Policy brief – February, 2024

GIS technologies and modelling approaches for more sustainable management of natural resources

Introduction

The question of suitable approaches and technologies for more effective and environmentally friendly management of natural resources has great relevance for the countries of Central Asia in the context of the UN Sustainable Development Goals. Despite the wide range of natural resources, Central Asia is still facing increasing land degradation and water scarcity. These problems are being accelerated by land-use pressure and climate change, which is particularly severe in Central Asia. The following recommendations are developed together with scientists from international projects on the use of GIS technologies and modelling approaches for more sustainable resource management.

Recommendations

a) General (cross-project) policy recommendations for the effective use of Geographic Information Systems (GIS) and modelling in Central Asia to promote sustainable resource management:

1. **Integrated Land Use Planning:**
   - Develop comprehensive land use plans that incorporate GIS data and modelling techniques.
   - Prioritize sustainable land allocation for agriculture, industry, urban development, and conservation.
   - Consider transboundary aspects, especially for shared resources like rivers and ecosystems.
2. **Water Resource Management:**
   - Update and digitalize municipal, regional and national environmental databases and facilitate data exchange through web-based geo-portals and GIS systems.
   - Establish a regional water management framework using GIS-based hydrological models to improve the understanding of local and regional hydrologic cycles and support decision-making
   - Develop plans for conjunctive use and integrated management of surface water and groundwater.
   - Monitor water availability, quality, and usage patterns at local and watershed scales.
   - Identify and implement technical and governance solutions for retention, storage and efficient utilization of stormwater (including snowmelt water in Northern Kazakhstan).
   - Promote efficient irrigation practices and equitable water distribution.

3. **Climate Change Adaptation:**

- Integrate climate data with GIS to assess vulnerability and plan adaptation strategies.
- Identify climate-resilient agricultural practices and land-use patterns.
- Collaborate with neighboring countries to address cross-border climate challenges.

4. **Biodiversity Conservation:**
   - Map critical habitats, migration corridors, and biodiversity hotspots using GIS.
   - Implement policies to protect endangered species and their ecosystems.
   - Encourage sustainable tourism while minimizing ecological impact.
5. **Soil Health and Agricultural Practices:**
   - Use GIS to assess soil quality, erosion risk, and land suitability for crops.
   - Encourage sustainable farming practices, crop rotation, and soil conservation.
   - Provide incentives for precision agriculture and organic farming.
6. **Disaster Risk Reduction:**
   - Create hazard maps (floods, landslides, earthquakes) using GIS.
   - Develop early warning systems and evacuation plans.
   - Collaborate regionally to address natural disasters collectively.
7. **Cross-Border Cooperation:**
   - Facilitate data sharing and joint modelling efforts among Central Asian countries.
   - Establish regional research centers and capacity-building programs.
   - Promote policy dialogues on resource management.

The successful implementation of these policies requires collaboration, stakeholder engagement, and continuous monitoring.

b) Project-related recommendations

TERESA and YESIL projects:

- Multi-scale modelling represents a valuable tool for water resources managers to evaluate the behavior of technical solutions and to run predictive scenarios for assessing their impact under variable climatic and demographic conditions.
- At a local scale, climate observation stations provide high-resolution data on air, water and soil parameters at low cost and low maintenance. They facilitate a good understanding and characterization of local processes and refinement and validation of complex hydrological models.
- At city-scale, sustainable urban drainage systems can help to significantly reduce the urban runoff in newly-constructed areas and increase the water infiltration and evaporation to partially compensate for the impact of urbanization on local water cycle, thus reducing the costs of conventional water drainage systems.
- At the watershed scale upstream of urban areas (Northern Kazakhstan), detailed monitoring campaigns coupled with isotopic analysis revealed high intra-annual variability of water resources with the snowmelt being the most dominant source of water supply and groundwater recharge.
- At the national scale, GIS-based multi-criteria decision analysis helps to identify regions with high potential for implementation of solutions for sustainable management of water resources such as, for example, intentionally using the aquifers to store surplus stormwater and make it available for urban supply or irrigation.

Geospatial Insight: The Role of Geo-Data in Central Asia's Water and Food Security Landscape:

- **Data Analysis and Modelling:**
  Data, in its raw state, possesses limited intrinsic value until subjected to analysis and modeling processes. Additionally, the optimization of data monitoring systems can be achieved through the utilization of refined datasets.
- **Value of Information:**
  While raw data may be obtained at a relatively lower cost, it is generated through an expensive monitoring system comprising scientific devices, measurement sensors, and observatories. The true value of raw data emerges from the information derived through analysis. Facilitating easy access to data for research and scientific purposes can contribute significantly to achieving this objective, concurrently aiding in the modernization of the system and generating revenue.
- **Transition to Corporate Approach:**
  There is a suggestion to shift from a traditional raw data selling approach to a corporate approach. This implies that data should be viewed as a valuable asset (information) that can attract funding through participation in large environmental projects, thereby creating opportunities for revenue generation.
- **Poor Global Water & Agricultural Datasets for CA:**
  Global datasets for Central Asia (CA) are notably scarce, with accessibility particularly limited following the collapse of the Soviet Union. Enhancing and improving the integration of local, state-owned public datasets can be achieved by leveraging existing global databases such as IGRAC, ISMN, GPCC and GRDC.
- **Role of Remote Sensing:**
  It is crucial to emphasize the substantial contribution of remote sensing in producing data that proves valuable for diverse end users, encompassing policymakers, farmers, and water associations. This highlights the significance of employing remote sensing data based online interactive tools to disseminate pertinent data, enabling informed decision-making and effective resource management. Illustrative instances include WUEMoCA, Droughtmap-ASB, and SDSS, among others.

SUFACHAIN project

- The GIS approaches are very helpful in data scarce or other limited conditions.
- However the existing datasets (& historical monitoring data) in Central Asia are not always accessible and/or digitalized, sometimes outdated/only partly performed (e.g. hydrological measurements, soil quality assessment, forest inventories etc.)
- Thus in many cases the satellite image analysis (Remote Sensing) is being used by many researchers as a substitute to the missing datasets (but not always as precise as field measurements).
- Introduction of Remote Sensing tools to digitize and improve existing soil/forest/water datasets might be an important step forward in ecological monitoring for Central Asian countries.
- Exploitation of UAVs (drones) for ecological monitoring and referencing purposes (validation for remote sensing) might be an additional asset, especially in the complex mountain terrains.
- Capacity building (both knowledge dissemination, necessary infrastructure and tools, data

management approaches) are required in order to introduce these technologies in practice
- on the field (e.g. local land use and forest administrations).
- UAV (drone) utilisation requires a set of regulations for security purposes (legislation in Central Asian countries needs to be finalized).

c) Recommendations from high-level representatives

- develop national standards for better communication between countries in the region;
- get feedback from scientists and stakeholders;
- raise public awareness;
- invite politicians to scientific events/ meetings;
- organize joint activities on the regional level;
- include international organizations;
- develop a database on the regional level;
- implement AI

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