MINISTRY OF ECOLOGY, ENVIRONMENTAL PROTECTION AND CLIMATE CHANGE OF THE REPUBLIC OF UZBEKISTAN

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UN Multi-Partner Human Security Trust Fund for the Aral Sea Region in Uzbekistan

White paper: Policy recommendations on sustainable landscapes, climate smart agriculture, and forestry development in the Aral Sea region for human well-being

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With Annexes

Global Green Growth Institute

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Executive Summary

The population of the Republic of Karakalpakstan in the Aral Sea region faces critical challenges, such as ecological and economic instability, uncertainties related to ongoing climate change, and degradation of land and water resources, all leading to a worsening of livelihood conditions and the well-being of the local population. The continuous overextraction of the water from the Amudarya and Syrdarya rivers, which used to feed the Aral Sea, for irrigating vast agricultural lands and supporting unsustainable agricultural practices, combined with diminishing river flows due to melting glaciers and reduction of snow cover caused by climate change have led to the drastic situation known as 'Aral Sea crisis'.

Climate change is a threat multiplier that can have cascading effects across numerous sectors and aspects of human security leading to unlikely, rare and even unexpected outcomes. Climate change is already having and is likely to increase the pressure on the Aral Sea region over time through increased water scarcity manifested by diminishing river flows, decrease and volatility of precipitation; overall aridity of the climate with higher air temperatures and more frequent and severe droughts. Water resources in the Amudarya River basin are predicted to decline by up to 15% by 2050 (Jooyoung et. al., 2022) while irrigation water demand will rise by 25% (WB, 2023). In turn, the increased aridity of the climate will lead to lower productivity in agriculture, desertification, landscape degradation and decrease in productivity of desert forests and even extinction of *Tugai* forest patches. The more frequent droughts and declining quality of agricultural lands in Karakalpakstan due to soil salinization, erosion and unsustainable agricultural practices have led to a decline in crop yields (maize by a factor of 3, rice by a factor of 2, cotton by a factor of 1.6, and potatoes and vegetables by a factor of 1.5–2.5) (Jooyoung et. al., 2022). Production losses for all major crops grown in Karakalpakstan will be in the range of USD 9.9 million per year (Robalino et. al., 2022). Declining pasture and land productivity, loss of Tugai vegetation have already resulted in the loss of over 100,000 jobs throughout Karakalpakstan (Jooyoung et. al., 2022).

There is thus a real threat to food, economic, social and health security to the population of Karakalpakstan if no action is taken on adaptation to climate change consequences. Without action on climate adaptation, Uzbekistan's economy is predicted to be 10% smaller by 2050, resulting in significantly lower employment and household incomes (WB, 2023). Given the greater magnitude of climate change in the Aral Sea region, damage to the economy and the environment of Karakalpakstan is likely to override the country average indicators.

Karakalpakstan strives to achieve a balance between economic growth and environmental protection. Systematic measures to ensure environmental safety, human security, the efficient use of water resources, the widespread introduction of (and state support for) water-saving technologies in crop cultivation, as well as improving the reclamation condition of irrigated land actively adopting regulations to mitigate the consequences of the Aral disaster have been on the Government agenda. Much research has focused on how to reverse the negative trend or mitigate its negative impact on the environment, economy, and health of the people. Dozens of development projects have been implemented and are being implemented (or are in pipeline) in the Aral Sea region to help the population strive for their well-being.

Within a protection and empowerment framework, a UN human security concept/approach promotes people-centered comprehensive, context-specific, and prevention-oriented measures that seek to reduce the likelihood of crisis, help overcome the obstacles to development and promote human rights for all. The policy and regulatory framework and its enforcement are likewise critical for effective scaling up (this may include land ownership, extension services, taxes or subsidies on agricultural inputs, credit and insurance schemes) because they provide the rules and incentives (or disincentives) for disseminating adaptive measures and solutions.

The main goal of this analysis has been the compilation of strategic policy recommendations for decision-makers for a faster and wider transition to climate smart agriculture, sustainable land and forest management approach in the Republic of Karakalpakstan based on overview of the studies conducted by GGGI Aral Sea GRIP, UN agencies, development projects, and local entities.

In order to arrest or alleviate the negative trends and development projections, Karakalpakstan needs a sustainable development and adaptation strategy including but not limited to scaling up of climate smart agricultural technologies and diversification to less water-intensive agricultural crops, simply because there is no other survival alternative. Because the threats are interlinked and somehow dependent on each other, there is a need for a concerted, streamlined set of actions and interventions by the Uzbek Government, development projects and international financial institutions.

Successful dissemination and rate of adoption of adaptive measures, their scaling up requires that technical or infrastructure solutions come as a package, including capacity building, provision of extension, consultation and maintenance services. National programs for scaling up adaptive measures should include the sources and types of finances, system of monitoring, evaluation and update or correction measures. Thus, a set of five policy recommendations, describing technical solutions and adaptive measures (policy recommendations 1-3 below), as well as the main aspects of the enabling environment (policy recommendations 4 and 5), have been put together based on the available studies, which are:

1. Rehabilitation and modernization of water management system

2. Intensification and support of the transition from traditional water-intensive agricultural production systems to climate smart and climate resilient agricultural practices and prioritization of water efficient agricultural commodities

3. Scaling up sustainable landscape and forest management practices and approaches

4. Adaptation of the legislative and institutional arrangements for strengthening the enabling environment for climate smart agriculture, water and landscape management

5. Strengthening the enabling environment for sustainable landscape and forest management, climate smart agriculture in Karakalpakstan.

Introduction and Background

The Republic of Karakalpakstan, located in the Northwestern part of the country and in the immediate vicinity to the Aral Sea, covers an area of ca. 166.6 thousand sq.km. Most of the Karakalpak territory consists of low land (from 50 to 200 m above sea level) with small percentage of hills, whereas most of the settlements as well as the prevailing activities, including agricultural production, are concentrated in the irrigated river plain on the delta of the Amudarya River.

Despite Karakalpakstan forms 37% of the total territory of Uzbekistan, only 2 million people[1] (ca. 5.5% of the total population of Uzbekistan) inhabit Karakalpakstan. In 2023 total labor force reached 1.07 million people, currently employed in various branches of economy are 714.2 thousand people.[2] Average monthly salary in 2023 was ca. 3.8 million UZS[3] (or ca. 306 USD), below the national average of 4.5 million UZS per month and twice lower than average monthly salary in Tashkent city.[4] The unemployment rate of 9.1% is higher than the national average of 8.9%.

In 2022, Karakalpakstan ranked first among the regions of Uzbekistan with the highest monetary poverty rates with 19.7% of the population living below the poverty line (Ministry of Employment and Poverty Reduction, 2023). However, when including non-monetary deprivations to the poverty index, such as deprivations in health, education, and living standards, in 2022, 29.9% of the adult population of Karakalpakstan were considered multidimensional poor adults. The most contributing factors to multidimensional poverty index in Karakalpakstan are food security (15.6%), unemployment (14.9%), and sanitation (11.2%) (CERR and UNDP, 2023).

Gross Regional Product (GRP) of Karakalpakstan in 2023 amounted to 32,916.1 billion UZS[5] (or ca. 2.7 billion USD based on official exchange rate of the Central Bank of Uzbekistan at the end of 2023[6]), which constituted ca. 3.1% of the GDP of Uzbekistan.[7] Economic growth in Karakalpakstan in 2023 reached 3.5% (compared to 6% in Uzbekistan[8]). GRP per capita in Karakalpakstan in 2023 was 16.5 million UZS (or ca. 1,341 USD), almost twice lower than the average per capita GDP of Uzbekistan equivalent to 2,495 USD.[9]

The economic structure of the region is characterized by a considerable dependence on the service sector (39.1% of total GRP in 2023), agriculture (30.4%) and industry (22.2%), while construction accounts for 8.1%.[10] The main branches of industry include: light industry, electricity generating industry, food industry, fuel industry, chemical and oil-chemical industry, flour milling industry and industry of construction materials.

Agriculture is an important sector of the economy of the Republic of Karakalpakstan, making a significant contribution to the provision of raw materials and consumer goods to various industries. The agricultural landscape includes two main sectors: crop and livestock production, contributing 46.6% and 53.4%, respectively, to total value of agricultural production of Karakalpakstan.[11] The largest contributor to Karakalpakstan's agricultural output is dehqon farms and homestead landowners (small-scale agricultural producers) with 60.8%; second largest contributor are private farms (large-scale producers) with 30.9%; whereas agricultural enterprises contribute only 8.3%.[12]

Out of 16.4 million ha of the total territory of Karakalpakstan[13], total agricultural land varies in the range of 3.260 million ha (around 20% of the total territory).[14] This area is comprised of several land use categories: arable land 414.8 thousand ha; perennial forests 7.8 thousand ha; fallow land 9.4 thousand ha; pastures 1.717 million ha; other agricultural land 1.110 million ha. Area suitable for irrigation includes 1.6 million ha[15] (around 49% of agricultural land). Actually, annually cultivated area varies with irrigation water availability and supply and in some years may be as low as 50-55% of the total arable land[16]. In 2022, irrigated sown area by all categories of farms in Karakalpakstan stood at 283.1 thousand ha.[17] Most of the arable land in Karakalpakstan is allocated by the Government to grains (including rice), - 97.4 thousand ha in year 2023; cotton – 92.2 thousand ha; forage crops – 20.1 thousand ha for producing fodder for livestock; vegetables, melons, etc.

The main agricultural products in Karakalpakstan are winter wheat (*Triticum aestivum*), cotton (*Gossypium hirsutum*), vegetables, forage crops and livestock products. In 2023 agriculture of Karakalpakstan produced output worth 16,548.3 billion UZS (or ca. 1.3 billion USD), including output of the forestry sector of 681.9 billion UZS (55.2 million USD) with the main contributors: private farms (58.1%), rural households (dehqons – 34.3%) and agricultural enterprises (7.6%).[18] Due to increasing soil salinity and aridity of climate,the yields of the main

agricultural crops such as cotton, wheat, melon crops grown are decreasing. In the last years, for specific districts, high salinity and medium salinity soils analysis have shown a decreased corn yields up to 3 times, rice - 2 times, cotton - 1.6 times, potatoes and vegetable crops - 1.5-2.5 times compared to previous levels.[19]

Karakalpakstan, located in an arid climate belt, is considered a Cold Desert Climate (BWk, Kottek et. al, 2006). In the past, the Aral Sea regulated or mitigated the cold north winds from Siberia and reduced the summer heat. The drying of the vast Aral Sea has resulted in local/regional climate changes—dryer, shorter summers and longer, colder winters, as well as limited and unstable precipitation throughout the year (Kumar, 2002). The average annual temperature is around 18°C, with summer peaks averaging 40-45°C (Jooyoung et. al., 2022) and winter averages around 0°C.[20] The duration of the hot season averages 3-4 months[21]. The sparse precipitation 150-200 mm per year is unevenly distributed throughout the year[22]. The main part of precipitation falls in the fall-spring period, mainly in the form of rain and small amounts of snow. In winter and summer precipitation amounts are negligible. Over the last decade the effective growing season has reduced from about 220 to 170 days; pasture productivity has decreased by half; the destruction of vegetation has decreased meadow productivity by a factor of 10 (Kumar, 2002). Daily mean temperatures are projected to increase by between 3°C and 3.5°C for much of the region by mid-century (UNDP and Columbia University, 2021). Salt dust storms (SDS) originating from the dried Aral Seabed cause wind erosion of agricultural lands, health problems of the local population and lead to lower crop yields and agricultural production losses, valued on average at 11.6 million USD per year (Akramkhanov et. al., 2021).

The population in the Aral Sea region faces critical challenges, such as ecological and economic instability, uncertainties related to ongoing climate change, and degradation of land and water resources, all leading to a worsening of livelihood conditions. To arrest or alleviate these negative trends, the region needs to implement a sustainable development strategy that departs from the present situation.

Problem statement

Based on the climatic features of Karakalpakstan, the local population has historically depended on the water resources of the Amudarya River delta for irrigation of agricultural lands, as well as on the resources of the Aral Sea for fishing. However, in light of the desiccation of the Aral Sea and decreasing aquifer flows, the region began to face limitations in socio-economic development.

Due to the arid climatic conditions in the Aral Sea region, where potential evapotranspiration always exceeds precipitation, agricultural production fully relies on irrigation. About 90% of the total annual water take-off in the region is used in the agricultural sector, of which 83% is used for irrigation (Abdullaev et al., 2006) and 17% for leaching salt (Abdolniyozov, 2000). Average water use in irrigation (10-18 thousand m^3/ha) is high. At the same time water availability in the Aral Sea region is the lowest in the country (60%–70%) due not only to limited river water resources but also to their inefficient use, including high filtration losses in irrigation systems and unsatisfactory condition of hydraulic engineering structures technology (MEEPCC, 2023a). Large water losses occur in main and inter-farm canals and in on-farm networks. Because water is often provided by state distribution agencies and agricultural producers free of charge or at low cost, irrigation water application is very high, whereas irrigation application efficiency does not exceed 60-65% (Kurbanbaev et. al., 2021). According to the National Report of the Ministry of Ecology, Environmental Protection and Climate Change of the Republic of Uzbekistan on the State of Environment (MEEPCC, 2023a, p. 33), in Uzbekistan "water-saving technologies have been introduced in only 23% of the irrigated areas".

According to Gafurov et al. (2023), water availability is expected to decrease by 29.4% by 2030 in the Amudarya basin due to the construction of the Qosh-Tepa canal in Afghanistan. Ongoing climate change and more frequent droughts increase further the likelihood of water scarcity. As a result, the land area under cultivation in Karakalpakstan may decrease by 18.9%. The estimated impact would be equal to 0.7% of GDP and about 250,000 jobs could be lost in crop production, affecting similar name of livelihoods.

Current and expected climate change trends are already having a significant impact on the socio-economic development of the country as a whole, and the Aral Sea region in particular. The main negative impacts of climate change include:

— **increase in the overall aridity** of the climate due to increase in air temperatures, increase in the duration of the dry hot period of the year, which causes an increase in the level of evaporation and an increase in water losses in irrigation zones;
— **decrease in average annual precipitation; increased fluctuations in precipitation** and, as a consequence, an increase in the frequency of dangerous phenomena associated with the water factor;
— continuation of degradation of mountain glaciation and reduction of snow and ice resources in the zone of formation of river runoff in the Amudarya and Syrdarya River basins, which leads to a **reduction in water resources**, and in the future - to deterioration of the quality of surface waters;

— increase in the frequency, severity and scale of droughts, leading to **intensification of desertification** processes, threat of extinction of Tugai forests, coastal and aquatic ecosystems of the Amudarya River delta;
— **low productivity in agriculture**, land and water resources, causing threat to food security, economic and social security of the local population;

— **landscape degradation** and decrease in productivity of desert forests.
— **health risks** for the local population from cardiovascular, vector-borne, infectious and other diseases;
— **sustainability of housing and infrastructure** (access to safe drinking water, electricity, heating and other living conditions of population).

During the years of independence, the increase in the area of arable land in Karakalpakstan has gone hand in hand with the desire to increase yields per hectare. A similar commitment to progress has been evident in the livestock sector, where the focus has been on increasing livestock numbers and productivity. As a result, Karakalpakstan is now considered an agro-industrial enclave. However, climate change continues to negatively affect the yield and quality of crop products through the effects of high temperatures, extreme temperature fluctuations and shifting seasons, heavy rainfall, lack of water in hot times, and low moisture availability. The productivity of crop, livestock and fishery in the area is still low. Agricultural yields in the Aral Sea region are one-half to one third of the country levels. In addition, high temperatures provide a favorable ground for pests, which requires the use of pesticides and other agricultural chemicals. Agricultural producers of Karakalpakstan experience a very high level of application of mineral fertilizers (60–70% higher than the world average), which is the main condition for agricultural production on irrigated lands due to inefficient irrigation methods, low soil fertility (UNECE, 2020; Robalino et. al., 2022), enhanced by excessive mechanization and topsoil removal by traditional farming methods.

"Scientifically unsound cropping patterns have led to water and wind erosion. A significant proportion of irrigated land has been degraded: 2 million ha of deflation, 619 ha of irrigation erosion, and 40,000 ha of gully erosion" (MEEPCC, 2023a, p. 56). The continuation of irrigated agriculture in Karakalpakstan for meeting the growing needs of the population and processing industries, such as textile or food processing industries, with diminishing water resources (both by quantity and quality) is under threat.

Climate change impact on food security can be reflected in terms of food availability (the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports), food access (economic and physical access to food influenced by income, markets, prices), food utilization (utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being), and food stability (the time dimension of food security – access to food at all times) (FAO, 2006).

Ensuring food security in Karakalpakstan has its own specific features related to the state of land and water resources, environmental challenges, the level of socio-economic development, access to transport, and the capacity of food markets (MPHSTF, 2023).
Despite some progress/initiatives achieved in Karakalpakstan with regards to improving food security[23] evidenced by rational distribution of crops, the development of new lands, slight increase in productivity of some crops, modernization of agricultural infrastructure and logistics (storage and refrigerating facilities), increasing areas equipped with resource (water) saving technologies, drilling of artesian wells, the actual consumption of basic foodstuffs by the region's population remains unbalanced. The rate of actual consumption in the region for almost all main food items (except for bread and bakery products, and rice) did not reach the minimum consumption norms (standards) recommended by the Ministry of Health (MPHSTF, 2023). The predominance of carbohydrates, and low levels of fats and proteins, disrupts the balance of rational nutrition. This is especially true for remote rural areas affected by environmental and climate risks.

According to the WB (2023) due to climate change, by 2050 the production of legumes in Uzbekistan will decrease by 8%, oilseeds by 4%, fruits and vegetables by 3%, and cereals by 7%. Declining crop yields and agricultural output are expected to be even worth in Karakalpakstan, where deteriorating quality of air and water resources together increase the risk of malnutrition and unbalanced diets, anemia and low birth weight.

Risks to food security in the Aral Sea region are many-fold and include not only the quantity and quality of available food products in the region, but also their stable supply throughout the year, economic access and affordability of food products for the population of Karakalpakstan, both urban and rural. The challenges faced by local food production in meeting the population's growing needs are aggravated by high transportation costs, due to the region's geographical location. In remote areas of the Aral Sea region, food costs exceed more than half of household expenditures (MPHSTF, 2023; Jooyoung et.al., 2022). At the same time the current level of income and wages remains below the national average, while the population's solvency is not balanced with the minimum consumer basket and is aggravated by extreme natural and climatic conditions.

MEEPCC (2023a) announced that access to the centralized (tap) water supply in the Aral Sea region increased from 40% to 71% in the recent years largely due to the Resolution of the President No. 2731 from January 18th, 2017 "On the state program for the development of the Aral Sea Region for 2017 - 2021" (Robalino & Bathe, 2022), but still remains low, especially in the remote rural areas of Karakalpakstan. Study by GGGI revealed that the average rate of usage of water distribution supply for drinking water in some districts of Karakalpakstan is 45% (Jooyoung et al., 2022). Population's access to sewerage is also low (with 16% coverage) in fact last among the regions of Uzbekistan. Reflecting such conditions, the level of livelihood in the area is considered to be low and one of the most depressed regions in the Republic of Uzbekistan.

Decreasing water supply poses a threat to the remaining ecosystems, habitat for flora and fauna, and healthy environment for the local population. The delta

have deteriorated considerably: By 1990, more than 95% of the marshes and wetlands had given way to sandy deserts, and more than 50 delta lakes, covering 60,000 ha, had dried up[24]. Overgrazing, declining productivity of pasture and irrigated land, depletion of *Tugai* forest vegetation and drying of marshes and lakes have led to landscape degradation, and the loss of numerous jobs and livelihoods. Many plant and animal species are adapting to the new conditions, but such changes lead to the extirpation or even to the extinction of other species of flora and fauna, thereby destabilizing ecosystems. It was estimated by the Ministry of Ecology that over 50 species of wild animals and plants disappeared (Turanian tiger, Asian cheetah, striped hyena, etc.) in the Aral Sea region, and the number of endangered species increased[25] (12 species of mammals, 26 species of birds, and 11 species of plants) (MEEPCC, 2023a).

Deterioration of the environment and ecosystems in the Aral Sea region is also linked to the energy sector. This is due to the fact that about 90% of the energy is produced by burning fuel, a method that is considered not only the main contributor to greenhouse gas emissions, but also a significant source of pollutants entering into the environment due to insufficiently treated emissions of pollutants from burning fuel, discharge of wastewater into water bodies, as well as large-scale disposal of coal ash and slag waste (MEEPCC, 2023a).

"Overgrazing on the pastures of arid zones is the main cause of their desertification. The sparse vegetation cover and low productivity of desert vegetation mean that grazing easily results in deterioration. The low level of watering of pastures and a very sparse network of wells in deserts sharply aggravates this process" (MEEPCC, 2023a, p.56).

Despite the measures taken in the Aral Sea region towards sustainable landscape management, such as improvement of water management infrastructure (improved water supply for more than 47,000 ha of land, a reduction in land experiencing high and medium salinity levels by an area of 11,200 ha, and the maintenance of a stable land reclamation status on over 140,000 ha, (Robalino & Bathe, 2022); expansion of protected areas (five new protected areas with a total area of 3.6 million hectares have been created in the Republic of Karakalpakstan to preserve unique biodiversity and their habitats, afforesting of 1.7 million hectares of dried seabed with salt- and drought-tolerant plants, MEEPCC, 2023b); reduction of emissions of pollutants into the atmosphere, Karakalpakstan's environmental situation remains tense, if not worsening. According to survey conducted by MPHSTF (2023), the environmental condition remains a priority among the main socio-economic problems of the local population. The WB (Akramkhanov et. al., 2021) has predicted that over the coming 20 years the damage caused by landscape degradation, desertification and deterioration of environment in Karakalpakstan will reach more than 840 million USD, or on-site and off-site costs of ecosystem service loss under current conditions of approximately 44.2 million USD per year (equivalent to 2.1% of Karakalpakstan's GDP).

Deteriorating air, water and land resources already pose and will continue posing direct and indirect effects on the health of the population of the Aral Sea region. Direct ones include increased mortality, exacerbation of chronic diseases, diseases of the cardiovascular system, respiratory diseases, and oncology due to sharp fluctuations in air temperature, relative humidity and atmospheric pressure. Indirect effects include the range and activity of disease vectors, the occurrence of allergens, bacterial growth, degradation of water quality and reduction in crop yields, leading to an increase in infectious and parasitic diseases, reduced food security, an increase in cancer and many other consequences. In the long term, indirect consequences will also lead to long-term psychological and emotional stress, chronic neurohormonal changes, decreased performance, and negative effects on the reproductive, endocrine, immune, nervous systems and malignancies. Excessive use of mineral fertilizers and pesticides, both in the short and long term, also negatively affects public health. Short-term effects include an increase in the prevalence of gastrointestinal infections, and long-term effects include malignancies and allergies (MPHSTF, 2023).

Impact of climate change on agricultural productivity, income, health are not always proportionate between men and women due to the existing regional gender-differentiated relative powers, roles and responsibilities at the household and community levels. In Karakalpakstan, women tend to be overburdened with household duties and caring for children, the sick and the elderly. Socio-economic study of the state of women-led agricultural business in Karakalpakstan (UNDP, 2021) revealed that the degree of participation of rural women in training and capacity building events is still low; women in rural areas are less competitive in the labor market, given the limited number of formal jobs, lack of education, professional qualifications, skills and pervasive gender stereotypes. Women conducting agricultural activities face systematic discrimination in terms of access to resources and services, such as bank loans, land warranties and education, which are necessary for increasing agricultural productivity and family incomes (UNDP, 2021).

Strategic Roadmap for promoting integrated sustainable landscapes in the Aral Sea region

The entry point for altering the present challenges of climate, environment, and economic, human security in Karakalpakstan is the water sector. Measures for ensuring water supply to Karakalpakstan, such as rehabilitation, upgrading of irrigation and drainage network, coordination and integrated water resource management with upstream provinces and countries will lead to stable river water supply. Increased availability of water

resources will allow the continuation of agricultural production and transition to climate smart agriculture. Climate smart agriculture strengthened with water saving technologies will increase water use efficiency and agricultural productivity. Improved agricultural output will back-up food security, economic development, jobs and thus will contribute to social security. Increased availability of and access to water resources and environmentally friendly, climate smart agricultural practices will allow for sustainable long-term landscape management. To realize the changes and implement technical solutions, a strong, sustainable enabling environment is required starting with legislation, capacity building of the involved stakeholders, extension and consultation services, information and awareness raising, monitoring and evaluation mechanism, and finally finance system and services to support full-scale climate change adaptation.

Governments and partners seeking to facilitate the implementation of mitigation, adaptation and prevention measures or solutions can undertake a range of actions to provide the foundation for effective adoption across production systems, landscapes and food systems (Figure 1).

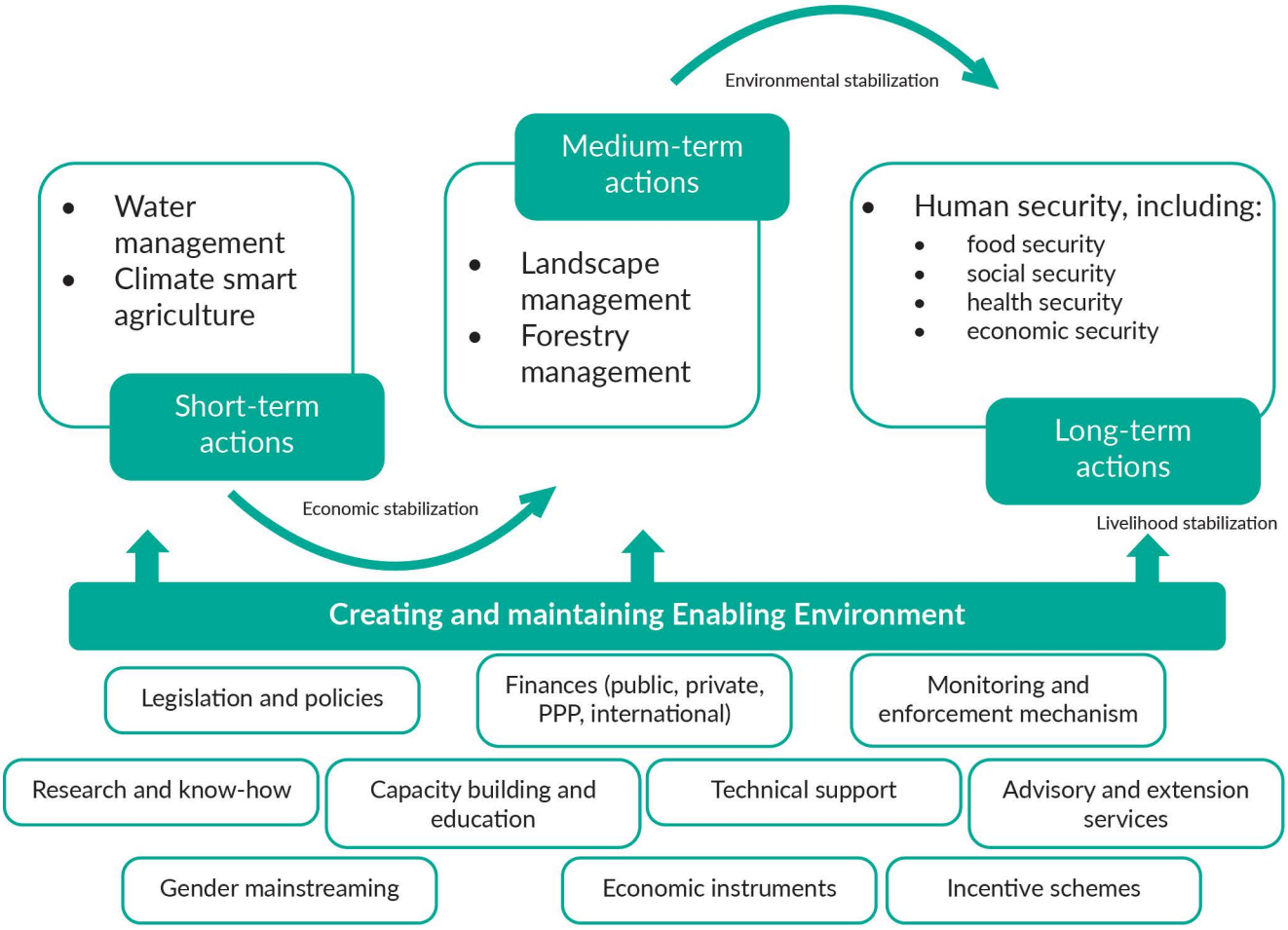

Figure 1. Roadmap for promoting integrated mitigation, adaptation and prevention solutions for sustainable landscape management in the Aral Sea region

Policy recommendations on sustainable landscapes climate smart and climate resilient agriculture and forestry development in the Aral Sea region for human well-being

Since the consequences of the ongoing climate change in the Aral Sea region have multiple impacts on various aspects of human security, alter various sectors of the economy and the environment, their mitigation and adaptation measures have to be elaborated following holistic, comprehensive approach. The adoption of adaptive, preventive or preparatory measures for sustainable landscape management integrated with a climate smart agriculture and sustainable forestry implementation at the field level could provide a major solution for several of the problems described above.

A sustainable landscape approach, provides "a framework to integrate policy and practice for multiple land uses, within a given area, to ensure equitable and sustainable use of land

while strengthening measures to mitigate and adapt to climate change" (Reed et.al., 2015, p. 3). In the context of the Republic of Karakalpakstan, sustainable landscape management embraces the environment (desert and semi-arid ecosystems), agriculture (irrigated crop production systems) and livestock rearing (pasture and meadow ecosystems).

"Climate-Smart Agriculture (CSA) is an approach to help the people who manage agricultural systems respond effectively to climate change. The CSA approach pursues the triple objectives of sustainably increasing productivity and incomes, adapting to climate change and reducing greenhouse gas emissions where possible"[26]. In Karakalpakstan context, CSA refers to sustained, resource saving agricultural production, capable to respond to the pressing issues of regional climate change.

"The concept of sustainable forestry supports the very existence of forestlands[27]*. Sustainable forestry policies and practices support the use of forest products without causing harm to them and guide reforestation, afforestation, agroforestry measures to protect forest-dependent wildlife and other forms of biodiversity"* (Burton, 2019).

Comprehensive policy reform programs in sustainable landscapes, climate smart agriculture and forestry development are required targeting short-term, medium-term and long-term horizons. Solutions and actions developed and proposed by international development organizations active in the Republic of Uzbekistan, such as UN agencies, the WB, GGGI, MPHSTF, ZEF, GIZ, CGIAR, ICARDA, GEF SGP, FAO, as well as national state organizations, Ministry of Water Resources (MoWR), Ministry of Agriculture (MoA), Ministry of Ecology, Environmental Protection and Climate Change (MoEEPCC), Ministry of Economy and Finance (MoEF), Ministry of Health (MoH), Ministry of Investments, Industry and Trade (MoIIT) could be grouped around five policy recommendations, as described below. Suggested recommendations are prioritized based on their urgency, spill over and scaling effects.

Since in Uzbekistan, more strategies, solutions, and approaches focus on adaptation to climate change, special attention is required to a wider introduction and dissemination of climate change mitigation strategies. "Mitigation means implementing actions that slow down the causes of climate change, or reduce the net release of greenhouse gas emissions, the main cause of temperature rise"[28].

The conceptual and methodological approach for developing policy recommendations is shown in Annex I. Annex II provides detailed technical and managerial options and recommendations for improving water sector, climate smart agriculture, landscape management and various aspects of human security, including food, health, economic and social securities for the population of the Republic of Karakalpakstan.

Policy Recommendation 1: Rehabilitation and modernization of water management system.

Policy Recommendation #1:	**Rehabilitation and modernization of water management system**
Issues	1. Large part of the irrigation network throughout the country and specifically in the lower reaches of the Amudarya River, including Karakalpakstan, remains unlined or not "water-proofed" and much irrigation water infiltrates and adds to groundwater stock. Due to seepage losses only about one third of water withdrawn from rivers for irrigation reaches farmers' fields directly. *In the water sector development concept until 2030[29] the Government of Uzbekistan has set the targets of increasing the efficiency of the irrigation system and irrigation networks in the country from the current coefficient 0.63 to 0.73 by the year 2030; modernization of the irrigation system and increasing the proportion of canals with concrete coating from the current 34% to 46% of irrigation channels by the year 2030. In Karakalpakstan, the government plans to construct 405 km of irrigation channels and rehabilitate and modernize 2,246 km of irrigation network at the expense of local budgets, and rehabilitate 14,200 km of irrigation on-farm channels at the expense of agricultural water users[30].* 2. Conventional irrigation practices require excessive leaching of both water and fertilizers thereby needlessly wasting water resources. Diminishing water resources will require further exploration and eventual adoption of viable, water-saving agricultural solutions on field level. On-farm water management interventions can provide important and often overlooked opportunities. Benefits of water-saving technologies include significant increases in water and fertilizer use efficiency, greenhouse gas emission reduction, power saving where water is pumped, reduction in manpower and labor, expanded use of more varied soil types and topography, reduction in certain diseases and pests, reduced arsenic uptake, and improved crop quality. *The Government of Uzbekistan has set the target to convert 2 mln. ha throughout the country by the year 2030 to water saving solutions, including 600 thousand ha to drip irrigation. In Karakalpakstan, the target is to equip 41,922 ha with water saving technologies and methods, including 7,322 ha with drip irrigation[30].* 3. Extensive use and dependence of water pumps on non-renewable energy sources continues to be an issue, especially in light of diminishing energy stock in the country. 4. Excessive use of water resources, their inefficient application and loss takes place due to managerial issues on a system level. There is lack of water measuring devices and points, still manual regulation of water in-take points.
What	1. **Renovating, modernizing the irrigation and drainage network** in Karakalpakstan, but also in upstream provinces is absolutely required and will lead to substantial water saving amounts; 2. Water application efficiency can be substantially improved through better management of irrigation events or current (furrow) irrigation methods. **Improving traditional furrow irrigation methods** (double-sided irrigation, intermittent irrigation, irrigation every second furrow); Further wider **dissemination of water saving technologies** in Karakalpakstan; Targeted introduction of non-traditional water saving techniques (**hydrogel and biochar**[31] in orchards and agroforestry plantations); **Introduction of precision irrigation techniques** based on soil moisture level or plant water requirement.

	3. Apply climate change mitigation strategies in water management sector by introducing water saving technologies with **solar driven pumps**; establish wells in pastures with solar driven pumps; rehabilitating existing channels or constructing new channels with a certain slope as to **ensure gravity flow** of water and reduce the use of diesel or electric pumps. 4. Implementation of the "Smart Water" system for monitoring and accounting of water at water management facilities in real time is among the priority targets of the government until 2030.
How	The pathway for implementation of all suggested solutions for PR#1 includes the following cross-cutting elements: — Attract further **direct investments in water infrastructure** in Karakalpakstan (private, donor organizations); — **Establish PPP schemes** for water management at system level in Karakalpakstan; — **Introduction of a system of incentives** based, for example, on the introduction of water rights and water fees both at the user level (farmers) and at system level (governments of riparian states), or alternatively tax privileges and tax exemptions; — Pay special attention to mitigation of climate change in the water sector.
Ambit (intervention level, scope) and responsible institutions	Country, province, landscape & farm level. **MoWR, MoA, MoEF, MoIIT, Farmers' Council, Uzhydromet, (Uzbekistan and Karakalpakstan levels)**

Policy Recommendation 2: Intensification and support of the transition from traditional water-intensive agricultural production systems to climate smart and climate resilient agricultural practices.

Policy Recommendation #2:	**Intensification of transition to climate smart agriculture**
Issues	1. Climate-smart agricultural practices and integrated approaches to management of landscapes are crucial for further sustainable growth in the Aral Sea region. Given the evident impacts of climate change and reduced water resources on current agricultural production, a range of measures and solutions have to be introduced to support the shift to climate smart or climate resilient agriculture. 2. Currently environmental factors are not taken into account when developing agricultural practices and norms for agricultural inputs. When improving agroecological practices and developing standards and mechanisms for the protection of natural resources, the integration of environmental factors is necessary. *'Agriculture Development Strategy (ADS) for the Republic of Uzbekistan for 2020-2030[33]' envisages the introduction and implementation of Good Agricultural and Environmental Practice (GAEP) standards among agricultural producers in Uzbekistan, as well as Good Manufacturing Practice (GMP) in agricultural entrepreneurship and other quality standards.* 3. Agriculture continues to be the main water user in Karakalpakstan. Irrigation water in not used efficiently. Crop yields in Karakalpakstan are below the average yields compared to the rest of the country. 45% of irrigated areas in Uzbekistan are salinized to various degree, whereas soil salinization in Karakalpakstan is even worth.

	ADS has set the targets (on country level) to: reduce water use per hectare of irrigated area by 20% until 2030; increasing the number of farmers who have adopted good agricultural and environmental practices and an international quality management system from the current 2% to 20% by the year 2030; decreasing the share of salinized irrigated areas to 37%. *Measures taken to develop irrigation and improve the reclamation condition of irrigated lands in Karakalpakstan, under Presidential Resolution No. 4912 (from December 5th, 2020), resulted in improved water supply for more than 47,000 ha of land, a reduction in land experiencing high and medium salinity levels by an area of 11,200 ha, and the maintenance of a stable land reclamation status on over 140,000 ha. However, water supply remained low for 44,900 ha of irrigated land and 95,200 ha retained high or medium salinity levels.* *'The strategy for the transition of the Republic of Uzbekistan to a green economy for the period 2019 – 2030'[34] describes the following priority actions: introduction of organic farming methods; replanting crops to ensure constant surface coverage of cropland; diversification of crops (expansion of perennial trees and perennial grasses); proper storage/processing of organic animal waste; preventing pollution of water sources by agricultural waste; breeding highly productive animal breeds and plant species (varieties) that are resistant to salinity, drought and other dangerous phenomena and risks, preserving the gene pool of local animal breeds and plant varieties, as well as the gene pool of the wild ancestors of cultivated plants.*
What	1. Prioritization of water efficient agricultural commodities in districts of Karakalpakstan, **diversification of agricultural crops**[35] via **planting stress (drought, frost, heat) tolerant crops**[36] or traditional crops' varieties; **improving rice production systems**[37] via introducing drought tolerant or low water consuming rice varieties, or improving rice irrigation practices (alternate wetting and drying, drip irrigation, subsoil irrigation); planting **halophytes**[38] for managing soil salinity and forage production for livestock. 2. **Greening agricultural production** can be achieved through wider adoption of integrated pest management approaches; transferring to organic agriculture[39]; increasing value chains for agricultural crops via processing and storage facilities. Management of agricultural production and output can include **smart spatial crop allocation**[40] in Karakalpakstan with regards to water source; reallocation of fertile land to food crops; decreasing areas under rice; application of mixed crop systems; moving food crops to greenhouses. 3. **Soil** improvement and **reclamation practices** in Karakalpakstan must focus on raising soil fertility via **phytomelioration**[41] (planting green manure); planting **wind breaks**; shifting to **organic fertilizers**; improving **mineral fertilizer application** practices[42] (in required amounts, timing); reducing soil disturbance; introducing **crop rotation systems** and legumes crops . Gradual reduction of soil disturbance and **conservation agricultural practices**[44]. Apply climate **change mitigation strategies** in agricultural sector by constructing solar greenhouses (without traditional heating systems); reducing mechanization activities in the fields, i.e. shifting to min. or zero till practices; improving livestock waste management.
How	The pathway for implementation of all suggested solutions for PR#2 includes the following cross-cutting elements: — Necessary **institutional support measures** must include establishing Drought Early Warning System, installing mini meteo-stations in districts of Karakalpakstan; adoption and implementation of the system of incentives, such as tax exemption or tax privileges, licensing eco products, organic agriculture products; establishing the necessary infrastructure for smart agriculture tools and machinery; providing more space for independent decision making for agricultural producers, decentralizing management of agricultural production.

	— It is necessary to **improve the financing system** and review the volumes of budget funds allocated for government programs and services in environmental protection, increasing soil fertility and introducing water-saving technologies; food safety, animal disease control, veterinary and phytosanitary services in Karakalpakstan. Example: KK jurisdictional programs on carbon offsets - carbon fund/tax). As a policy and implementation program facilitated by the KK and Uzbek government. — Conducting a detailed audit of the activities of all extra-budgetary funds related to the agri-food sector and gradual transfer of provided services to the private sector. — Pay special attention to mitigation of climate change in agricultural sector
Ambit (intervention level, scope) and responsible institutions	Country, province, landscape & farm level. **MoA, MoEEPCC, MoEF, MoIIT, Uzhydromet, Farmers' Council (Uzbekistan and Karakalpakstan levels)**

Policy Recommendation 3: Scaling up sustainable landscape and forest management practices and approaches.

Policy Recommendation #3:	**Scaling up sustainable landscape and forest management practices and approaches**
Issues	Sustainable landscape management can contribute to several SDGs simultaneously, including poverty eradication (Goal 1), food and water security (Goals 2 and 6), biodiversity protection (Goal 15), and climate change mitigation and adaptation (Goal 13).[45] *"Five new protected areas were created in Karakalpakstan, covering a total of 3.6 million ha, and 1.7 million ha of Saxaul, Cherkess and other trees were planted on the dried Aral Sea bottom" (MEEPCC, 2023, p.35), areas of protective forest plantations have been expanded, wind-protective green belts on agricultural lands increased, improved monitoring systems and improve environmental education programs was created.* 'Agriculture Development Strategy (ADS) for the Republic of Uzbekistan for 2020-2030' envisages development of minimum environmental standards and requirements based on Good Agricultural and Environmental Practices (GAEP) *to monitor the impact of agricultural production on the state of ecosystems and biotopes; expanding green zones in cities throughout Uzbekistan to more than 30% by planting 200 million seedlings per year and bringing the total number of seedlings to more than 1 billion; bringing the republic's forest reserves to more than 90 million cubic meters; increasing the level of recycling of generated household waste to more than 65%.* *'The strategy for the transition of the Republic of Uzbekistan to a green economy for the period 2019 – 2030' describes the following priority actions: restoration of degraded pastures and introduction of mechanisms for sustainable pasture management; preventing pollution of water sources by agricultural waste.* Karakalpakstan remains the most vulnerable region in Uzbekistan to climate change, prone to various climate change hazards, risks and damage to the ecosystems and the population. Since the territory of Karakalpakstan is large and includes: **(1) irrigated areas, (2) pastures/meadows, (3) mountains and deserts and the dried bottom of the Aral Sea, (4) settlement areas**, separate/specific options for landscape restoration and sustainable landscape management have to be developed and applied.

What	1. In the **irrigated zone**, sustainable landscape practices may include planting **windbreaks** and forest patches in irrigated areas with local tree species (Russian olive or *Elaeagnus angustifolia*); conservation of wetlands; adhering to integrated pest management and plant protection system in **agroforestry practices. Afforestation of degraded land**; reclamation of degraded irrigated land. 2. For **pasture and meadow zone** activities should focus on introduction and enforcement of improved pasture management (rotational grazing of animals); promoting integrated sylvo-pastoralism solutions, through windbreaks and agroforestry; restoration of pasture productivity (estuary irrigation and improvement of the botanical composition of herbage); installation of vertical wells with **solar driven pumps in pastures** (for animals and vegetation irrigation); establishing in pastures **traditional (ancient) rain water collection reservoirs**, such as 'takyr', 'hak', 'chirle', 'sardoba' and planting vegetation around such constructions. 3. For **desert zone** recommendation include to continue **afforestation of desert areas** with desert trees (Saxaul, desert shrubs) mixed vegetation types (shrubs and local grasses) for reducing wind erosion and dust storms as well as restoring lost ecosystems. 4. **For urban or rural settlements** zone recommended is to create protected areas (national parks, etc.) and **green zones**; adhere to green urban development concept; improve and modernize **waste management and recycling systems**; resolve the issue with uncontrolled open landfills (as climate change mitigation strategies). Reduce burden on local forest for timber and fuel wood in Karakalpakstan through intensification of **agroforestry practices**.
How	The pathway for implementation of all suggested solutions for PR#3 includes the following cross-cutting elements: — Leverages on management and institutional levels include **providing incentives** for local population and forestry organizations to upscale afforestation measures. On the restriction side, in Karakalpakstan this can include fines for cutting trees or unsustainable land use practices, up to withdrawing land plots, cutting off soft credits or financial support. On the incentive side, local land users can face tax cuts, subsidies for land reclamation or clean production; conducting campaigns for provision of local population with tree seedlings, etc. — Continue attraction of international **attention and financial aid** to Aral Sea ecosystems by conducting international scientific, research and conservation events; participation in international or regional nature conservation initiatives, etc. — Development of economic measures and instruments, including the introduction of fees for reducing greenhouse gas emissions; development and implementation of mandatory requirements for energy efficiency and environmental assessments for manufacturers in any sector of the economy who use natural resources and ecosystem services in their activities. Example: Carbon tax with a specific destination of the collected tax volume for a sustainable land management fund (including conservation and CSA activities) — Pay special attention to mitigation of climate change in landscape and forest management
Ambit (intervention level, scope) and responsible institutions	Country, province, district levels and urban settlements **MoEEPCC, MoA, MoEF, MoIIT, Uzhydromet, Farmers' Council, Association of Makhallas, Forestry Agency (Uzbekistan and Karakalpakstan levels)**

Policy Recommendation 4: Adaptation of the legislative and institutional arrangements for climate smart agriculture, water and landscape management in Karakalpakstan.

Policy Recommendation #4:	**Adaptation of the legislative and institutional arrangements for climate smart agriculture, water and landscape management in Karakalpakstan**
Issues	1. Many of the developed by international organizations and projects recommendations, solutions in the sphere of climate smart agriculture, sustainable landscape management, management of the water sector are optional, are not mandatory for execution, and often the case remain just in the corresponding reports. Recommendations and solutions developed, tested and described by international and national organizations for Karakalpakstan may be fully and sustainably implemented and upscaled upon the necessary legislative support. 2. The economy-ecology balance is complex, embraces many areas and resources and thus cannot be achieved by the efforts of any single (separate) institution/ministry/organization. Support is required from the government for developing inclusive economic institutions as a mechanism for accelerating the adoption of adaptive technologies. Inclusive economic institutions feature secured land tenure, an unbiased system of law, and a provision of public services that provide a level playing field in which people can exchange and contract. Strengthening trust in the land rentals and leasing system and the implementation of consistent farm policies over time are crucial to encourage long-term on-farm investments (USAID, 2020). 3. Sectoral adaptation plans in the country and in Karakalpakstan, although under development, remain rather weak and not fully introduced through legislative framework.
What and How	1. It is necessary to update and improve the legislative environment by reviewing recommendations developed so far by various organizations and donor agencies and **amending relevant laws and incorporating the issue of climate change adaptation and mitigation**, and human security into the concept of national security tailored to the Republic of Karakalpakstan. A **mechanism for enforcing** of the adopted legislation focusing on improved water management sector, agricultural sector and sustainable landscape management should be in place. 2. Establishment of the intergovernmental structure - a Consulting Committee for sustainable development of the Aral Sea region/ Coordination body (committee) which will coordinate all adaptation and mitigation activities in the Aral Sea region, with representation of the involved ministries (MoWR, MoA, MoEF, MoIIT, Farmers' Council, Uzhydromet, MoEEPCC and Forestry Agency, etc.). To attract investments in climate-smart agriculture, it is important to **strengthen the land tenure security** of local farmers, and develop a clear roadmap underpinned by an investment plan to implement adaptation actions. 3. Legislation regulating water sector, agriculture and landscape management under development must be shaped with consideration of climate change consequences and the required **adaptation, mitigation and prevention measures tailored for the Aral Sea region**.

Ambit (intervention level, scope) and responsible institutions	Legislation at the national level and subnational level (for the Republic of Karakalpakstan) Potential Coordination body with representation of all involved ministries, Legislative chamber (at Oliy Majlis), Council of Ministers of the Republic of Karakalpakstan

Policy Recommendation 5: Intensification of the enabling environment for sustainable landscape and forest management, climate smart agriculture in Karakalpakstan.

Policy Recommendation #5:	**Intensification of the enabling environment for sustainable landscape and forest management, climate smart agriculture in Karakalpakstan**
Issues	1. The lack of an effective agricultural extension system linking research, education and the provision of information and extension services remains one of the most serious obstacles to science-based sustainable development of the Aral Sea region. Realizing adaptive changes in agriculture, water and landscape management will require supporting measures, such as effective and extended consulting and advisory services for farmers to disseminate knowledge. Implementing infrastructural adaptation measures based on access to information and extension services will add to success of such changes. Support is required for local population and producers in selecting the proper infrastructural adaptation measures, their maintenance and management, as well as providing advisory services in export, marketing, value-adding activities. 2. Educational and professional training courses, the education system, the form and methods of teaching in educational institutions in agricultural or landscape management sectors do not meet the modern requirements. Investing in human & social capital will help reducing the implementation risk and promoting a successful and efficient adoption of the technologies. In this regard, stakeholders' understanding of the proper management of each technology, the benefits and timely returns from these measures, as well as the potential economic and external impacts on the production systems, will support reducing the implementation risk and will increase the effectiveness of their adoption. Uzbekistan will need to expand on the quality of foundational and technical skills through education and training opportunities to prepare people for jobs generated by a green economy. 3. There are barriers that impede effective integration of green growth principles in policies, strategies, and investment decisions such as insufficient knowledge, capacity, and public awareness. For sustainability of solutions - access to information and extension services is highly required for a successful adoption of adaptation and mitigation measures. The issue of developing and implementing communication programs, raising awareness and educating the public on climate change and its impact on human security will remain relevant for years to come. 4. There is an urgent need for the government to closely monitor the positive impacts of the adaptation solutions and technologies, the economic conditions in the region, and the impacts of climate change. 5. Karakalpakstan has its specifics of soil and climate, on-site research and experimentation is required for selecting and adapting technologies and techniques in water management, climate smart agriculture, and sustainable landscape management areas.

	6. Accessibility to formal finance and promoting focused and tailor-made **government subsidy programs** for people in the agriculture sector is needed to enable them to tackle climate change disasters.
What	*1. System of consultation and extension services* Realizing adaptive changes in agriculture, water and landscape management will require supporting measures, such as **effective and extended consulting and advisory services** for farmers to disseminate knowledge. Implementing infrastructural adaptation measures based on access to information and extension services will add to success of such changes. Support is required for local population and producers in selecting the proper infrastructural adaptation measures, their maintenance and management, as well as **providing advisory services in export, marketing, value-adding activities**. *2. Education, capacity building and retraining* Capacity development efforts will bring about more judicious use of natural resources, crop production growth, improved living standards and incomes, more employment opportunities, a wider range of crop production, and overall food security in the region. *Gender considerations* Mainstreaming gender perspectives in addressing the causes of climate change is critical at the planning, designing and implementation stages of climate change adaptation and mitigation strategies. Engaging as many women as possible in capacity development activities is recommended, as women are increasingly involved in farming activities, especially on their house plots. Women in rural areas take on more responsibilities in house chores, and climate change increases women's workloads. Therefore, broad female participation in risk resilience capacity development is suggested, as they are major agricultural actors in the Aral Sea region. *3. Information and awareness raising* — developing communication products and communication channels climate change awareness raising; — conduct periodic awareness campaigns on climate change trends, consequences and threats, as well as adaptation measures, financial support options; — encouraging a healthy lifestyle through awareness raising, education, training. *4. Establish a transparent, open monitoring, evaluation system* in the areas of CSA, water and landscape management, climate change, human security. Proposed measures can include: — development of agrometeorological monitoring system for assessment and forecasting climatic conditions during vegetation season — development of a **national green taxonomy and monitoring, reporting, and verification system**; conducting regular monitoring and updating the population on the quality of drinking water, the state of soil and air; expanding the existing air quality monitoring network and its complementing with a network of low-cost sensors to inform the public with real-time information on water, air quality. *5. Observation, research and experimentation/testing* It is recommended to establish in the region a well-developed scientific and experimental base, or support, intensify and upgrade the existing research institutions and stations.

	6. System of financial services and support Strengthening financial and investment regulations is critical for promoting green investment and climate risk management. However, the state budget has limited capacity to cover multibillion-dollar costs of decarbonization and climate adaptation measures. A large part of these investments can be carried out by the **private sector**, if the government creates a conducive environment for both local and foreign investors to support the green transition. Public and private investments in climate adaptation and decarbonization are expected to have high returns.
How	The pathway for implementation of all suggested solutions for PR#5 includes the following cross-cutting elements: — The government should accelerate the current reform program to support greater business dynamism and private sector development and establish monitoring, reporting, and verification systems to facilitate the scale-up of climate projects. Strengthening financial and investment regulations will also be critical for promoting green investment and climate risk management. — The government also could strengthen market incentives to reduce emissions, such as a carbon tax. It will also require improving access to credit so that farmers can invest in water-wise technologies, and this will in turn require improvements in the banking system, as well as financial support. — Accelerating the development of private sector is critical to absorb the costs and take advantage of the opportunities of the green transition. Market incentives and financial market development will help bring in the private sector at scale and relieve burdens on public finances. — In the short term, the system of extension and consultation services can be established with the support of the state and international organizations, with gradual transition of the former to self-sufficiency mode, i.e. financed by agricultural producers and other stakeholders. — Reviewing the distribution of expenditures for financing agriculture, providing for an increase in the allocated volumes of funds for research and development activities, the agricultural extension network, as well as information and advisory services.
Ambit (intervention level, scope) and responsible institutions	Country, province, district levels. MoEEPCC, MoA, MoEF, MoIIT, Uzhydromet, Farmers' Council, Association of Makhallas , Forestry Agency (Uzbekistan and Karakalpakstan levels), education and retraining sector, mass media, corresponding research institutes and research stations in the Aral Sea region

Conclusions

The current characteristics of the Aral Sea region include a vast desert area affected by the desiccation of the Aral Sea; remoteness of the region and its settlements from more advanced territories of the country; limited water and irrigated land resources; pressured environmental and demographic factors, and others. There is numerous evidence of deleterious effects of a changed climate in the Aral Sea region, igniting development challenges of sustaining economic growth, preserving livelihood and health of the population, and reversing degradation of natural resources.

Water issues are multifaceted and stem from a combination of geographical, climatic, economic, and management factors. The region's arid climate, coupled with limited water resources, presents significant challenges to sustainable water management, climate smart agriculture and sustainable landscape management.

Since Uzbekistan is one of the countries quite vulnerable to climate change, the adoption of adaptive, preventive or preparatory measures is required to prevent climate risks throughout all provinces. Without action on climate, Uzbekistan and the Aral Sea region will not achieve their development vision.

Official and informal sources of data confirm some positive shifts in socio-economic development and efforts made towards mitigating the consequences of the Aral Sea crisis, enabling human security and improving well-being of the population. **Still, successful dissemination of climate change mitigation and adaptation measures geared towards improvement of the well-being of the local population, their scaling up requires that technical or infrastructure solutions come as a package, including capacity building, provision of extension, consultation and maintenance services. The success of adaptation actions to climate change relies on not only technological innovations, but also supporting institutional, policy, and investment environments, which can help innovations reach scale rapidly**. National programs for scaling up adaptive measures should include the sources and types of finances, system of monitoring, evaluation and update or correction measures.

The enabling environment is critical for scaling up. Any program working on issues of scaling should take into account existing institutions and their capacities as well as the policy and regulatory framework, and the opportunities and constraints they provide (Linn, 2012). Consideration of the special features of natural-climatic, transport-geographic, demographic and settlement conditions is highly important when developing and implementing the tactics and strategies for socio-economic development, the formation of institutional and regulatory frameworks for transformation processes in Karakalpakstan, regional building codes and rules for zonal design, and the creation of specialized scientific, innovative, medical and educational centers (institutes and institutions).

The priority recommendations for creating the required enabling environment include strengthening institutional arrangements and coordination mechanisms for climate change policies and investments at the central and subnational levels, instituting national implementation planning (such as through the Long-term Strategy on climate change), and tightening regulation (including the adoption of legally binding national climate targets). Because the proposed recommendations are complex and in many instances crosscutting, their implementation cannot be assigned to a single separate ministry or other government body. Implementation of policy recommendations can be delegated to a potential Working group consisting of the Ministry of Ecology, Environmental Protection and Climate Change; Ministry of Agriculture, Ministry of Water Resources; Ministry of Investments and other. The policy and regulatory framework and its enforcement are also critical for effective scaling up (this may include land ownership, extension services, taxes or subsidies on agricultural inputs, credit and insurance schemes) because they provide the rules and incentives (or disincentives) for disseminating adaptive measures and solutions.

Green transition towards sustainable development of the Aral Sea region will require considerable financial resources (public, private, international aid, PPP), however, the benefits including cleaner air, improved health, and economic growth outweigh the costs. Investments in infrastructural adaptation measures are strongly recommended for the Aral Sea region as short-term (in water management and agricultural sectors) and medium-term solutions (in landscape and forest management sectors). Successful and efficient adoption of the suggested technologies such as planting trees for windbreaks, wider application of water saving technologies, building energy efficient greenhouses, etc. requires investments in human & social capital.

Mainstreaming gender perspectives in addressing the causes of climate change is critical at the planning, design and implementation stages of climate change adaptation and mitigation strategies. Gender perspectives are crucial for the analysis of successes and failures in implementing climate strategies, adaptation measures, and actions at the central, regional, and local levels.

Annex I. Conceptual framework for developing policy recommendations

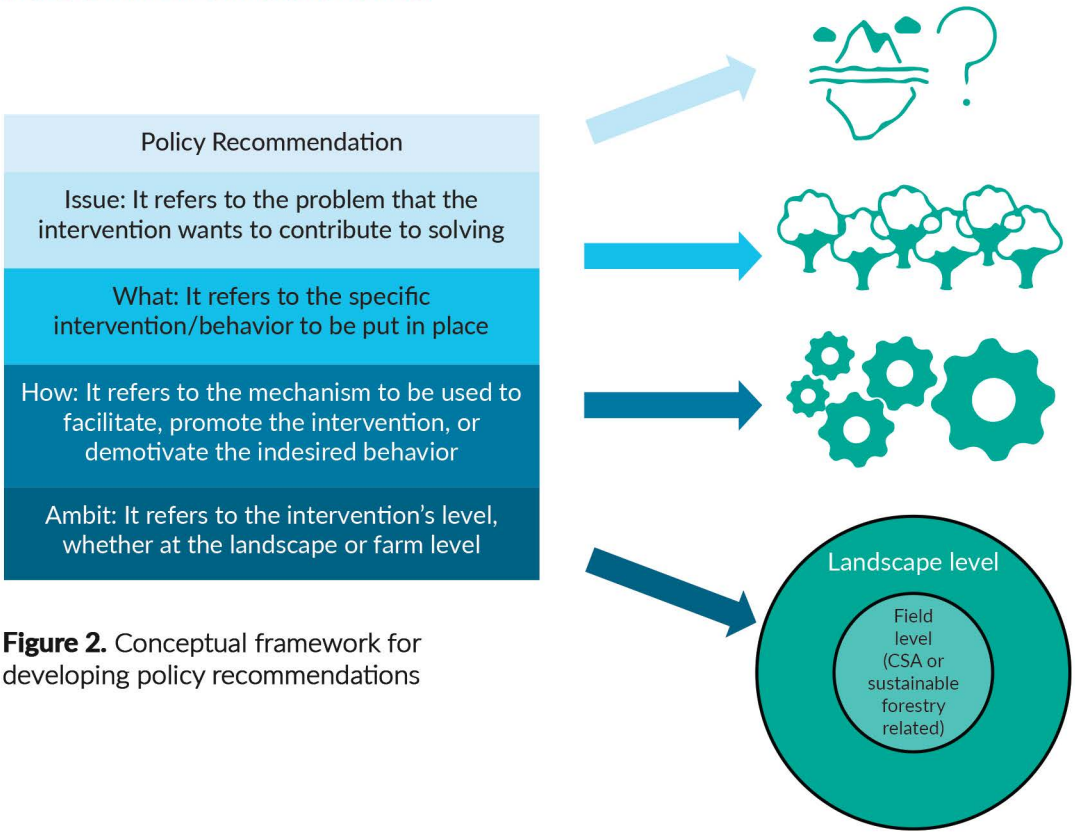

Figure 2. Conceptual framework for developing policy recommendations

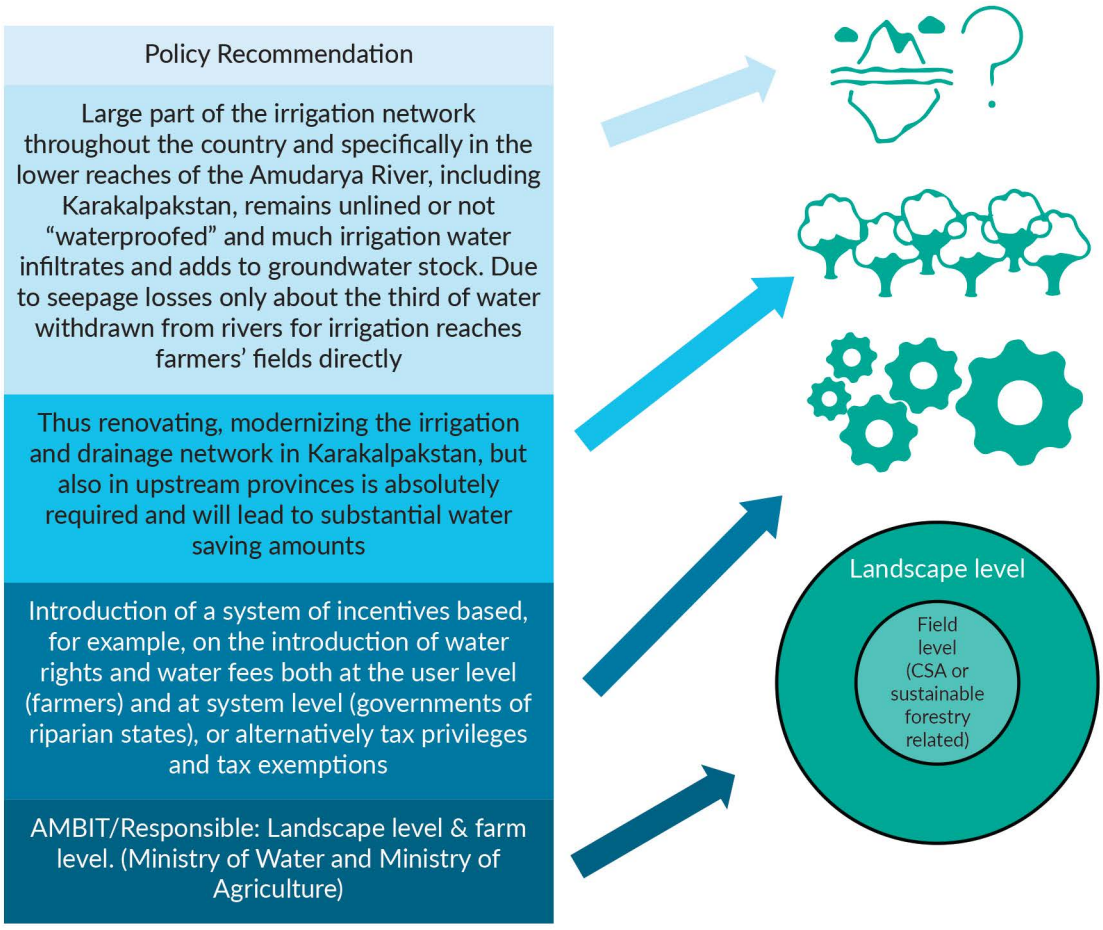

Figure 3. Example of a separate policy recommendation in the water resources management sector

Annex II. Detailed recommendations Recommendations for improving water management system

Recommendations for water sector extracted from the consulted publications range from technical solutions to managerial and institutional options, and can be grouped as follows:

Technical solutions for water saving on system and field level

— concrete lining of irrigation main channel beds, which require considerable investments, but will reduce conveyance losses and will improve channel efficiency from the current average efficiency of 0.63 to 0.73;

— lining of on-farm (small channels) with plastic cover (to reduce infiltration losses), which requires less investments, but still lead to saving water;

— install closed irrigation pipelines;

— efficient collection and use of snow and rain water resources (in underground storage facilities or water reservoirs along the Amudarya River) to offset the seasonal water shortage during summer;

— wider adoption of water saving technologies on field level (drip irrigation, sprinkler irrigation, Buried Diffuser (subsoil irrigation method);

— apply improved furrow irrigation methods, such as double-sided irrigation, intermittent irrigation, etc.);

— use of hydrogel (specifically in orchards);

— establish windbreaks to reduce evapotranspiration and generate micro climate;

— use of ground water and treated drainage water for irrigation purposes

— establishing Artesian wells

— subsurface pulse drip irrigation

Improved water management

— reuse of wastewater for irrigation (collection of municipal wastewater, cleaning and using for irrigation of agricultural (non-food) of crops. Irrigation of food crops with highly cleaned waste water is also possible, but will require strong standards and monitoring to avoid contamination. This option will require huge investments in infrastructural changes, but can support agricultural production in drought years;

— Cleaning and use of drainage water, cleaning with Reverse Osmosis method

— introduce precision irrigation techniques based on soil moisture level (use of tools hydroautoscan, tensiometers, sensors like 'Viridix' from Israel);

— introduce precision irrigation techniques based on plant water requirements (use of sensors for monitoring crop water consumption and irrigation needs like 'Treetoscope' in Israel);

— improve application of irrigation water (fertigation; sequence, timing and duration of irrigation events);

— improve the management of waste and agricultural runoff and the expansion of the existing water collector system to prevent its entry into water sources;

— biochar, mulching and no tillage for soil amendment and water retention;

Necessary institutional leverages

— adopt and apply water tariffs that reflect the scarcity of water resources and which will lead to water saving habits;

— adopt and implement the system of incentives, such as tax exemption or tax privileges for farmers adopting water saving technologies;

— transfer irrigation management to the private sector;

— introduce flexible water allocation mechanisms;

— promote the adoption of water- and energy-efficient technologies, in combination with complementary measures and climate-aligned agriculture policies;

— implement energy saving and energy efficiency measures in irrigation practices; wide use of alternative energy sources in water saving systems, for example solar driven pumps in drip irrigation systems

— Regulation of water use (limits) in coordination with adjacent countries (Tajikistan, Afghanistan, Turkmenistan, Kazakhstan)

— Take into consideration the gradual commissioning of the Kush tepa channel in Afghanistan

— Development of agrometeorological monitoring system for assessment and forecasting climatic conditions during vegetation season

Recommendations for transition to climate smart and climate resilient agriculture

Solutions for consecutive transition to climate smart agriculture include:

Technical solutions

— Crop diversification to include stress (water shortage, heat, soil salinity) tolerant crops, such as for example licorice, Indigofera tinctoria, sorghum, maize, aerobic rice etc.;

— change of current water intensive rice production systems to dry rice, drip irrigated rice, alternate wetting and drying rice production; introduction or expansion of rice seeding through high precision seeders and seedling transplanting;

— breeding and importing drought tolerant or low water consuming rice varieties;

— phytomelioration of irrigated lands, reclamation of land via planting green manure systems;

— minimum soil disturbance (min tillage to zero tillage);

— laser leveling of fields' surface (once in 3-5 years depending on cultivated crops);

— decrease soil erosion, salinization and dust storms through wind breaks (trees around the fields);

— production of fodder with hydroponic systems (vertical fodder production systems) for livestock;

— improvement of the wintering conditions of livestock;

— increase areas under drought resistant crops for export and ensuring food security

Management related solutions

— decreasing areas planted with rice, but increasing the yields by introducing sustainable cultivation practices, such as better use of fertilizers and chemicals, use high productive seeds;

— changing the structure of crop allocation (from cotton and wheat towards food crops: vegetables and fruits);

— changing the structure of spatial crop allocation with regards to access to water resources, water intense crops along the river or irrigation channels, drought resistant crops further away from the irrigation network;

— application of mixed crop systems, intercropping such as intensive orchards with vegetables, legumes crops;

— moving food crops to greenhouses (for better crop management);

— improved management of soil fertility (targeted application of mineral fertilizers, strong crop rotation systems, composting, mulching or crop residue retention, etc.);

— adhering to integrated pest management and plant protection system (towards non-chemical methods);

— A strategic water management and crop allocation plan

Necessary institutional leverages

— establish and put into force Drought Early Warning System, installing mini meteo-stations in districts of Karakalpakstan for on-spot climate observation and early adaptation of agricultural production;

— adopt and implement the system of incentives, such as tax exemption or tax privileges, licensing eco products, organic agriculture products;

— establish the necessary infrastructure for smart agriculture tools and machinery (sale points, extension and maintenance centers, etc.).

— Development of agrometeorological monitoring system for assessment and forecasting climatic conditions during vegetation season

Recommendations for sustainable landscape and forest management practices and approaches

Scaling up sustainable landscape management can be achieved via development and implementation of an integrated environmental risk adaptation plan. Since the territory of Karakalpakstan is large and includes irrigated areas, pastures/meadows, mountains and deserts and the dried bottom of the Aral Sea, separate specific options for landscape restoration and sustainable landscape management have to be developed. A specific legislation on planting trees is required.

For irrigated zone:

— planting wind breaks and forest patches in irrigated areas with local tree species (Russian Olive or Elaeagnus angustifolia) for soil fertility improvement, apiculture development, fodder and fuelwood production;

— conservation of wetlands;

— adhering to integrated pest management and plant protection system (towards non-chemical methods);

For desert zone and dried seabed:

— afforestation of desert areas with desert trees (Saxaul, desert shrubs);

— vegetating of desert areas with mixed vegetation types (shrubs and local grasses);

— vegetating the bare, dry Aral Seabed with shrubs and trees for reducing wind erosion and dust storms;

For pasture/meadow zone:

— introduce and enforce improved pasture management (rotational grazing of animals);

— restoration of pasture productivity (estuary irrigation and improvement of the botanical composition of herbage);

— installation of vertical wells with solar driven pumps in pastures (for animals and irrigation);

— establishing in pastures traditional (ancient) rain water collection reservoirs, such as 'takyr', 'hak', 'chirle', 'sardoba' and planting vegetation around such constructions;

— wide use of alternative energy sources in pasture management, for example solar driven pumps to receive water from wells in remote pastures drinking and irrigation purposes;

— Planting salt tolerant and drought resistant meadow and pasture plants for development of the livestock sector

For urban/settlements zone:

— creation of protected areas (national parks, protected areas; etc.);

— focus on green urban development;

— designing and constructing small innovative enterprises for the timely recycling of waste in rural areas;

— creation of green zones based on the specifics of desert territories, both in urban and rural areas;

— waste collection systems need to minimize open dumping and uncontrolled landfilling;

— manage GHG emissions from landfills, and divert organic waste from landfills.

Recommendations for enhancing food security in the Aral Sea region in light of climate change

The agricultural policy should address food availability, access, usage, and stability. The resilient food security system can be accomplished when the agricultural policy aligns with other policies such as trade, social safety-net, climate change, health, and nutrition as they are interconnected. The mechanism and the responsible state body should be established to coordinate the different policies to be aligned in order to ensure food security in the area. Actions may include:

— expanding the production of food crops adapted to the environmental conditions and land and water resources;

— increase in fruit and vegetable growing areas;

— establish small scale agrologistics centers (refrigerating facilities) in remote areas;

— management of fertilizer application for safer food crops (tools Chlorophilmeter, GreenSeeker, SPAD);

— intensify subsurface greenhouse production systems;

— intensify energy efficient greenhouse production systems;

— support home processing and storage of food crops (drying and conservation of fruits and vegetables);

— creation of a special veterinary and epidemiological service to combat the spread of various weeds, infectious insects and diseases of plants and animals;

— collection and primary processing of agricultural raw materials, medicinal plants, development of innovative livestock complexes.

Recommendations for modernizing and strengthening the health care system in the Aral Sea region for coping with growing health threats

Sustainable monitoring of the health vulnerability of the population of the Aral Sea region is required to identify

long-term trends and prevent additional burden on the health care system for various population groups (disaggregated by sex and age). Modernization of the health care system should aim at eliminating and minimizing direct and indirect factors that aggravate the negative impact of climate change on human health, including such measures as:

— monitoring the safety of water supply and the use of pesticides and mineral fertilizers in agriculture;

— strengthening control over occurrence of infectious and parasitic diseases;

— enhancing innovative medical equipment and medicines, and the streamlining of the pharmacy network in remote rural areas;

— organizing the systemic recycling of waste from health institutions;

— encouraging a healthy lifestyle;

— full digitalization of the healthcare system;

— improve sanitation services, sewage systems;

— improve agricultural runoff and poor wastewater management, search for other sources of safe drinking water for raising the quality of drinking water;

— upgrading the existing manual groundwater pumps and filters;

— invest in safe water artesian wells in rural areas;

— enhancing innovative medical equipment and medicines, and the streamlining of the pharmacy network at the makhalla and village levels;

— ensuring decent and safe working conditions for healthcare employees;

— development of an optimal scheme to cover the population with the medical institutions and pharmacy network;

— conducting trainings with women from rural areas on precautionary measures against the effects of climate change, including such aspects as extreme climate events, scarcity and insecurity of water resources, etc.;

— strengthening dialogue between the health and water sectors on the impacts of climate change and related adaptation will play a significant role in limiting the effects of climate change (at the ministerial level and at the level of research and academic programs of universities.

Recommendations for strengthen social protection measures for the most vulnerable population of the Aral Sea region

Uzbekistan will need to continue to strengthen its social protection system to safeguard the most vulnerable groups from climate-related risks. Climate mitigation and adaptation policies need to be complemented with carefully designed and well-implemented social protection policy packages to protect vulnerable groups from harm and to win broad support for policy goals. Moreover, skill development and climate action at the local level will be essential. Examples of measures for social protection and enhancing well-being of the population may include:

— sustainable self-sufficient settlements for the period up to 2050, taking into account climate change trends, and placement of industrial and social infrastructure facilities, with due consideration of potential risks and threats;

— sustainable CC adaptive housing, utilities and transportation services for remote areas;

— introduction of a district-specific wage supplement coefficient, including for public sector employees;

— sustainable provision of high-quality drinking water and sewerage access;

— formation of an effective drinking water supply management system in rural areas;

— phasing out of coal-based heating of educational institutions, and transitioning to solar panels and wind turbines;

— strengthening the material and technical base of the local authorities to address the issues of repairs and maintenance of the local roads;

— development of kindergarten dislocation schemes; designing typical kindergarten projects that meet modern architectural standards, local conditions and demand; development of family kindergartens in the rural areas;

— organization of transportation of pupils by school shuttle buses;

— improvement of roads and the supply of electricity and gas;

— resettlement of the population from rural areas with adverse natures to cities;

— upgrading the existing manual groundwater pumps and filters;

— infrastructures should endure extreme weather, considering the changeable weather conditions and increasing heat.

Recommendations for adapting legislative and institutional arrangements for shaping the enabling environment for CSA, water and sustainable landscape and forestry management

It is necessary to review and improve the legislative environment by reviewing and amending relevant laws and incorporating the issue of climate change and human security into the concept of national security.

Recommendations for capacity building and retraining in the areas of CSA, water and landscape management, climate change, human security

Capacity development efforts may bring about more judicious use of natural resources, crop production growth, improved living standards and incomes, more employment opportunities, a wider range of crop production, and overall food security in the region.

Capacity development measures may focus on the following:

— train local professionals and experts to utilize climate and water forecasting and early warning technology, and deploy the technology itself

— capacities of national education and training institutions need to be strengthened to develop skills on green adaptation measures to provide climate change education, with a focus on the national climate adaptation planning process

— increase access to training and education in Information Technologies

— increase access to training and education on financial literacy, and introduce systems that enable access to finance for economically/socially disadvantaged populations

— reeducation, capacity building, new skills required for the green economy

— improvement of the material and technical base of the educational institutions

— significant improvement in the level of qualifications and raising the prestige of the teaching staff

— increasing juridical literacy on legal issues

— improvement of financial literacy of monitoring expenditures, income, market prices

— increase access to training and education in Information Technologies

— increase access to training and education on financial literacy, and introduce systems that enable access to finance for economically/socially disadvantaged populations

— health training to encourage population to keep a healthy lifestyle, visit health facilities on time, and select the appropriate health services

— raising the quality of formal education which is a critical contributor to green skills

Recommendations on establishing sustainable and self-sufficient system of consultation and extension services

Realizing adaptive changes in agriculture, water and landscape management will require supporting measures, such as effective and extended consulting and advisory services for farmers to disseminate knowledge. Implementing infrastructural adaptation measures based on access to information and extension services will add to success of such changes. Support is required for local population and producers in selecting the proper infrastructural adaptation measures, their maintenance and management, as well as providing advisory services in export, marketing, value-adding activities. In the short term the system of extension and consultation services can be established with the support of the state and international organizations, with gradual transition of the former to self-sufficiency mode, i.e. financed by agricultural producers and other stakeholders.

Recommendations for establishing sustainable system of information and awareness raising

There are barriers that impede effective integration of green growth principles in policies, strategies, and investment decisions such as insufficient knowledge, capacity, and public awareness. For sustainability of solutions - access to information and extension services is highly required for a successful adoption of adaptation measures. The issue of developing and implementing communication programs, raising awareness and educating the public on climate change and its impact on human security will remain relevant for years to come. Actions can include:

— creation of a permanent monitoring system for the region's state of climate and environment

— forming a digital platform for the timely detection and anticipation of droughts and other extreme weather events

— invest further into efforts to increase agricultural stakeholders' capacity to use and access forecasting tools and early warning systems to enable them to anticipate coming changes and respond accordingly

— developing communication products and communication channels climate change awareness raising

— conduct periodic awareness campaigns on climate change trends, consequences and threats, as well as adaptation measures, financial support options

— encouraging a healthy lifestyle through awareness raising, education, training, ads

Recommendations for establishing sustainable system of financial services and support for green transition and adaption measures

The government should accelerate the current reform program to support greater business dynamism and private sector development and establish monitoring, reporting, and verification systems to facilitate the scale-up of climate projects. Strengthening financial and investment regulations will also be critical for promoting green investment and climate risk management.

The government also could strengthen market incentives to reduce emissions, such as a carbon tax. It will also require improving access to credit so that farmers can invest in water-wise technologies, and this will in turn require improvements in the banking system, as well as financial support.

— continue strengthening of land tenure and property rights as a foundational step toward easier access to finance

— restructuring of the economy from sectors vulnerable to CC to less vulnerable (from agriculture to industrial/processing sectors)

— shift from agriculture to manufacturing and services sectors (less vulnerable to CC)

— development of small business and utilization of local resources in rural (remote) areas

— greening the manufacturing and residential facilities / buildings (low energy, location, insulation, ventilation systems)

— modernizing manufacturing technologies (less energy, less waste, recycling, reusing)

— introducing non-waste technologies

— improving/introducing standards (construction, energy, ventilation, etc.)

— providing small entrepreneurship trainings to women, especially in rural areas

— create employment opportunities for rural women (based on agricultural processing, storage, logistics businesses)

— developing the "green certificates" market

— adopting environmentally friendly public transport

— enhancing energy efficiency

— digitizing energy resource accounting

— expansion of the existing air quality monitoring network and its complementing with a network of low-cost sensors to inform the public with real-time information on air quality

— additional enforcement measures targeting the most polluting sectors and industries

— continue strengthening of land tenure and property rights as a foundational step toward easier access to finance

— repurposing subsidies to support green sectors: differential value added tax (VAT), tariffs, import duties, and excise

— decentralizing the local budgets

— home-based business, branches and workshops of large enterprises, family businesses, liberalization of informal employment

— low-cost bank loans

— incentivize climate-smart technologies adoption with access to green finance to achieve economic efficiency for high, climate-resilient, and inclusive agricultural growth and restore degraded productive lands.

Recommendations for establishing a transparent, open monitoring, evaluation system in the areas of CSA, water and landscape management, climate change, human security

To conduct an annual national assessment of the vulnerability of the health sector of the Republic of Uzbekistan to climate change, it is necessary to digitize existing statistical data and monitor their quality, as well as integrate historical data on climate, air pollution and health, along with socio-economic indicators, into a single portal. This will allow policymakers to conduct better analysis to assess the impact of climate change on the health sector and socio-economic situation of Uzbekistan in a shorter time frame.

It is highly recommended that the government closely monitor the positive impact of these technologies, the economic conditions in the region, and the impacts of climate change and SDS. Proposed measures can include:

— develop a national green taxonomy and monitoring, reporting, and verification system

— conduct regular monitoring and updating the population on the quality of drinking water, the state of soil and air basin

— expand the existing air quality monitoring network and its complementing with a network of low-cost sensors to inform the public with real-time information on air quality

Recommendations for establishing sustainable system of continuous observation, research and experimentation/testing required in a dynamic climate change environment

Because Karakalpakstan has its specifics of soil and climate, on-site research and experimentation is required for selecting and adapting technologies and techniques in water management, climate smart agriculture, and sustainable landscape management areas. It is recommended to establish in the region a well-developed scientific and experimental base, or support, intensify and upgrade the existing research institutions and stations.

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