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LAND MANAGEMENT, ENVIRONMENT & SOLID-WASTE: INSIDE EDUCATION AND BUSINESS IN CENTRAL ASIA ERASMUS-EDU-2023-CBHE Project Number: 101129032

MICRO-CREDENTIAL

CLIMATE CHANGE FOR SUSTAINABLE LAND MANAGEMENT IN CENTRAL ASIA

4.- Water, Cryosphere and Climate in Central Asia

Activity

Short scenario worksheet: "Adapting irrigation scheduling under reduced glacier melt"

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1. Learning Objectives

This activity is designed as an integrated analytical and interactive exercise that combines quantitative reasoning, environmental analysis, and decision-making under uncertainty.

By the end of this session, students are expected not only to understand the technical aspects of irrigation scheduling but also to critically evaluate how climate change—specifically reduced glacier melt—reshapes water management strategies in vulnerable regions.

Students will develop the ability to interpret hydrological data, assess water deficits, and connect physical processes (such as glacier retreat) with socio-economic outcomes (such as agricultural productivity and food security). In addition, the activity emphasizes decision-making under constraints, encouraging students to weigh competing priorities, negotiate trade-offs, and justify their choices using evidence.

2. Scientific and Conceptual Background

In many regions of Central Asia, river systems depend heavily on meltwater originating from high mountain glaciers in the Tien Shan and the Pamir Mountains. These glaciers function as natural reservoirs, releasing water gradually during warmer months. This seasonal release is critically important because it coincides with peak agricultural demand.

However, climate change is altering this balance. Rising temperatures initially accelerate glacier melt, temporarily increasing river discharge. Over time, as glacier mass declines, the total volume of available meltwater decreases. This creates a long-term trend of declining summer flows, which is particularly problematic for irrigation-dependent agriculture.

Irrigation scheduling becomes a key adaptive tool under these conditions. Traditionally, irrigation systems in the region have followed fixed schedules or have relied on abundant water availability. Under increasing scarcity, these approaches become inefficient and unsustainable. Modern irrigation scheduling requires aligning water application with crop growth stages, soil moisture conditions, and expected water availability.

At the same time, irrigation systems themselves often suffer from inefficiencies. Open canal systems lose significant amounts of water through seepage and evaporation. This means that even when water is available at the source, only a fraction reaches the fields.

Thus, adapting irrigation under reduced glacier melt is not a purely technical problem. It is a complex socio-environmental challenge involving hydrology, infrastructure, agricultural practices, and governance.

3. Extended Scenario: Regional Water Stress under Climate Change

You are part of a multidisciplinary water management team working in a transboundary agricultural region downstream of glacier-fed rivers.

Over the past decade, monitoring data has shown a steady decline in summer river discharge. Recent assessments indicate that meltwater contribution has decreased significantly, especially during peak irrigation months. Farmers are already reporting lower yields, and competition for water between agricultural users is increasing.

The region's agricultural system is structured around three main crops:

- Cotton, which provides high economic returns but requires large volumes of water
- Wheat, which is essential for food security and has moderate water demand
- Vegetables, which are important for local markets but are sensitive to water stress

Water is distributed through a canal system built several decades ago. Losses during transport are estimated to be substantial, but infrastructure upgrades are limited by financial constraints.

Tensions are beginning to emerge between upstream and downstream users. Upstream communities prioritize hydropower and local agriculture, while downstream farmers depend on consistent irrigation supply.

You have been tasked with proposing a strategy that ensures **efficient irrigation scheduling under reduced water availability**, while maintaining agricultural productivity and minimizing conflict.

4. Dataset and Contextual Interpretation

Students are provided with simplified but realistic data representing water availability before and after glacier decline.

Rather than treating the dataset as purely numerical, students should interpret it within the broader context of seasonal water dynamics.

The data clearly indicates that the most significant reductions occur during summer months—precisely when irrigation demand is highest. This mismatch between supply and demand is the central problem of the scenario.

Students are encouraged to think beyond calculations and consider questions such as:

- How reliable is this data?
- What uncertainties might exist?
- How might extreme weather events alter these patterns?

5. Guided Analytical Tasks

Students will work through a structured sequence of analytical steps.

First, they must interpret the data and identify patterns of water availability. This includes recognizing seasonal peaks and deficits, and understanding how these relate to crop water needs.

Next, students perform calculations to quantify water shortages. However, the emphasis is not only on obtaining correct numbers but on interpreting what those numbers mean in real-world terms. For example, a calculated deficit should lead to questions about crop survival, economic losses, and social impacts.

Students then move to decision-making. They must design an irrigation schedule under constrained conditions. This requires prioritization: not all crops can receive sufficient water, so trade-offs are unavoidable.

Finally, students develop adaptation strategies. These should not be limited to technical fixes but should include institutional and behavioral changes, such as water-sharing agreements or changes in cropping patterns.

6. Interactive Learning Component: Role-Play Simulation

"Negotiating Water Under Scarcity"
Students are divided into groups representing different stakeholders:

- Upstream water managers
- Downstream farmers
- Government policymakers
- Environmental experts

Each group receives a brief describing their interests and constraints.

For example, farmers prioritize maximizing crop yields, while environmental experts emphasize maintaining river ecosystems. Policymakers must balance all interests while avoiding conflict.

The task is to negotiate a **joint irrigation strategy**.

Rules:

- Each group presents its priorities (5 minutes)
- Open negotiation (15–20 minutes)
- Final agreement must be reached and justified

This activity develops:

- negotiation skills
- systems thinking
- understanding of competing interests

7. Problem-Solving Game: "Water Allocation Challenge"

Students participate in a simulation game where they are given a fixed amount of water and must allocate it across crops and time periods.

Each decision has consequences:

- Over-irrigation reduces future availability
- Under-irrigation reduces crop yield
- Efficient allocation increases overall system sustainability

The instructor may introduce **unexpected events**, such as:

- a drought reducing water supply by an additional 10%

- infrastructure failure causing water loss
- policy intervention limiting water use

Students must adapt their strategy in real time.

8. Instructor Analytical Guide (Conceptual Insights)

The activity is designed to guide students toward several key insights.

First, water scarcity is not only a function of physical availability but also of management efficiency. Even limited water can be used effectively with proper scheduling.

Second, high-value crops are not always sustainable under changing climatic conditions. Students often recognize the need to reduce dependence on water-intensive crops such as cotton.

Third, cooperation is essential in transboundary contexts. Unilateral decisions can worsen overall outcomes.

Finally, climate change introduces uncertainty, meaning that adaptive and flexible management strategies are more effective than rigid plans.

9. Reflection and Synthesis Discussion

Students reflect on the broader implications of the exercise.

They are encouraged to consider how local decisions scale up to regional challenges, particularly in transboundary river systems.

Discussion should also address ethical dimensions, such as:

- Who should bear the cost of adaptation?
- Is it fair to restrict farmers' choices?
- How should water be allocated during extreme scarcity?

10. Assessment Task (Mini-Test + Writing)

Conceptual Questions

Explain how glacier retreat affects seasonal water availability and why this creates challenges for irrigation scheduling.

Applied Question

Propose a realistic irrigation adaptation plan for a region experiencing reduced summer flows. Your answer should include technical, economic, and institutional measures.

Short Essay (200–250 words)

"Sustainable irrigation under climate change requires both technological innovation and institutional cooperation."

Discuss.

REFERENCES

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