#TechChallengeCA

GLOBAL DISRUPTIVE TECH CHALLENGE 2021

RESTORING LANDSCAPES IN THE ARAL SEA REGION

SYNOPSIS OF THE BASELINE ANALYSIS OF LANDSCAPE RESTORATION SITUATION IN THE ARAL SEA WATERSHED WITHIN THE REPUBLICS OF KAZAKHSTAN AND UZBEKISTAN

Photo Credit: Тихонина

CAWEP CENTRAL ASIA WATER & ENERGY PROGRAM

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Introduction

Land is an essential natural resource that assures humanity survival and prosperity. Despite its unconditional importance for mankind's well-being, land degradation continues to increase causing very rapid adverse effects, especially at the local level. Degradation of land resources exacerbates economic, social, and environmental problems such as poverty, poor health, food insecurity, loss of biodiversity, water scarcity, reduced resilience to climate change, and forced migration. The relevant importance of land resources and the need for their protection have found its reflection in the United Nations (UN) Sustainable Development Goals (SDGs). The Goal 15 calls on countries to protect, restore and promote the sustainable use of terrestrial ecosystems, sustainable management of forest, combat desertification, prevent and reverse the degradation of land resources, and stop the loss of biodiversity.

The Aral Sea basin countries, including the Republic of Kazakhstan and the Republic of Uzbekistan are actively working to achieve sustainable development goals, including the restoration of degraded land resources. The ECCA30 initiative inquires to bring 30 million hectares of degraded and deforested land in Europe, Caucasus, and Central Asia (ECCA) into restoration by 2030. Within those seven countries of the ECCA region, including Kazakhstan and Uzbekistan, have committed to restore around 3 million hectares of degraded lands.

The introduction of modern SLM practices could effectively reduce poverty and improve the living standards of the population in areas affected by desertification. About 66% of Kazakhstan territory has degraded lands and up to 70% of the territory of Uzbekistan is subject to desertification processes [1, 2]. Over 40% of Kazakhstan population and almost 50% of the Uzbekistan population are rural residents who face the negative consequences of land degradation through losses in agriculture, lack of drinking water, increased burden on health [1].

General assessment of the current situation

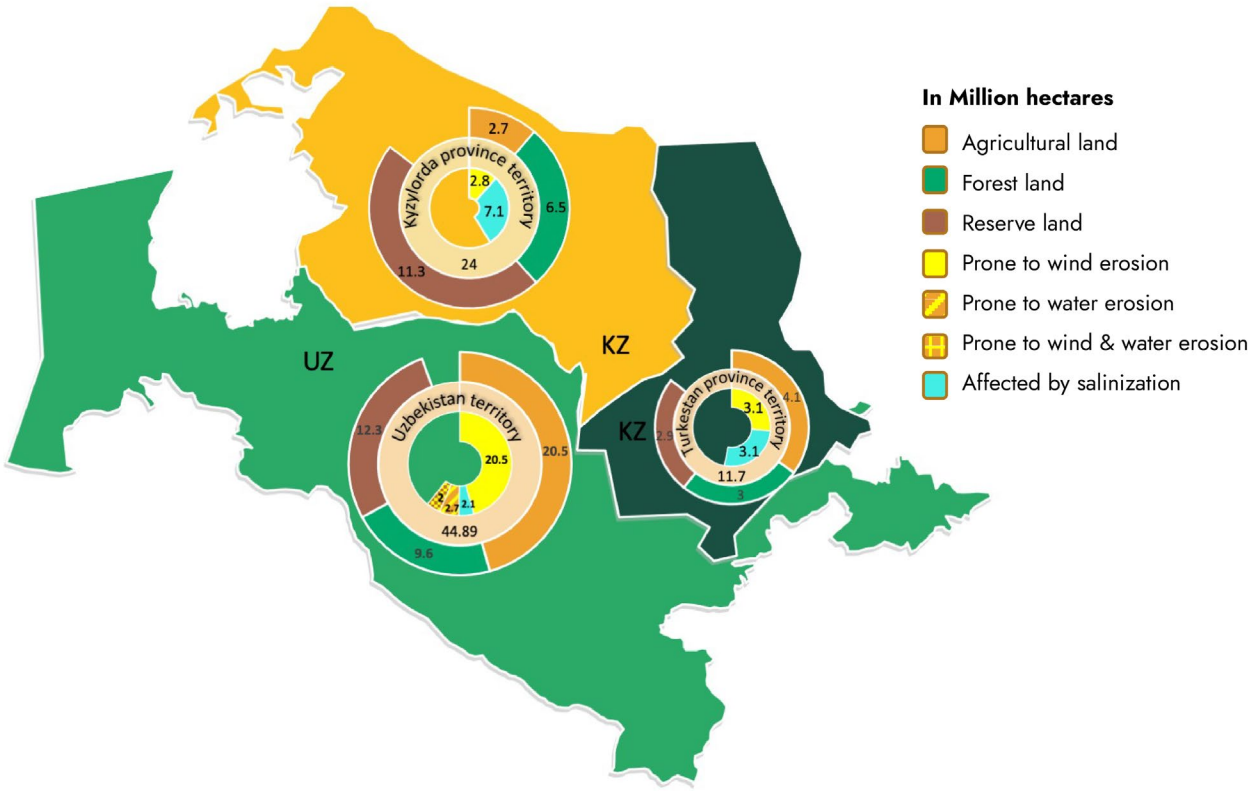
Once the fourth-largest lake in the world, the Aral Sea has been shrinking since the 1960s due to excessive withdrawal of water for irrigation, and by 2010 it had largely dried up. The seabed of the dried-up area has formed a new 5.5 million hectares[2] desert called Aralkum meaning Aral Sands. The declining sea level affected the groundwater level and contributed to the erosion of the Syr Darya and the Amu Darya river basins, causing problems to nearby wetland areas and threatening its unique biodiversity. The region is generally considered to be one of the most vulnerable to climate change. The Aral Sea Watershed in Kazakhstan includes Kyzylorda and Turkestan provinces and in Uzbekistan, all regions are part of it. The data [1, 4] on type of land use and degradation is reflected in the figure below.

The salts, sand, and dust that originate from dried-up seabed contain pollutants. Spreading with winds and dust storms they pose a risk for the world environment and people's health. There is no unified data on the volume of salt dust erosion, but the most common figure is around 450,000 tons per year [1].

To save and replenish the North Aral Sea, the Kokaral dam has been constructed within the partnership project of the Republic of Kazakhstan Government and the World Bank. As a result, the level of the northern part of the Aral Sea increased to 41.4 meters, and salinity has dropped allowing for some fishing activity to return and be viable.

Declining land productivity and colossal economical losses, environmental deterioration, and social inequality are major issues in the Aral Sea region. The main cause of land degradation is poor land and water management. Lack of proper pasture management resulted in extensive degradation due to overgrazing. The deterioration of the irrigation and drainage systems has led to soil salinization. Large filtration losses of irrigation systems and the unsatisfactory technical condition of hydraulic structures led to water shortage in the Aral Sea region which already suffers from limited water resources. For example, in furrow irrigation water losses can reach 25-30% due to evaporation (2-5%), filtration (10-20%), and surface fault (10-15%) [3].

Impact of land degradation



The efficiency of land and water management determines the quality of life for the local population and sustainability for the environment. The impact of land degradation for the countries of the Aral Sea basin can be seen in: (1) economic losses at different levels, (2) rural poverty, (3) access to and quality of education, (4) water deficit and insufficient water quality, (5) increased sickness rate due to environmental pollution, and many other areas of people's livelihoods.

Economic losses due to land degradation are imposed at local, national, and global levels. At the local level in terms of decline in land productivity, at the national level, in terms of loss of productive capacity of the agricultural land and lower growth of the agricultural gross domestic product (GDP) and export earnings. At the local and national level agricultural sector also ensures the food security of states. At a global level, land degradation in the Aral Sea region has a negative effect on carbon sequestration and climate change, biodiversity loss, and pollution of transboundary waters. General estimation of the total economic damage from desertification (including costs of reforestation and stabilization of mobile sands) was at USD 1,985 per hectare per year [5]. The agricultural sector accounts for 17% of GDP and 27% of employment for Uzbekistan [5, 6] and for 3.5-4% of GDP and 31.3% of employment for Kazakhstan [1]. Although, the direct and indirect socio-economic value of land and water resources is much higher than the GDP share of the agriculture sector economy.

Despite the overall decline in the share of the rural poor in recent years in both countries, the highest level of poverty was registered in the territories with a higher percentage of degraded land [1,5,6]. Rural areas have scarce job opportunities, low wages, and a population dependent on the use of natural resources like land plots and livestock. Low livelihood level diminishes rural population potential to combat land degradation and requires external support.

Poverty caused by land degradation negatively affects access to quality education. At the local level, we can observe that decreasing the economic opportunities of the population leads to downsizing or closing educational institutions. On the contrary, the opposite process can be observed with the restoration of the lands or ecosystems productivity, such as the restoration of the North Aral Sea, where new schools have been opened in recent years.

The availability or lack of required quality water resources is directly linked with land degradation processes. Inefficient and deteriorated irrigation systems lead to water losses in the area already struggling with water resources shortage. Apart from the availability problem, the quality of the water is poor due to contamination and erosion. In many villages, people use unsafe open drinking water sources or bring water from elsewhere. The ongoing discharge of collector-drainage waters into the Amu Darya and the Syr Darya and high level of chemical use in agriculture has led to an extreme sanitary-epidemiological situation, dangerous to the life of the population, and health risk for ecosystems.

The burden on local population health is increased due to environmental pollution with toxic chemicals (industries, pesticides, and fertilizer runoff) from dried seabed. Pollutants exceed maximum permissible concentrations (MPC) in the region environment (atmosphere, water, soil). For example, in the Kyzylorda region, nitrogen dioxide in the air exceeded MPC by 1.3 times; phenol, pesticides, lindane, arsenic, surfactants slightly exceeded MPC in region soils, and Mg, Fe, U, Se, Cd exceeded the MPC by 2.0 times in Kyzylorda and Zhanakorgan urban tab water and open reservoirs [7]. Among the causes of death, the main ones are circulatory diseases and cancer [8].

The list of economy, social, and environmental sectors affected by the quality of land resources is much wider. Some other examples of adverse effects of land degradation in the Aral area are increased climate continentality, decrease in air humidity by 20–30%, extreme heat events like 50°C, increase in dust storm frequency up to 60% per year, an increase of groundwater salinity up to 150-170 mg/l [7].

Photo Credit: Камар Аскар «Уран и высохшее озеро - угроза живому существу!»

Current needs and priorities for rehabilitation of degraded land

A brief analysis of the land degradation significant negative impact on economical, ecological, and social areas in Kazakhstan and Uzbekistan described above demonstrates the need for a coordinated approach to achieve sustainable land management (SLM) in the Aral region. Such approach combines political will, the capacity to implement it at a local level, the need to improve the existing land management system, and technical solutions in the form of projects to restore the required level of reclamation of agricultural lands.

Four priority direction reflected in the figure below represents the recommendations on preferable directions for the projects' competition within "The Disruptive Technology Innovation Challenge for Landscape Restoration in the Aral Sea Watershed (Kazakhstan & Uzbekistan)" project. Only projects that use scientifically based and inter-sectoral approaches that take into account environmental, economic and social factors should be included in the number of projects within the framework of the proposed Competition. To ensure the progress and sustainability of projects' results the monitoring and evaluation system needs to be incorporated. Monitoring should cover data on salts and dust mobility, deposition of salt and dust on agricultural fields, the impact of irrigation sediments, the toxicity of seabed deposits, quality of groundwater, local population health status, and other factors that would help to determine dynamics of changes.

Irrigated agriculture

- Farm management improvement
- River basin management improvement
- Water erosion prevention
- Efficient water use

Rainfed agriculture

- Soil fertility conservation
- Seed production improvement
- Soil management improvement

Pastures

- Pastureland rehabilitation
- Pastureland management improvement
- Forage-grasses seed production improvement
- Steppe and semi-desert ecosystems management improvement

Forests

- Degraded and deforested forest lands rehabilitation
- Forest fires protection improvement
- Forest management improvement
- Agroforestry promotion

Existing institutional capacity and experience in project implementation

Effective prevention of land degradation and desertification strongly depends on the successful inter-sectoral interaction of all stakeholders. The Republics of Kazakhstan and Uzbekistan have a developed system of laws related to sustainable land management, but they're still some gaps, duplications, and contradictions in the current legislation, the work on the elimination of which is carried out systematically. Both countries have developed and implementing strategies and concepts on Sustainable Land Management (SLM), engage in SLM scientific research, and in the implementation of international projects in that area.

The figure below shows that Kazakhstan and Uzbekistan have required institutional capacity. Both nations have accumulated good experience and sufficient potential in the implementation of projects to introduce new innovative technologies to order to improve land use efficiency and restore degraded lands.

Table 1 | Institutional capacity and experience in SLM

	KAZAKHSTAN	UZBEKISTAN
Key government agencies	Ministry of National Economy, Ministry of Energy, Ministry of Agriculture (incl. Committee for Land Management) Ministry of Ecology, Geology and Natural Resources (incl. Forestry and Wildlife Committee and Committee for Water Resources) Ministry of Finance and others	Ministry of Agriculture Ministry of Water Management State Committee on Forestry Goskomzemgeodezkadastr (The State Committee of the Republic of Uzbekistan on Land Resources, Geodesy, Cartography and State Cadaster)
Key legislation & Government programs	Republic of Kazakhstan Land Code, 2003 [last edits 2020] The State Program for the Development of the Agro-industrial Complex of the Republic of Kazakhstan for 2017 – 2021 (approved - 2018, aim - improving the efficiency of land and water resources use, budget - 779 billion tenge)	Republic of Uzbekistan Land Code, 1998 [last edits 2019] Strategy for the development of agriculture of the Republic of Uzbekistan for 2020-2030 Concept for the development of water management in the Republic of Uzbekistan for 2020-2030 Concept of environmental protection of the Republic of Uzbekistan for the period up to 2030

Table 1 | Institutional capacity and experience in SLM (Continued)

	KAZAKHSTAN	UZBEKISTAN
Science research	National Agrarian Scientific and Educational Center State Institute of Agricultural Aerophotogeodetic Surveys (SIAAGS) Joint research experience together with UNDP, International Wheat and Maize Center (CIMMYT), International Centre for Agricultural Research in the Dry Areas (ICARDA), Japan international research centre for agricultural sciences (JIRCAS), German Technical Center and other centers in the USA, Russia, Israel and the UK.	Research Institute of Soil Science and Agrochemistry Tashkent Institute of Irrigation and Melioration National and international projects on forestry Plantings of mostly saxaul with an area of about 1 million hectares at the Aral seabed; creating pistachio plantations in marginal lands of the foothill zones
Collaboration with Development Agencies (examples)	joint work with the World Bank on the restoration of the North Aral Sea: second phase of the project to improve irrigation and drainage systems (IDIP-2) and the second phase of the project "the Syr Darya river control and northern Aral sea" (SRCaNASII)	joint work with the World Bank on Agricultural Enterprise Restructuring Project - Phase 2 Horticultural Development Project with the IBRD Project to improve water resources management in South Karakalpakstan with the IDA/IBRD Project on restoration of the main irrigation canals of the Tashsakinsk system of the Kharezm region with the IDB

Conclusions and recommendations

Governments in the region are making significant efforts to mitigate the impact of land degradation. However, in the face of increasing climate change the degradation of most types of lands continues, is likely to accelerate. The work on land degradation prevention and soil rehabilitation needs to be expanded. To reach their national commitments to UNCCD and ECCA30 initiative, both Kazakhstan and Uzbekistan need to invest more into practical on-the-ground innovative solutions and put more effort into joint collaboration and coordinated approach.

Both countries have sufficient institutional capacity and experience in SLM project implementation. Experience exchange could strengthen collaboration and create a stronger network. The ability to learn from implementation experience and better understanding the other region's and partners' specifics through experience exchange could further strengthen countries' institutional capacity and promote activities coordination.

New innovative technologies and approaches are required to improve land use efficiency and restore degraded lands. Analyzing own experience, learning from each other and words' best practices would aid to identify and address the gaps and prepare improved innovation and research strategy for restoration of degraded land and SLM.

Based on the assessment of the current situation, impact of land degradation, and priority direction for land rehabilitation described above, the experts' priority recommendations **of high-priority topic areas are proposed for the Contest of Breakthrough Innovative Technologies in the Field of Land Restoration in the Aral Sea Basin**. The experts' recommendations on topics priority cover four major themes: irrigated agriculture, rainfed agriculture, pasture management, and forest management *[see annex 1 for the list of recommendations]*.

Endnotes

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[4] State Committee of the Republic of Uzbekistan on ecology and environmental protection (2013), National state-of-the-environment report of the Republic of Uzbekistan.

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[8] Akimat of the Kyzylorda region (2015), The program for the development of the Kyzylorda region territory for 2016-2020.

Annex 1. Experts' priority recommendations

Innovative projects in the field of irrigated agriculture	
	Farm management improvement
	Development and integration of overall farm management systems throughout the entire production cycle, including farming practices and management, maintenance of facilities and equipment. Also, the creation of specialized applications (apps) using artificial intelligence technologies, capable of collecting and analyzing data based on remote sensors to increase the land use efficiency and yield.
	Development of unified projects and construction of energy- and water-efficient greenhouses. Including solar heating for crop production.
	Development and integration of soil protection technologies and crop rotation. For example, the development of effective seed feeding and micro-fertilization techniques adapted to the region.
	River basin management improvement
	Development and integration of water allocation management systems within the framework of water users' associations and water supply to farms. For example, the introduction of automated and open-access systems for water distribution, accounting, and monitoring.
	Water erosion prevention
	Development and integration of cost-effective technologies for rehabilitation and maintenance of irrigation and drainage systems that prevent water erosion and increase its efficiency
	Efficient water use
	Incentives for the economical and efficient use of water for irrigation
	Development and integration of technologies for the secondary use of drainage and sewage wastewater. Considering that as an option for creating wetlands and irrigated hay lands or to sustain water supply for existing ones. Including technologies on biological agents (various types of symbiotic mycorrhiza fungi) as stimulants of plant salt tolerance and soil additives.
	Integration of innovative water-saving technologies and practices, including the use of subsurface drip irrigation systems.
Innovative projects in the field of rainfed agriculture	
	Soil fertility conservation
	Production of the organic fertilizers to enrich soil organic matter
	Development and integration, demonstration, and wider application of zero/minimum tillage methods in rainfed croplands
	Seed production improvement
	Creation of drought-resistant and hybrid varieties of grain crops suitable for arid rainfed lands; establishing consistent seed production of adapted crops.
	Creation of new or improved varieties of crops or cultivated grasses to create productive artificial pastures and hayfields that are better suited to specific environmental conditions and have better economic and environmental benefits for the area (production of forage crops to reduce feed shortages).
	Soil management improvement
	Development and integration of optimal schemes for grain and fallow/fodder turnover based on the priorities of rainfed arable agriculture within the integrated context of land use at the district level (soil, climate, economic and social parameters).
	System of express soil analysis in the fields that allows farmers to make an informed decision on necessary fertilizers

	Possible conversion of inappropriate arable land into grassland with natural rangeland vegetation and sustainable grazing system
Innovative pasture management projects	
	Pastureland rehabilitation
	Rehabilitation and maintenance of distant pasture grazing management system
	Maintenance of hayfields and forage land to provide forage reserves
	Pastureland management improvement
	Provision of the necessary facilities for shepherds in remote pastures as stimulus to engage
	Development and integration of technologies for restoration/sustainable use of wells using renewable energy sources or more efficient/reliable methods and creation of a mechanism for their maintenance.
	Development and testing of new seasonal haul methods that combine the positive aspects of traditional and seasonal mobile systems, as well as new successful and adapted methods.
	Forage-grasses seed production improvement
	Development and adaptation of standardized project on fodder grasses production for the rapid restoration of degraded and abandoned pastures.
	Steppe and semi-desert ecosystems management improvement
	Restoration of wild ungulate animal populations for effective management of steppe and semi-desert ecosystems
Innovative forest management projects	
	Degraded and deforested forest lands rehabilitation
	Creation of a forest seed base selection of desert species and introduction of innovative crops for cultivation on degraded forest lands of the Aral Sea basin.
	Creation of a nursery and selection of environmentally adapted trees and shrubs species to create a plantation of fast-growing local tree species and to improve the ecological situation in the region.
	Development and integration of methods/techniques on natural regeneration and restoration of tugay forest in the riparian zones of the Amu Darya and Syr Darya deltas.
	Forest fires protection improvement
	Protection of forests from fires through proper control and firefighting, and through public awareness campaigns
	Forest management improvement
	Incentives for forest users promoting sustainable use of forest resources
	Conversion prevention to other land categories of forest areas attractive for development
	Priority of forests sustainable use over afforestation of non-forested land
	Agroforestry promotion
	Creation of desert "forest" belts as windbreaks through cooperation with local forestry enterprises and local communities to reduce the impact of moving sand on key infrastructure.
	Development and integration of joint forest management methods with government forest farms and local households for the development of forest lands requiring afforestation and fruit/nut plantations in the foothills

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