Managing Interrelated Environmental Challenges in Central Asia and the South Caucasus through Regional Collaboration

Nina Miholjčić Ivković*

Central Asia and the South Caucasus face a range of environmental challenges critical to their future, including deteriorating ecosystems and resource depletion. These challenges necessitate coordinated regional efforts and sustainable resource management, underscoring the need for effective policies that respect ecological standards and principles. The unique characteristics of environmental issues in these regions often necessitate collaborative approaches, as many challenges, such as water scarcity and climate change, extend beyond national borders and impact multiple regions or countries. These challenges do not respect political boundaries and often require cooperative efforts and shared solutions to address them. This article advocates for a unified response to these pressing issues, emphasizing the importance of collective action and shared knowledge to foster resilience and sustainable growth. Moreover, this article examines how regional collaboration among Central Asian and South Caucasus countries can effectively address the interrelated environmental challenges of water scarcity, climate change, and energy dependence. By analysing both recommended and existing strategies for collaboration, it highlights specific environmental issues in the regions and their implications for sustainable development. Although both regions face geopolitical and historical tensions that could hinder future regional collaboration on environmental issues, there is a plausible expectation that the countries in Central Asia and the South Caucasus have the potential to address environment-induced challenges through initiatives and strategies involving transboundary cooperation.

Keywords: Central Asia, South Caucasus, environmental challenges, regional collaboration, water scarcity, climate change, energy dependence

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Introduction

Central Asia and the South Caucasus are regions characterized by their rich natural resources and diverse ecosystems, yet they are simultaneously facing myriad interrelated environmental challenges. These interlinked environmental problems, including water scarcity, climate change, land degradation, and energy dependence, are exacerbated by the region's complex geopolitical landscape, historical tensions among states, and socio-economic disparities.[1,2] Central Asia grapples with severe water scarcity, exacerbated by inefficient management practices, climate change, and the degradation of the Aral Sea.[3] Water resources are used in an inefficient way, which causes serious water stress across the region. According to the Food and Agriculture Organization (FAO), Central Asian countries are among the top ten water consumers in the world: Turkmenistan (5,319 m^3/year), Kazakhstan (2,345 m^3/year), Uzbekistan (2,295 m^3/year), Kyrgyzstan (1,989 m3/year), and Tajikistan (1,895 m^3/year). It has been also noted that 2.5–3 times more water is used in these countries to produce a unit of agricultural product than in developed countries.[4]

Meanwhile, the South Caucasus is confronting water challenges, but in a rather different context. The region's rivers, such as the Kura and Aras, which are vital for agriculture and energy production, suffer from pollution and over-extraction.[5] The geopolitical tensions in both regions further complicate cooperative management of these water resources.

Climate change additionally exacerbates environmental issues in

1 Veliyev, J., Manukyan, S., and Gvasalia, T., "The environment, human rights, and conflicts in the South Caucasus and Turkey: Transboundary water cooperation as a means to conflict transformation", Caucasus Edition: Journal of Conflict Resolution, Vol. 3, No. 1, January 2019, Available at: https://caucasusedition.net/the-environment-human-rights-and-conflicts-in-the-south-caucasus-and-turkey-transboundary-water-cooperation-as-a-mean-to-conflict-transformation/ (Accessed: November 1, 2024).

2 Mohapatra, N.K., "Geopolitics of water securitisation in Central Asia", GeoJournal, Vol. 88, May 2022, pp. 897–916, Available at: https://link.springer.com/article/10.1007/s10708-022-10661-0#citeas (Accessed: November 1, 2024).

3 Rudenshiold, E., "Is it too late to save Central Asia? The COP crisis is already here," Caspian Policy Center, December 2023, Available at: https://api.caspianpolicy.org/media/ckeditor_media/2023/12/14/is-it-too-late-fopr-central-asia.pdf (Accessed: November 2, 2024).

4 Mammadov, S., "Central Asia and the struggle for water", BNE Intellinews, July 20, 2024, Available at: https://www.intellinews.com/central-asia-and-the-struggle-for-water-334613/ (Accessed: November 23, 2024).

5 Ismayılov, R., and Suleymanov, F., "Water resilience under climate change in Azerbaijan", Geojournal of Tourism and Geosites, Vol. 53, No. 2, 2024, pp. 677–686, Available at: https://doi.org/10.30892/gtg.53231-1243 (Accessed: November 2, 2024)

these two regions. Rising temperatures and altered precipitation patterns threaten water resources and agricultural yields, intensifying existing challenges in the communities across the regions. The World Bank's 2009 report, *Adapting to Climate Change in Central Asia*, assesses that average temperatures in the region have already increased by 0.5°C and are projected to increase by 1.6 to 2.6°C by 2030–50.[6] The glaciers in the Tien Shan mountains, crucial for regional water supply, are retreating, which could lead to severe water shortages in Central Asia in the future. Moreover, the glaciers in the Greater Caucasus are losing mass at alarming rates, which poses a risk to hydropower generation and irrigation systems that are vital for local agriculture. Between 2000 and 2020, glaciers in the Greater Caucasus lost about 23.2% of their area, or roughly 320.6 km².[7] Due to increased climate change impact causing more frequent extreme weather events such as droughts, floods, and heatwaves, the region's biodiversity, land, and agricultural productivity are under serious risk.

Climate change additionally exacerbates environmental issues in these two regions. Rising temperatures and altered precipitation patterns threaten water resources and agricultural yields, intensifying existing challenges in the communities across the regions.

Energy dependence in Central Asia and the South Caucasus poses significant interconnected environmental challenges, stemming from reliance on fossil fuels, water scarcity, and geopolitical tensions. This region's energy landscape is characterized by a mix of abundant natural resources that can complicate and decelerate the green transition process and sustainable development. It is necessary for the countries that are heavily dependent on fossil fuels for economic growth to accelerate the transition to the green economy. In order to limit global warming to below 1.5°C, immediate action is essential to reduce carbon emissions. This goal necessitates a significant reduction in the use of fossil fuels, which can be accomplished through a transition to clean energy sources.[8] The gap between our present trajectory of fossil fuel consumption and the

6 The World Bank, "Adapting to Climate Change in Europe and Central Asia", June 2009, Available at: https://documents1.worldbank.org/curated/es/127181468024643244/pdf/489480ESW0ECA010Box338935B01PUBLIC1.pdf (Accessed: November 23, 2024).

7 Tielidze, L. G., Nosenko, G. A., Khromova, T. E., and Paul, F., "Strong acceleration of glacier area loss in the Greater Caucasus between 2000 and 2020", The Cryosphere, Vol.16, No. 2, February 2022, pp. 489–504, Available at: https://doi.org/10.5194/tc-16-489-2022 (Accessed: November 2, 2024).

8 Barbier, E. B., "Transitioning to green energy is key to both tackling climate change and creating sustainable economies. Here's why", World Economic Forum, July 11, 2022, Available at: https://www.weforum.org/stories/2022/07/green-energy-transition-democracy-economy/ (Accessed: November 23, 2024).

In Central Asia, water resources from the Amu Darya and Syr Darya rivers are vital for energy and agriculture, but mismanagement can cause severe droughts, affecting food security. In Armenia, hydropower systems have been disrupting local ecosystems and threatening biodiversity.

required path toward sustainability is widening. In the longer term, such a tendency might lead to significant air pollution and greenhouse gas emissions, which will exacerbate climate change.[9]

In Central Asia, water resources from the Amu Darya and Syr Darya rivers are vital for energy and agriculture, but mismanagement can cause severe droughts, affecting food security.[10] In Armenia, hydropower systems have been disrupting local ecosystems and threatening biodiversity.[11] In Georgia, hydropower plants account for over 73 per cent of the country's total electricity production. However, the heavy use of large-scale hydropower systems has led to several environmental issues, such as deterioration of flora and fauna, as well as the flooding of villages and farmland caused by construction and operation of the hydro plants.[12] The geopolitical landscape, influenced by Russia, China, and Western countries, often prioritizes energy projects over environmental standards, raising concerns about biodiversity and ecological degradation in the region.

The implications of these environmental challenges extend beyond local borders, threatening regional stability, food security, and economic resilience. Such interconnectedness necessitates comprehensive regional strategies that address water management, land use, climate adaptation, and transition to renewable sources of energy.

This article aims to investigate how Central Asian and South Caucasian countries can collaborate to manage these interrelated environmental issues. In order to address this important question, the article identifies successful regional collaboration models that tackle environmental

9 "Greenifying Central Asia: From fossil fuel to renewable energy giants?" News Central Asia, August 8, 2024, Available at: https://www.newscentralasia.net/2024/08/30/greenifying-central-asia-from-fossil-fuel-to-renewable-energy-giants/ (Accessed: November 3, 2024).

10 Pingua, R., "The Distribution of Water Resources In Central Asia", World Affairs: The Journal of International Issues, Vol. 24, No. 1, 2020, pp. 118–31, Available at: https://www.jstor.org/stable/48622911 (Accessed: November 2, 2024).

11 "From Overexploitation of Water Resources to River Pollution and Unemployment: Problems in Goris Enlarged Community," Ecolur, February 16, 2022, Available at: https://www.ecolur.org/en/news/water/13783/ (Accessed: November 2, 2024).

12 Gegechkori, T., "Georgia's hydropower dilemma", Caspian Policy Center, February 2022, Available at: https://api.caspianpolicy.org/media/ckeditor_media/2022/03/02/georgias-hydropower-dilemma-final.pdf (accessed: November 23, 2024).

challenges in Central Asia and the South Caucasus. It further examines political, economic, and cultural barriers that hinder effective cooperation among states, highlighted by historical and geopolitical tensions. The article also proposes actionable strategies for enhancing collaborative efforts in the region.

Considering the interrelated nature of the environmental challenges affecting both regions and their implications for future regional development, it is of utmost importance that the countries of Central Asia and the South Caucasus accelerate and strengthen their efforts in applying strategies and solutions that promote mutual collaboration and understanding. Resolving, or at least alleviating, geopolitical issues, as well as recognizing the seriousness of environmental problems if not addressed in time, requires a more proactive role from governments and a better-informed local population.

Shared knowledge, regional cooperation, and strategies that involve key stakeholders – governments, local and regional NGOs, organizations, the local population, and other civil society initiatives aimed at promoting ecological standards and principles – are considered effective approaches in combating the negative impacts of environmental degradation in Central Asia and the South Caucasus.

Water scarcity and water management

Water scarcity and management in Central Asia and the South Caucasus are critical issues due to the combination of climatic, geographic, and geopolitical factors. This region faces significant challenges related to water resources, exacerbated by population growth, economic development, and climate change. Addressing water scarcity in both regions requires integrated water resource management (IWRM) approaches that consider social, economic, and environmental factors. One of the key strategies for resolving water shortages, in addition to improved infrastructure and policy reform, is regional cooperation. Enhancing dialogue and collaboration among countries can help establish equitable water-sharing agreements and joint management frameworks.[13]

13 Janusz-Pawletta, B. and Gubaidullina, M., "Transboundary Water Management in Central Asia", Cahiers d'Asie centrale, No. 25, December 2016, Available at: http://journals.openedition.org/asiecentrale/3180 (Accessed: November 3, 2024).

Central Asia is characterized by a semi-arid climate and limited freshwater resources. The region suffers from severe water scarcity, largely due to inefficient irrigation practices, high evaporation rates, and competing demands from agriculture, industry, and urban areas. Nearly one-third of the population in the region lacks access to safe water, with this issue being especially pronounced in rural areas.[14] World Bank research predicts that, as the regional population is expected to grow to between 90 and 110 million by 2050, alongside continued urbanization, climate change, and the pressures of economic growth, the strain on finite water resources will intensify significantly.[15] Agriculture consumes approximately 90% of available water resources.[16] The over-extraction and mismanagement of water resources have led to environmental degradation, such as the shrinking of the Aral Sea, which has seen dramatic reductions in water levels and biodiversity loss.[17]

The South Caucasus faces issues similar to those in Central Asia, including outdated infrastructure, pollution, and climate variability. Water quality is a primary concern, particularly due to industrial runoff and inadequate wastewater treatment.[18] Additionally, urbanization and economic development have increased demand for water, stressing existing resources.

Water management has been ineffective in both regions. In Central Asia, the transboundary nature of major rivers complicates the establishment of efficient water management. Lack of meaningful cooperation among the Central Asian states has led to tensions and disputes over water

14 Sara, J.J. and Proskuryakova, T., "Central Asia: at the confluence of global water action and climate resilience Dushanbe conference to emphasize role of water in sustainable development", World Bank Blogs, June 7, 2022, Available at: https://blogs.worldbank.org/en/water/central-asia-confluence-global-water-action-and-climate-resilience-dushanbe-conference (Accessed: November 23, 2024).

15 Ibid.

16 Li, Z., Fang, G., Chen, Y., Duan, W., and Mukanov, Y., "Agricultural water demands in Central Asia under 1.5 °C and 2.0 °C global warming", Agricultural Water Management, Vol. 231, March 2020, Available at: https://doi.org/10.1016/j.agwat.2020.106020 (Accessed: November 3, 2024).

17 Li, Q., Li, X., Ran, Y., Feng, M., Nian, Y., Tan, M., and Chen, X., "Investigate the relationships between the Aral Sea shrinkage and the expansion of cropland and reservoir in its drainage basins between 2000 and 2020", International Journal of Digital Earth, Vol. 14, No. 6, December 2020, pp. 661–677, Available at: https://doi.org/10.1080/17538947.2020.1865466 (Accessed: November 3, 2024).

18 Mammadova, L., Guliyeva, R., and Mammadov, M., "Environment and Water Resource Protection: Measures to Modernize Water Infrastructure in the South Caucasus", German-Azerbaijani Chamber of Commerce, July 2023, Available at: https://www.sustainerasolutions.com/images/954764e0-b5a1-464c-9771-37a3974bb694-RAHMENANALYSE%20English%20Final.pdf (Accessed: November 3, 2024).

allocation. The Soviet legacy of centralized water management created an infrastructure that many countries now struggle to maintain.[19] Moreover, efforts to manage water resources are often hampered by political disagreements and differing national priorities, particularly between upstream countries (Kyrgyzstan and Tajikistan) and downstream countries (Uzbekistan and Kazakhstan).[20]

In the South Caucasus, water management also poses significant challenges. The region is rich in freshwater resources, but political instability and regional conflicts have complicated collaborative water management efforts.

In the South Caucasus, water management also poses significant challenges. The region is rich in freshwater resources, but political instability and regional conflicts have complicated collaborative water management efforts. The Kura River, the main watercourse, flows through all three countries – Azerbaijan, Georgia, and Armenia – highlighting the need for cooperative management strategies.[21] Azerbaijan is especially susceptible to water stress, as approximately 70–75% of its water resources are derived from upstream sources in Armenia and Georgia, rendering the country highly vulnerable to changes in river flow induced by climate change or political dynamics. Even though, after the Second Garabagh War, Azerbaijan managed to reclaim control over several vital rivers passing through its formerly occupied territories, essential for irrigation and drinking water, the persistent uncertainties with Armenia continue to pose a significant risk to the country's long-term water security.[22]

Although Central Asia's water management initiatives have evolved since the Soviet era, there are still a lot of issues concerning implementation and modernization of existing projects and initiatives. The Almaty Agreement (1992) established a framework for cooperation on transboundary water resources including arrangements on the

19 Roberts, F. J., "Rival Eco-Anxieties: Legacy of Soviet Water Management in the Syr Darya Basin", Security and Human Rights, Vol. 32, No.1-4, February 2022, pp.41-52, Available at: https://doi.org/10.1163/18750230-bja10011 (Accessed: November 3, 2024).

20 Pohl B. et al., "Rethinking water in Central Asia: The costs of inaction and benefits of water cooperation", ADELPHI and CAREC, 2017, Available at: https://carececo.org/Rethinking%20Water%20in%20Central%20Asia.pdf (Accessed: November 3. 2024).

21 Suleymanov, F., "The institutionalization of the Kura-Aras River Basin for effective management of water resources", International Journal of River Basin Management, Vol.1, No. 11, June 2024, Available at: https://doi.org/10.1080/15715124.2024.2363310 (Accessed: November 3, 2024).

22 Mammadova, G., "Water security in Central Asia and the South Caucasus", Topchubashov Center, November 8, 2024, Available at: https://top-center.org/en/analytics/3689/water-security-in-central-asia-and-the-south-caucasus (Accessed: November 23, 2024).

quantity of water that would be released by the upstream states.[23] The International Fund for Saving the Aral Sea (IFAS), created in 1993, aims to restore the Aral Sea and facilitate regional collaboration.[24] There are a number of bilateral arrangements on water infrastructure in Central Asia that have been signed over the years.[25] However, the water management system in Central Asia has been mostly declarative, but remains outdated and often improperly implemented.[26]

The South Caucasus has several key water management initiatives aimed at promoting cooperation among its countries. In 1992, Armenia, Azerbaijan, and Georgia, along with other countries in the region, participated in a Framework Agreement under the auspices of the United Nations Economic Commission for Europe (UNECE). This agreement emphasizes cooperation in managing transboundary water bodies with the aim of preventing pollution and promoting sustainable water use.[27] Over the years, there have been a number of bilateral treaties and agreements between Georgia and Azerbaijan concerning the joint management of the Kura River, which is vital for both countries. However, the degree of realization of these agreements, especially the items concerning water resource management, remains low profile, and actions undertaken are usually one-sided.[28]

Although there are various regional initiatives, treaties, and agreements

23 Weinthal, E., "Water Conflict and Cooperation in Central Asia", UNDP Human Development Report Office. Human Development Report 2006, 2006, Available at: https://hdr.undp.org/system/files/documents/weinthalerika.pdf (Accessed: November 4, 2024).

24 "International Fund for Saving the Aral Sea," Interstate Commission for Water Coordination of Central Asia, 1993, Available at: http://www.icwc-aral.uz/ifas.htm (Accessed: November 4, 2024).

25 "Agreement on the use of water management facilities of intergovernmental status on the Rivers Chu and Talas", Bishkek 1998, Available online at: http://www.cawater-info.net/library/eng/chu_talas_e.pdf; "Agreement between the Government of the Republic of Kazakhstan, the Government of the Kyrgyz Republic and the Government of the Republic of Uzbekistan on cooperation in the field of environmental protection and rational nature management", 1997, Available at: http://www.cawater-info.net/library/eng/l/nature_use.pdf Almaty; "Agreement between the Government of the Republic of Uzbekistan and the Government of the Republic of Kazakhstan on cooperation in the field of environmental protection and rational nature management", Available at: http://cawater-info.net/library/rus/uzbekistan-kazakhstan_1997.pdf.

26 Janusz-Pawletta, B. and Gubaidullina, M., op.cit.

27 United Nations Economic Commission for Europe (UNECE), "The 1992 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes", 1992, Available at: https://unece.org/DAM/env/water/documents/brochure_water_convention.pdf (Accessed: November 4, 2024).

28 United Nations Economic Commission for Europe (UNECE), "National Political Dialogue on Integrated Management of Water Resources in Georgia in the Framework of European Water Initiative," 2011, Available at: https://unece.org/sites/default/files/2021-04/Transboundary_Water_resources_Management_Problems_in_Georgia_Eng.pdf (Accessed: November 4, 2024).

aimed at addressing the challenges posed by shared water resources in Central Asia and the South Caucasus, water management in these two regions remains dysfunctional. Political tensions and environmental challenges further complicate resolving water allocation and pollution issues. Moreover, climate change impact, which has increased variability in precipitation and glacial melt, poses additional risks to water availability and management in the region. Water resources in these regions are often viewed through a national security lens, hindering trust and cooperation. Effective water governance in Central Asia and the South Caucasus requires updated initiatives and solutions, especially due to increased negative effects of environmental issues.

Climate change in Central Asia and the South Caucasus is already having profound environmental, social, and economic impacts. The increased frequency of extreme weather events, rising temperatures, and threats to agriculture are among the most pressing challenges.

Climate change impact and response

Climate change in Central Asia and the South Caucasus is already having profound environmental, social, and economic impacts. The increased frequency of extreme weather events, rising temperatures, and threats to agriculture are among the most pressing challenges. Although both regions have initiated adaptation and mitigation efforts, much more needs to be done to build resilience and reduce vulnerabilities. Regional cooperation, increased investment in the agricultural sector, focus on renewables, and better water management are key elements for addressing the challenges posed by climate change in these areas.

Central Asia has been experiencing a rising trend in temperature, which is already significantly above the global average.[29] Between 1957 and 2005, the annual mean temperature in the region significantly increased at rates of 0.32°C/decade, 0.24°C/decade, and 0.41°C/decade, respectively, which were much higher than the increase rates globally or across the Northern Hemisphere.[30] This warming is causing

29 Yao, J., Chen, Y., Chen, J., Zhao, Y., Tuoliewubieke, D., Li, J., Yang, L., and Mao, W., "Intensification of extreme precipitation in arid Central Asia", Journal of Hydrology, Vol. 598, July 2021, Available at: https://doi.org/10.1016/j.jhydrol.2020.125760 (Accessed: November 5, 2024).

30 Zhang, M., Chen, Y., Shen, Y. and Li, B., "Tracking climate change in Central Asia through temperature and precipitation extremes", Journal of Geographical Sciences, Vol.29, No. 1, 2019, pp.3-28, Available at: https://doi.org/10.1007/s11442-019-1581-6 (Accessed: November 23, 2024).

glaciers in the Tien Shan and Pamir mountain ranges of Central Asia to melt at an accelerated pace.[31] According to a report by the Eurasian Development Bank, between 14% and 30% of the glaciers in these mountain ranges have melted over the past 60 years.[32] Glaciers provide crucial freshwater resources for much of the region, and their retreat threatens water availability for millions of people.

Moreover, changes in precipitation patterns are becoming increasingly apparent, with some areas experiencing droughts and others suffering from heavy rainfall and flooding. The World Meteorological Organization found that, in 2023, precipitation was below normal in large parts of the Turan Lowland (Turkmenistan, Uzbekistan, and Kazakhstan).[33] The World Bank reports that Central Asia's agricultural sector, which relies heavily on irrigation from rivers fed by glaciers, is highly vulnerable to these shifts.[34] Droughts and reduced river flow are exacerbating water scarcity, impacting food production, and threatening the livelihoods of rural populations who depend on agriculture.[35]

The South Caucasus is also experiencing the effects of climate change. Similar to Central Asia, rising temperatures and erratic precipitation are reshaping the region's environmental landscape. In Armenia, the average temperature increased by about 1.23°C between 1929 and 2016.[36] Similarly, the average annual temperature in Georgia has

31 Shaw, R., Luo, Y., Cheong, T.S., Abdul Halim, S., Chaturvedi, S., Hashizume, M., Insarov, G.E., Ishikawa, Y., Jafari, ., Kitoh, A., Pulhin, J., Singh, C., Vasant, K., and Zhang, Z., "Asia" in "Climate Change 2022: Impacts, Adaptation, and Vulnerability", Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY, USA, 2022, pp. 14571579, Available at: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Chapter10.pdf (Accessed: November 5, 2024).

32 Kalouay, B., "'Disappeared completely': melting glaciers worry Central Asia", September 16, 2024, Science X, Available at: https://phys.org/news/2024-09-glaciers-central-asia.html (Accessed: November 24, 2024).

33 World Meteorological Organization, "Climate change and extreme weather impacts hit Asia hard", April 23, 2024, Available at: https://wmo.int/news/media-centre/climate-change-and-extreme-weather-impacts-hit-asia-hard (Accessed: November 24, 2024).

34 Clement, V., Rigaud, K.K., de Sherbinin, A., J`ones, B., Adamo, S., Schewe, J., Sadiq, N., and Shabahat, E., "Groundswell Part 2: Acting on Internal Climate Migration", World Bank, Washington, DC, Available at: https://openknowledge.worldbank.org/entities/publication/2c9150df-52c3-58ed-9075-d78ea56c3267 (Accessed: November 5, 2024).

35 Miholjcic-Ivkovic, N., "Impact of climate change on migration trends in rural Central Asia", Central Asian Journal of Sustainability and Climate Change, Vol. 3, No.1, May 2024, pp. 74-95, Available at: https://doi.org/10.29258/CAJSCR/2024-R1.v3-1/74-95.eng (Accessed: November 5, 2024).

36 The World Bank Group and the Asian Development Bank, "Climate Risk Country Profile:

been increasing at an alarming rate. The average annual temperature increased by 0.25 to 0.58°C in most regions of the country, and by 0.63 to 0.73°C in bigger cities.[37] Azerbaijan is also facing rising temperatures, affecting its arid lowland regions, which are particularly vulnerable to desertification.[38] The number of days exceeding 16°C increased across the country by 3 to 26% between 1991 and 2010, relative to the 1961–1990 baseline, with the most pronounced increases occurring in mountainous districts such as Gadabay, Quba, and Nakhchivan.[39] These changes are contributing to reduced agricultural productivity and increased stress on water resources, especially in the irrigated areas of the Kura–Aras River Basin, which spans parts of Azerbaijan, Armenia, and Georgia.

Agriculture is a critical sector in both Central Asia and the South Caucasus, contributing significantly to the economies of these regions. Climate change has the potential to disrupt food production through shifts in temperature and precipitation, and increased frequency of extreme weather events. Implementing climate-smart agricultural practices, including crop diversification, soil conservation, and agroforestry, is essential. For instance, in Kazakhstan, the government has been promoting the use of drought-resistant crops.[40] In the South Caucasus, Georgia's adoption of climate-resilient farming techniques such as reduced tillage and the use of organic fertilizers is helping mitigate agricultural risks.[41]

Armenia", 2021, Available at: https://www.adb.org/sites/default/files/publication/709836/climate-risk-country-profile-armenia.pdf (Accessed: November 5, 2024).

37 Sulava, I. and Tchitchinadze, S., "Georgia assesses climate change impact, plans next steps in building climate-proof society", June 2021, available at: https://georgia.un.org/en/131830-georgia-assesses-climate-change-impact-plans-next-steps-building-climate-proof-society (accessed: November 5, 2024).

38 Abbasov R.K, Allahverdiyev R., Zaynalov R., Habilov A., and Aliyeva R., "Azerbaijan National Ecosystem Assessment", Baku, Azerbaijan: Government of Azerbaijan, RECC Azerbaijan, 2024, Available at: https://files.ipbes.net/ipbes-web-prod-public-files/webform/impact_tracking_database/76826/AZERBAIJAN-NEA-SPM-2024-2.pdf (Accessed: November 5, 2024).

39 The World Bank Group and Asian Development Bank, "Climate Risk Country Profile: Azerbaijan", June 2021, Available at: https://www.adb.org/publications/climate-risk-country-profile-azerbaijan (Accessed: November 24, 2024).

40 ElDala, Kazakhstan presents latest water-saving technologies to farmers, July 30, 2024, Available at: https://eldala.kz/novosti/kazahstan/19805-noveyshie-vodosberegayushchie-tehnologii-prezentovali-fermeram-kazahstana (Accessed: November 5, 2024).

41 Gönner, C., Weigel, O., Kodiashvili, A., Kolbin, G., and Muzafarova, A., "Approach for "Climate-adapted Agriculture in East Georgia" ", Integrated Biodiversity Management, South Caucasus – IBiS, 2019, Available at: https://biodivers-southcaucasus.org/uploads/files/Approach%20Climate-adapted%20Agriculture%20Georgia.pdf (Accessed: November 6, 2024).

The response to climate change in Central Asia and the South Caucasus is still evolving, and while some steps have been taken toward adaptation and mitigation, much more needs to be done to address the growing risks posed by changing climate. Effective cooperation at the regional and international levels, combined with strong national policies, is crucial for ensuring sustainable development and climate resilience in these regions.

Energy dependence and environmental impact

Energy dependence is a critical and interconnected environmental challenge in Central Asia and the South Caucasus. These regions are heavily reliant on energy resources, both in terms of production and consumption, yet face growing environmental risks linked to this dependence. The environmental implications are compounded by geopolitical tensions, economic challenges, and the effects of climate change, making sustainable energy transitions more urgent. In both regions, energy dependence is closely tied to fossil fuels, which dominate the energy mix. This reliance limits the ability to diversify energy sources and slows the transition toward more sustainable and renewable energy options.

Countries like Kazakhstan, Azerbaijan, and Turkmenistan heavily rely on oil and gas exports, primarily hydrocarbons, which constitute a significant portion of their GDP.[42] Nations such as Kyrgyzstan and Tajikistan depend on their hydropower systems, supplied by melting glaciers and river flows from the Pamirs and Tien Shan Mountain ranges. In Tajikistan, hydropower accounts for over 90% of electricity generation.[43] Central Asia's dependence on hydropower, particularly in Kyrgyzstan and Tajikistan, is jeopardized by glacial melting and unpredictable rainfall patterns that affect the region's water availability.[44]

Energy dependence also intersects with geopolitical tensions. The South Caucasus, strategically located between Europe, Russia, and the Middle

42 Aydin, U. and D. Azhgaliyeva, "Assessing Energy Security in the Caspian Region: The Geopolitical Implications for European Energy Strategy", Asian Development Bank Institute, October 2019, Available: https://www.adb.org/publications/assessing-energy-security-caspian-region (Accessed: November 11, 2024).

43 UNECE, "Energy Policy Brief: Tajikistan", March 2022, Available at: https://unece.org/sites/default/files/2024-09/tajikistan%20%287%29.pdf (Accessed: November 11, 2024).

44 Pohl B. et al., op.cit.

East, faces complex energy security issues. For instance, Armenia relies heavily on Russian natural gas supplies, which are almost entirely imported by pipeline through Georgia.[45] Armenia's reliance on Russian natural gas can be considered not just an economic issue, but also a geopolitical challenge. It limits Armenia's flexibility in foreign policy, creates tensions with Western countries, and ties its security to Russia in ways that might not align with Armenia's long-term strategic interests. Such connectivity to the Russian energy market creates vulnerabilities in both countries' energy security.

Azerbaijan, on the other hand, was able to diversify its energy exports through the Southern Gas Corridor, a chain of pipelines transporting Azerbaijan's natural gas to Europe.

Azerbaijan, on the other hand, was able to diversify its energy exports through the Southern Gas Corridor, a chain of pipelines transporting Azerbaijan's natural gas to Europe. However, this has created a dynamic that has long inhibited the process of a sustainable and green energy transition. However, backed by its recent experience of hosting COP29, Azerbaijan is ideally positioned to be one of the leads in lowering greenhouse gas emissions and prevent environmental degradation through a rapid and sustainable transition to a green economy.

The interrelationship between energy dependence and environmental issues is also manifest in the green transition process. For example, the push for renewable energy sources, although necessary for sustainable development, faces obstacles due to existing investments in fossil fuel infrastructure and political interests.[46] Transitioning to renewables could alleviate some environmental pressures but requires substantial investment and technological support, which many of these countries struggle to secure.

Kazakhstan has made progress in promoting renewable energy. In 2020, the government adopted an Action Plan for implementing the Green Economy Concept with plans to generate 50% of its electricity from "alternative or renewable" sources, which could include nuclear, by 2050.[47] Uzbekistan has also made significant progress in the renewable

45 IEA, "Armenia energy profile", 2023, Available at: https://www.iea.org/reports/armenia-energy-profile (Accessed: November 11, 2024).

46 Scott, M., "Why aren't we reducing our reliance on fossil fuels faster?", World Economic Forum, August 12, 2024, Available at: https://www.weforum.org/stories/2024/08/speed-fossil-fuel-transition-climate-energy/ (Accessed: November 11, 2024).

47 IEA, "Kazakhstan 2022: Energy Sector Review", 2022, Available at: https://www.iea.org/reports/kazakhstan-2022/executive-summary (Accessed: November 12, 2024).

energy transition in recent years, though the process is still in its early stages. In 2017, Uzbekistan adopted a Renewable Energy Development Strategy with a target to obtain 25% of its electricity from renewable sources by 2030. Moreover, in 2019, Uzbekistan launched its first renewable energy auctions for solar power projects, a move designed to drive competition, reduce costs, and attract international investors.[48] These auctions are expected to continue throughout the renewable transition.

Georgia is expanding its hydropower capacity, while Azerbaijan is investing in solar and wind energy projects. In 2023, through cooperation with Masdar from the UAE, the 230 MW Garadagh Solar Power Plant, the largest in the Caspian and the CIS regions, was put into operation.[49] Central Asian and Caspian Basin states are actively working on the green energy transition. At COP29 in Azerbaijan's capital city of Baku, Azerbaijan, Kazakhstan, and Uzbekistan, were actively working on developing a sustainable "green energy corridor" as part of the Middle Corridor trade route, aiming to boost renewable energy exports to Europe. These countries signed important infrastructure agreements, including for a strategic power line and cargo terminals.[50] However, these efforts must be intensified in order to reduce reliance on fossil fuels and mitigate the environmental damage associated with energy production.

Strategies for enhancing regional collaboration

Enhancing regional collaboration in addressing environmental issues in Central Asia and the South Caucasus requires a multifaceted approach that builds on existing frameworks, strengthens governance structures, promotes inclusive stakeholder engagement, and allows for knowledge

48 The International Finance Corporation (IFC), "Uzbekistan Announces Winner of First Ever Solar Power Auction in the Country", October 31, 2020, Available at: https://www.ifc.org/en/pressroom/2019/uzbekistan-announces-winner-of-first-ever-solar-power-auction-in-the-country (Accessed: November 24, 2024).

49 Ministry of Energy of Republic of Azerbaijan, "The Use of Renewable Energy Resources in Azerbaijan", March 6, 2024, Available at: https://minenergy.gov.az/en/alternativ-ve-berpa-olunan-enerji/azerbaycanda-berpa-olunan-enerji-menbelerinden-istifade (Accessed: November 12, 2024).

50 Benson, B., "COP29: Caspian and Central Asian states make progress in promoting "green" trade plan", *Eurasianet*, November 20, 2024, Available at: https://eurasianet.org/cop29-caspian-and-central-asian-states-make-progress-in-promoting-green-trade-plan (Accessed: November 24, 2024).

and experience to be shared across the region. The environmental challenges in these regions are interconnected. Thus, addressing these challenges requires coordinated action that transcends national borders, supported by robust regional cooperation mechanisms, shared policy frameworks, and integrated solutions.

Regional cooperation is also essential for addressing these challenges. Regional cooperation on environmental issues necessitates strengthened institutional frameworks, yet political tensions often hinder effective collaboration.[51] Organizations such as the Caucasus Environmental NGO Network (CENN)[52] and the Central Asia Regional Economic Cooperation (CAREC)[53] are vital for facilitating dialogue and cooperation. Since 1998, CENN has promoted green growth and sustainable development through collaborative, region-wide initiatives involving local communities, national governments, and all sectors of society across Armenia, Azerbaijan, and Georgia to address environmental challenges. CAREC is a collaboration of 11 countries and development partners aimed at fostering economic growth and poverty reduction through cooperation, guided by the vision of "Good Neighbours, Good, and Good Prospects".

These organizations should be further empowered to create platforms for regular interaction among governments, civil society, and the private sector. The creation of similar organizations that would include all concerned countries of both regions could further contribute to a more meaningful and robust response to transboundary environmental issues.

Such examples of regional environmental governance must be inclusive, involving local communities and civil society in decision-making processes. Environmental NGOs, youth groups, and local community organizations play an important role in raising awareness, fostering dialogue, and implementing grassroots initiatives. CAREC shows a great potential as a platform for stakeholder engagement that can help build capacity and foster cross-border collaboration.

The Caspian Sea, the Aral Sea, and rivers such as the Amu Darya, Syr Darya, and Kura are shared by multiple countries, which leads to

51 Asian Development Bank, "CAREC Energy Outlook 2030", 2022, Available at: https://www.adb.org/sites/default/files/publication/850111/carec-energy-outlook-2030.pdf (Accessed: November 12, 2024).

52 Official site of the organization: https://www.cenn.org/ (Accessed: November 8, 2024).

53 Official site of the organization: https://www.carecprogram.org/ (Accessed: November 8, 2024).

disputes over water usage. However, such a transboundary situation also creates an opportunity for resolving the issue with integrated management and initiatives that transcend national borders and foster peaceful and sustainable development.

IFAS, which has worked with Central Asian nations to address environmental degradation of the Aral Sea, is a positive initiative. But it needs more development and modernization in order to face the issues of poor water management in the region more proactively. Similar mechanisms could be applied to other shared water bodies in the South Caucasus and Central Asia. This is especially true of the Caspian Sea basin, which has been receding at an alarming rate.[54]

Climate change impacts such as droughts, floods, and extreme weather events require joint regional climate adaptation strategies for resilience purposes in both regions. This could include climate risk assessments, vulnerability mapping, and the creation of early warning systems for extreme weather events. Central Asian and South Caucasus countries can benefit from the UNDP's regional climate change programmes that support countries in developing national climate strategies and regional adaptation mechanisms.[55]

Encouraging the transition to renewable energy and sustainable development practices is another crucial strategy. The potential for renewable energy – particularly wind and solar – is high in both Central Asia and the South Caucasus. Regional cooperation in clean energy projects can foster energy security, reduce greenhouse gas emissions, and improve energy efficiency. Although the transition process will not be complete or on a fast track in the foreseeable future, especially considering the current pace of replacing fossil fuels with renewables, it is important to continue emphasizing the positive outcome of such a transition and to educate governments and local populations about the benefits of green energy.

Countries in Central Asia and the South Caucasus could work together to develop regional renewable energy grids, thereby facilitating energy

54 Board, J., "'A catastrophe': Why world's largest inland water body could disappear and what it says about climate change", CNA, November 9, 2024, Available at: https://www.channelnewsasia.com/sustainability/sustainability-caspian-sea-cop-climate-change-4707106 (Accessed: November 12, 2024).

55 UNDP, "Europe and Central Asia: Environment", Available at: https://www.undp.org/eurasia/our-focus/environment (Accessed: November 12, 2024).

trade and sharing technology. Collaborative projects that use solar and wind potential across sea and mountain areas in both regions could stimulate economic growth while addressing environmental concerns and even alleviating geopolitical hostilities and tensions.

Concluding remarks

Regional collaboration is arguably one of the most effective approaches to addressing the interconnected environmental challenges in Central Asia and the South Caucasus, particularly given the transboundary nature of these issues. An understanding of the geopolitical and historical tensions in both regions provides insight into the slow pace of the green transition and the limited success of regional initiatives and strategies aimed at mitigating environmental problems. The findings emphasize the critical need to strengthen collaborative efforts through the exchange of knowledge, increased governmental commitment, and greater local involvement to combat environmental degradation and advance sustainable development.

The environmental challenges of water scarcity, climate change, and energy dependence in Central Asia and the South Caucasus are intricately linked, and their resolution demands collaborative, cross-border strategies. As demonstrated, regional cooperation mechanisms such as CAREC, IFAS, and various bilateral initiatives, while beneficial, need modernization and stronger implementation to achieve meaningful results.

Although these environmental issues are compounded by geopolitical tensions, they also present opportunities for cooperation and innovation. Effective regional governance, strengthened institutional frameworks, and inclusive stakeholder engagement are critical to overcoming the political, economic, and social barriers that hinder collaborative action.

Moving forward, enhancing cooperation in areas like shared water resources, renewable energy, and climate resilience will be essential for ensuring sustainable development in both regions. Addressing the complex environmental challenges in Central Asia and the South Caucasus requires a multi-faceted approach that provides gradual, adaptive, and integrated solutions to the interrelated issues of environmental degradation. Although such an approach might be

complex and difficult to embrace, it is important to support small-scale projects that not only tackle immediate concerns, such as water scarcity and energy dependence, but also pave the way for long-term stability in the face of climate change. By fostering collective action, these countries can not only mitigate the environmental impacts they face but also contribute to regional stability and prosperity, ultimately building a more resilient future for Central Asia and the South Caucasus.