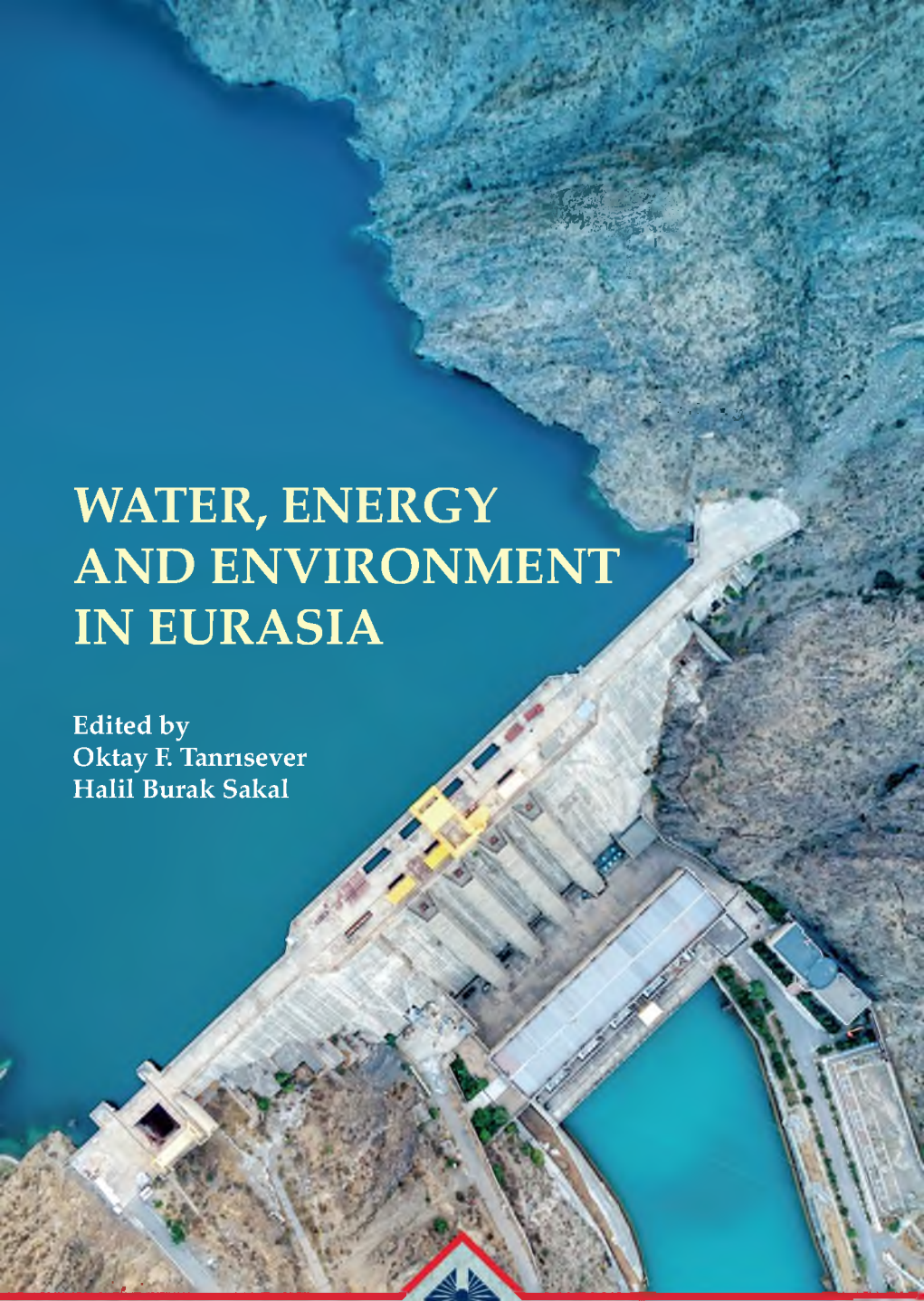
WATER, ENERGY AND ENVIRONMENT IN EURASIA

Edited by
Oktay F. Tanrısever
Halil Burak Sakal



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Cappadocia University Press: 43
Politics Book Series: 11
ISBN: 978-605-4448-22-7
DOI: https://doi.org/10.35250/kun/9786054448227
URL: https://hdl.handle.net/20.500.12695/1573

Water, Energy and Environment in Eurasia
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Series Editor: Halil Burak Sakal
Cover Design: Nazile Artla Çakır
Page Design: aitemsenet.com
Language Editor: Colin Sutcliffe

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Tanrisever, O. F., Sakal, H.B. (eds). (2022). *Water, Energy and Environment in Eurasia.* Nevşehir: Cappadocia University Press.
258 p. 13,5 x 21 cm.
ISBN: 978-605-4448-22-7
DOI: https://doi.org/10.35250/kun/9786054448227
Keywords: 1. Water-energy-environment nexus, 2. Sustainability, 3. Central Asia, 4. Caucasus, 5. Turkey, 6. International Relations.

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Water-Energy-Food Security Nexus in Turkmenistan

Aksulu Kushanova, Batyr Kurbanov, Claire Franco

Introduction

The nexus approach was considered under the former Soviet Union, in which the water-energy infrastructure was developed in such a way that it would benefit from and engage a number of sectors, leading to efficient resource allocation and use. However, after the collapse of the Soviet Union, the Central Asian countries moved toward a more sectoral approach, affecting the existing regional water-energy relationships between the upstream and downstream countries. The European Union project "Nexus Dialogue in Central Asia" (the Project) raise the multisectoral water-energy-food (WEF) approach at the regional and national levels in Central Asia (CA) – assuming multisectoral collaboration and planning, in contrast to the resource allocation under "sector by sector" approach. Understanding that a multisectoral approach involves different sectors, depending on the economic peculiarities and the availability of natural resources in the country and region, the EU project championed specifically a water-energy-food nexus as this sectoral interlinkage is mostly sensitive to CA countries.

Table 1. Nexus principles

Principle 1:	There is no single "nexus", but rather a range of "nexi".
Principle 2:	A nexus is often construed as a response to perceptions of insecurity by the state, civil society and the private sector, and by those responsible for environmental sustainability and productivity.
Principle 3:	Nexus is about compromise.
Principle 4:	Nexus is about trade-offs.
Principle 5:	Nexus is about synergies.
Principle 6:	Water is widely considered the senior nexus element.
Principle 7:	Nexus is not the same as Integrated Water Resources Management (IWRM).
Principle 8:	Nexus may be our last chance to achieve sustainable and equitable investments in water, agricultural and energy infrastructure.
Principle 9:	Nexus makes economic and socio-economic sense.

Source: Meyer, 2019.

During the Project implementation (Phase I: 2016-2019), the new term "Nexus" met resistance from regional and national stakeholders, and the mandate and responsibilities of the sectoral ministries limited to their particular sector exacerbated the discussion on the multisectoral approach. That said, while the stakeholders understand the rationality behind their consideration of the Nexus approach, there is a strong need for quantitative and qualitative data on the application of the Nexus approach to particular policies and/or projects before making a policy decision. The final evaluation of the Project showed that less than 30 percent of all the assessed stakeholders were able to integrate the multisectoral approach into their daily practices due to the lack of the necessary institutional set-up, technical capacity and the availability of instruments. The simulation Nexus Game piloted by the project team among young professionals in Central Asia and Afghanistan at the tenth annual Central Asian Leadership Programme (2019) showed that the practical application of the multisectoral

approach and the handling of the trade-offs between competing sectors and ministries improved the participants' understanding by up to 90 percent, and inclined them to favor the Nexus approach (CAREC, 2019).

An institutional and capacity gap analysis undertaken as part of the Project by the International Union for the Conservation of Nature (IUCN) revealed that the concept of nexus is still new to Central Asia, and key decision-makers lack experience with it. A full buy-in by all states would necessitate an improved understanding of the WEF Nexus approach, as well as a demonstration of its relevance and applicability through concrete actions and best practices in the context of Central Asia (Meyer et al., 2019).

During the three-year introduction of the Nexus concept to Central Asia, both regional and national stakeholders voiced a need for practical and hands-on activities to better understand the benefits of the Nexus approach concerning: i) the implementation of joint (transboundary) Nexus projects; ii) the identification of adequate financing mechanisms for multilateral Nexus projects; iii) the development of institutional frameworks at national and regional levels to support multisectoral regional Nexus dialog, planning and decision-making; and iv) well-structured capacity-building interventions to cultivate WEF Nexus thinking among the expert community.

At this time, the project team identified some major gaps impeding the transition to a WEF Nexus approach at national and regional levels, including:

- The current sector-based planning practice does not allow for complex, cross-sectoral planning and resource efficiencies;
- Different sectors continue to consider themselves as competing agents for the state budget;

- Finance and Economy Ministries are not involved in thematic planning activities;
- The bottom-up approach is still at the initial stage of formation.

To address the needs of the national stakeholders and to showcase the Nexus projects in practice, the Project implemented three small-scale Nexus demonstration projects in Tajikistan, Turkmenistan and Uzbekistan to introduce the Nexus jargon and to review the implementation process from a multisectoral perspective on the ground. After receiving positive feedback from state officials and the rural community the practical application/demonstration of the Nexus approach witnessed an increase in buy-in.

This article is dedicated to the small-scale Nexus demonstration project in Turkmenistan, providing a greater opportunity to analyze the case from a multisectoral approach. This pilot project was proposed for the demonstration and was supported by the Interstate Commission on Sustainable Development under the International Fund for Saving the Aral Sea (IFAS). Following the completion of the pilot project, the Global Nexus Secretariat analyzed the project based on the Nexus criteria and found it to be a good nexus demonstration case. The results of the pilot project were then reviewed and presented to the Nexus Regional Dialogue Programmes[1] in early 2020, who acknowledged and recognized that the needs of such projects are common for other regions around the world.

1 Latin America (LA), Niger Basin Region (NBA), Southern Africa (SA), Middle East and North Africa (MENA) and Central Asia (CA).

Table 2. Nexus principles

Principle 1 – Equitable and balanced weighting
Principle 2 – Leaving no one behind
Principle 3 – Political commitment to international agendas
Principle 4 – Strengthening cross-departmental and multisectoral cooperation
Principle 5 – Enhancing mechanisms for data exchange and modelling
Principle 6 – WEF Nexus Capacity Development
Principle 7 – Inclusive and participatory multi-stakeholder approach
Principle 8 – Financing schemes and investments
Principle 9 – Considering the broader context of the natural resource governance system
Principle 10 – Sustainable and efficient resource use
Principle 11 – Furthering peace and preventing conflict

Source: Global Nexus Secretariat, 2020.

Nexus pilot project implementation

Expanding on the sixth nexus principle in Table 1, water is the most important component of the WEF intersection, in that water, energy and food security all depend on its infrastructure. Recognizing this has led to new initiatives related to water infrastructure and technological solutions, with the vision being optimized through the coordinated planning, development and operation of a portfolio of man-made and natural-based water infrastructures. The proposed solutions will strengthen economic and environmental resilience, while bridging divides between sectors and industries (IUCN, 2015).

The small-scale demonstration project in Turkmenistan was implemented in April–December 2019 with support from the EU-funded "Nexus Dialogue in Central Asia" project and the UNDP/GEF project "Supporting climate-resilient livelihoods in agricultural communities in drought-prone areas of Turkmenistan" (SCRL). The small-scale demonstration project aimed at: i) increasing the adaptation potential of a local livestock farm; ii) supporting water-energy-food security in desert pastures; and iii) supporting rural areas and the vulnerable population. As one of the main characteristics of the demo project, the local

community, represented by shepherds, was actively engaged in the demo project implementation and took over certain tasks.

Specifically, the demonstration project restored the old *sardobs* feeding a remote desert pasture in the Daşoguz Province, Turkmenistan, and arranged livable conditions for the local shepherds. The works included:

- The restoration of two neglected *sardob*s with a volume of 250 m^3 each as a water supply; cleaning both *sardob*s and a sump. The restoration works included the reinforcement and concreting of the ceiling, the installation of floor support, the installation of a waterproof barrier and the concreting of the *sardob* floor;
- Covering the area for the collection of water downhill from the sump with a 4 cm-thick concrete pad;
- Building a shepherd's house and livestock drinking troughs;
- Erecting barbed wire fencing;
- Planting a forest belt 2–2.5 m wide inside the fence;
- Installing a pump for pumping water to the animal drinking troughs;
- Installing solar panels to provide electricity for lighting in the house and to power the pump.

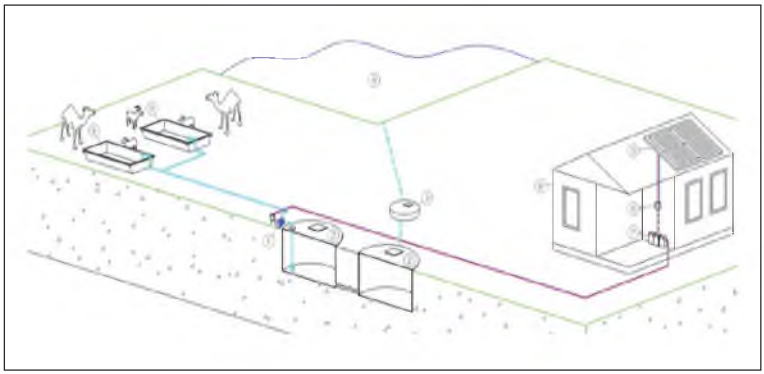

Figure 1. Site of the *sardob* in the desert pasture. 1. *sardob*s (250 m^3 each); 3. sump; 4. water collection area (1 ha); 5. solar panels; 7. pumping station; 8. Shepherd's house; 9. water trough.

*Sardob*s and their significance

A *sardob* is an ancient hydraulic structure for the collection of rainwater in the desert. The name comes from the Persian language, and can be translated as *assard* - "cold" and *âb* - "water". *Sardob*s have been identified dating as far back as the 10th century for the watering of livestock, in locations close to villages, for the satisfaction of social and domestic needs, and even for drinking. In ancient times, *sardob*s were protected by special armies along the Silk Road, ensuring the survival of livestock and people in the hot season. Since that time, they have continued to play an indispensable and strategic role in desert areas. In Turkmenistan, *sardob*s are the second most important source of water after groundwater. Due to the country's downstream location, the groundwater is naturally saline, which by Turkmen state standards means that one liter contains more than one gram of salt. In 2004, UNICEF project officer Arslan Berdiyev reported that the salinity of the Amudarya River can reach 1.6 grams per liter in the dry periods (Blua, 2004). When potable reserves are strained, the population ingests more highly salinized water, which can lead to serious health complications. Berdiyev claims that only around 20 percent of the 1.2 million people living in the Daşoguz Province have access to clean drinking water (Blua, 2004).

In the present day, most *sardob*s have fallen into disuse and disrepair under the influence of the hot climate and the destruction of the existing control system. As a result, water is no longer retained and evaporates during the hot period, leaving none for use. As a result, the territories in their vicinity can no longer be used for animal husbandry and become desolate. Despite the strategic role of *sardob*s as a vital source of drinking water, they are not protected or subject to regular maintenance.

Figure 2. A *sardob* in a desert location

Particularly in desert-dominated countries with large rural populations that are heavily reliant on cattle breeding, *sardob*s have considerable social and economic significance. The volume of the collected water reservoirs varies from 60 to 500 cubic meters. Climate change and external environmental factors interrupted this ancient technique of farming due to very dry periods, a decrease in rainfall and the decay of *sardob*s. Thus, the shepherds stopped grazing their livestock in the remoted pastures, since the *sardob*s were not functioning anymore and water was unavailable for their livestock. As a consequence, farmers, solely let their livestock graze on local pastures which are close to villages, which further speeded up the process of desertification in the area. As water is scarce in the region, restoring and maintaining the *sardob*s is economically more meaningful than the transportation of water, which would overall be four times more expensive.

It is also estimated that one *sardob* allows the prevention of land degradation in the size of 2,700 up to 7,500 ha. For the last decades the contribution of agriculture, forestry and fisheries to the country's GDP has decreased from 33 percent in

1990 to just 9 percent in 2015, which might also be explained by increasing land degradation and deteriorated water-energy access in remote areas.

A comparative analysis of the costs of delivering the same volume of water by water carriers and collecting water in *sardob*s reveals the transportation of water to be four times more expensive than the construction and operation of a *sardob*.

Pilot site

> The farmers are ready to build the wells through collective effort, however, we have no clue about the coordinates of the groundwater. We simply cannot waste resources digging wells in the desert based on guesswork.
>
> *Director of the Garagum livestock farm*

The demo project was conducted at the Esenaman pasture of the Gorogly etrap (district) of the Daşoguz Province in northern Turkmenistan. The Daşoguz Province is mainly covered by the Karakum desert – the third largest desert in Asia, covering an area of approximately 350,000 square kilometers (Britannica, 2013). This region, including the Khoresm Province across the border in southern Uzbekistan, has been deeply affected by the Aral Sea catastrophe, which contributed greatly to water scarcity and salinity. The Daşoguz Province lies 88 meters above sea level and has a desert climate with an average annual rainfall of 100 mm (the lowest in the country).

In this regard, the wellbeing of the mostly rural population and the environmental security of the Daşoguz Province rely heavily and intensively on access to water, and *sardob*s play a significant role under the limited alternatives associated with the geographical peculiarities of the country.

The Esenaman site is managed by the local Garagum livestock farm, which is the largest holder of animals in the Gorogly

etrap and is recognized locally for its scale and efficiency. In 2014, it recorded the highest performance among the other livestock complexes in the region, with the best offspring figures, being 13,662 heads of lambs were obtained from 12,575 ewes. The livestock complex comprises two sheep farms. The total area of desert pasture managed by the Garagum livestock farm is 887,000 thousand hectares, of which 99 hectares are arable land, and the rest are natural pasture.

Figure 3. Map of the pilot site

The Garagum livestock farm is a state cooperative, whose farmers report to the Ministry of Agriculture of Turkmenistan. That said, over the past two decades there has been an ongoing process by which the state livestock alliance will become privatized, and will consequently become an alliance that brings together private farmers.

The population of the Gorogly district as of October 2018 was 942 (Table 3), with children under 17 years making up 31 percent of the total. The entire population of the *gengeshlik* (local council jurisdiction) lives in three villages. Half of the

population are of active economic age, with over 40 percent of the population engaged in livestock farming due to: i) the traditional way of life; ii) their residence in remote areas with poor road access; and iii) that lack of any industrial sites nearby.

Table 3. Demographic information on the Garagum District

	Village names	Total household number	Total population	Out of the total population		0-17 years old		Pensioners	
				Female	Male	Female	Male	Female	Male
1	Damla	96	574	283	264	78	71	13	11
2	Kyrkguyy	21	106	54	52	22	18	5	3
3	Garayanyk	58	289	145	144	65	41	7	8
Total in the local council jurisdiction		**175**	**942**	**482**	**460**	**165**	**190**	**25**	**22**

Source: Garagum District Municipality.

The pasture of the Garagum livestock farm falls under the responsibility of the Garagum Gengeshlik (municipality). The local municipality allocate the pastures to the Garagum livestock farm and the latest allocates/lease the pastures along with its cattle to the local farmers for grazing during the spring and summer seasons.

One peculiarity of economic activity based on pasture animal husbandry in Turkmenistan is that the lease agreement for livestock is concluded between the local livestock farm and the head of the family. Under this agreement, all adult members of the shepherd's family become engaged in the raising and grazing of the livestock with various seasonal roles. The agreement further stipulates that the shepherd receives his salary in the form of the animal yield. For example, for 100 grazed animals, the shepherd should return 100 pastured animals plus a yield of 40 animals. Thus, everything that is produced (the resulting offspring) in excess of the specified remains will belong to the shepherd.

> Our men earn on the livestock farms, but there are no jobs for women in the villages. We use milled products and wool to produce homemade products, which we sell at the cities markets.
>
> *Local woman*

As a rule, the male half of the family is engaged in cattle grazing almost all year round, with fathers, sons and brothers taking turns to graze the livestock. The female half of the family is engaged mainly in housekeeping, but can generate income through handicrafts that can be sold at the market or to intermediaries. Thus, the female portion of some shepherd families is self-employed, and contributes to the household income through their activities.

According to municipality estimates, cattle grazing is the main source of employment for the male population, with the "economically active" population engaged in this type of activity in the surveyed group being above 40 percent. As ascertained during the meetings held with local pasture users, the income from farm work does not fully cover the needs of the local population, and so small-scale livestock and poultry farming is carried out on the household plots of the villagers, as the main livelihood and source of monetary income for the rural population.

The poor transportation infrastructure makes it difficult to find work in nearby areas or to commute to the larger cities for income. This drives some people to leave their rural homes and move to the city where there are more employment opportunities. Those that remain have few options other than engaging in animal husbandry to make a living (due also to the traditional way of life). As can be seen, the local Garagum livestock farm serves as the main source of food and employment for the populations of all three villages of Gorogly etrap, where the livestock activities fully depend on access to water-energy in the desert pastures. This situation related to employment

opportunities and the importance of livestock breeding can be found also in other countries and regions.

Figure 4. Migrated rural population and lack of road infrastructure due to climatic conditions.
Source: Photos provided by local residents.

Esenaman pilot site and the implementation of the demo project

There are two *sardob*s on the Esenaman site, both of which were built in the Soviet times. Over time, and under the influence of the forces of nature, they fell into ruin, and one completely collapsed. There is a 1-hectare site for the collection of water adjacent to the *sardob*s, but without maintenance and use due to consecutive years with seasons of drought since 1995, the water collection area also fell into disrepair. As a result, water stopped being collected in the tanks and the site became unusable. Without this critical water component, the local shepherd population began to move away from Esenaman, and relocated their herds to neighboring pastures in search of more reliable fodder. In short, the cattle stopped grazing when the water source disappeared. According to the shepherds' estimates, the *sardob*s had not been touched in 30 years. The nearby pastures within a 30–35 km radius are overflowing with fodder, but the livestock cannot use it due to the absence of a watering hole.

When better climatic conditions brought a generous amount of rain in 2019, the deteriorated water reservoirs highlighted a new issue of water accumulation. Due to the poor conditions of the *sardob*s, the local shepherds have been unable to utilize the desert pastures for the last 30 years, despite the rich grass yields, and have had to rely instead on only a few pastures over the decades, increasing the deterioration of the land and the rate of desertification in the country, where over 80 percent of the territory is already desert. Adding to the critical need for better resource management is the fact that this part of Turkmenistan is the area that was most affected by the Aral Sea catastrophe.

Water scarcity and the increase in the competition for food over the previous three decades have led to a sharp decrease in the size and quantity of livestock, and the increased pressure on the pastures has expedited desertification in neighboring areas

(UNDP Eurasia, 2020). The revitalization of the catchment area through the restoration of the *sardob*s will allow the movement of the flocks of sheep 30–35 km deeper into the sands, and will support the recovery of previously used pastures amounting to around 105,000 ha within 3–4 years. The restored *sardob*s will open access to an additional 50,000 ha of pasture that is teeming with grass that has not been utilized for the last 30 years. Furthermore, according to shepherds' estimates, the fodder supply of the Esenaman settlement will increase the number of sheep to 5,000–6,000 head, and farmers will gain the opportunity to alternate between two pastures, thus managing the degradation.

Figure 5. A previously extensively used desert pasture "Adzhi Guyi". Source: Photo provided by local residents.

In 2019 two *sardob*s have been restored under the project and equipped with water pumps, providing a total capacity of 500 cubic meters (see *Annex 1*). The project has exceeded its

targeted quantity of solar panels and electricity capacity by 25 percent, which is expected to extend the duration of stay for the shepherds. The third link in the results chain relating to the restored pastures and increased herd sizes will materialize later in 2020.

One *sardob* matters for water-energy-food security

The restoration of even one *sardob* contributes to water-energy-food security in countries like Turkmenistan. On average, only 12 percent of the available pasture is used in Turkmenistan due to insufficient or uneven watering. For example, in the Daşoguz Province, where the pilot project was implemented, pasture productivity is 0.8–0.9 centner per hectare – a unit of measurement reflecting the mass of hundreds of kilograms per area. This means only 36 percent of Daşoguz Province has access to water, which is one of the lowest rates in the country.[2]

Some 30 percent of the pasture of Garagum livestock farm is irrigated land, close to the villages. While there are fodder-rich pastures 70 km from the villages, these rangelands are currently impractical and inaccessible due to their lack of water, although they have the potential to accommodate an additional 150,000 head of livestock. Currently, the Garagum livestock farm has around 40,000 head of livestock, and so there are considerable opportunities to be had in terms of increased breeding output should access to water and energy be provided. In this regard, two restored *sardob*s would provide sufficient water for around four herds, meaning more than 2,400 head of sheep.

Precipitation in the Karakum Desert occurs mainly in the winter and early spring, more than half of it falling between December and April (Owen, 2018). A year in the pasture is divided into three seasons: winter (November-April), summer

2 "Natural pastures and the development of transhumance livestock in Turkmenistan," 2014.

(May-July) and autumn (August-October). The renovation of the shepherds' houses and the provision of solar-powered electricity would allow shepherds with their families to move to these territories and stay there for two seasons, supporting a higher animal yield and greater productivity. Solar-powered water pumps will help free Esenaman from its dependence on the larger electricity grid, access to which is currently almost impossible in the middle of the desert (UNDP Eurasia, 2020). From 2008 to 2018, the energy consumption per capita rose by 8 percent per annum (BP, 2020), indicating that the demand for accessible, affordable energy is increasing, especially in rural areas.

A) Shepherd's house (before the implementation project)

B) Renovated house, allowing shepherds to stay in the pastures for two additional seasons (after project implementation)

C) Old sardobs abandoned for 30 years (before project implementation)

D) Restored sardobs (after project implementation)

E) Solar generated electricity is on

F) Solar panels

G) Local shepherds enjoying their new shepherd house

Figure 6. A) to G): Pilot project results. Source: Project team, local shepherds, UNDP office in Ashgabat, Turkmenistan

Nexus component

The pilot project demonstrates in a practical way how the interlinkages between water, energy and food contribute to the provision of economic and social security, and, if scaled up, can show even more substantial results at a national level. With a budget of around US$25,000, the pilot project not only had a multisectoral dimension, illustrating the Nexus interlinkages, but also served as an example of what could be achieved and replicates at a national level, demonstrating the social and economic importance of *sardob*s for Turkmenistan.

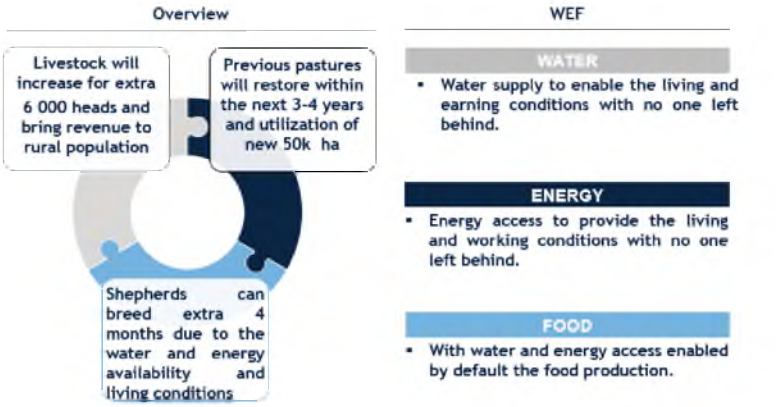

Figure 7. Results of the pilot project in terms of its multisectoral water-energy-food achievements at a livestock level.
Source: Project team, CAREC.

The pilot project employs a multisectoral approach, taking into account water, energy, food security and ecological conservation. As an outcome, the Garagum livestock farm acquires a new water source for the watering of livestock, expands their grazing lands, increases the head of livestock and harnesses solar energy to satisfy household needs in a remote location. The local shepherds, on the other hand, gain a socially well-maintained site for business purposes and play a role in reforestation works. The head of the Garagum livestock farm stated that the top three obstacles they faced were the lack of electricity in remote households, the lack of unpaved access to pasture lands and the lack of water resources for irrigation. Having a local partner that can benefit directly from the work can be considered a valuable input, and increases the likelihood of the attentive maintenance of the facilities (UNDP Eurasia, 2020). The introduction of solar-powered technologies for the management of water and to support the fertility of the land will improve the sustainable growth of the agricultural complex (Embassy of Turkmenistan, Georgia, 2020).

The pilot project provided inputs that would be equally important at local and national levels, as shown in Table 4.

Table 4. Pilot project impact at local and national levels

Local level	National level
Increase of climate adaptation potential; Securing the labor market in a remote area; Prevention of land degradation; Restoration of previously used pastures; Introduction of the RES technology to a rural area; Free up valuable and rare agricultural lands by making distant land areas suitable for cattle-breeding; Improved environment and socio-economic development of the population.	Demonstrating the Nexus WEF approach; Replication of the pilot throughout the country; Development of action programs for agricultural communities, local communities, especially those located in remote areas without access to water or electricity; Restoration of previously used pastures; Promoting RES sources utilizing the country's vast solar potential; Ensuring food security; Revising the traditional way of living.

Water	Energy	Food security
A drainage system for rain and melt water is created, resulting in alternative sources of water for watering and pasture irrigation.	A sustainable system is created in which solar energy is used for lighting and to pump water to the drinking troughs for livestock.	The number of livestock is increasing, and new pastures are being developed.

Preservation of ecosystems
The vegetation cover of currently over-grazed territories is being restored.

Results of the pilot project in terms of its multisectoral water-energy-food achievements at a livestock level. Source: Project team, CAREC.

The decision-making aspect of the pilot project implementation involved the three "water-energy-food" sectors, and the engagement of the vulnerable rural population with limited access to such resources. The pilot project was aligned with Paris Agreement, and advanced the country's goal of SDG fulfillment. Through the Nexus approach, SDGs and other international agendas can be satisfied in a more efficient and cost-effective

manner. The cooperation between the project partners was built on existing structures and capacities at municipal and governmental levels. The pilot project also ensured the inclusion of local practices and knowledge in the sustainable management of the resources of local communities.

Country specifics

> The traditional way of life has not changed. Breeding is still passed down from generation to generation. This is what we can and love to do.
>
> *Local shepherd*

For countries like Turkmenistan, where up to 80 percent of the territory is desert, these kinds of pilot projects help ensure socio-economic and environmental security. Turkmenistan has the lowest precipitation rate in Central Asia (fewer than 200 mm per year, the lowest in Central Asia), and approximately 70 percent of the pasture lands in Turkmenistan have various levels of degradation, due mostly to overgrazing, which strips the land of its vegetative cover and results in the erosion of the topsoil. Furthermore, more than 90 percent of the irrigated areas are subject to salinization (Nepesov & Mamedov, 2016). In a 2016 report, the Economics of Land Degradation Initiative encouraged Turkmenistan to come up with more reliable water and fodder stocks to support the needs of herders and farmers, highlighting "the rehabilitation, reconstruction and maintenance of traditional water sources, including water wells and reservoirs" (Nepesov & Mamedov, 2016).

The limited access to water in the desert pastures forces local shepherds to overutilize the watered pastures, worsening the rate and extent of degradation. One *sardob* will allow the prevention of land degradation of an area of 2,700–7,500 ha. Most water resources originate outside the country, and so in

a country like Turkmenistan, in which over half the population resides in rural areas and is heavily reliant on the breeding of livestock, a *sardob* can make a significant impact.

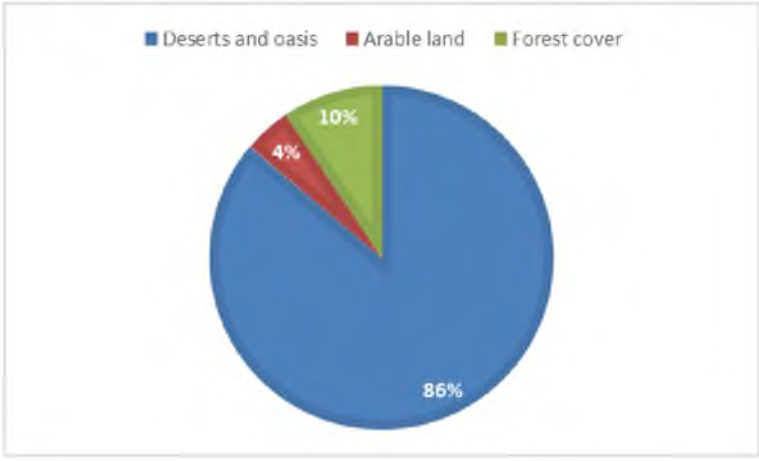

Figure 8. Turkmenistan land type. Source: World Bank.

A pilot project of this nature demonstrates that such an action as restoration of *sardob*s can serve as a climate adaptation measure to collect the resources that will be harnessed under the climate change (World Bank, 2020b). As such, Turkmenistan is projected to experience an increase in average ambient temperature of 6–7°C by 2100, while hydro-meteorological modelling forecasts predict a steadily declining national precipitation of 8–17 percent up to 2100 and beyond (UNDP, 2015). At a regional level, the flow of the Amu Darya and Syrdarya Rivers is expected to decrease by at least 30 percent, severely affecting the availability of water in the region. All of the above will have implications on water management and food security, and will increase the nation's vulnerability to extreme climatic events.

In the presence of climatic and topographic conditions like those experienced in Turkmenistan, climate adaptation measures

are mainly focused around water, and include: i) the construction of new, and the repair of existing wells; ii) the construction of new, and the renovation of existing *kaks*; and iii) the construction of new, and the repair of existing *sardob*s.

The pilot project to support Turkmenistan's public policy

Overall, the pilot project was in line with Turkmenistan's public policy. While no massive restoration of *sardob*s is being undertaken at a national level, the government recognizes the need for water-energy-food security and the application of innovative solutions to ensure the generation and allocation of WEF resources.

As such, Turkmenistan has highlighted food abundance as an area of particular importance and recent achievement. In an address on June 1, 2020, President Berdimuhamedov stressed the priority of improving and expanding the capacity of the domestic energy system, and the application of advanced experience and digital technologies (State Information Agency of Turkmenistan, 2020). Furthermore, the growth of strategic reserves of water was one of the priorities outlined in the "Programs of social and economic development of the country in 2019–2025" (UN, 2019).

The food security landscape is highly vulnerable in Turkmenistan. Self-sufficiency in domestic products by the rural population is vital and highly encouraged, while beyond the rural population, there are numerous business opportunities related to the supply of food, and two-thirds of agricultural production is currently carried out by private entrepreneurs. Currently, experts estimate that domestically produced food in Turkmenistan accounts for around 40 percent of the total, while the remaining 60 percent is imported. This means that a fracture in the import chain, such as the closure of the border with Iran in February 2020 due to the COVID-19 outbreak,

immediately affects food security in Turkmenistan. This particular example had a significant impact on basic food supply, as around 80 percent of all food imports are somehow connected with Iran (Turkmen News, 2020).

Food production is a major employer in rural Turkmenistan, and any steps to limit the impact of local meat production on the environment would support the sustainability of the sector (UNDP Eurasia, 2020). More than half of the Turkmenistan population lives in rural areas and is engaged in animal husbandry and agriculture, although the annual urban population growth rate is around 2 percent (PreventionWeb, 2014). Utilizing the limited amount of arable land, around 30 percent of the population is employed in agriculture, and 19 percent of this figure is female (World Bank, 2021). Each decade, the added value of GDP from agriculture, fisheries and forestry declines by 10–15 percent. Thus, in 1990 the added value was 33 percent, but had fallen to 9 percent by 2015 (World Bank, 2020a), with attributing factors being the increased degradation of land and the limited water resources.

The pilot project demonstrated the efficiency of the electrification of the pastures through solar application in the depth of desert where the electrification is extremely capital expenditure-intensive and not rational. According to the 2020 BP Statistical Review of World Energy, Turkmenistan sourced less than 0.05 percent of its consumed energy from renewable resources in 2018 and 2019, and in 2019, the per annum growth rate of renewable consumption declined by 0.4 percent (BP, 2020). Nevertheless, the country has tremendous potential for solar power, primarily in the Karakum Desert, which covers 80 percent of the country's landmass, due primarily to the availability of vacant land as well as the high silicon content of the sand – a necessary chemical element for the manufacture of solar panels (UNDP, 2014). According to the World Bank's

Global Solar Atlas (2019), the Daşoguz Province, where the pilot project was implemented, has a daily photovoltaic power potential of 4.1–4.5 kWh/kWp. According to Geldi Myradov – a UNDP/GEF project manager working on sustainability initiatives in other parts of the country – "Turkmenistan's climatic conditions are highly favourable for the intensive use of renewable energy sources, particularly solar energy. The introduction of small-sized renewable energy installations in remote and sparsely populated areas is economically beneficial due to high cost of construction of power transmission lines" (UNDP Turkmenistan, 2020).

Conclusion

The Nexus pilot projects, including on *sardob*s, implemented in 2019 under the EU funded project "Nexus Dialogue in Central Asia" (the Project) advanced the narrative of WEF connectivity among stakeholders in the regionally specific context of Central Asia. The projects span borders, industries and sectors in a way that legitimizes the nexus principles as tools for further exploration. In order to optimize the potential for more efficient, cooperative and sustainable development of WEF security, regional actors must acknowledge their interdependence. Developing a robust profile of man-made and nature-based water infrastructure is a fundamental step toward the bolstering of food security and energy access. Solutions should mitigate vulnerability to natural disasters and the changing climate.

The restoration of traditional *sardob* water reservoirs and their increased role within private agricultural communities powered by renewable energy meet several of Turkmenistan's priorities. The success of the project and the momentum it transfers to Phase II to be implemented during June 2020 to June 2023 by CAREC reflect its academic merit and practical application. As the project advances into second phase, there

will be more data and analytical papers produced to communicate where the challenges and successes of the application of the Nexus approach.

In the long term, the pilot project on *sardob*s analyzed above will serve as a practical demonstration of the nexus principles when applied as a solution within a regionally localized landscape. By restoring the capacity to accumulate rainwater, generating cost-efficient renewable electricity and expanding the area of usable grazing pasture, the quality of life of the herding families and their livestock in rural areas will improve at the Esenaman site.

Disclaimer

This chapter has been produced with the financial assistance of the European Union in the framework of the "Central Asia Nexus Dialogue Project: Fostering Water, Energy and Food Security Nexus and Multi-sector Investment". Its content is the sole responsibility of the authors and does not necessarily reflect the views of the European Union.

The project team will continue monitoring the baseline indicators after the improvement of the pandemic situation in Central Asia and the easing of travel restrictions.

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Annex 1. Baseline indicators on the reconstruction of *sardob*s on the "Esenaman" land plot (as of the end of *Phase I*, December 2019), CAREC

Results chain	Indicator	Baseline	Target	Current value	Source and mean of verification	Remarks
1. Improve access to water for livestock (sheep and camels)	Nr of *sardob*s restored	0	2	Restored	Before and after photo-graphs	Provided
	Nr of water pumps installed	0	1	Done	Before and after photo-graphs	Provided
	Volume (m^3) of drink-ing water available for livestock at farm-level	0	500 cubic meters (given that each *sardob* is 250 cubic meters)	Done	Before and after photo-graphs	Provided
2. Provide electricity access to remote shepherd houses to allow pro-longed stay	Nr of solar panels installed	0	16 pieces of solar (pho-toelectric) panels with capacity of 250 watts each. In total supply the electric-ity with the capacity of 4 kilowatt	Installed 20 pieces of solar (pho-toelectric) panels with a capacity of 250 watts each, reaching a total supply of electric-ity with a capacity of 5 kilowatts	Before and after photo-graphs	Provided
	Duration (month) of stay on pasture land (2-3 months)	0	How many seasons (4-5 months)	First winter-ing on this site expect-ed from Nov 2019 – April 2021	Reports and/or indi-cators/infor-mation of «Garagum» farm	Target value can only be measured starting from 2021, after the solar panels have been installed

3. Increase access to pasture to improve food security and income generation potential at farm-level	Increase of head of livestock on «Garagum» farm	32 024	6000	Expected from 2020	Livestock estimates	Target value can only be measured in 2020-2021 after grazing in a new pasture territory.
	Hectares (ha) of pasture land used by «Garagum» farm	880,661 ha. Of which 265,000 is waterlogged	50,000 ha	Expected from 2020	Land area plan	Target value can only be measured starting from 2020, when the «Garagum» farm will begin the reclamation of grazing land.
	Hectares (ha) of pasture land restored, previously used by «Garagum» farm	0	50,000 ha + an additional 105,000 ha saved from degradation	Expected from 2020	Land area plan Google earth	The pasture will be recovered in 3-4 years, measurement of the indicator possible only then
	Nr of workers employed at «Garagum» farm	Total 30 staff. 20 seasonal workers employed.	Not planned	The engagement of additional staff will depend on the yield of the livestock. In perspective, it is expected from 2020.	Financial reports and inquiries of «Garagum» farm	New staff will come with the purchase of additional livestock. Indicator can be measured only after that.
	Revenue of «Garagum» farm	In total: sheep – 39,276, camel – 2,187	«Garagum» farm rents livestock to shepherds, stipulating that the shepherds should return 100% of livestock + 40% of return/ yield.	Expected	Financial reports and enquiries of «Garagum» farm	Changes in revenue will occur as a result of the purchase of additional livestock. Indicator can be measured only after that.