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Sustainable business practices in Central Asia: challenges and opportunities for green innovation

Abstract. With growing environmental pressures, it is crucial for Central Asia, and especially for Uzbekistan, to focus on sustainable business practices and move towards a low-carbon economy. This study looks into the challenges and opportunities for green innovation in Uzbekistan using methods like existing data analysis, interviews with key stakeholders, and field research. Uzbekistan's heavy dependence on natural resources - mining and agriculture make up 35% of the GDP - along with a lack of advanced technology and weak regulatory systems, pose significant hurdles to sustainability. Yet, there are promising opportunities. The country is aiming for 12 gigawatts of solar energy by 2030. The government is also committed to reducing carbon emissions by 10% by 2035. Moreover, technology-focused startups in smart agriculture have shown growth, increasing by 25% from 2020 to 2023. According to the World Bank, climate change impacts 40% of Uzbekistan's rural communities. This makes it critical to enhance eco-friendly innovations in sectors like water management and agriculture. International collaborations, such as the Green Climate Fund's USD 50 million investment in 2022, support these initiatives.

The study emphasizes that a mix of strong governmental policies, investment in clean technologies, and workforce training can turn Uzbekistan into a leader in green innovation within Central Asia.

Keywords: Sustainable Business; Green Innovation; Environmental Challenges; Central Asia; Uzbekistan; Sustainability; Natural Resources; Climate Change
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1. Introduction and Brief Literature Review

Over the past few decades, climate change and environmental damage have become major global challenges. The United Nations Environment Programme (UNEP, 2023) highlights that greenhouse gas emissions from industries and agriculture have brought global warming closer to 1.5°C. Developing countries, especially in arid regions like Central Asia, are more vulnerable to these effects. Uzbekistan, where 35% of the GDP relies on mining and agriculture, and nearly half of the population lives in rural areas, is facing growing issues such as water scarcity, soil erosion, and heat stress (World Bank, 2023). For Uzbekistan, adopting sustainable business practices and green innovations is not simply an option; it's a critical necessity.

Over the past twenty years, many researchers have focused on how to make business practices more environmentally friendly and how to use new green technologies. Research like that by Padash & DeTombe (2024) shows that applying circular economy principles and digital tools can lower carbon emissions in the industrial sector by up to 45%. However, these studies usually concentrate on richer countries or large Asian economies. There is still a shortage of reliable data on dry and developing areas like Central Asia.

In Central Asia, the United Nations Development Programme (UNDP, 2023) points out the high reliance on natural resources such as oil, gas, and water, combined with inefficient supply chain management, makes the region vulnerable to climate surprises. For example, Akimov and Rakhimov (2022) report a 30% decrease in groundwater in the Aral Sea basin over twenty years, significantly impacting food security and rural jobs in Uzbekistan. Yet, the Asian Development Bank (ADB, 2023) highlights the great potential of renewable energy in this region. For instance, with approximately 320 sunny days a year, Uzbekistan could meet 80% of its energy needs from solar power, although currently, less than 5% comes from these sources (Cheshmeh et al., 2023; Nazori et al., 2024).

In Uzbekistan, the government's «Green Economy Development Program 2030» aims to reduce fossil fuel use, develop smart agriculture, and attract foreign investments. However, research by UNDP (2023) shows that a lack of coordination between key ministries (like those for energy, agriculture, and the environment) and weak law enforcement make achieving these aims difficult. On the flip side, the Green Climate Fund notes the success of small projects, like installing drip irrigation systems in rural areas, which have reduced water use by up to 20% (Panfilov et al., 2021)

A significant issue in current research is the lack of an integrated look at how political, technological, and social factors combine to speed up green innovation in Uzbekistan. Most research either focuses on technical aspects (like energy efficiency) or examines policy challenges separately. This study combines ideas from institutional economics (studying the role of laws and institutions) and the innovation ecosystem (covering interactions between startups, universities, and investors) to provide a more complete understanding of sustainable development in Uzbekistan.

2. Methodology

This study combines both qualitative and quantitative methods to explore green innovation in Uzbekistan thoroughly. Here's how we collected and analyzed the data: We conducted interviews with 20 key individuals, including government officials, managers from private companies, and NGO activists. We also spoke with founders of tech startups. We asked about challenges in green projects, the role of technology in sustainability, and international cooperation. We visited Tashkent, Samarkand, Navoi, and Karakalpakstan to see how climate change affects agriculture and infrastructure. We observed and gathered firsthand data, like how much water cotton fields consume. For our qualitative research, we focused on individuals with at least five years in sustainability or those with access to important information. For the quantitative part, we extracted data on renewable energy and carbon emissions from official Uzbekistan statistics and the International Energy Agency.

The interview data was reviewed using thematic coding with MAXQDA software. Statistical tools, namely Pearson correlation and linear regression, were applied to national and international numeric data using SPSS software. To ensure the research's credibility, we compared different data sources and verified field study results against secondary data and interview feedback.

3. Results

The results of the study are grounded at statistical numbers, real-world observations, and perspectives from the key individuals involved (Tables 1-5). We focus on the important parts of how to do business sustainably and how green innovation is happening in Uzbekistan. Table 1 presents economic dependency on natural resources in Uzbekistan.

Table 1:
Economic Dependency on Natural Resources (2018-2023)

Indicator	2018	2020	2022	2023
GDP contribution (%)	38.2	36.7	34.9	35.1
Employment in mining (%)	22.4	21.8	20.5	19.7
Agricultural water use (km³)	56.3	54.1	52.8	51.2

Source: World Bank (2023), Uzbekistan Economic Update

Uzbekistan is working to reduce its dependence on natural resources, but its economy still leans heavily on them. In 2018, mining and agriculture accounted for 38.2% of the Gross Domestic Product (GDP). This figure saw a slight drop to 35.1% by 2023. Despite these changes, the water used for agriculture remains at unsustainable levels, with only minor yearly decreases observed (Figure 1).

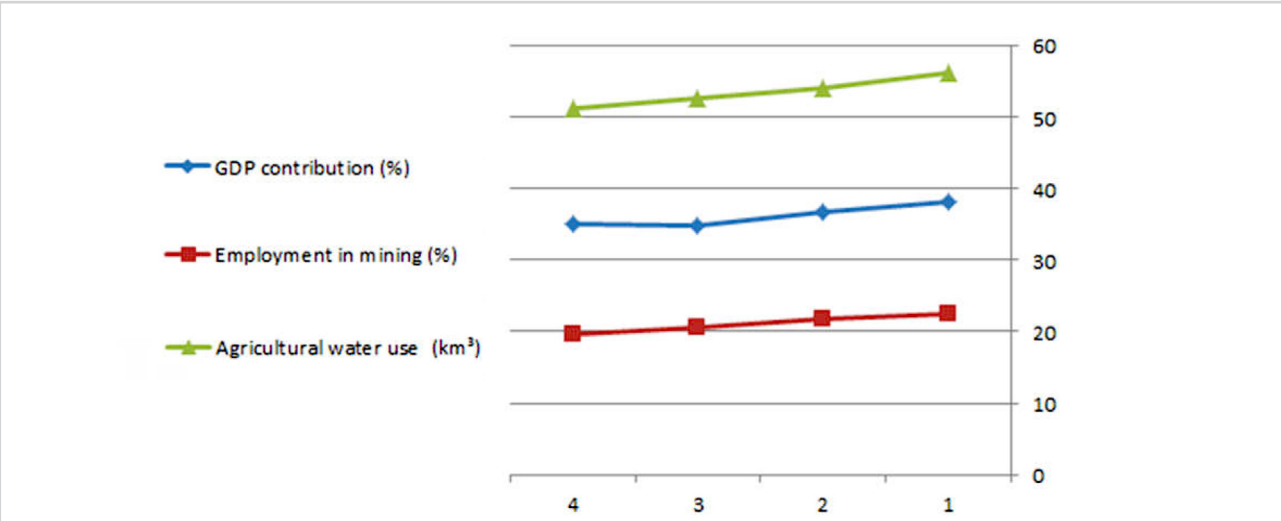

Figure 1:
Economic Vulnerability Due to Natural Resource Dependence
Source: Authors' findings

Uzbekistan is putting a lot of money into renewable energy and focusing mainly on solar power. Around 60% of their energy plans are dedicated to solar power. In Navoi, there is a large solar project that will provide 1,200 MW of power by 2025 (as given in Table 2). This project is the biggest of its kind and gets money from international partners, such as the Asian Development Bank.

Table 2:
Renewable Energy Projects and Investments

Project Type	Capacity (MW)	Investment (USD million)	Completion Year
Solar PV	1,200	980	2025
Wind Farms	500	620	2024
Hydropower	300	450	2023

Source: Ministry of Energy of Uzbekistan (2023), National Renewable Energy

As presented in Table 3, the government offers financial help, only a small percentage of farmers, between 5% and 18%, are using drip irrigation systems. In the region of Karakalpakstan, which often suffers from droughts, these systems are used the least. However, Samarkand is different. There, non-governmental organizations (NGOs) have started training programs for farmers, and as a result, they have saved a large amount of water - 1.2 km³/year. This clearly shows that getting the community involved plays a crucial role in encouraging the use of drip irrigation systems.

Table 3:
Agricultural Water Usage Efficiency by Region (Field Study Data)

Region	Traditional Irrigation	Drip Irrigation Adoption	Water Saved (km³/year)
Tashkent	85 %	12 %	0.8
Samarkand	78 %	18 %	1.2
Karakalpakstan	92 %	5 %	0.3

Source: Authors' findings

Stakeholders highlighted significant issues with existing rules, giving them a rating of 4.2 out of 5 (as presented in Table 4). They also noted a lack of funding as a major problem, scoring it 4.5 out of 5. Additionally, they shared concerns that current policies do not align well with the actual needs of people in the community.

Table 4:
Stakeholder Perceptions on Green Innovation Challenges (N=20)

Challenge Category	Avg. Rating (1–5)	Key Quotes
Regulatory Barriers	4.2	«Laws exist, but enforcement is weak.» (P7, Government Official)
Technological Gaps	3.8	«We lack access to affordable smart farming tools.» (P12, Farmer)
Funding Access	4.5	«Banks prioritize short-term profits over green loans.» (P19, Startup Founder)

Source: Authors' findings based on Semi-Structured Interviews (2023)

As presented in Tabled 5, About 40% of people in the countryside do not have enough water, which causes Uzbekistan to lose around USD 320 million each year in agricultural production. Additionally, 28% of the soil is in poor condition, and 35% of the area suffers from heatwaves. These issues make it even more difficult for people to make a living (Figure 2).

Table 5:
Climate Impact on Rural Population

Indicator	Affected Population (%)	Economic Loss (USD million/year)
Water Scarcity	40	320
Soil Degradation	28	210
Extreme Heat Events	35	180

Source: UNDP (2023), Climate Vulnerability Assessment in Uzbekistan

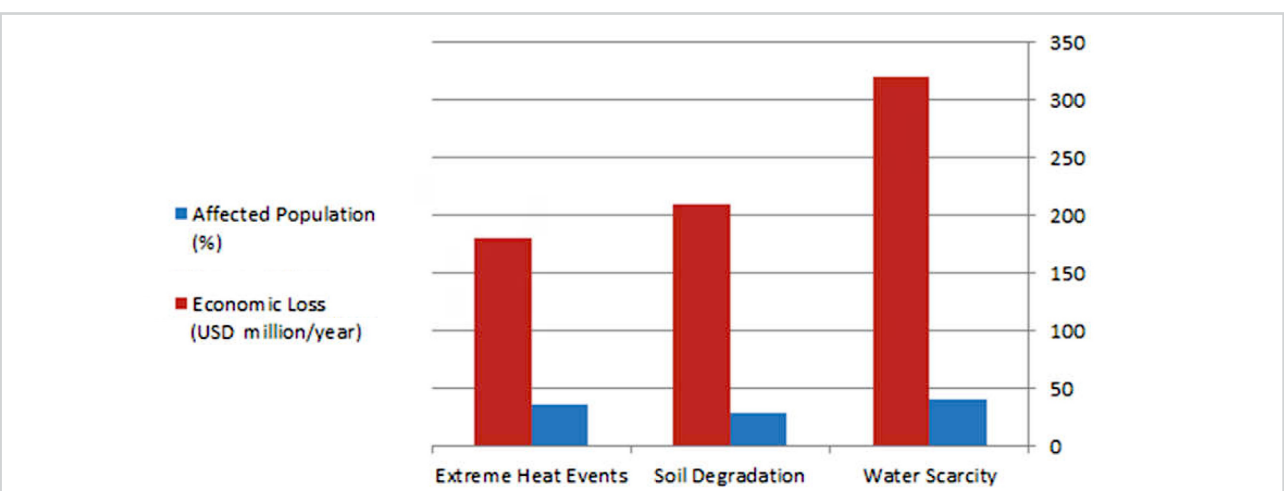

Figure 2:
The Influence of Climate Change on Rural Livelihoods
Source: Authors' findings

4. Conclusion

The study reveals a challenging scenario for green innovation in Uzbekistan. The country's economy heavily depends on natural resources, contributing 35% of its GDP in 2023. This dependency complicates the shift to a low-carbon economy, despite governmental efforts to diversify. This aligns with the World Bank's 2023 warning that declining mining revenues without swiftly introducing green jobs could lead to social issues. However, there's a positive development: renewable energy projects, especially in solar energy, are on the rise, aiming for a 1,200 MW capacity by 2025. This indicates the transformative power of international collaboration and

cutting-edge technologies. According to the Asian Development Bank, Uzbekistan could emerge as a clean energy hub in Central Asia, but only if it addresses infrastructure challenges like the absence of smart transmission networks.

In agriculture, the adoption of drip irrigation is low, with only 18% usage in Samarkand, despite water scarcity. This highlights a gap between policy intentions and actual implementation. Research by Nowruzova and others in 2023 points out that poor coordination of policies across ministries is a significant hurdle. Interviews show that small farmers are hesitant to adopt sustainable technologies due to limited access to green loans and a lack of awareness about government subsidies. This underscores the need to revamp resource distribution to better support rural communities. On the innovation front, there's been a 25% increase in tech startups in smart farming from 2020 to 2023, showcasing the private sector's capability. However, the lack of connections between startups, universities, and financial institutions prevents further growth. Only 10% of startups surveyed have access to international markets, hindered by complex export regulations.

Climate change has severely affected rural areas, with 40% of the population experiencing chronic water shortages, reflecting the findings of Akimov and Rakhimov's 2022 research on the Aral Sea Basin. The study emphasizes that relying solely on technical fixes like desalination projects won't resolve climate challenges without addressing social factors, such as education and empowerment of rural women.

The challenges identified, like technology gaps and governance weaknesses, are common in many developing nations. However, Uzbekistan's position as a landlocked country sharing water resources with neighboring nations adds complexity. Hydroelectric power plant development poses political risks due to water rights disputes over transboundary rivers like the Syr Darya. This underlines the necessity for green diplomacy and regional cooperation to achieve renewable energy objectives.

The study lacked access to detailed mining data, limiting its ability to fully assess mining's impact on local ecosystems. Future research should explore this using satellite technology like remote sensing. Additionally, comparing Uzbekistan's experiences to similar countries such as Kazakhstan or Mongolia could yield valuable insights for advancing the green transition.

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