area, as indicated by growing numbers of reported climate projections and scenarios. It is known that a significant number of lakes in Asia, like the Aral Sea, had considerably shrunk, while some were in danger or had fully disappeared. Evidence indicates unusual water level fluctuations in large water bodies (i.e. Issyk-Kul Lake) and the Caspian Sea.
- The current knowledge on the likely climate change impacts on fisheries and aquaculture in the CACFish area seemed inadequate, and uncertainty remained regarding the projected impacts of climate change, particularly on local inland aquatic ecosystems in the CACFish area.
- The challenges are difficult to manage and monitor; in this regard, TAC noted the lack of specialized institutional research capacity for interaction between climate change and fisheries.
- Additionally, TAC noted that climate change could have economic impacts on the fisheries and aquaculture sectors in the region, including the support industry, customers, and other stakeholders. However, it was stated that mitigation options and strategies for the direct and indirect climate impacts on inland fisheries and aquaculture, including culture-based fisheries, existed. These included: increased water usage efficiency; usage of recirculation systems in aquaculture production systems; innovative technologies; integrated water resource management and planning. In this regard, the development of adaptation and mitigation strategies for climate change preparedness both at the national and regional levels were suggested. Taking up the challenges of changes in climate and applying the appropriate strategies could also mean an opportunity for aquaculture in the CACFish Area. Besides these other issues, policy and planning instruments were described as the main areas of focus in terms of preparedness for climate

change in fisheries and aquaculture. In connection with this, the preparation of wide-level policy and planning documents based on the reliable and best available was recommended. One successfully completed study is the Regional FAO Project titled "Strengthening Adaptation of Aquaculture and Culture-based Fisheries for Climate Change", which aimed, among other things, to deliver governance guidelines for the preparation of action plans and to strengthen capacity building in the context of climate change adaptation (FAO, 2015).

TAC stressed that the Central Asian and Caucasus region had some valuable historical meteorological, hydrological, and limnological data which could be used as input for improved impact evaluation for fisheries and aquaculture. These data were also useful in the development of possible adoption and mitigation options and associated measures. After the Soviet Union collapsed, ongoing studies on climate change and its impact on fisheries and aquaculture sector were interrupted. As mentioned during the presentations, sharp fluctuations in water and temperature adversely affect the planning of fish breeding events and fishing planning. Establishing the term of the spawning ban on specific dates that do not depend on the timing of the actual spawning of fish causes to fishers to lose income.

Regarding the impact of climate change on fish biology (including breeding, spawning season, spawning age, and spawning area), some participants suggested that:

Many studies show that the climate change effects on fish behaviour including breeding, spawning season, spawning age, and spawning area which are common measures for policy development of sustainable management inland fisheries and aquaculture. Besides human activities, climate change also determines fishery management policy. Fisheries' activities are managed with circulated regulation by the countries. These regulations are mostly prepared in consultation with experts, scientific studies on spawning behaviours by region and by species and other technical data records about the freshwater fishes and other organisms. Determination of spawning behaviours is also essential to prepare a fishery management legislation. It is clear that there is a significant lack of studies conducted in the region about the spawning behaviours of economic inland fishes in the region, especially after the collapse of the Soviet Union. Even in Turkey, most of the data used as scientific evidence dates back a few decades. Fishery associations, cooperatives, or non-governmental organizations (NGOs) are requesting updates to fishery regulations in terms of fishing prohibition seasons, fish size, fishing area, and fishery equipment due to environmental changes as a result of climate impact. Most studies and observations of climate activity show that most freshwater organisms in natural or man-made water reservoirs developed new life habits. In this respect, not only Turkey but also some other Central Asian countries should update the data profile through a regional study.

Conclusions and future prospects

Climate change is one of the biggest global challenges facing humanity. Scientific evidence shows that the Earth has already warmed 1°C since the 19th century. The IPCC warns that exceeding a 1.5°C warming level will lead to drastic consequences. However, the Earth is currently on pace for a rise of 3.9°C by the end of this century (UNEP, 2020). Precise and trustworthy climate models are available for predicting climate change. Although the CAC region lacks historical climate data, the region is projected to be significantly affected by the climate change with implications for many communities and industries, including fisheries and aquaculture. Climate change impacts are also expected to be more intense in developing countries due to the economic costs of climate change for the economy and communities. Renewable energy and green technologies would help countries to mitigate these impacts.

There are two global strategies for action on climate change: i) mitigation to reduce or remove greenhouse gas emissions from the atmosphere, and (ii) adaptation to adjust systems and societies to withstand the impacts of climate change. The cost of climate action will be significant, and the necessary actions will require a coordinated public-private sector response. In the context of the CAC region, further studies/research, inter alia, on the following topics would provide useful information for climate actions at both national and regional levels:

- climate change impacts on aquatic ecosystems, species, and water resources and their flow regimes;
- ecological restoration, biodiversity conservation and land connectivity;
- farming of species tolerant of a wide range of environmental conditions and stressors;
- farming of low trophic level species;
- water-smart, eco-friendly aquaculture productions systems.

About the FAO-Turkey partnership programmes

The objectives of the FAO-Turkey Partnership Programmes are to provide support to ensure food security, rural poverty reduction and sustainable forest management, combat desertification and preserve ecosystems in Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkey, Turkmenistan and Uzbekistan and other countries of mutual interest.

Established in 2007, the first phase of the FAO-Turkey Partnership Programme on Food and Agriculture (FTPP) has benefited from trust fund contributions totalling USD 10 million, financed by the Government of Turkey and represented by the Ministry of Agriculture and Forestry.

During the first phase of the programme, 28 projects were implemented in 16 countries between 2009–2015. In 2014, Turkey and FAO commenced the second phase of the FTPP along with the first phase of the FAO-Turkey Forestry Partnership Programme (FTFP) with an additional fund of USD 20 million, bringing Turkey's total contribution to USD 30 million.

Under this new phase, a range of projects will be implemented in the areas of:

- food security and nutrition;
- agricultural and rural development;
- protection and management of natural resources;
- agricultural policies;
- food safety;
- sustainable forests, land and natural resource management and land degradation neutrality;
- institutional reform, training and national capacity enhancement.

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Appendix 1

Agenda

Tuesday, 23 June 2020	
Moderator: *Haydar Fersoy, Senior Fishery and Aquaculture Officer, FAO*	
10:00 - 10:15	**Opening and welcome addresses** • *Viorel Gutu, Sub-regional Coordinator for Central Asia and Representative in Turkey, FAO* • *M. Altug Atalay, Director General, General Directorate for Fisheries and Aquaculture of the Turkish Ministry of Agriculture and Forestry* • *M. Levent Kurnaz, Professor, iklimBU*
10:15 - 10:30	**Objectives and expected outputs of the virtual workshop** • *Ramazan Celebi, National Expert Fisheries, FAO*
10:30 - 10:50	**Understanding climate change: Physical drivers impacting aquatic ecosystems** • *Dursun Yıldız, Professor, IklimBU*
10:50 - 11:10	**Climate change impacts on fisheries and aquaculture in Central Asia** • *Serik Timirkhanov, Head of Aqua Alliance LLP (aqua-alliance.kz), Kazakhstan*
11:10 - 11:30	**Climate change impacts on water resources in the Central Asia and Caucasus region and the experience of BU/CORDEX** • *M. Levent Kurnaz, Professor, IklimBU*
11:30 - 11:50	**International action on climate change: International governance instruments for climate change** • *Haydar Fersoy, Senior Fishery and Aquaculture Officer, FAO and the Lead Technical Officer of the project*
11:50 - 12:00	**Question and answer session**

Wednesday, 24 June 2020	
Moderator: *Haydar Fersoy, Senior Fishery and Aquaculture Officer, FAO*	
10:00 - 10:30	**Economic instruments for combating climate change** • *Evetta Zenina, Natural Resources Officer (Climate Change), FAO*
10:30 - 11:00	**An overview of the impacts of climate change on inland fisheries** • *John Jorgensen, Fishery and Aquaculture Officer, FAO*
11:00 - 11:30	**Perceptions of Turkish aquaculture stakeholders on climate change-aquaculture interactions** • *Ferid Rad, Professor, Mersin University, Department of Fishery, Mersin, Turkey*
11:30 - 12:00	**Climate-smart fisheries and aquaculture** • *Binhan Ganioğlu, Freelance Consultant, Ankara, Turkey*
12:00 - 12:15	**Question and answer session**
12:15 - 12:30	**Closing and evaluation** • *Haydar Fersoy, Senior Fishery and Aquaculture Officer, FAO and Project Lead Technical Officer*

Appendix 2

List of participants

AZERBAIJAN	
Aysel Mammadova	Advisor, Ministry of Environment and Natural Resources (MENR) Biological Diversity Protection Service
Farida Alakbarova	Senior Advisor, Environmental and Natural Resources Regulation Division of MENR, National Focal Point of FishCap in Azerbaijan
Kamala Rustamova	Lead Advisor, Biological Diversity Protection Service of MENR
Rena Babashova	Advisor, Biological Diversity Protection Service of MENR
Solmaz Bayramova	Advisor, Biological Diversity Protection Service of MENR

KAZAKHSTAN	
Assylbekova Saule	Deputy Director, LLP, Fisheries Research and Production Centre
Eldar Marlenov	Master of Agricultural Sciences, Senior Lecturer, Kazakh Agrotechnical University
Kuanysh Isbekov	Director General, LLP, Fisheries Research and Production Centre
Saya Koyshybayeva	Head of Aquaculture Laboratory, LLP, Fisheries Research and Production Centre

TURKEY	
Gulser Fidanci	Aquaculture Engineer, Directorate General of Fisheries and Aquaculture, Ministry of Agriculture and Forestry of Turkey
M. Altug Atalay	General Director Directorate General of Fisheries and Aquaculture, Ministry of Agriculture and Forestry of Turkey
Murat Sahin	Aquaculture Engineer, Directorate General of Fisheries and Aquaculture, Ministry of Agriculture and Forestry of Turkey
Mursel Yilmaz	EU Expert, DG of EU and Foreign Affairs, Ministry of Agriculture and Forestry of Turkey
Nuran Cavdar	Aquaculture Engineer, Directorate General of Fisheries and Aquaculture, Ministry of Agriculture and Forestry of Turkey
Nuri Celik	Aquaculture Engineer, Directorate General of Fisheries and Aquaculture, Ministry of Agriculture and Forestry of Turkey
Ozerdem Maltas	Head of Aquaculture Department, Directorate General of Fisheries and Aquaculture, Ministry of Agriculture and Forestry of Turkey
Turgay Turkyilmaz	Deputy Director General of Fisheries and Aquaculture, Ministry of Agriculture and Forestry of Turkey

Volkan Gungoren	Deputy Director General of EU and Foreign Affairs, Ministry of Agriculture and Forestry of Turkey
Yesim Aslanoglu	Aquaculture Engineer, Directorate General of Fisheries and Aquaculture, Ministry of Agriculture and Forestry of Turkey

TURKMENISTAN	
Berdi Berdiyev	International Environment Cooperation and Projects, Ministry of Agriculture and Environment Protection of Turkmenistan
Chary Yazdurdyyev	Fishery and Aquaculture, Union of Industrialists and Entrepreneurs of Turkmenistan
Hudarbeydi Hajyyev	Department of Agrarian Progresses and World Practices
Kuwwat Abdurahmanow	State Fisheries and Water Supervision Department of the Agency for Economic Risk Protection under the Ministry of Finance and Economy of Turkmenistan
Magtymguly Akmyradov	Ambassador, Ministry of Foreign Affairs of Turkmenistan
Mergen Yusupov	Department of Coordination of International Environmental Cooperation and Projects, Ministry of Agriculture and Environment Protection of Turkmenistan
Nazar Orazow	"Elin balyk" Private Aquaculture Enterprise
Oraz Myradow	State Fisheries and Water Supervision of the Agency for Economic Risk Protection under the Ministry of Finance and Economy of Turkmenistan
Suwhanmyrat Atayew	"Hazar balyk" Open Joint-Stock Company

FAO	
Ferrahi Saracoglu	GPS-Fisheries and Aquaculture Expert
Haydar Fersoy	Senior Fishery and Aquaculture Officer
Melek Cakmak	FAO Representative, FAOAZ
Ramazan Celebi	National Consultant on Fisheries and Aquaculture
Viorel Gutu	Sub-regional Coordinator for Central Asia and Representative in Turkey, FAO

LECTURES	
Binhan Ganioğlu	Freelance Consultant, Ankara, Turkey
Dursun Yildiz	Hydropolitics Association / Hidropolitik Akademi
Evetta Zenina	Natural Resources Officer (Climate Change)
Ferid Rad	Mersin University, Department of Fishery, Mersin, Turkey
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REPUBLIC OF TÜRKİYE
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