LAND MANAGEMENT, ENVIRONMENT & SOLID-WASTE: INSIDE EDUCATION AND BUSINESS IN CENTRAL ASIA
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MICRO-CREDENTIAL

CLIMATE CHANGE FOR SUSTAINABLE LAND MANAGEMENT IN CENTRAL ASIA

3.- The Carbon Cycle, Land Use and SLM

Case Study

Land degradation in the Aral Sea basin

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1. Introduction

The Aral Sea Basin, shared primarily by Kazakhstan, Uzbekistan, Turkmenistan, Tajikistan, and Kyrgyzstan, represents one of the most significant examples of environmental degradation caused by unsustainable land and water management. Beginning in the 1960s, large-scale irrigation projects diverted substantial amounts of water from the Amu Darya and Syr Darya rivers to support agricultural production, particularly cotton cultivation.

While these projects increased agricultural output, they also triggered severe environmental consequences, including the shrinkage of the Aral Sea, soil salinization, desertification, and declining ecosystem productivity. Today, the basin remains a key example of the challenges associated with balancing agricultural development, water use, and environmental sustainability.

2. Land Use Change and Degradation

The expansion of irrigated agriculture transformed extensive natural ecosystems into cultivated land. However, inefficient irrigation systems resulted in considerable water losses through evaporation and seepage.

As water availability decreased and groundwater conditions changed, salts accumulated in the soil profile and on the soil surface. This process reduced soil fertility and crop yields, making agricultural production increasingly difficult in many areas.

The main forms of land degradation observed in the Aral Sea Basin include:

- Soil salinization;
- Wind erosion;
- Desertification;
- Loss of vegetation cover;
- Declining soil fertility;
- Reduced agricultural productivity.

In addition, the drying of the Aral Sea exposed large areas of former seabed, creating new sources of dust and salt storms that further affected surrounding agricultural lands and human settlements.

3. The Carbon Cycle and Land Degradation

Land degradation has important implications for the carbon cycle. Healthy soils function as carbon sinks by storing organic matter derived from plant growth. When soils become degraded, their capacity to store carbon decreases.

In the Aral Sea Basin, vegetation loss, soil erosion, and declining soil quality have contributed to reductions in soil organic carbon stocks. Degraded soils release part of their stored carbon back into the atmosphere as carbon dioxide (CO_2), while reduced vegetation cover limits carbon uptake through photosynthesis.

As a result, land degradation not only affects agricultural productivity but can also contribute to climate change by weakening the capacity of terrestrial ecosystems to sequester carbon.

4. Sustainable Land Management Responses

To address land degradation, several Sustainable Land Management (SLM) practices have been promoted across Central Asia:

SLM Measure	Expected Benefit
Improved irrigation efficiency	Reduced water losses and soil salinization
Conservation agriculture	Increased soil organic matter and carbon storage
Crop rotation	Improved soil fertility and resilience
Afforestation and shelterbelts	Reduced wind erosion and dust storms
Sustainable grazing management	Protection of vegetation cover
Salt-tolerant crops	Improved productivity on saline soils

These measures aim to restore ecosystem functions, improve soil health, enhance water-use efficiency, and strengthen carbon sequestration.

5. Lessons Learned

The Aral Sea Basin demonstrates how unsustainable land-use decisions can generate long-term environmental consequences. Intensive irrigation and poor water management contributed to widespread land degradation and ecosystem decline.

The case also highlights the importance of Sustainable Land Management practices for restoring degraded lands, improving agricultural sustainability, and supporting climate change mitigation through enhanced carbon storage in soils and vegetation.

6. Discussion Questions

- How did irrigation expansion contribute to land degradation in the Aral Sea Basin?
- Why is soil salinization a major challenge for agricultural sustainability?
- How does land degradation affect the carbon cycle?

- Which Sustainable Land Management practices could be most effective in restoring degraded lands in the region?

7. References

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