→ EO4SD - EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

Climate Resilience | Earth Observation data for environmental management

ACRONYMS

EO	Earth Observation
IFI	International Finance Institution
EO4SD CR	Earth Observation for Sustainable Development Climate Resilience Cluster
ADB	Asian Development Bank
WB	World Bank
LVB WRIS	Lake Victoria Basin Water Resources Information System
IFAD	International Fund for Agricultural Development
RUSLE	Revised Universal Soil Loss Equation
PDF	Portable Document Format (PDF)
GIS	Geographic Information System
RRPCP	Regional Resilient Pastoral Communities Project
CASP	Community-based Agricultural Support Project
GCF	Green Climate Fund
USD	United States Dollar

INTRODUCTION

The world is currently on a path to be at least 2 degrees Celsius warmer than the pre-industrial average before the end of this century. A 2-degree planet will look very different to today. Around 70% of Earth's coastlines are likely to experience sea-level rise greater than 0.2 meters, resulting in increased coastal flooding, beach erosion, salinisation of water supplies and other impacts on humans and ecological systems.[1] Environmental management is essential to avoid the destruction or overuse of natural resources and to reduce pollution and prevent the continued degradation of nature, especially in the face of climate change. Considering the welfare of future generations, proper decisions regarding the environment are necessary.

Earth Observation (EO) data and services are valuable tools for assessing and understanding environmental relationships and exposure to present and future risks, making them a crucial tool for environmental management. They can be used to identify structural constraints, inform modelling activities, and investigate development opportunities. The Earth Observation for Sustainable Development Climate Resilience (EO4SD CR) Cluster has worked on several projects to integrate EO services into the decision making and design processes to help enhance environmental management. As more and more environmental managers become increasingly aware of the strengths and benefits of EO data, they are being used for an even greater range of problem-solving to help build climate resilience in many different contexts. Through an ongoing, multi-year engagement with several International Finance Institutions (IFIs), the EO4SD CR cluster has identified real-world use cases for EO data in several projects. A selection of these cases is presented here.

EARTH OBSERVATION FOR ENVIRONMENTAL MANAGEMENT: USE CASES

Burned area detection to assess wildfire risk

Where: Changde, China

IFI: Asian Development Bank (ADB)

The problem: Since the 1990s, Changde has seen considerable urbanisation and economic development, underpinned by significant investment in infrastructure as part of an economic program aimed at reviving inland China. Substantial population increases and demand for housing have fuelled the rapid construction of extensive high-density buildings, which have significantly increased the city's urban footprint. The risks associated with natural disasters have been exacerbated by unsuitable land use planning, including urban development in wildfire-prone areas. Current technical standards for urban planning do not adequately incorporate projected climate change or its associated risks. Hazard indicators from ThinkHazard[2] classify wildfire hazard throughout China as high, meaning that there is greater than 50% chance of encountering weather that could support a significant wildfire likely to result in loss of life and property in any given year. Based on this information, the impact of wildfire must be considered in all project phases, from project planning and design to emergency response planning.

How might EO data be deployed? EO data may be used to map areas of the Changde jurisdiction which may be exposed to wildfire. Wildfires are prone to occur in arid areas, with a higher risk of combustion during periods of drought and high temperatures anomalies. EO products may help underpin a more evidence-based approach to proactively manage wildfire risk to Changde by considering where wildfire management interventions could be most effective, enable better planning decisions, and avoid unnecessary development in acutely wildfire-prone areas. By combining historic burned areas with land cover map, drought information and temperature records, it may be possible to identify at-risk wildfire areas in the jurisdiction.

1 Buis, Alan. (2019) A Degree of Concern: Why Global Temperatures Matter https://climate.nasa.gov/news/2865/a-degree-of-concern-why-global-temperatures-matter/

2 ThinkHazard, GFDRR. https://thinkhazard.org/en/report/147295-china/WF

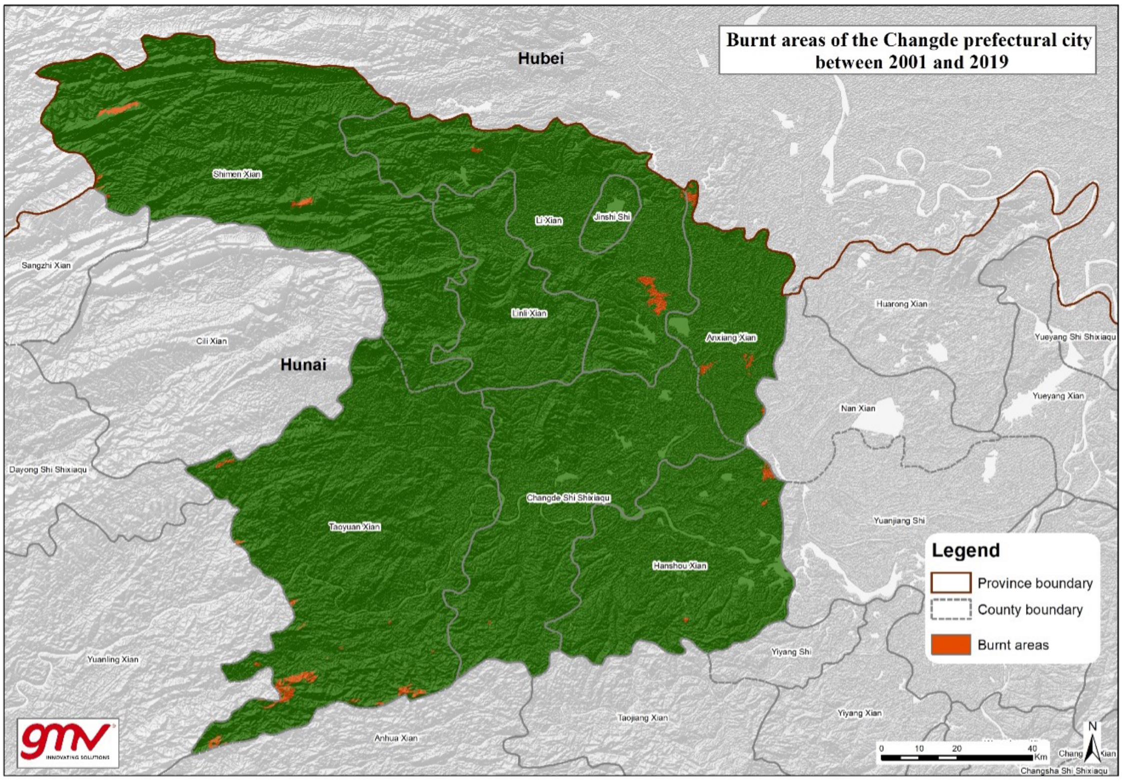

Image 1: Total hectares burned during 2001 and 2019 in Changde jurisdiction obtained from ESA's CCI Fire initiative. Source: GMV

Wetland monitoring and assessment for restoration and rehabilitation plans

Where: Lake Victoria and Lesotho

IFI: World Bank (WB) and International Fund for Agricultural Development (IFAD)

The problem: The Nyabugogo catchment is the country's most densely populated catchment in Rwanda, covering eight districts with a population of 1.4 million inhabitants. The Nyabugogo natural wetland in Kigali suffers from significant degradation of land, vegetation and water resources due to the increasing occupation by various industries, intrusive agriculture and housing areas. Rising temperatures and changing rainfall patterns resulting in more frequent droughts and higher intensity rains will cause additional threats to the wetlands, rivers and catchments that feed into Lake Victoria. Lake Victoria is one of the major lakes in Africa but is greatly affected by increasing loads of pollution from anthropogenic activities and greatly exacerbated by climate change. In partnership with the Lake Victoria Basin Commission, the World Bank's environment and natural resources management activities develop environmental management plans for the Lake Victoria Basin.

Lesotho is a land-locked country within South Africa and well-endowed with wetlands of varying types. Healthy wetland ecosystems have several functions including carbon cycling; flood protection, erosion reduction, and play a large role in water purification (particularly in urban and agricultural areas). Lesotho depends on its water resources to create revenue for the country. Lesotho's mountains are e.g. water suppliers to South Africa. IFAD executes a project to ensure that rural communities in Lesotho adopt transformational practices for regenerated landscapes and sustainable livelihoods.

How might EO data be deployed? EO data can help continuously monitor wetlands degradation (extent and health) on a national coverage, as well as monitoring and evaluating the impact of each type of rehabilitation intervention on the wetlands. Data measured can include, for example, lake water level and extent, water quality, water hyacinth invasion, land use/land cover changes and biodiversity trends among others. To understand how productive catchment/sub-catchments are in delivering water and how this productivity has changed over time is information of great interest for local authorities. All this information can then help inform decision makers about the wetlands status and trends, types of impacts that may affect populated areas and how much risk is being avoided by rehabilitating wetlands.

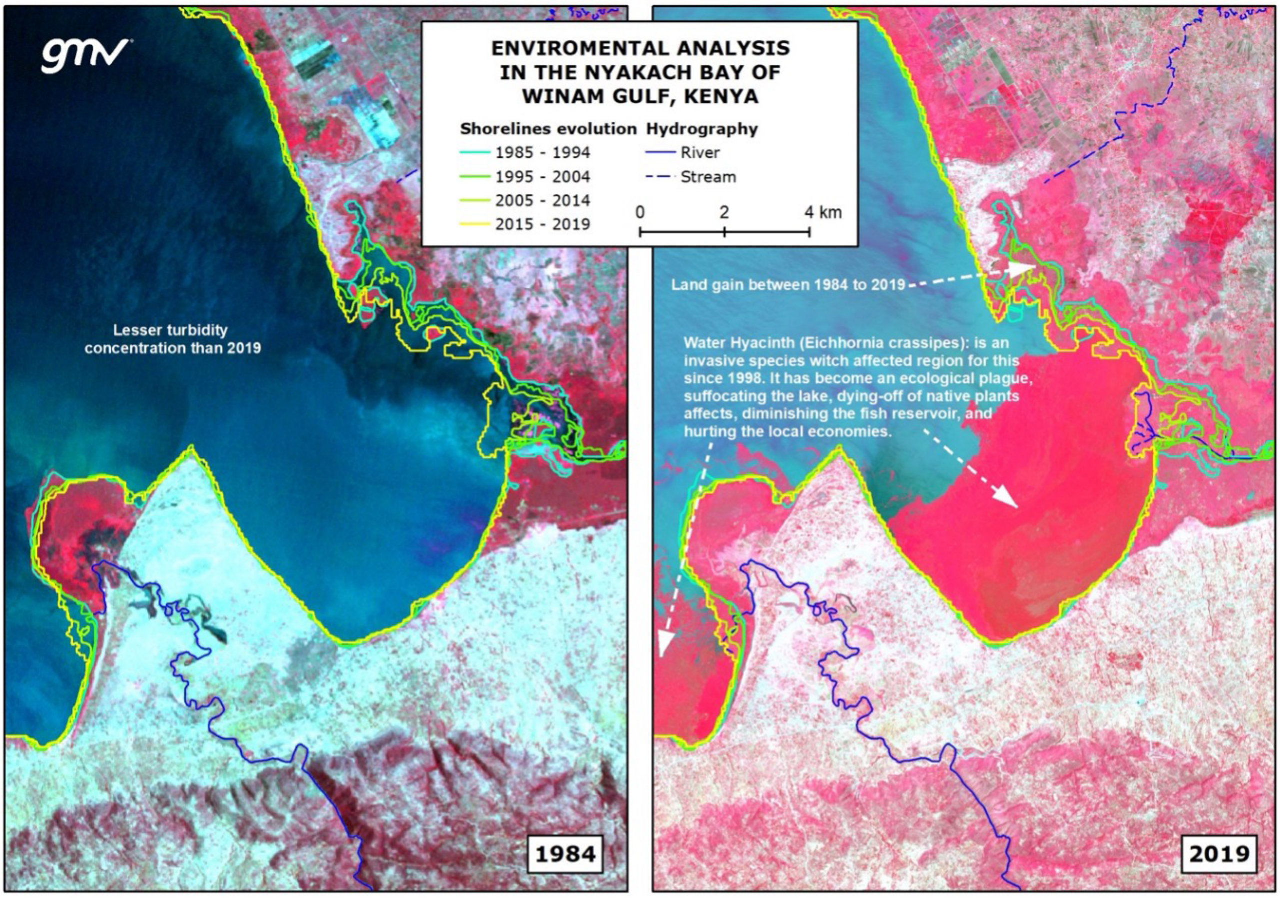

Image 2: Environmental changes in the mouth of the Nyando River (Lake Victoria) between 1984 and 2019. The false colour composition emphasises changes in vegetation. Plants-covered land and water is red. Plants growing quickly (more photosynthetic activity) are brighter red. Water bodies are dark blue, while turbid water appears in cyan shades. Source: GMV

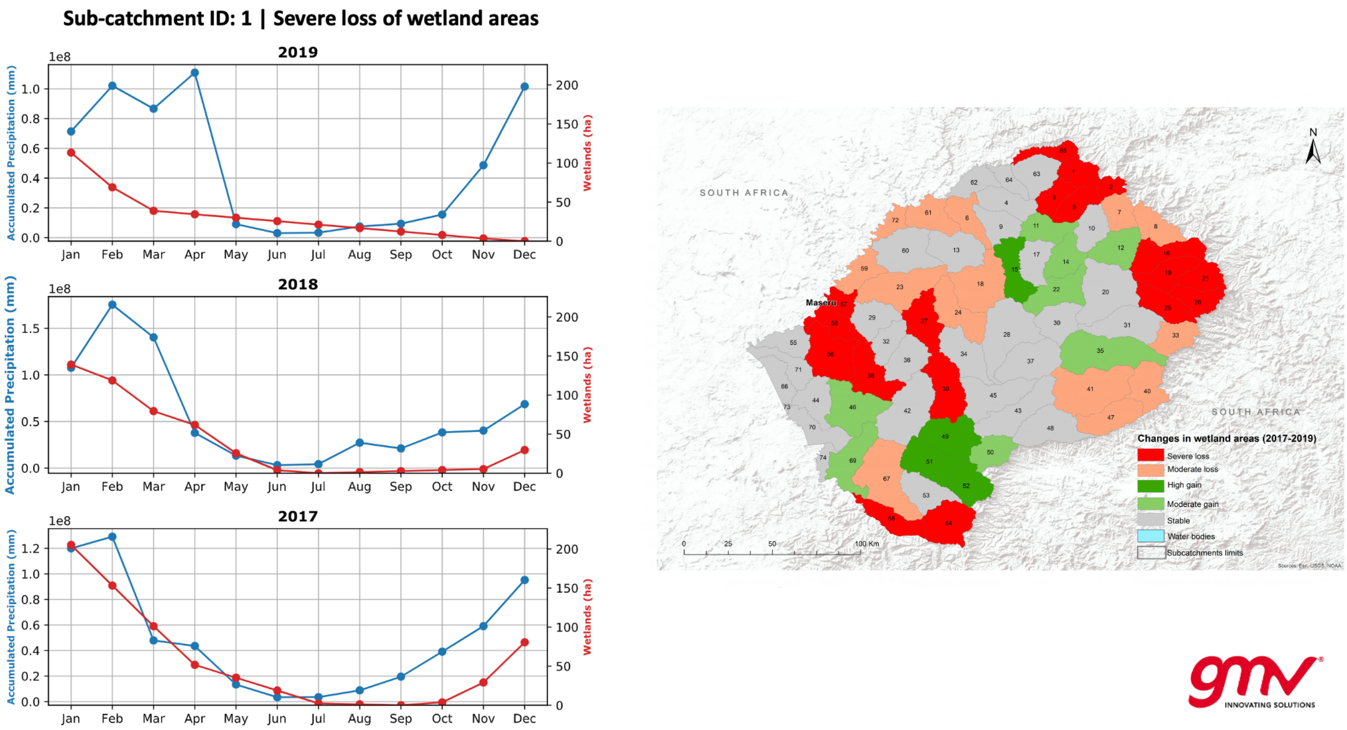

Image 3: Geospatial analysis of the wetland areas in Lesotho at sub-catchment level (right) and monthly evolution over the period 2017 to 2019 (left). Source: GMV

Monitoring land degradation to target landscape rehabilitation investment

Where: Lesotho, Kyrgyzstan and Tajikistan

IFI: International Fund for Agricultural Development

The problem: Among the world's regions suffering from land degradation, the most affected continent is Asia with 79% of the global rural population residing in degrading agricultural areas. Tajikistan and Kyrgyzstan in Central Asia are both severely affected by soil erosion. Soil erosion is to a large extent a result of poor land management practices chief of which is mismanagement of rangelands due to overgrazing. With just 7% of Tajikistan's land suitable for agriculture, soil erosion and land degradation represent a major threat to the soil and water resources the country needs to ensure sustainable agricultural production. In the Kyrgyz Republic, 40% of agricultural land is seriously degraded and over 85% of the total land area is eroded. As the climate continues to change, the seasonal redistribution of rainfall and rising temperatures will increasingly exert direct pressure on forest and grassland ecologies. The second most affected region by land degradation is Africa, with a share of 12% in the global rural population living in degrading agricultural areas. In South Africa Lesotho suffers amongst the most severe soil erosion in the world. Lesotho is regularly exposed to floods, droughts, but land degradation as a result of soil erosion has been identified as one of the greatest environmental challenges facing Lesotho. The analysis of the evolution of the soil erosion rate due to the climate variability is of great help in understanding patterns and trends in erosion-related risks.

How might EO data be deployed? In response to recognised challenges associated with land degradation and ecosystem health, EO-based products can provide evidence related to soil erosion that could be used to prioritise sites for landscape restoration investments. Soil loss rates due to water erosion can be derived from satellite (using EO-based rainfall, surface elevation, land cover and vegetation density as inputs for the Revised Universal Soil Loss Equation) to analyse different periods, trends and anomalies on a national scale. Data aggregation per catchment and sub-catchment areas, averages per land cover and identification of hot spots provide valuable data to prioritize restoration interventions.

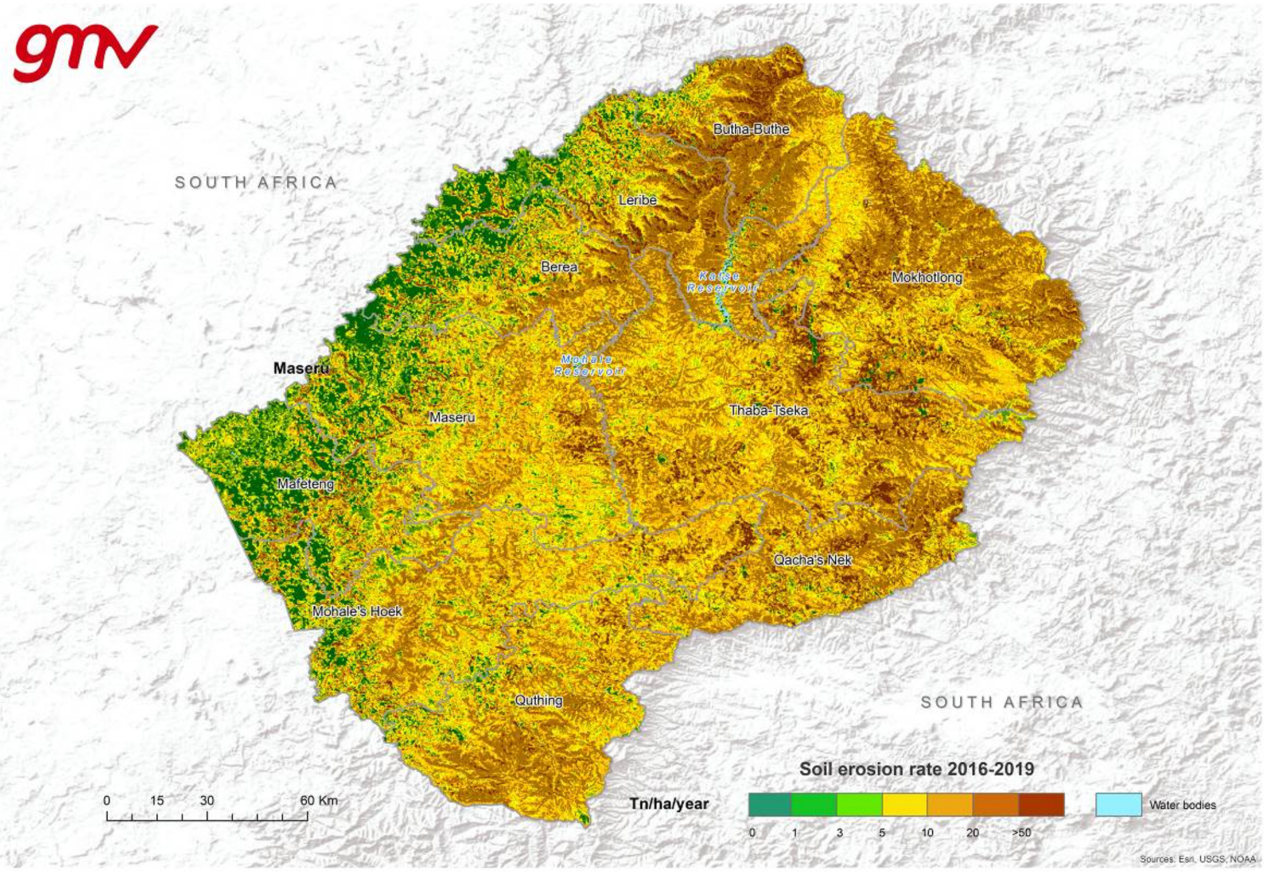

Image 4: Map of soil loss rate due to water erosion in Lesotho. Source: GMV

Building the case for climate resilience investment and climate finance

Where: Kyrgyzstan and Tajikistan

IFI: International Fund for Agricultural Development

The problem: Tajikistan is a landlocked country with a population of 9.1 million (2018), of which 73 percent live in rural areas. Agriculture makes up 18.7% of its GDP and while Tajikistan has seen progress in reducing poverty, the country remains in 129th place in the global ranking with one fifth of the population affected by food insecurity. Similarly, Kyrgyzstan hosts a population of 6.4 million (2018); 66% of which live in rural areas and depend predominantly on agriculture and livestock for their livelihood. Irrigation is critical for the development of Tajikistan's agricultural sector. In 2018, more than 67% of its arable land (563,000 ha) was irrigated. However, irrigated area is decreasing due to deteriorating irrigation and drainage infrastructure, salinisation, waterlogged soils and unreliable electricity to pump stations. Enhancing the resilience of smallholder producers to climate risks will be achieved by mainstreaming sustainable participatory natural resource management into all agricultural production systems and diversifying income sources.

Meanwhile, in Kyrgyzstan the livestock-rangeland system is trapped in a vicious cycle, whereby several decades of overgrazing have contributed to extensive land degradation that has in turn reduced animal productivity. Natural disasters currently trigger annual average damages of USD 30-35 million, or some 1-1.5% Gross Domestic Product. Climate change will continue to exacerbate land degradation across Kyrgyzstan, as well as compound existing natural hazards such as flooding, mudslides, and drought. In this context, the risk of food and wider social insecurity could increase.

How might EO data be deployed? EO data can be used to help build the rationale for climate resilience investments and improve access to climate finance. This can be achieved by presenting EO-based climate indicators and natural hazard information, such as related to landslides, floods, droughts, vegetation deterioration, and land degradation. EO data can highlight patterns and trends related to a range of climate variables across a country over time, as well as be mobilised in the production of up-to-date multi-hazard maps that highlight pasturelands exposed to the most severe overall levels of climate-related hazard. This information can help to both identify key degraded areas exposed increasing hazard, and prioritise areas with the greatest potential to benefit - ecologically, economically, and socially - from climate resilience investments. By being presented as interpreted maps and plots in standard documents, this solution enables EO-derived information to be consulted with minimal effort, placing in it in the hands of project sponsors for easy integration into applications for climate finance.

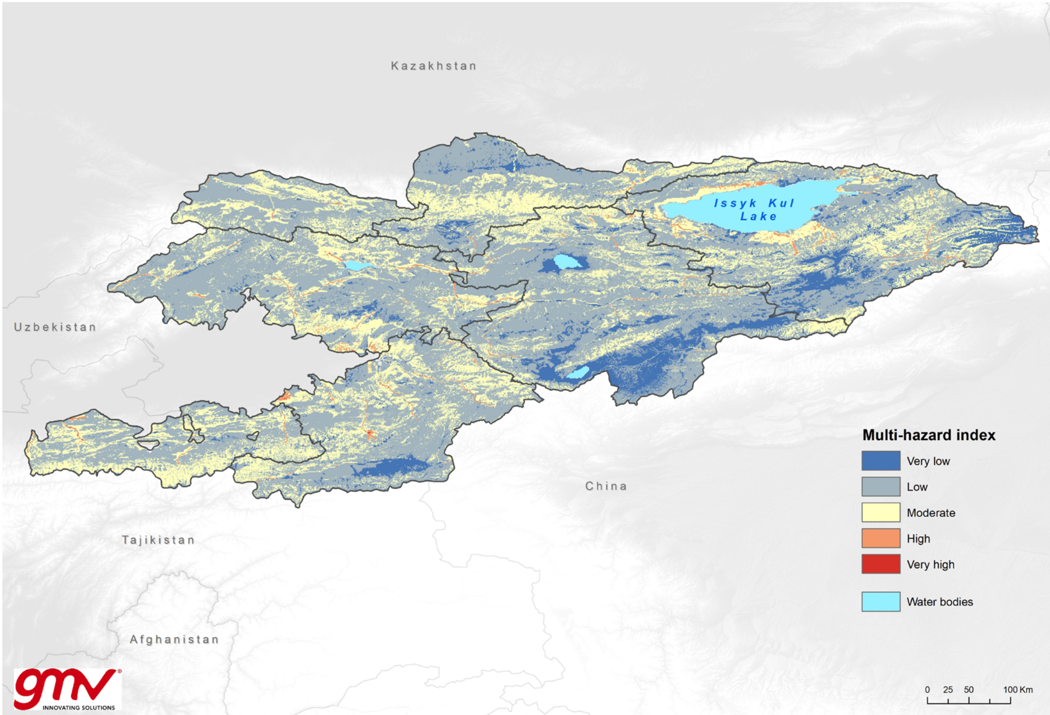

Image 5: Multi-hazard risk map combining landslide susceptibility, vegetation heat and water stress, flooding and soil erosion hazards in Kyrgyzstan. Source: GMV

Assessing impact of pasturelands degradation on soil organic carbon stock

Where:Kyrgyzstan and Tajikistan

IFI: International Fund for Agricultural Development

The problem: Rangelands ecosystems cover a large portion of Earths' surface and contain substantial amounts of soil organic carbon. In Central Asia (e.g., Kyrgyzstan, Tajikistan), the largest contiguous area of grazed land in the world, serve as an important source of livelihood for pastoral and agro-pastoral communities in the region. Soil carbon stocks are sensitive to management and land use changes: grazing, species composition, and mineral nutrient availability can lead to losses or gains of soil carbon. Unsustainable management of rangelands has led to their degradation hugely by downgrading their potential agro-ecological, environmental and socio-economical roles. Land degradation is indeed recognized as a main environmental problem that adversely depletes soil organic carbon stocks, which in turn directly affects soils, their fertility, productivity and overall quality. There has been growing interest in how changes in management might shift the net balance of these flows, stemming losses from degrading grasslands or managing systems to increase soil carbon stocks (i.e., carbon sequestration).

The causes of rangeland degradation within the Central Asian region are numerous, complex and inter-related. IFAD is exploring measures that land managers can adopt to enhance the sustainable management of these vast degraded rangelands. For instance by incentivizing the collective action of small-scale pastoralists who group together to facilitate access to remote pastures can reduce the degree of overgrazing within community pastures, such as those near the settlements.

How might EO data be deployed? EO can provide quantitative information on pasturelands degradation by assessing the health of palatable species in rangelands over the last decades. This information can be used to evaluate the impact of rangelands on the depletion of soil organic carbon stocks allowing to predict the impacts of land management on the carbon losses to the atmosphere and associated global warming.

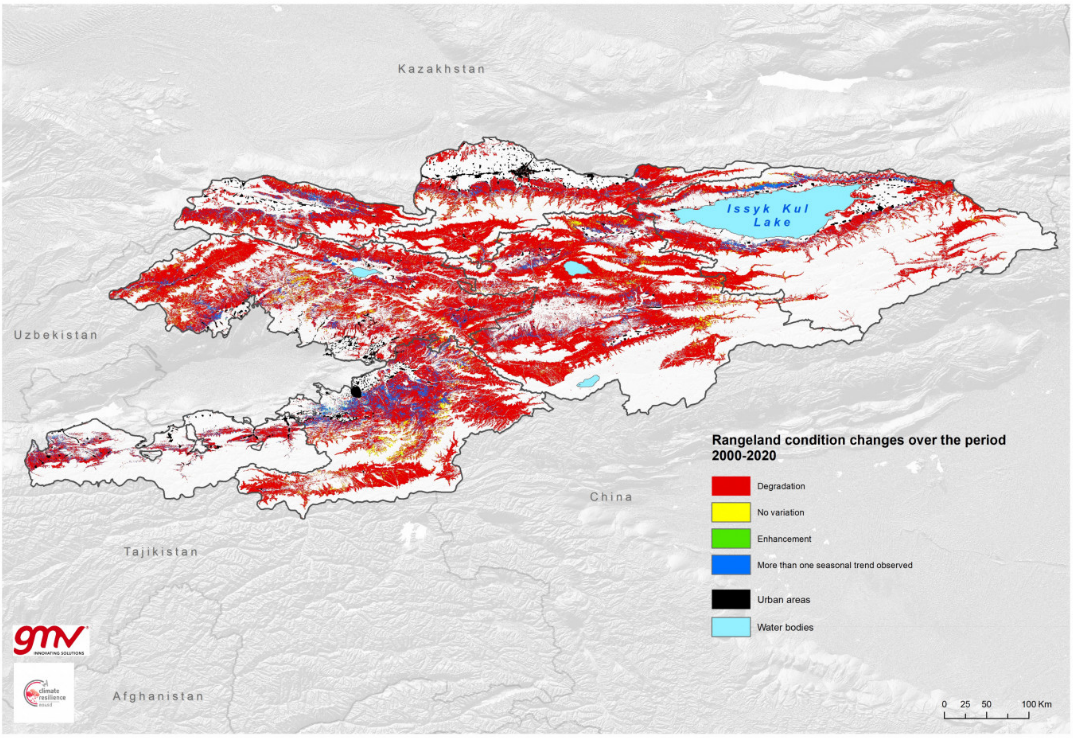

Image 6: Changes in seasonal pastures condition in Kyrgyzstan over the period 2000-2020 developed using a composite of Landsat-based indexes, AI-improved LULC map, IPCC pastures degradation thresholds, and local information on grazing seasonal periods, grazing altitudes, grazing on slopes, pastures distance to villages in winter provided by Camp Alatoo Public Foundation. Source: GMV

Partners of the Climate Resilience Cluster

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