VALUATION OF REFORESTATION

IN TERMS OF CLIMATE-INDUCED DISASTER RISK REDUCTION IN TAJIKISTAN

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VALUATION OF REFORESTATION IN TERMS OF CLIMATE-INDUCED DISASTER RISK REDUCTION: A TECHNICAL STUDY FROM THE REPUBLIC OF TAJIKISTAN

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ACRONYMS

CEP	Committee on Environmental Protection
CESCD	The Committee of Emergency Situations and Civil Defense of Tajikistan
DRS	Districts of Republican Subordination
EECCA	Eastern Europe, Caucasus and Central Asia
ES	Ecosystems Services
ESV	Ecosystems Services Value
GLOFs	Glacial Lake Outburst Floods
GDP	Gross domestic product
GBAO	Gorno-Badakhshan Autonomous Region
GEF	The Global Environment Facility
LULC	Land Use/Land Cover
MEDT	Ministry of Economic Development and Trade
NBT	National Bank of Tajikistan
NHS	National Hydrometeorological Service
NCBB	National Center on biodiversity and Biosafety of The Republic of Tajikistan
NTFP	Non-Timber Forest Products
OECD	Organization for Economic Cooperation and Development
PES	Payments for Ecosystems Mechanisms
PPCR	Pilot Program for Climate Resilience
RT	The Republic of Tajikistan
TRRM	Tropical Rainfall Measuring Mission
USSR	Union of Soviet Socialist Republics
UN	United Nations
UNDP	United Nations Development Program
USLE	Universal Soil Loss Equation
USA	United States of America
USAID	United States Agency for International Development Asian
USPC	UNDP Seoul Policy Center

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EXECUTIVE SUMMARY

Humankind faces one of the biggest challenges in history – climate change. Drastic consequences can compromise worldwide, though some countries are more vulnerable due to social, economic, and geographic characteristics. Tajikistan has 93% of its surface covered by mountains, 73% of the population rural-based, and remains the poorest country among the former Soviet Republics. This scenario suggests significant susceptibility to natural disasters and adaptation, and evidence the urgency of Disaster Risk Reduction (DRR) approaches. Considering that land degradation contributes to the occurrence of disasters, the country's unsustainable agricultural practices and deforestation increases significantly a region's sensitivity to climate change and reduces its adaptative capacity.

In that context, Nature-Based Solutions (NBS) are essential to deal with the impacts of climate change in the country. The present report showcases a first research to give indications on the value of NBS, more precisely, natural land cover (forests, shrubs and grasslands) on their role of mitigating degradation factors as erosion and increasing soil stability and water infiltration. The work consisted in developing a framework for an holistic analysis during Q4 2021 using desk review, experts views, remote sensing, data systematization and analysis.

Remote sensing of recent high resolution images from Sentinel-2 were used with the aim of creating a risk prioritary map were the high risk areas are indicated for 1) landslides and soil erosion, 2) floods and mudfloods, and 3) fire and droughts. Estimates were done to assess the necessary surface to cover buffer areas in riversides and main watercouses in the areas below 3.200m of altitude (where forests and shrubs naturally occur).

Recent studies from Khudaybergenova et al., indicates a minimum total economic cost of land degradation in Tajikistan in 2019 between USD $538.674.221 and USD $772.465.936 which are equivalent to 7.59 % and 10.88 % of GDP, respectively. While these estimates are conservative, the actual cost of land degradation in Tajikistan could be much higher. The major economic cost is related to crop and crop residue loss in crop lands including those abandoned or fallowed to regenerate (7.45% of GDP) followed by biomass loss in natural pastures (1.73% of GDP).

Considering a range of costs for reforestation from $200 to $3.000 per hectare, starting with low cost techniques as assisted natural regeneration and enrichment of forests patches, going up to complex plantations in steep slope and in semi-arid regions. Applied to the estimates of 90.385 hectares of priority areas to be restored for water and soil conservation, a cost range of $18 Million or 200 TJS – $271 Million or 3 billion TJS would be necessary as an effort to reduce disasters, and therefore avoid remediation costs estimated between $ 20 or 223 Million TJS to $ 100 milion or 1.1 bilion TJS of tangible dammage annually. That without accounting for permanent losses of intangible aspects and a continous environmental degradation that is priceless.

In addition, such restoration and management actions would also contribute to climate change mitigation efforts, sequestering a total gross carbon sequestration rate of 1.2 million tonnes of CO_2e per year could be achieved. In total, accounting from losses from degradation factors, and disasters damages, close to 20% of the actual GDP could be compromised. To that, one could add the reduction in agricultural production due to soil fertility losses, salinization and water scarcity, afecting 18-22% of the country's GDP, and 1.5 million people employment – most of Tajikistan's population.

MAIN REPORT

1. Background and rational

Climate change is by far, one of the biggest challenges for humankind. Demography together with historical unsustainable productive usages of natural resources increases the risks of natural disasters and human losses. In this context, Tajikistan experiences great challenges due to its geographic and social characteristics. The country has 93% of its surface covered by mountains and half of it is in areas of more than 3.000m[1]. Moreover, national statistics indicate that 73% of the population is rural-based and about 65% of its earning income is from a source derived from agricultural production, forestry, or fishing[2]. However, United Nations estimations from 2012, reported that close to 90% of the 3.8 million hectares of pastureland were suffering from medium to strong erosion. Currently, the increase in livestock number and weak governance of mountain pasture use is intensifying erosion problems[3]. That scenario entails specific challenges not only in terms of planning and management, but also in terms of climate predictions and the future economy resilience.

Although forestry is not a determinative sector, forests, shrubs, and grasslands represent significative ecological and environmental importance considering the mountainous topography. In addition, sustainable use and conservation of forestry land have the potential of accelerating and sustaining pro-poor economic growth in Tajikistan. Thus, a better understanding of forestry and sustainable forestry management approaches are crucial in the context of climate change, not to mention the importance of demonstrating its economic benefits relative to current practices on behalf of future evidence-based policy making.

Degradation of mountain pastures, together with deforestation and unsustainable agricultural land use management practices, exacerbates the vulnerability of rural communities to natural hazards. The country has up to 500 different natural disasters per year, resulting in losses of between $ 20 million and $ 100 million annually[4]. Landslides, flooding, and mudflows threaten lives and property, and present a real and ongoing risk.

That context establishes the urgency to discuss Disaster Risk Reduction (DRR) measures, giving special attention to Nature-Based Solutions (NBS) as grasslands and forests conservation and restoration. In that sense, estimating the economic value of those measures compared to remediate has the potential to be cost-effective in terms of preventive measures to avoid increased vulnerability to climate hazards.

[1] Forest Development and best practices of forest management in Tajikistan, Tajikles Services LLC
[2] Philipona A., et al., 2019, Disaster Risk Reduction in Tajikistan: Broader implications of an effective national law on pastures
[3] Ibid 1
4 MUSTAEVA, Nailya; WYES, Heinrich; MOHR, Benjamin; KAYUMOV, Abdulkhamid. Tajikistan: Country situation assessment. Pathways To Resilience In Semi-Arid Economies (Prise), 2015

The research is intended to document and build the ground to an increase in policy making awareness with regards to the correlations of land cover and increased resilience to extreme climate change events. It shall set an approach that can be generally applied to provide information on the costs of climate-induced disasters, benefits of sustainable forest management practices, and trade-offs involved in policy choices that could guide decision-making, with the aim of supporting the mainstreaming of disaster risk reduction linkages into the national planning and budgeting processes, in the long run.

2. Objective

This research study was commissioned by the UNDP Tajikistan with the aim to develop a comprehensive assessment with recommendations and quantification of the benefits of maintaining land cover on climate-induced Disaster Risk Reduction (DRR). Allowing to showcase potential measures, policies and investments that would reduce the country's vulnerability to climate change, increasing its resilience capacity.

The present report summarizes the state of the art of key indicators relevant to the country's resilience and adaptative capacity with regards to DRR and land cover. It is a humble start to dicuss the value of land cover in reducing disasters and climate-risks, as well as the limitations of such approach.

Under the limitation of available data and time, key aspects of three main groups of disasters were considered, mainly landslides and erosion, then floods and mudflows, and fire and droughts. Although forest and land cover can have deliver several ecosystems services and positive externalities like biodiversity maintenance and scenic value – to mention a few. Only soil stability and reduced erosion, as well as water infiltration, carbon sequestration and storage, were considered as the main services of land cover. This research includes a combination of desk reviews, primary and secondary data collection, remote sensing and economic valuations methods.

Finally, the study has a main results a first exercise of valuation of reforestation in terms of climate-induced disaster risk reduction providing indicative physical values, monetary values and a simple cost-benefit analysis for the expected positive outputs of increasing land cover as a form to reduce the risks from disasters.

3. Methodology

The present study was undertaken over 3 months with the support from independent experts, UNDP staff and international experts. The main steps are described below:

3.1. Step I: Desk review on existing methodological frameworks, databases, governance and institutions mapping

A desk review was conducted on the main aspects related to the topic of environmental, social and economic, and legal and institutional aspects with regards to climate change, DRR and natural hazards. The desk review supported the identification of key organizations, databases and institutions that were part of the research. This step allowed to develop an appropriate methodological framework for the Tajik context, considering the social environmental specificities, and available information. It is important to stress out that one research was particulary important in the development of the global framework, that is the research conducted by Korea (Valuation of Reforestation in Terms of Disaster Risk Reduction: A Technical Study from the Republic of Korea, UNDP February 2017, Sustainable Development Goals, Policy Brief Series).

3.2. Step II: Development of a methodological framework adapted to Tajikistan

Based on the desk analysis and institutional mapping, a methodological framework was created to structure the analysis. The methodological framework included three main categories of important variables: 1) Environmental, 2) Legal and Institutional, and 3) Social.

For each category, a set of indicators (a total of 26) were established, they are:

1) Environmental
- Land cover & biomes
- Climate
- Declivity and geography
- Geology and soil erosion
- Rainfall
- Disasters (frequency and intensity) - primarily floods, mudflows, landslides and droughts
- Water availability and river basins
- Carbon sequestration and storage potential
- Fires incidence
- Forests and restoration
- Forest degradation and deforestation drivers

2) Legal and Institutional

- Land tenure & legal frameworks for terracing and other actions that can prevent extreme events in the forestry sector
- Legal frameworks related to land cover management and usage (ex. 2013 national law on pastures, etc)
- Tax mechanisms
- Banking and investment system capacity in the country
- National insurance schemes if existing

3) Social and economic

- Energy sources and usages (special attention to fuelwood)
- Extreme events risks levels and coping mechanisms
- Population size, identities/ethnical, structure, Purchase Power Parity (PPP) levels
- Social security with regards to extreme events and insurances
- Main sources of country's income
- Transport conditions and investments
- Potable water and sanitation conditions
- Remediation costs of disasters
- Opportunity costs and economic analysis of damages

For each category a set of questions was developed in order to investigate at maximum Tajikistan's state of the art on the topics and available data. Such framework is displayed in Annex I.

3.3. Step III: Data Collection

With these at hand, UNDP Tajikistan mobilized national experts to have their views and support in the data collection close to governments, local relevant organizations and institutions. Below a list of the agencies and organizations that took part in the data collection:

Table 1: List of consulted agencies and organizations

	Agency or organization	Department, position	Person
1.	Committee on Environmental Protection under the Government of the Republic of Tajikistan	Head of the National Center for Biodiversity and Biosafety	Yatimov O.
2.	Committee on Environmental Protection under the Government of the Republic of Tajikistan	Head of Division National Center for Biodiversity and Biosafety	Sukhrob Irgashev
3.	Committee on Environmental Protection under the Government of the Republic of Tajikistan	Head of the Department of State Control over the Use and Protection of Flora and Wildlife	Shamsiddinov H.
4.	Committee on Environmental Protection under the Government of the Republic of Tajikistan	Head of the Department for State Control of Land Use and Protection and Waste Management	Nematzoda N.
5.	Committee on Environmental Protection under the Government of the Republic of Tajikistan	Director of the Agency for Hydrometeorology, Permanent Representative of Tajikistan to WMO, National Coordinator of the UN Convention on Climate Change	Қurbonzoda Abdullo
6.	Committee on Environmental Protection under the Government of the Republic of Tajikistan	Head Climate change and ozone center, Head of NDA Secretariat to the GCF	Nasim Rajabov
7.	Forestry Agency under the Government of the Republic of Tajikistan	Head of the Sector of International Relations and Information	Nazarov Azizbek
8.	Forestry Agency under the Government of the Republic of Tajikistan	Deputy Director of the Forestry Agency	Nabizoda Naim
9.	Forestry Agency under the Government of the Republic of Tajikistan	Head of forestry department	Madibron Saidzoda
10.	Committee for Emergency Situations and Civil Defense	Head of the Main Directorate for the	Kamolov Jamshed Jamolovich

	under the Government of the Republic of Tajikistan	Protection of Population and Territory	
11.	Committee for Emergency Situations and Civil Defense under the Government of the Republic of Tajikistan	Head of the Department of Radiation, Chemical and Biological Protection of the Main Directorate for the Protection of the Population and Territories	Tojiddin Mahmadov
12.	State Committee for Land Management and Geodesy of the Republic of Tajikistan	Specialist of the State Land Cadastre Department	Radjabov Ibrohim
13.	Ministry of Agriculture of the Republic of Tajikistan	Chairman of the State Institution "Pasture and Reclamation Trust"	Nazarov Safarali
14.	Ministry of Agriculture of the Republic of Tajikistan	Deputy Chairman of the State Institution "Pasture and land reclamation trust"	Kurbonov Abdurakhmon
15.	Ministry of Energy and Water Resources of the Republic of Tajikistan	Head of Department	Abdurazokzoda Daler
16.	Agency for Land Reclamation and Irrigation under the Government of the Republic of Tajikistan	Head of Investment Department	Kurbonov Firuz
17.	Agency for Land Reclamation and Irrigation under the Government of the Republic of Tajikistan	Head of Basin Administration	Nazifov Shafoat
18.	Main Department of Geology under the Government of the Republic of Tajikistan	Specialist South Hydrological Expedition of the Main Directorate of Geology	A. Kuvvatov
19.	Forestry Agency under the Government of the Republic of Tajikistan	Head of the department of Breeding and Forest Species of the State Institution of Scientific Research	Ustyan Ivan Petrovich

In addition, for the remote sensing, several datasets were used in order to build the geospatialization of the areas with higher risks of disasters and identify physical values for land cover. Those aspects were limited to a desk exercise given the time restriction for the research. That said, field validation is recommended to improve the conclusions of the present research, notably through forestry inventories to identify precisely the land extension per typology and their degradation level today.

Table 2: List of datasets used in the study

#	Data type	Data	Time	Dataset	Spatial Resolution	Spatial scale	Source
1	Topography	Hypsometry, Digital Elevation Model (DEM)	2000	SRTM (*Shuttle Radar Topography Mission)*	30 meters	1:150.000	Radar SRTM (1 Arc-Second), 32 GeoTIFFs files, USGS Earth Explorer site
2	Dominant soil	Soil types	1978	Soil map of the world	1 kilometer	1:5.000.000	FAO - UNESCO, Volume VIII, North and Central Asia
3	Dominant soil	Soil types	2003	Digital soil map of the world	1 kilometer	1:5.000.000	Version 3.6, FAO
4	Rainfall	Precipitation	2019	TRMM (Tropical Rainfall Measuring Mission)	25 kilometers	1:125.000.000	Radar TRMM, NASA, Giovanni site
5	Land cover	Land use	2020	A ten class global land use/land cover (LULC) map for the year 2020 at 10 meter resolution	10 meters	1:50.000	ESRI, Sentinel-2
6	Main River and Water Bodies	Water resources	1992	Digital Map of The World	200 meters	1 : 1.000.000	National Tibetan Plateau Data Center

3.4. Step IV: Data analysis – spacial priorization and economic results & analysis

The previous step allowed to understand the available data and challenges of correlating climate change and disaster risk reduction in the Tajikitan's context. A clustered approach was proposed in order to define the prioritary zones and areas that are more exposed to hazards and therefore losses, and that could benefit from a more targeted action over land use and reforestation.

An important part of the analysis was to define the physical values for the trigger factors of disasters. A GIS based multicriteria decision making for landslide hazard zonation method was applied using the methodological reference from Othman A. N, Naim W. M. and Noriani S., 2011[1].

Key maps were done using GIS and remote sensing, to illustrate the regions and different risks levels and how forest cover are close to those areas, and can contribute to increase the social and environmental landscapes resilience. Including a clear indication of the gaps of information and proxies that were applied to allow for a first estimate of physical values and cost related to climate induced disasters, damage costs and how reforestation would contribute to a reduction of such remediation costs and generally speaking, social losses.

Remote sensing

The maps were generated using secondary data from different datasets (NASA, ESRI and FAO). It was processed at UTM projection 42N Zone for calculating areas, and later reprojected to Geographic WGS84 for the final layout maps. The details of each map type and its main information are described below:

Hypsometry

The hypsometry and slope maps were produced with the radar SRTM 1 Arc-Second mosaic from 32 GeoTIFFs files, which were downloaded at USGS Earth Explorer site. It was used the SRTM 1 Arc-Second (Shuttle Radar Topography Mission). The data is available with 30 meters of spatial resolution and each pixel has the height value. It allows the processing at GIS software to calculate the slope in degrees and percentage.

Precipitation

The precipitation map was generated from the NASA TRRM (Tropical Rainfall Measuring Mission) precipitation rate in millimeters of 2019, downloaded as a *raster* file at Giovanni site. Them at GIS ambient it was displayed on cubic convolution for continuous data, and resampled to 30 meters cell size, also to use it on landslide map.

[1] GIS Based Multi-Criteria Decision Making for Landslide Hazard Zonation, Othman A. N., Wan Mohd Naim, Norini S. , 2011. Asia Pacific International Conference on Environment-Behaviour Studies, Salamis Bay Conti Resort Hotel, Famagusta, North Cyprus, 7-9 December 2011

Land Use/Cover

The land cover map data was downloaded from ESRI website as a *raster* file with 10 meters of spatial resolution, released on 2020 from processed Sentinel-2 datas and named as "a ten class global land use/land cover (LULC) map for the year 2020 at 10 meter resolution". This data is inedited and it was built from a deep learning classification method, using a new machine learning workflow teaming by ESRI in partner with Impact Observatory and Microsoft. It was the newest dataset and with better spacial resolution that could be found for download.

Classes definitions[1]

1. Water

Areas where water was predominantly present throughout the year; may not cover areas with sporadic or ephemeral water; contains little to no sparse vegetation, no rock outcrop nor built up features like docks; examples: rivers, ponds, lakes, oceans, flooded salt plains.

2. Trees/Forests

Any significant clustering of tall (~15 m or higher) dense vegetation, typically with a closed or dense canopy; examples: wooded vegetation, clusters of dense tall vegetation within savannas, plantations, swamp or mangroves (dense/tall vegetation with ephemeral water or canopy too thick to detect water underneath). It also includes perennials and plantations.

3. Grasslands

Open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting (i.e., not a plotted field); examples: natural meadows and fields with sparse to no tree cover, open savanna with few to no trees, parks/golf courses/lawns, pastures.

4. Flooded vegetation

Areas of any type of vegetation with obvious intermixing of water throughout a majority of the year; seasonally flooded area that is a mix of grass/shrub/trees/bare ground; examples: flooded mangroves, emergent vegetation, rice paddies and other heavily irrigated and inundated agriculture.

5. Crops

Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land.

6. Scrub/shrub

Mix of small clusters of plants or single plants dispersed on a landscape that shows exposed soil or rock; scrub-filled clearings within dense forests that are clearly not taller than trees; examples: moderate to sparse cover of bushes, shrubs and tufts of grass, savannas with very sparse grasses, trees or other plants.

7. Built Area

Human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings and residential housing; examples: houses, dense villages / towns / cities, paved roads, asphalt.

[1] Karra, Kontgis, et al. "Global land use/land cover with Sentinel-2 and deep learning." IGARSS 2021-2021 IEEE International Geoscience and Remote Sensing Symposium. IEEE, 2021

8. Bare ground

Areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation; examples: exposed rock or soil, desert and sand dunes, dry salt flats/pans, dried lake beds, mines.

9. Snow/Ice

Large homogenous areas of permanent snow or ice, typically only in mountain areas or highest latitudes; examples: glaciers, permanent snowpack, snow fields.

10. Clouds

No land cover information due to persistent cloud cover.

Dominant Soils

The Soils maps was generated by the *shapefile* data from FAO 1974, as the Digital Map of The World 2003, using the Dominant Soil class to generate the soils map and the landslide map. The data was converted to *raster* file and resampled to 30 meters resolution. This data contains the main pedological classes that occurs at Tajikistan.

3.5. Step V: Final report and roadmap

Finally, on the basis of the available information and analysis results, the present report was consolidated presenting the main conclusions and limitations of this initial exercice. The first results were presented in a meeting and built the ground for a policy brief. The later shall give insights to UNDP and policy-makers in terms of the continuity of such a research and implementation of monitoring process, and land cover restoration processes.

4. Timeline and Study milestones

The present report is the result of a set of activities and timelines described below:

		2021			2022
Activities	Responsible entity	Oct	Nov	Dec	Jan
1. Methodological framework for assessing the impact of climate-induced disasters in Tajikistan developed and accepted by UNDP [DELIVERABLE 1: Methodological framework] – Annex I	Ubá Institute	29th Oct			
2. Delegation of data collection and referencing to local consultants	UNDP				
3. Desk review of available data	Ubá Institute				
4. Data reception and data analysis	Ubá Institute				
5. Final report on valuation of reforestation in terms of climate-induced disaster risk reduction in Tajikistan developed, discussed with USPC, presented to stakeholder and accepted by UNDP. [DELIVERABLE 2: FINAL REPORT]	Ubá Institute				
6. At least 1 Policy Brief for Government decision-makers based on the findings of the study, on future activities to develop the evidence base on the economics of sustainable forest management in Tajikistan. [DELIVERABLE 4: POLICY BRIEF (4 PAGES)]	Ubá Institute				

5. State of the art – main aspects of disasters and climate change

Tajikistan is a land-locked country located in Central Asia region and its boundaries stands between Afghanistan, Uzbekistan, Kyrgyzstan, and China. The country occupies an area of approximately 143.000 km^2 and has a population of 9.537.642 people[1] distributed in four administrative provinces: Khatlon Region, Sugd Region, Districts of Republican Subordination (DRS), Gorno-Badakhshan Autonomous Region (GBAO).

Because of its geographical location, physical features and specific climate, Tajikistan is prone to frequent natural disasters, including earthquakes, floods, mudflows, landslides, avalanches, droughts, and epidemics, and ranks first among the countries of Europe and Central Asia in terms of vulnerability to climate change due to its low ability to adapt[2].

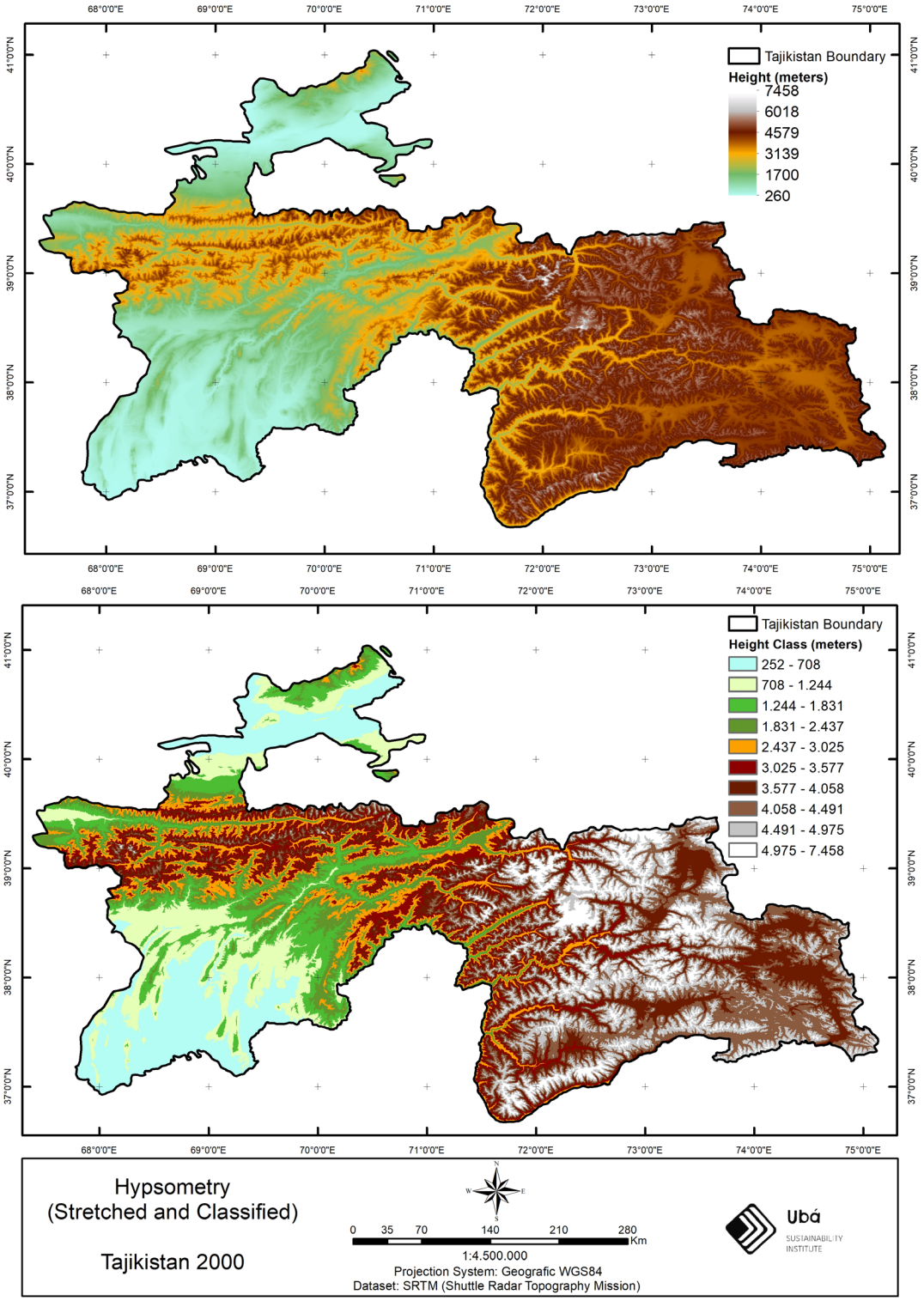
5.1. KEY FEATURES

5.1.1. Topography

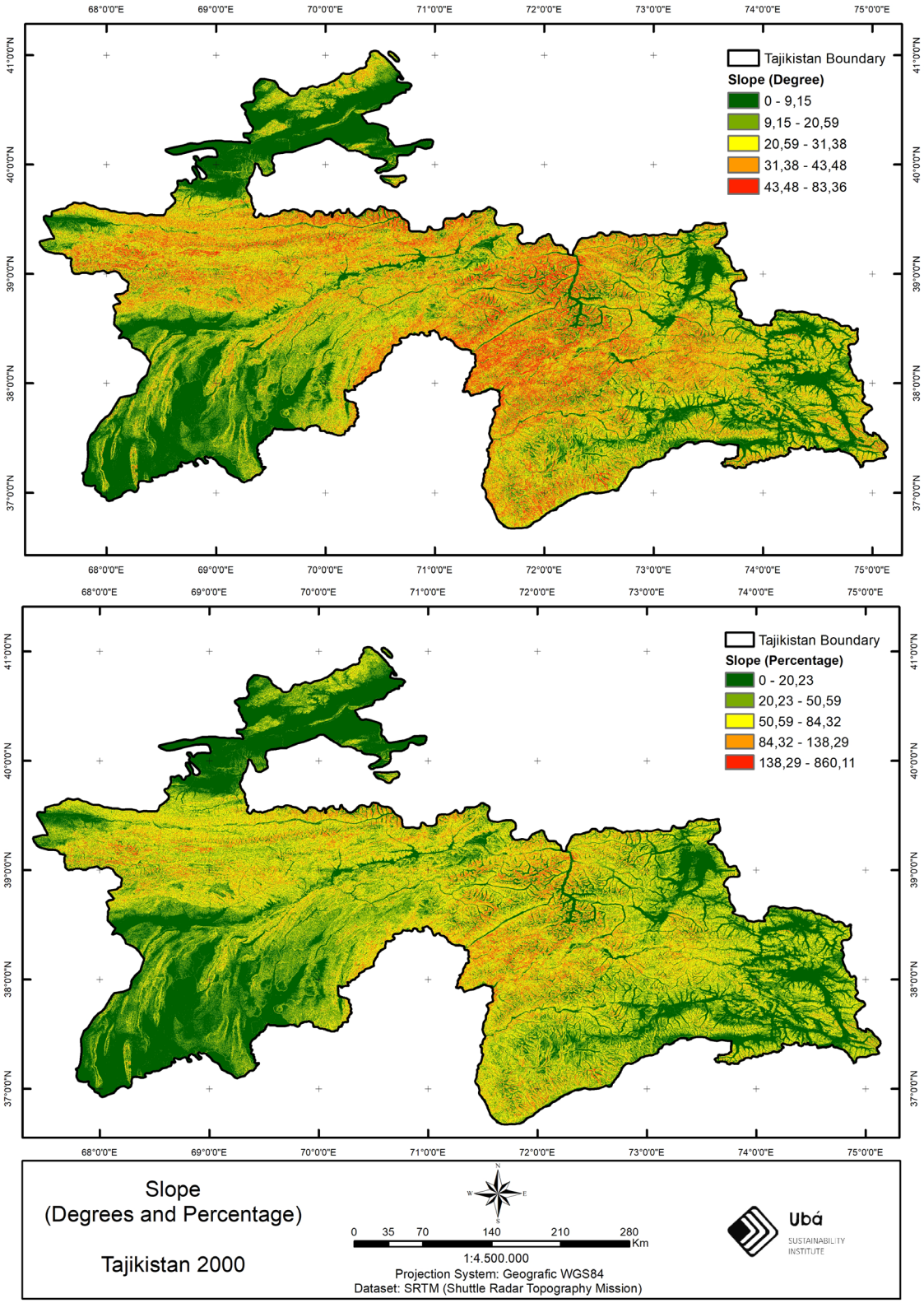
Tajikistan main topography characteristic is its 93% surface area covered by mountains, which about half of it is more than 3.000 m elevation[3]. The largest mountains areas correspond to the Alay Rage at north and Pamir chain at southeast. Furthermore, Tajikistan has 60% of glaciers in Central Asia and one of the largest glaciers outside of the polar region, Fedchenko Glacier, with approximately 77 km long and 651.7 km^2[4].

[1] United Nations World Population Prospects, 2020. Available on: https://data.worldbank.org/indicator/SP.POP.TOTL?locations=TJ
[2] The World Bank, Adapting to Climate Change in Europe and Central Asia, 2019.
[3] Tajikles Services LLC, Forest Development and best practices of Forest Management in Tajikistan.
[4]Ministry of Energy and Water Resources of the Republic of Tajikistan.

Map 1: Hypsometry (Stretched and Classified)/ Tajikistan 2000



Map 2: Slope (Stretched and Classified)/ Tajikistan 2000



River Basins & Water resources

The mountainous and foothill regions of the country constitute the main flow formation zone of the Aral Sea basin. The main sources of water resources are glaciers, rivers, lakes, reservoirs and groundwater. The rivers of Tajikistan, in turn, have huge reserves of hydropower resources, which are estimated at 527 billion kWh in a year[1]. The largest glacial zone in Tajikistan (60%) is the territory adjacent to the highest peaks - Ismoili Somoni (7,495 m) and Lenin (7,134 m), where the largest dendrite glaciers in terms of area are located - Fedchenko (651.7 km^2), Grumm-Grzhimailo (143 km2) Garmo (114.6 km2) and dozens of other glaciers with an area of more than 30 km^2.

The rivers are the most sacred wealth of Tajikistan. There are 947 rivers flowing through the country, the total length of which exceeds 28,500 km. The runoff formation zone in Tajikistan is 90% of its territory. The melting of glaciers forms up to 25% of all water resources and they constitute a significant part of the summer baseline runoff, while it increases up to 50% in dry years[2].

The main waterways of the country are Amu Darya and Syr Darya with their tributaries. The Amu Darya river basin is composed of the main river systems: the Panj rivers with the main tributaries Gunt and Bartang, the Vakhsh river, which collects the waters of the Alai valley and the northern Pamir; Kofarnihon, and Surkhandarya rivers, flowing down from the southern slopes of the Gissar ridge. In general, the average long-term river flow in Tajikistan is 64 km^3/year, including 62.9 km^3 in the Amu Darya basin and 1.1 km^3 in the Syr Darya basin. The rivers of Tajikistan provide for 55.4% of the average long-term surface basin of the Aral Sea. According to the Agency of Hydrometeorology, there are four main catchment areas: the Syr Darya River (Northern Tajikistan), the Zeravshan River (Central Tajikistan), the Panj River (Southwestern Tajikistan and Pamir), and the salt Lake basin in the Eastern Pamir.

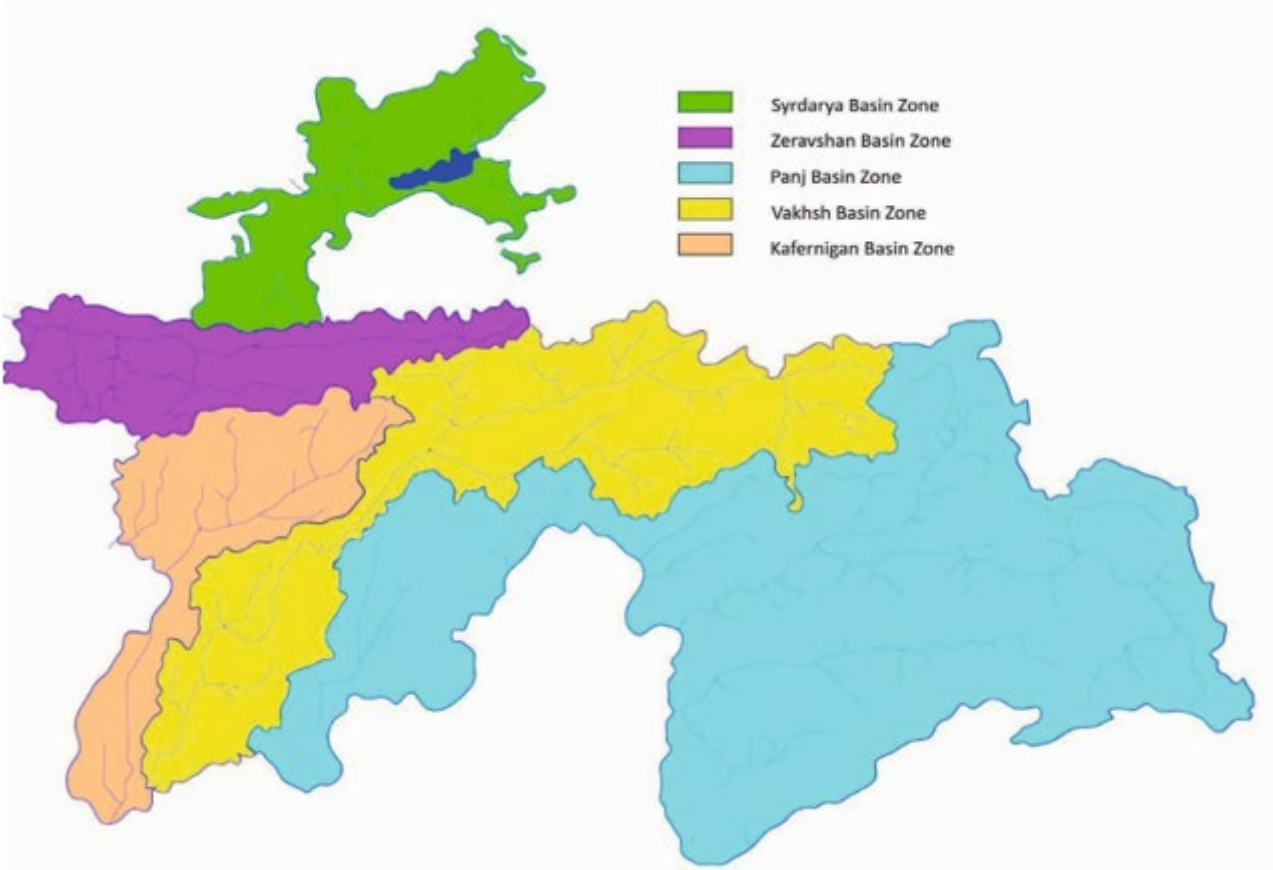
The largest rivers in Tajikistan are: Panj, Vakhsh, Syr Darya, Zeravshan, Kafirnigan and Bartang. The country is divided into five main river basins. Its respective average annual runoff are: of the Panj River is 33.669 km^3 (41.6%), the Kafarnigan River is 5.191km^3 (6.5%), the Vakhsh River is 18.90 km^3 (23.6%), the Zeravshan River is 5.139 km^3 (6.4%), the Syrdarya River is 15.978 km^3 (19.9%)[3].

[1] Ministry of Energy and Water Resources of the Republic of Tajikistan.

[2] Ibid 1

[3] Tajikles Services LLC, Forest Development and best practices of Forest Management in Tajikistan.

Map 3: River basins zones in Tajikistan



Source: Ministry of Energy and Water Resources of the Republic of Tajikistan, Water Sector Reform in Tajikistan - 2021

Currently, the water sector is being reformed, new laws are being developed in order to change the governance and decentralize the management of the resources at river basin levels. The Government of the Republic of Tajikistan adopted the Water Sector Reform Program for the period 2016-2025, by Decree N° 791 of December 30, 2015, which implemented Integrated Water Resources Management (IWRM) principles. As part of the water sector reform for the Tajik, five basin zones were established: the Syr Darya, Zeravshan, Panj, Vakhsh and Kofarnihon basin zones, and its respective basin's plans for water resources management have been developed, in order to improve management efficency. The development and implementation of basin plans made it possible to carry out a comprehensive analysis and assessment of the existing water management situation for river basin organizations, plan water use and protection of water[1].

[1] Water Sector Reform of Republic of Tajikistan, 2021 – Ministry of Energy and Water Resources.

Thus, regarding IWRM principles, concepts such as "basin management of water resources", "national water council" and "basin water council" were introduced to the Water Code. A National Water Council was created, and it concentrate the activities of ministries, departments and other State bodies, as well as non-governmental organizations, regarding planning, management, use and protection of water resources.

The project "Water Supply and Sanitation in Tajikistan (TajWSS)", implemented by UNDP and Oxfam GB with financial support of the Swiss Agency for Development and Cooperation (SDC), developed, within its framework, the draft law "On drinking water supply and sanitation". The law was signed by the president of the country on July 2019, and integrated the regulation of water supply and water disposal (waste water treatment and discharge).

5.1.2. Soil

Soil is a resource of great importance. It is important to stress out that although there are national maps describing soil types, for purposes of simplification and accessibility of the datasets, FAO's Soil Map of The World (1974)[1] data was used in order to support the understanding of erosion. The predominant soil type is **Lithosols** (74.77%) – that is soils which are limited in depth and continuous coherent hard rock within 10 cm of the surface. Followed by **Calcic Xerosols**, soils with a calcic horizon within 125 cm of the surface; lacking an argillic B horizon overlying the calcic horizon; and finally **Glaciers** (7.29%). Table 3 describes the main soil types in the country.

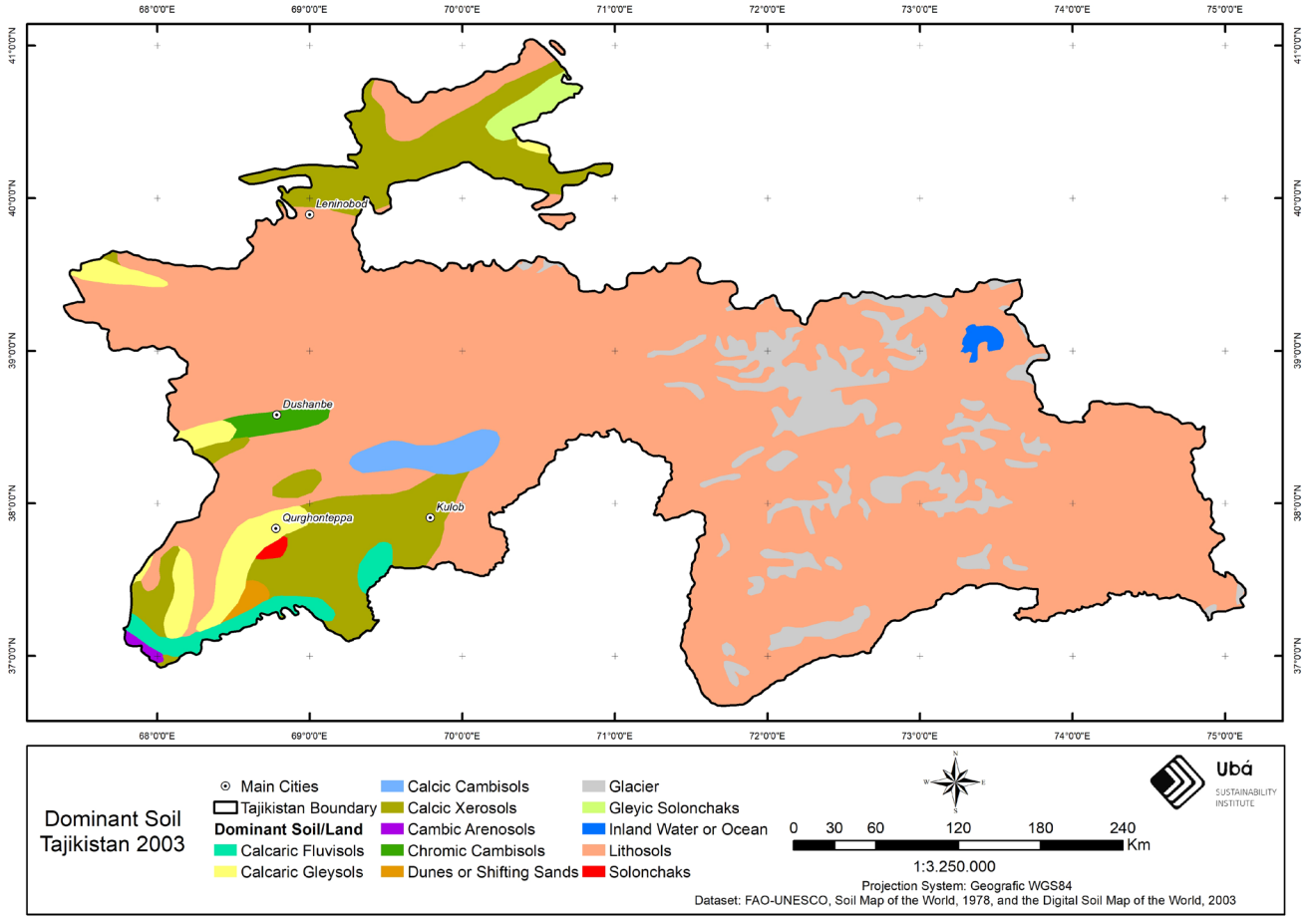
Table 3: Dominant soil/area

Dominant Soil	Area (km^2)	Area (%)
Solonchaks	175,70	0,12
Cambic Arenosols	177,62	0,12
Dunes or Shifting Sands	330,37	0,23
Inland Water or Ocean	389,04	0,27
Chromic Cambisols	889,55	0,63
Gleyic Solonchaks	994,52	0,70
Calcic Cambisols	1750,14	1,23
Calcaric Fluvisols	1 888,46	1,33
Calcaric Gleysols	3 863,16	2,72
Glacier	10 365,81	7,29
Calcic Xerosols	15 028,18	10,57
Lithosols	106 263,09	74,77
Total	**142 115,65**	**100%**

Source: Fao (1974)

[1] FAO, Soil map of the world 1: 5 000 000. Paris: United Nations Educational, Scientific And Cultural Organization, 1974.

Map 4: Dominant Soil/ Tajikistan 2003



5.1.3. Climate

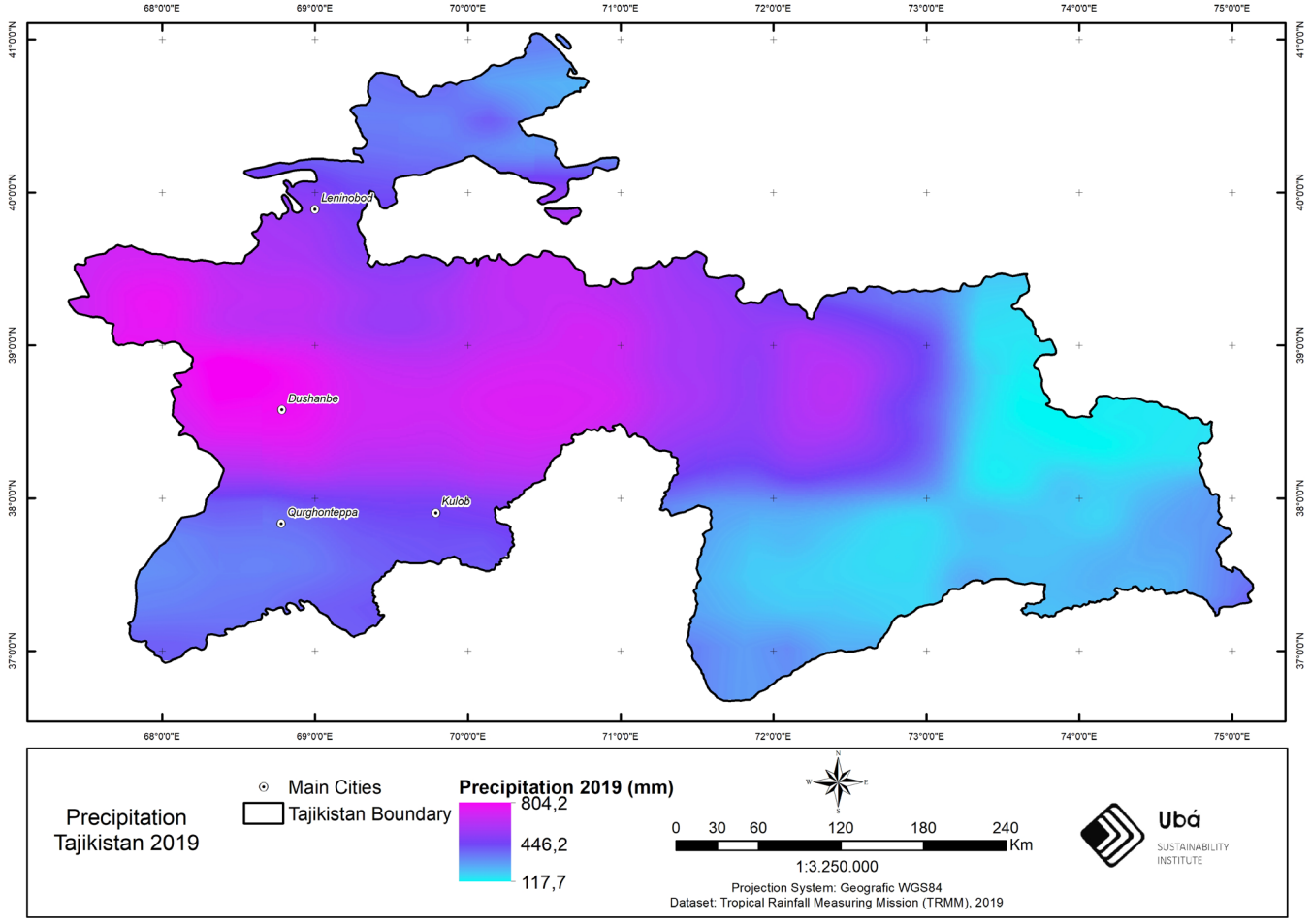
The climate of Tajikistan is determined by its geographical position within the Eurasian continent on the border of the subtropical and temperate zones. It is predominantly classified as continental climate, subtropical, or semi-arid and desert climate with hot summer and cold winter, but it undergoes a wide variation due to elevation. Its characteristic features are high intensity of solar radiation, aridity, low cloud cover, long duration of sunshine, sharp fluctuations in daily and seasonal temperatures, and significant dustiness in the air.

The average annual precipitation is 691 mm[1] and despite the significant difference in amount along the country because of its orographic features, it falls mainly in winter and especially in spring[2]. In the South

[1] FAO, AQUASTAT Country Profile – Tajikistan. Food and Agriculture Organization of the United Nations (FAO). Rome, Italy, 2012
[2] NCBB, Fifth National Report On Preservation Of Biodiversity Of The Republic Of Tajikistan. Dushanbe: Republic of Tajikistan, 2014

Tajik depression, precipitation decreases from northeast to southwest. In cotton areas, precipitation reachesonly 150-300 mm. There, from June to October, there is almost no rain and because of the extremely high temperatures raindrops evaporate before reaching the ground. The Eastern Pamirs receive the least moisture in Tajikistan, where there is almost no snow and real rain. On the other hand, in central region, precipitation can hit 2.400 mm[1]. Most of the precipitation brought by westerly winds remains on the mountain slopes, mainly in the axial parts of the Hissar Ridge, the Peter I Ridge and the Academy of Sciences Ridge. The upper reaches of the Varzob River, Kafirnigan Obikhingou and Fedchenko Glacier are located in this zone of high humidity.

Map 5: Precipitation/Tajikistan 2019



According to FAO's country profile[2], Tajikistan average temperature is 16-17° C, the maximum temperature registered is 48° C in July, and the minimun -49° C in January. Wide valleys and plateaus

[1] FAO, AQUASTAT Country Profile – Tajikistan. Food and Agriculture Organization of the United Nations (FAO). Rome, Italy, 2012
[2] Ibid above

with altitudes up to 1.000 m are characterized by hot long summers with an average July temperature of about 30° C. The frost-free period lasts 210-250 days. Average January temperature from +20° C to +2.5° C. Although, the occasional intrusion of Arctic air brings significant cooling.

The National Hydrometeorological Service (NHMS), which is part of the global information network, provides this information. However, the capacity of NHMS services in the country has suffered a significant decline, at least since 1985. Currently, this service is not able to provide the necessary level of services to meet the needs of the country. In Tajikistan, the accuracy of the standard weather forecast for 3-5 days is 60-70%, compared with 90-95% accuracy of forecasts of NHMS in developed countries[1]. Today the country has a Center for Climate Change and Ozone Layer Studies and Department of Meteorology, and according to this agency, the data collected are analyzed every 3 horus, multi-year weather mode (from 1 year to 60-70yy).

Climate change is one of the main sources of uncertainty, which can lead to increased economic losses if not effectively managed in this area. Reducing vulnerability requires adequate hydrometeorological and climate services that can provide relevant information. This information is particularly relevant for early warning, supporting disaster risk reduction strategies, as well as improving performance and shaping climate change adaptation strategies in sectors such as agriculture and food security, transport, water resources management, hydropower and health.

In 2011, the project "Strengthening the Coordination of Humanitarian Assistance and Early Warning Systems in Tajikistan" was implemented and its main components were: hydrometeorological forecasting, data exchange and early warning of natural disater. With that purpose, it was conducted a technical and economic assessment of existing data and gaps regarding specialists and equipment. As result, was possible to generate long-term forecasts (expert statement).

In Tajikistan, monitoring and early warning reports are compiled on a monthly basis, for regularly provision of information and a brief analysis of the development of environmental, economical, food, energy and other sectors vulnerable to disaster occurance. The report is provided by various sources and compiled by a group of Experts from government organizations and institutions of the Monitoring and Early Warning Center under the Ministry of Economic Development and Trade (MEDT) of the Republic of Tajikistan and UN agencies in Tajikistan (expert statement).

5.1.4. Agriculture and Forest

According to the National Center on Biodiversity and Biosafety of the Republic of Tajikistan (NCBB)[2], the typological structure of ecosystems in Tajikistan includes 12 classes: Medium-and low-mountain savanna, Foothill-semi-desert, Foothill, water-near-water (Tugay), Agro-ecosystems. Weeds ruderal, High-mountain cryophytic, Medium and high-mountain (Subalpine) moderately cold (continental), High-mountain medium-mountain, coniferous-forest, Medium-mountain mesophilic-

[1] Tajik HydroMet

[2] NCBB, Fifth National Report On Preservation Of Biodiversity Of The Republic Of Tajikistan. Dushanbe: Republic Of Tajikistan, 2014

forest, Medium - and low-mountain xerophytic sparsely wooded), 33 types, 6 subtypes and 259 ecosystem species.

In 2015, it was reported that since the end of Soviet period, the forest area have reduced by 27%[1]. The Tajik State Land Use Committee reported approximately 14.255.000 hectares in 1987 and then the exact same value in 2003 of forests (forests, woodlands and other land that includes tree-covered vegetation).

Scientific studies suggested that in early twientieth century, some one fifth of the country was covered with forests[2]. According to official data, forest cover corresponds to approximately 3% of the country's area, but it hasn't been done any national inventory since independence[3], leading to uncertanties. Considering the annual global rate of deforestation (1-2%), actual forest cover can be estimated in about 2%[4]. Beyond forest cover, the country's flora is characterized by the predominance of grasses, semi-shrubs, shrubs of steppes, deserts and highlands. Considering all kinds of vegetation, there are more than 5 thousand plant species in the country, and in view of fauna and flora there are 23 thousand species, of which 1 900 are endemic . Many plants of Tajikistan are well adapted to the desert and mountainous conditions and settle on "high-rise floors". The leaves of some desert plants are small, with needles, which contribute to less evaporation, the roots are long, branched and allow access to water from deep layers of the earth. Plants in areas that are characterized by a very dry and harsh climate have a pillow-like shape that helps them retain moisture and heat.

In the new Forest Code of the Republic of Tajikistan, a forest is characterized as a complex of natural vegetation that forms naturally and artificially in a certain territory on the basis of a set of trees and shrubs. The national forest definition is 10 percent of land cover, with an area of at least 0.5 hectares and at least 10 meters height. Given the sparse distribution and shrub likely vegetation, it becomes a challenge to apply the forest definition to Tajikistan's local context. Despite of a theoretical definition, those ecosystems, interacting with other components of wildlife and having important ecological, economic and social significance. The structure of forest cover consists on 37% of coniferous forests, 22% of xerophytic woodlands, 14% of shrubs, 13% of broad-leaved forests and other tree-shrub vegetation. However, woody vegetation does not form continuous massifs on Tajikistan's territory, but is found in some areas along the slopes of ridges, in gorges. The composition varies in different parts of the republic.

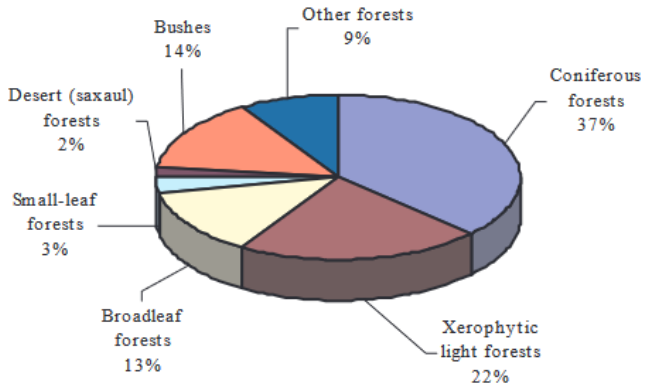
Graphic 1: Structure of the forest areas/typologies

[1] MUSTAEVA, Nailya; WYES, Heinrich; MOHR, Benjamin; KAYUMOV, Abdulkhamid. Tajikistan: Country situation assessment. Dushanbe: Pathways To Resilience In Semi-Arid Economies (Prise), 2015

[2] UNECE, Forest and forest products country profile: Tajikistan, 2008

[3] UNECE, United Nations Economic Commission For Europe; FAO, Food And Agriculture Organization Of The United Nations. Overview of the State of Forests and Forest Management in Tajikistan. Geneva: Economic Commission For Europe., 2020.

[4] FORST, Hessen; KIRCHHOF, Joachim-F.; FABIAN, André. Forestry Sector Analysis of the Republic of Tajikistan. Dushanbe: Deutsche Gesellschaft Für Technische Zusammenarbeit (GTZ) Gmbh, 2010.



Source: Forest Authority. The State of the Environment Report Year 2002.

For the present study, the Forestry Agency shared the following classes of forests in the country:

Table 4: Surface per forest typology (2016)

Main characteristics of forests	Unit ed.	Indicators
Forested area in the whole country	ha	421 100
Natural forests	ha	340 000
Artificially created forests	ha	81 100
Average completeness of forest stands	In tenths of	0.4
Total stock of wood on the root	million kbm	5,1

Source: Forestry Agency

In 2016, the estimated are of the State Forest Fund of Tajikistan is 1.85 million hectares as of January 1, 2016, which are under the jurisdiction of the State Agency for Forestry under the Government of the Republic of Tajikistan according to the report of the State Land Committee approved by the Government of the Republic of Tajikistan.

Distribution of the State forest fund :

1. Forested land - 421.000 thousand hectares
2. Pastures (summer and winter) - 741.000 hectares
3. Hayfields - 21.800 hectares
4. Unforested area - 19.200 hectares
5. Land located under water (river and lakes) - 17.700 hectares
6. Cattle runs - 1.200 hectares
7. Peski - 7.800 hectares

8. Unsuitable land (rocky, rocky, landslides, yarchs) – 589.000 hectares
9. Gardens - 3.600 hectares
10. Nurseries – 70 hectares
11. Arable land (rainfed) - 2.000 ha

According to 2008 UNECE's assessment, the lower boundary of Tajikistan's forests runs approximately along the 500-700 m contour line, the altitude at which, in southern Tajikistan, scattered stands of pistachio (*Pistacia vera*) plantations. Over most of the country, however, the lower boundary of forest cover rises to 1.200-1.500 m and in places as high as 2.200 m, as a consequence of the widespread destruction of forests in the past, primarily during the development of the mining industry in Central Asia. The upper limits of the country's forests run along the 3.200-3.400 contour line, sometimes rising as high as 3.700 m, while isolated shrubs may be seen in the Pamirs at altitudes as high as 4.800 m. At these altitudes, forest clumps of juniper (*Juniperus spp.*), birch (*Betula spp.*) or willow (*Salix spp.)* form unusual environmental niches in a general landscape of treeless terrain, covered with low thorny scrub, or cold-resistant heathland. None of the trees or shrubs growing here manifest any signs of expansion: they have a low rate of seed propagation, tend to be stunted in growth and have a shallow root stock. The occurrence of occasional live trees in vast "cemeteries" of dead forest testify to the former existence of large and species-rich forest stands. Their disappearance is due no doubt to abrupt changes in the natural conditions caused by extensive orogenic processes, both in the past and those still under way in the latest phase of geological development in the Pamir-Alai region[1].

For the Republic of Tajikistan, although it is a low-forest country, the role and importance of forest resources is becoming especially important today due to global climate change and social transformations in the country. The majority of the rural population, which is at least 70 %, is directly dependent on natural resources.

Forest stands perform not only important ecological functions - protecting mountain slopes from erosion, landslides and other natural disasters, but also form the water flow of such transboundary rivers as the Amu Darya and Syr Darya. The local population largely provides itself with firewood, fruits, medicinal and food plants due to the availability of forest resources. The forest areas also serve as a habitat for numerous species of wild animals. They contain the main specific biodiversity of fauna. In addition, many forest lands are pasture lands for livestock, which in general negatively affects the state of forest resources and representatives of the animal world living in forest areas.

Thus, the state and fertility of soils, the availability of hydrotechnical resources of the country, the biodiversity of flora and fauna, and the well-being of the country's population largely depend on the state of forest ecosystems. Despite the insignificance of the country's forest resources, the species diversity of tree and shrub vegetation is quite rich. Moreover, the dendroflora of Tajikistan contains more than 50 species of wild fruit plants, which represent a unique gene pool for scientific and breeding work.

[1] UNECE, Forest and forest products country profile: Tajikistan, 2008

The loss of any kind of dendroflora is a national irreplaceable loss, which is not yet really perceived by our society.

Table 5: Main types of forests by forest-forming tree species

Main forests types	Areas covered by each type of forest Ha	Basic views for each type	
		Forest-forming species	Related types
Juniper forests (Juniper forests)	150.000	Junipers of Zeravshan, hemispherical, Turkestan	Turkestan birch, Tajik poplar, barberry
Pistachios	79.000	Real pistachio	Bukhara almonds
Maplehouses	44.000	Turkestan maple	Tajik poplar
Hazelnuts	8.000	Walnut	Tajik poplar, Turkestan maple
Almonds	12.000	Bukhara almonds	Real pistachio Vermilion
Saksaulniki	8.000	Saxaul white and black	Solyanki, Cherkez
Sea buckthorn	2.000	Sea buckthorn	Shrub willow
Poplars and Willows	2.000	Poplar, willow	Sea buckthorn

Source: Forestry Agency

Due to changing climatic conditions, those types of forest stands that grow in extreme conditions are the most vulnerable. These include, first of all, saksaulniki in the desert zone in the extreme south of the country, then pistachios in the low mountains of southern Tajikistan, where the climate is characterized by high temperatures and low precipitation, as well as in the highlands, in the upper part of the juniper forest belt, where there is very little precipitation, poor soils and low temperaturesDue to the development of mountain slopes and the shortage of fuel and energy resources, the scale of forest destruction by unauthorized logging has increased. Over the past 20 years, unauthorized illegal logging has decimated large areas of forest in many places. Poplar, saxaul, pistachio, almond and hazel trees were particularly affected, and their areas were significantly reduced. In many areas, economically valuable tree species were replaced by various types of shrubby vegetation.

According to the Forestry Agency, unregulated grazing of livestock on the territory of the state forest fund without observing pasture turnover and without taking measures to increase pasture productivity was the main reason for the degradation of forest areas in large areas. UNECE and FAO also states that illegal timber cutting and intensive grazing are the main causes of forest degradation and destruction. Nevertheless, open access to forests, high fuelwood demand and lack of alternative fuels are also great contributors for deforestation.

On the subject of goods and services provided by forests, wood removals are recorded to be under 10.000 m^3, however estimates suggest that the actual removal could be ten times higher[1]. That's strictly related with energy supply, since about 70% of population depends on fuelwood[2].. As a result of energy shortages, the use of fuelwood has increased in three times compared to a decade ago in some areas, which led to an enhance of illegal logging[3]. However, felling of trees is prohibited. Non-Timber Forest Products have a great importance for rural livelihood and economy, especially fruit trees.

The volume of reforestation activities carried out by forestry enterprises has significantly decreased in recent decades. If in 1990, 4.500hectares of forest crops were created by sowing and planting, now this figure is 1.500 hectares, that is, three times less. Moreover, the quality of forest cultivation works has significantly decreased, and their care and protection from damage and other violations is also in unsatisfactory condition. Annually, in the amount of 8.400 hectares, the forest is protected by biological methods, mainly by land-based control measures, which reaches almost the figure of 1991[4].

In 2005, it was developed the National Forestry Program 2006-2015, but due to lack of financial resources many of the recommendations weren't implemented[5]. A new version of the "Strategy for the Development of the Forest Sector of the Republic of Tajikistan for the period up to 2030" and an Action Plan for its implementation for the period 2021-2025 have been developed. To date, 2.077 contracts of Joint Forest Management (SUM) have been concluded covering an area of 58.425 ha[6]. As well as 4.515 contracts have been concluded with the local population and 268;138 hectares of state forest fund land have been assigned to them. The area of perennial plantings is growing rapidly due to the implementation of the Program for the Development of Horticulture and viticulture in the Republic of Tajikistan for 2016-2020, and in 2018 this figure was 150.900 hectares. Although in 1991 this figure was only 99.8000 thousand hectares. Hayfields make up 15.800 hectares.

The Forestry Agency reported that every year, the State budget allocates financial resources to the Forestry Agency for protection and restoration of forests. In 2018, the cost of forest protection amounted to 1.019,000 TJS ($89,779), in 2020 – 982.984 TJS ($86,606), which is less than in 2018. The cost of creating forest crops in 2018 is 403.331 TJS ($35.535), in 2020 – 424.250 TJS ($37.378), which is higher than 2018.

The Republic of Tajikistan is a member State of the International Pilot Program on Climate Change Adaptation (PPCR). At the time of NDC (Nationally Determined Contributions) preparation, the main

[1] UNECE, United Nations Economic Commission For Europe; FAO, Food And Agriculture Organization Of The United Nations. Overview of the State of Forests and Forest Management in Tajikistan. Geneva: Economic Commission For Europe, 2020.
[2] FORST, Hessen; KIRCHHOF, Joachim-F.; FABIAN, André. Forestry Sector Analysis of the Republic of Tajikistan. Dushanbe: Deutsche Gesellschaft Für Technische Zusammenarbeit (Gtz) Gmbh, 2010
[3] Ning, Wu; Rawat, GS; Joshi, S; Ismail, M; Sharma, E. High-altitude rangelands and their interfaces in the Hindu Kush Himalayas. Kathmandu: ICIMOD, 2013.
4 Forestry Agency
[5] Ibid 1
[6] Expert view

efforts of the PPCR in the Republic of Tajikistan are focused on hydropower, development of other renewable energy sources, agriculture and forestry. Within the framework of the Project "Adaptation to climate change through rational forest management in the main catchment areas of Tajikistan" funded by the German Development Bank (KFW), 4 pilot zones were planted and restored (funding amount is 8 million euros). Thanks to this project, Khovaling, Farkhor, Vanch forestry enterprises and GBAO forestry created forest stands on a total area of more than 6.000 hectares. Currently, within the framework of a Grant Program funded by the Korean Forest Service, work has begun this year on the development of *Saxaul* cultivation technology and the creation of forest stands on an area of 300 hectares, as well as the creation of pistachio plantations on a selection basis on an area of 20 hectares (the amount of funding is $1,640 million).[1]

Regarding the agricultural sector, it represents a contribution of 22% to the country's GDP[2]. In 2012, agricultural area was 4.546.100 ha, while arable land consisted on 734.300 ha[3] and, approximately 95% of crop production is from irrigated land.

The sector principal output is cotton production[4] which corresponds to an area of 230 to 270.000 hectares of irrigated lands, per year[5]. According to Index Mundi[6], Tajikistan imports about 70% of its food. Furthermore, 70% of agricultural lands are covered by grazing and hayfield, and 60% of the most valuable natural fodders are in highlands[7]. The topography combined with intense agricultural activity are main the cause of soil erosion, resulting in 97,7% of soil erosion in cultivated land.[8]

Livestock breeding is an important part of Tajiskistan tradition and represents a great contribution to the economy of rural livelihood[9]. At the same time, Tajikistan's pastures are degraded and may be depleted if the number of livestock in the republic is not reduced. This conclusion was reached by the staff of the Institute of Botany, Physiology and Plant Genetics of the Academy of Sciences of the country. Scientists note that there are not enough pastures for all farm animals and spontaneous year-round grazing leads to their desertification. Unregulated and excessive grazing of livestock on pasture lands is one of the threatening factors of land and forest degradation. Summer pastures are degraded by 89 %[10], and pasture productivity has decreased by 5-10 times due to changes in the plant species composition.

[1] Forestry Agency
[2] National Bank of Tajikistan, Banking Statistics Bulletin, 2021
[3] Tajikles Services LLC, Forest Development and best practices of Forest Management in Tajikistan.
[4] Ibid 2
[5] NCBB, Fifth National Report On Preservation Of Biodiversity Of The Republic Of Tajikistan. Dushanbe: Republic Of Tajikistan, 2014
[6] Index Mundi : Tajikistan Economy Profile 2021, available on: https://www.indexmundi.com/tajikistan/economy_profile.html
[7] NCBB, Fifth National Report On Preservation Of Biodiversity Of The Republic Of Tajikistan. Dushanbe: Republic Of Tajikistan, 2014
[8] BANN, Camille; SHUKUROV, Rakhmon; BOZIEV, Lutfullo; RAKHMATOVA, Dilorom. The Economics of Land Degradation for the Agriculture Sector in Tajikistan – A Scoping Study. Dushanbe: UNDP-UNEP Poverty Environment Initiative In Tajikistan, 2011.
[9] FORST, Hessen; KIRCHHOF, Joachim-F.; FABIAN, André. Forestry Sector Analysis of the Republic of Tajikistan. Dushanbe: Deutsche Gesellschaft Für Technische Zusammenarbeit (Gtz) Gmbh, 2010
[10] Ibid 7

In order to provide with additional and more recent figures on land use and land use change, using recent Sentinel-2 images, a 2020 land cover map was done, and estimates on the surface per category is described below.

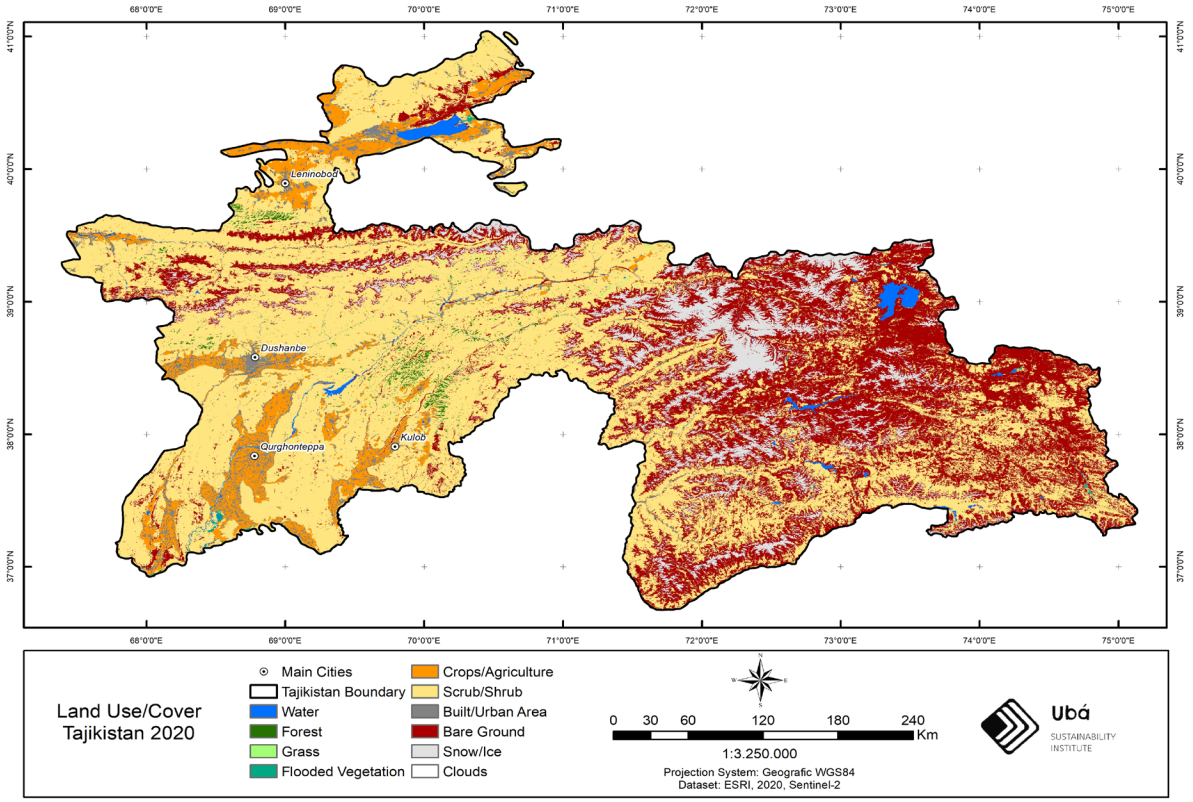
Table 6: Land Use/Cover

Land Use/Cover	Area (Km²)	Area (%)
Water	1 801,25	1,27
Forest	853,60	0,60
Grasslands	228,63	0,16
Flooded vegetation	103,26	0,07
Crops/Agriculture	8 483,59	5,97
Scrub/Shrub	76 728,37	53,99
Bilt/Urban Area	3 734,75	2,63
Bare Ground	39 023,45	27,46
Snow/Ice	11 154,57	7,85
Clouds	2,68	0,00
Total	**142 114,15**	**100,00**

Fonte: ESRI, 2020

PS.: A note on the forest class is that it includes perennials (vineyards) and fruit trees. A distinction amongst those two classes will be welcome in the future.

Map 6: Land Use/Cover/ Tajikistan 2020

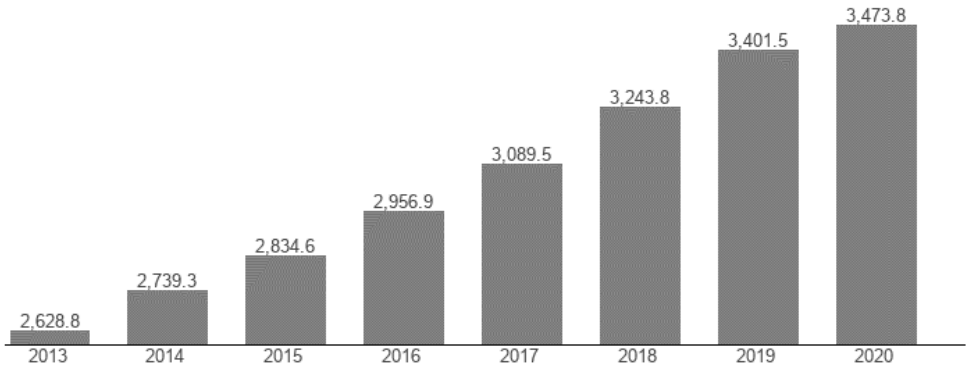


5.1.5. Population and Economy

As of 1 January 2021, the population of the Republic of Tajikistan is 9.506.300 and this number has been increasing on average 2,1%. The rural population corresponds to 73,68% and urban population, 26,32%. Moreover, the proportion between men and women population is, currently, 1.029 men per 1.000 women. 0-14 years old population size has made 3.258 thousand people and has increased by 12,2% compared to 2014, while older than able-bodied population size has made 555.4 thousand people and has increased by 39,9% compared to 2014. In 2019, life expectancy at birth had made 75,1 years, for boys – 73,5 years, and for girls – 76,8 years[1]. As the capital of the republic, Dushanbe City is the largest city by population size and is the cultural and economic center.

In 2019, in comparison with 2013, it was observed a 31,5% increase in intraregional migration and a 2,6% increase in interregional migration. For the period of 2013-2019 years, the number of people who left the republic seeking a permanent place of residence in other countries has increased 2,7 times. Among those who left the country, mainly are people with general secondary education, making 62,3%. In 2019, there is an observed increase in population movement compared to 2013, in women – by 25,7%, and in men – by 21,2%[2]. Currently, a significant part of the densely populated territory of the country is included in the arid and insufficiently humid zone according to climatic parameters. GDP per capita from 2013 to 2020 is related in the graphic below:

Graphic 2: GDP per capita from 2013 to 2020



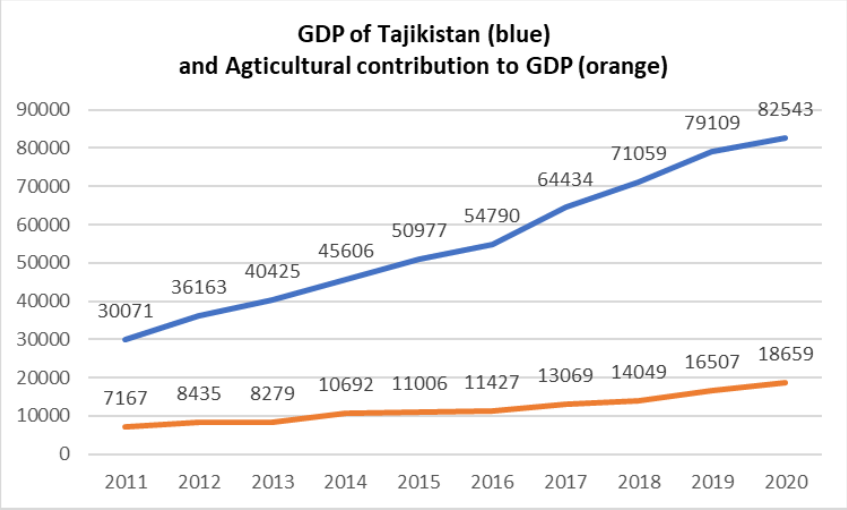
Source: National Bank of Tajikistan, Banking Statistics Bulletin, 2021

[1] Tajstat, Tajikistan 30 years of State Independence, Statistics Data, 2021
[2] Tajstat, Women And Men Of The Republic Of Tajikistan. Dushanbe: Republic Of Tajikistan, 2020.

The national average monthly income in 2019 was 475 TJS ($ 49,80). The average per region in 2021 is: Dushanbe: $184, Khatlon Region: $93, Sogd Region: $109, DRS: $105, GBAO: $119 (Tajstat 30 years). Furthermore, the national average cost of living per month in 2019 was 429 TJS ($44,90)[1].

The National Bank of Tajikistan (2021), shows that in 2020 GDP has reached 82.543,0 million TJS ($8 billion) and the contribution of each sector is the following: agriculture – 22%, industry – 23%, construction – 11%, trade – 12%, transport communication – 6%, financial sector – 2%, other services – 24%. The agriculture contribution, as the rural population and the provision of jobs countrywide (1,5 million people), testify the importance and the impact of this sector in the country's economy.

Graphic 3: GDP/ Agricultural contribution to national GDP



Source: National Bank of Tajikistan, Banking Statistics Bulletin, 2021

Tajikistan is the poorest country among the former Soviet republics. Lack of employment opportunities in Tajikistan lead more than one million Tajik citizens to work abroad - roughly 90% in Russia - supporting families back home through remittances, that in 2017 were equivalent to nearly 35% of GDP[2]. The large remittances from migrant workers in Russia exposes it to monetary shocks, and so the country often delays devaluation of its currency for fear of inflationary pressures on food and other consumables. The economic activity per region is presented in the table below:

Table 7: Economic activity per sector and per region

[1] Tajstat, Tajikistan 30 years of State Independence, Statistics Data, 2021
[2] Index Mundi : Tajikistan Economy Profile 2021, available on: https://www.indexmundi.com/tajikistan/economy_profile.html

Economic Activity	Khatlon (total 100%)	Sugd (total 100%)	DRS (total 100%)	GBAO (total 100%)	Dushanbe (total 100%)
Industry					
1. Mining industry (energy and non-energy items, coal)	4,3%	18%	28,2%	37%	2%
2. Manufacturing industry (foodstuff, metal equipment, textile, chemistry, cement)	49,1	74,4	41	18,3	59,1
3. Production and distribution of energy, gas and water	46,6	7,2	30,8	44	38,9
Agricultural sector					
1. Areas under crop, ha (Cotton, potato, grain crops, leguminous plants, vegetables, melons and gourds etc.), **ha**	426.319	278.640	141.188	10.531	56
2. Agricultural production, **tn.** (Cotton, potato, grain crops, leguminous plants, vegetables, melons and gourds etc.)	985.322	351.374	217.555	7.103	2
3. Cattle livestock, **heads**	1.010.971	667.061	613.406	100.028	-
4. Sheeps and goats, head	2.400.223	1.576.019	1.486.513	334.747	-
5. Poultry, heads	2205214	4635128	2847395	94952	-
6. Meat production, tn.	172445	66594	52159	8984	-

Source: Tajikistan 30 years of State Independence, Statistics Data, Tajstat 2021

Tajikistan has as main energy sources, eletrictricity, coal, oil and natural gas. Overall forest resources (forest fund) Tajikistan cover 1.9 million of hectares, of which 423.000 hectares consists of forest (2020)[1]. Some people rural areas still use illegally cut firewood as energy sources, however coal is the main energy source in the autumn-winter period due to low price. In addition, rural people use dungs for cooking and heating purposes. Average family purchase 1-2 tons of coal and dungs during fall period. Firewood is expensive energy source so wealthy families acquire 3-4 m^3 of firewood for autumn-winter period[2].

Finally, social development and resilience is also linked to mobility. In the country, given its topography, roads maintenance are a challenge. Road assets worth an estimated $1 billion were lost between 1990 and 2010, and 80% of the registered 14.000 km road network is in a state of disrepair. For the common use roads this percentage may be equally high or higher. Over 50% of the road network has an average international roughness index (IRI) of over 7 meters per km, which results in lower travel speeds, increased fuel consumption, and higher vehicle operating cost. Average vehicle speeds across the road network have declined from 50 km per hour to 30 km per hour. Poor road quality affects access and mobility and hinders economic growth. Moreover, vehicle overloading has increased and road safety has deteriorated[3]. Since 1991 the Government has implemented over 53 investment project to the

[1] TajStat: Environment of the Republic of Tajikistan 2021

[2] Expert view

[3] WB, Integrating climate change adaptation and water management in the design and construction of roads: Assessment of Opportunities in Tajikistan, 2018

amount of $20,3 bilion. which resulted construction and rehabilitation of 2.200 km international roads, 21.4 km of tunnels, avalanche-protection galleries and 200 small and mid-scale bridges equal to 8.2 km. (President speech to the Parliament, 2021).

Within this context, disasters often worsen the situation, in particular for people cut from the main transportation ways. Increase of foodstuff prices is immediate indicator, which by-turn directly contribute to increase of poverty level[1].

5.1.6. Legal and institutional aspects

The Land Code was adopted on 13 December 1996; accordingly, the current typology in the territory of the Republic began its development after independence. All land in Tajikistan forms a single State land fund and, in accordance with their purpose, are divided into the following categories:

1) Agricultural lands;
2) Lands of human settlements (cities, urban settlements and rural settlements);
3) Land for industry, transport, communications, defence and other purposes;
4) Nature conservation, health, recreation and historical and cultural lands;
5) Lands of the State forestry fund;
6) State Water Fund lands;
7) State reserve lands.

There is no private land ownership in the Republic of Tajikistan; land, as it is stipulated in the Land Code of 1996 is state-owned and is not subject to sale, exchange, donation or bail. Public land use is implemented by local government, state unitary enterprises and they use land according to their purpose. Currently, more than 60% of the cultivated area in agriculture is managed by dekhkan households[2]. Today, collective land use stands out as a form of private land use. That is, dekhkan (farmer) household are granted land parcels on the right to a lifelong hereditary possession and members of dekhkan (farmer) household use land parcels for agricultural activities, registered as individual entrepreneurs and legal entities.

Tajikistan has a national system for determining the boundaries of land parcels and the land-use planning, known as the State Committee on Land Administration and Surveying, which collects information on the boundaries of land parcels. Terracing and other infrastructure activities concerned with disaster prevention are carried out by the Committee on Emergency Situations and Civil Defence of the Government of the Republic of Tajikistan (CES and CD).

The Act «On the protection of the population and territories against natural and man-made emergencies» establishes that Tajikistan has a unified State system for the prevention and elimination

[1] Expert view
[2] Expert view

of emergency situations. This system includes the activities of the President, the Government, the local executive authorities and the CES and CD, to prevent and eliminate the consequences of man-made and natural disasters.

In matter of fiscal mechanisms, the country charge a tax rate for land use and it differs according to urban or rural areas, and rain-fed or irrigated land. The tax for urban areas is higher than for rural area. Concerning the additional artificial irrigation, the land tax rate is calculated taking into account water use, based on the regional tax rate estabilished by Tax Committee of the Government of the Republic of Tajikistan every year.

5.1.7.

5.1.8. Banking and social security

According to experts view, the state of the banking system of the Republic of Tajikistan is recovering after a severe decline in 2014 because of liquidation and mistrust after two of the country's largest banks (Tojiksodirotbank and Agroinvestbank) went bankrupt. That said, in rural areas, people's wealth is probably materialized in goods and husbandry, reducing a resilience factor of having liquidity savings elsewhere than in its own household.

Although Tajikistan is an agrarian and industrial country, agricultural insurance has not found legal regulation. Including in insurance products of professional participants of insurance market, which according to information from the site of the National Bank number 19 organizations[1], there is no provision of agricultural insurance in either state or private insurance organizations. However, Tajik legislation and insurance organizations provide for savings insurance for individuals. Insurance in the Republic of Tajikistan is regulated by the Law of the Republic of Tajikistan «On insurance activity». This Act establishes the rights and obligations of the subjects of insurance activities, defines the requirements for the subjects carrying out insurance activities, provides legal definitions of the insurance event, the insurance payment and other definitions used in insurance activities.

5.1.9. Climate Change and Disasters

According to the Ministry of Energy and Water Resources, climate change is clearly observed in Tajikistan, as well as throughout the world. Over the past 65 years, in wide valleys, the average annual air temperature has increased by 0.7-1.2°C, in mountainous and high- mountainous regions by 0.1-0.7°C, and by 1.2-1.9'C in cities (Ministry of Energy and Water Resources). Due to the impact of climate change, the country's glaciers have also undergone changes, which, according to some estimates, have lost 20% of their volume and 30% of their area over the past 50-60 years.

[1]Official website of the National Bank of the Republic of Tajikistan. URL: https://http://nbt.tj/ (date of application: 08.11.2021);

By 2030, the average annual temperature in most regions of Tajikistan is expected to increase by 0.2-0.4 C[1]. In view of the country's surface covered by glacier, Glacial Lake Outburst Floods (GLOF), as well as a decrease in water storage, are very likely to happen as a result. Also, according to the UNDP assessment (2012), from the point of view of the population living in various regions of the country, drought is a disasterous consequence of climate change in the present and future. Due to a warming climate, it is likely that droughts in Tajikistan will occur with greater intensity and frequency.

The governmental Agency for Hydrometeorology shared that according to forecasts, under the studied scenarios, the temperature will continue to rise, and the redistribution of precipitation in different seasons of the yearwill increase.

As an example, the impacts of climate change will get to agriculture through a decrease in irrigation and crop yield, an increase in eroded soils and salinization[2]. It will also impact infrastructures, such as houses, roads, bridges and hydroelectric power generation (98-99% of annual share). The comparison between 2018/2019 and the share of each natural disaster type is described in the table below:

Table 8: Number of natural disasters in the Republic of Tajikistan during the period of 2018– 2019

Types of natural disasters	2018	2019	Decrease/Increase (+/-) per cent
	#	#	
Earthquakes	30	25	-16,7 per cent
Avalanches	8	445	+55,6 times
Landslides	8	13	+62,5 per cent
Rockfalls	44	37	-15,9 per cent
Strong wind	7	18	+2,6 times
Heavy snowfalls	1	8	+8 times
Hevy rainfalls	2	17	+8,5 times
Fog	2		-2 times
Floods	11	32	+2,9 times
Thunder and lightning	3	1	-3 times
Mudflows	48	80	+66,7 per cent
Glaze ice	4	2	-2 times
Glacier movement		2	+2 times
Wildfire	1		
Total	**169**	**680**	**+4 times**

Source: Committee Of Emergency Situations And Civil Defense Under The Government Of The Republic of Tajikistan. 2019 - Overview Of Emergency Situations In The Republic Of Tajikistan.

[1] MUSTAEVA, Nailya; WYES, Heinrich; MOHR, Benjamin; KAYUMOV, Abdulkhamid. Tajikistan: Country situation assessment. Pathways To Resilience In Semi-Arid Economies (Prise), 2015

[2] Climate change profile of Tajikistan, GIZ , 2020

From 1992 to 2016, natural disasters affected 7 million people in Tajikistan (more than 80% of the population) and caused economic losses of US$1.8 billion[1]. Annual losses from climate change and climate-induced extreme weather events are currently estimated at $600 million, or 4.8% of GDP[2]. As the interval and magnitude of these events increases, the impacts of such disasters are also expected to increase.

In order to reduce the risk of natural disasters, as well as response and prevention of emergency situations, the Committee for Emergency Situations and Civil Defense under the Government of Tajikistan was created, and it centralizes all the information about such events and their losses and gamages. In the structure of the Committee there is a CMC (Crisis Management Center), one of the functions of this center is forecasting the situation based on the available data on past natural disasters. Meetings of Emergency Commissions of local executive bodies of state power of GBAO, Sughd and Khatlon regions, the city of Dushanbe and cities and districts of republican subordination were held quarterly during 2019.

Aiming to regulate the procedure for coordinating the activities of republican ministries and departments on disaster risk reduction, the National Platform of the Republic of Tajikistan on Disaster Risk Reduction was established by Resolution No. 98 of the Government of the Republic of Tajikistan dated March 1, 2012, which, within its powers, unites executive bodies of State power, ministries and institutions, local and international non-governmental organizations, the private and public sector.

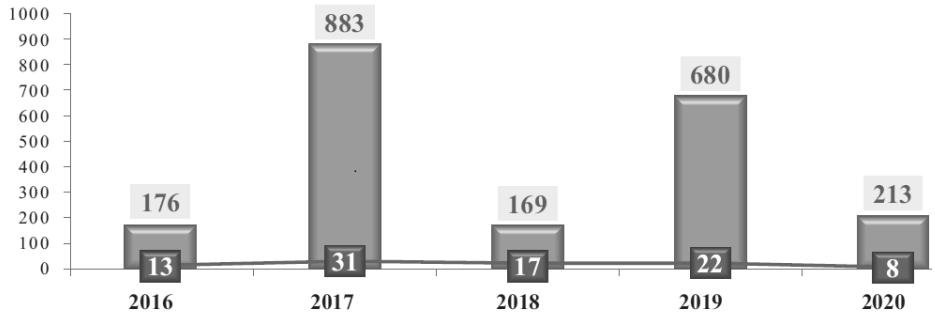
In case of natural disasters of a regional and republican scale, by order of the Government of the Republic of Tajikistan, construction materials and other necessary goods for the life of victims of natural phenomena are allocated, as well as from international organizations uniting under REACT (Rapid Assessment and Coordination Groups in Emergency Situations).

For example, in 2021. In several districts of Khatlon region and districts of republican subordination, natural disasters occurred, which had casualties and economic damage. In the cities of Kulyab, Gissar, Vakhsh, A. Jomi, Rasht, Tajikabad regions, there were serious natural disasters, as a result, housing and many households were damaged. In such cases, according to the Resolution of the GRT No. 799 of December 30, 2015. The State Commission for Emergency Situations, based on the nature and volume of the emergency, resumes its functions and monitors the situation, and also documents all activities to eliminate the consequences of the emergency.

For fires, the State Fire Service operates within the Ministry of Internal Affairs, which has all the information about such events. The following graphic point the number of deaths caused by disasters, from 2016 to 2020:

[1] EM-DAT: The Emergency Events Database, Université catholique de Louvain (UCL)–CRED, D. Guha-Sapir, Brussels, Belgium, www.emdat.be.
[2] Ibid 2

Graphic 4: Deaths caused by disastes from 2016 to 2020



Legend: Disasters Registered deaths

Source: Review of emergency situations in the Republic of Tajikistan 2020, Committee for Emergency Situations

Several disaster management programs were developed and implemented, including proposals for the implementation of the targeted integrated program “Elements”, Tajikglavgeology, the Program for studying the irrigated Adyr territories of southwestern Tajikistan for 1990-2005, the Program for hydrogeological and geoecological research on "Tajikgeology" for 1991-1996, the Program for organizing monitoring of dangerous geological processes, 1989-1993.

5.1.10. Disasters victims financial assistance & remediation actions

Compensation mechanisms were developed according to the Resolution of the Government of the Republic of Tajikistan “On the procedure and amount of providing one-time financial assistance population affected by natural disasters in the Republic Tajikistan”[1] from January 1, 2011 the victims of natural disasters are eligible to receive a one-time financial assistance in the amount of: - 1000 Somoni for each family of the deceased; - 100 TJS for the head of the family and 50 TJS for each family member.

According to the Resolution of the Government of the Republic of Tajikistan “On the procedure and amount of providing one-time financial assistance population affected by natural disasters in the Republic Tajikistan” (Resolution n° 632 of December 3, 2010) the victims of natural disasters are eligible to receive a one-time financial assistance and preferential loan in the amount of:
- 100 TJS for for head of the family

[1] Resolution of the Government of the Republic of Tajikistan “On the procedure and amount of providing one-time financial assistance population affected by natural disasters in the Republic Tajikistan, 2010

- 50 TJS for each family member
- 600 TJS for each family for the repair of partially destroyed housing;
- 1 500 TJS for each family for the construction of a completely destroyed residential building in the same place;
- 3 000 TJS of a soft loan to each family for a period of 5 years for construction of a completely destroyed house, when relocating to a safe place, taking into account the impossibility of building in the same place, except cases when construction of completely destroyed building will be carries out by the Government of the Republic of Tajikistan, companies or individuals.

Heads of regions, districts and cities damaged by the natural disaster should prepare and provide reports to the State Commission Government of the Republic of Tajikistan for Emergency Situations about purposeful use of funds. Depending of the scale of damage it takes 1-6 months until a budget funds provided to the victims. From 2017 to 2020 material damages caused by natural disasters, identified by the State Commission for Emergency situations was to the amount of 155.05 Milion TJS, however State Commission for Emergency situations allocated 14.8 Milion TJS[1].

For example, on May 6-7, 2021 local heavy rains and mudslides have damaged 20 houses in Abdurahmoni Jomi district. In the mid of August 2021 the Government have handed over 14 new houses in the safe area for victims of the natural disaster[2]. On May 11, 2021 there was a mudslide in Kulyab city of Khatlon Region. The disaster has fully damaged 43 houses and 102 partially damaged. Besides, the mudslide damaged 4 schools and kindergarters, 6 km road, 10 bridges, 23 km power transmission lines, 7 power transformers, and 500 m water pipes.

On May 14, 2021 Mayor of Dushanbe has sent 300 tons of construction materials and 170 tons foodstuff. Later the Government of Kulyab has provided aid, such as foodstuff, household items, clothes, construction materials and fuel for 1725 families. In June 2021 the President visited Kulyab city and donated 4 newly constructed houses. The other victims were waiting for additional support from the Government or started rehabilitation works themselves.

[1] Overview of the emergency situations in the Republic of Tajikistan, 2021
[2] Sputniknews – press release link; Myseldon - https://news.myseldon.com/ru/news/index/250738241; Ozodi - https://www.ozodi.org/a/31310214.html

5.1.11. Valuation of Ecosystems Services

A serie of recent ecosystems services valuation relevant initiatives were mapped during the desk review, they are (non-exhaustive) – in chronological order:

2015 -> Scoping document from ECNC and UNEP, on the initiatives related to assessment of Ecosystems Services (ES) in EECCA (Eastern Europe, Caucasus and Central Asia) and SEE (South East European) countries. […] "*The most recent revision stocktaking form for Tajikistan states that the stage of gathering information about ecosystem services status and trends is complete. The stage of developing national targets and identifying specific strategies, and the implementation of these strategies is in progress. However, details about these strategies for ESs are not available.The 5th National Report of Tajikistan frequently mentions the importance of ESs. It includes information about the value of ESs such as forestry and medicinal plants. However, exact details of how this data was collected are not given. The goal of developing a management plan for all ecosystems with consideration of intensity of ecosystem services by 2020 is stated and some targets are laid out for enhancing the benefits to all from biodiversity and ESSs, although no methodological data is given*[1].

2019 -> A study on the variations of ecosystems services value in response to land use/land cover changes in Central Asia from 1995- 2035, showcases that […] *the spatiotemporal variations in ecosystems services values are not yet well understood, however, they conclude that the modelling indicates a significant expansion of cropland (+22.10%) and urban areas (+322.40%) and shrinking of water bodies (-38.43%) and bare land (-9.42%) by 2035. They calculate that cropland ecosystem services value increased by 93.45 billion US$ from 1995 to 2035, which was mainly caused by the expansion of cropland area. However, the area of water bodies decreased sharply during 1995-2035, causing a loss of 64.38 billion US$. Biodiversity, food production and water regulation were major ecosystem service functions, accounting for 80.52% of the total ESVs (Ecosystems Services Value)*[2].

2019 -> A precious initiative to valuate the costs of degradation[3] in Tajikistan from ICARDA allowed to […] give costs indication although *the full costs of land degradation are believed to be high and increasing but they are also difficult to measure. Previous attempts to evaluate the impacts of land degradation had been based on the cost-benefit analysis, using secondary data complemented with expert and individual estimates, to compare the total economic benefits of land restoration to the economic costs of restoring degraded land. Wheat, a staple crop, cultivated in more than 40 percent of agricultural land in Tajikistan, was selected as a particular crop under consideration. Primary survey data from 690 farm households, representing the high, medium and low wheat production potential areas, as well as official statistics and expert estimates were used during the study to generate new and credible estimates of yield losses in wheat fields. The magnitude of land degradation in the country*

[1] ECNC, UNEP, Initiatives related to mapping and assessment of ecosystems and their services in EECCA and SEE countries; Scoping document, 2015

[2] Li J, Chen H, Zhang Chi, Pan T., 2019, Variations in ecosystem service value in response to land use/land cover changes in Central Asia from 1995 – 2035, Link

[3] Sanobar Khudaybergenova, Yigezu Yigezu, Akmal Akramkhanov, Tanzila Ergasheva, Murod Ergashev. (16/12/2019). CoED Leaflet: Estimating costs of environmental degradation in the mountains of Tajikistan EN.

is expected to increase, especially with climate change where extreme weather events are expected with which the cost will also increase. Therefore, the government of Tajikistan, its national and international development partners, civic societies and all citizens should join forces in raising awareness on the gravity of the problem and exert concerted efforts to prevent further degradation and also in taking mitigative measures to improve the situation. Considering that the agriculture sector contributes 18 percent to the GDP, land degradation can adversely affect the country's economy, threatening the livelihoods of about two thirds of the population living in rural areas. Along with waterlogging and salinization, overgrazing and deforestation are identified as the major contributors to land degradation in Tajikistan. Planting trees can be a key to prevent and stop it, especially in the mountainous areas. The resulting environmental degradation has significant toll on economic and sustainable development of the country, calling for integration of these issues. According to the results of the study, the minimum total economic cost of land degradation in Tajikistan in 2019 was between USD $538,674,221 and USD $772,465,936 which are equivalent to 7.59 percent and 10.88 percent of GDP, respectively. While these estimates are conservative, the actual cost of land degradation in Tajikistan could be much higher. The major economic cost is related to crop and crop residue loss in crop lands including those abandoned or fallowed to regenerate (7.45% of GDP) followed by biomass loss in natural pastures (1.73% of GDP). Costs related to land degradation-induced damages on infrastructure, loss of woody biomass, and natural disasters constitute 0.82%, 0.55% and 0.35% of GDP respectively. The magnitude of land degradation in the country is expected to increase, especially with climate change where extreme weather events are expected with which the cost will also increase. Therefore, the government of Tajikistan, its national and international development partners, civic societies and all citizens should join forces in raising awareness on the gravity of the problem and exert concerted efforts to prevent further degradation and also in taking mitigative measures to improve the situation.

2020 - > A publication from Olimov I. A. and Israilov M. I, on the introduction of Payments for Ecosystems Services in Tajikistan, discuss the legal framework, issues and potential mechanisms. The article gives usefull indications on legal barriers to the stablishment of incentives for water, biodiversity and land Payments for Ecosystems Mechanisms (PES) in Tajikistan. In addition, it cites the first PES project in Central Asia (Regional Ecological Center of Central Asia), launched in 2008 in Kyrgyyzstan in collaboration with GEF and local interested parties, including national and local authorities, water users and pasture associations, local experts and general public. The project aimed to improve the environmental health of alpine and subalpine ecosystems by increasing their pasturing sustainability. Among chargeable ecosystem services it was considered: water supply to the water drainage basin, conservation of water quality, biodiversity and forests[1]. They propose a mechanism for PES considering upstream providers and downstream buyers to compensate for measures of reducing water pollution and increasing reforestation to reduce soil erosion, maintain biodiversity, water quality and quantity.

[1] Olimov A. I., Israilov M.I, Introducing payments for ecosystems services (PES) in the Republic of Tajikistan: Legal Framework, Issues and Mechanisms – Genero e Interdisciplinaridade

2021 -> A World Bank initiative to assess the costs of sediment inflow from soil erosion in the Vakhsh river, notalbly the world's tallest dam, Nurek Dam. The project end is in 2021 and is supposed to assess the lower and upper sections of the Vakhsh Basin , including biophysical data sources and modelling and analytical methods; and economic valuation of the impact of sedimentation in electricity production and maintenance of the hydropower plants[1];

5.1.12. Valuation of Disaster Risk Reduction (DRR) prevention through reforestation

Climate change and Tajikistan geography and rural-based population, claim to actions regarding the country's vulnerabilities to disasters. "In many places across the world, disaster risk is increasing due to poorly planned or unplanned socio-economic development in locations exposed to a range of hazards"[2]. That occurrence is potentialized by a degraded environment, such as the mountainous surface of Tajik country. In that sense, implementation of Nature-Based Solutions, such as reforestation, are key actions for DRR. Forest cover can contribute to water flow, and to reduce landslides by stabilizing hillslopes[3].

Disaster risk reduction initiatives need to be reinforced, along with serious investments and economic measures to improve land cover management and remediation. A recent study conducted in the Republic of Korea (2017)[4] contributed to this growing demand, by evaluating the role of forestation on DRR. As a result, they point the benefits of reforestation, especially in the long term. In terms of the valuation of reforestation in DRR context, there is much to be studied and the present report is a first tentative to make progress on prevention measures as response to increase the country's resilience to climate change and food security.

[1] Information at Hydroc website

[2] UNDRR (2020), Ecosystem-Based Disaster Risk Reduction: Implementing Nature-based Solutions for Resilience, United Nations Office for Disaster Risk Reduction – Regional Office for Asia and the Pacific, Bangkok, Thailand

[3] Ibid 1

[4] MARKANDYA, Anil; SON, Yowhan; LEE, Woo-Kyun. Valuation of Reforestation in Terms of Disaster Risk Reduction: A Technical Study from the Republic of Korea. Sustainable Development Goals - Policy Brief Series, UNDP, 2017

6. Analysis & Results

6.1. Ecosystems services and valuation theoretical framework

Environmental goods and services are increasingly recognized as values provided by ecosystems (Bruschweiler et al., 2004[1]). These goods and services are tamed directly and indirectly by humanity. Awareness of cycles natural resources, as well as the interdependence of resources, have increased the "borders" of the thought. Now we are more attentive to the diffuse effects of degradation and interrelationships of ecosystems at global, regional and local levels. Forests, for example, are carbon reservoirs, participate directly in the production of water, maintain the microclimate and rain cycles. The functional multiplicity of the forest-water context ensures the existence of goods and services that have a value either because they are consumed or by their existence and through the regulation of important biophysical processes (Ibid., 2004). Failure to consider these interacting factors, as well as goods and services, leads to the inadequate use of resources, and consequently to the degradation of ecosystems.

Services can have different characteristics:
1- Productive (timber and non-forest products with productive functions);
2- Regulation (regulation of the water cycle, biodiversity of habitats with physiological functions);
3- Services to which no immediate tangible value can be attributed (scenic beauty, recreational function) but whose availability is required.

International market systems have evolved around services of a productive nature. This can be seen from the Doha Ministerial Declaration in 2001, which provides for negotiations on "environmental goods", without going so far as to give a definition (OECD[2], 2006). These negotiations have, above all, provided for the reduction or even the elimination of tariff and non-tariff barriers on environmental goods and services (Ibid., 2006). The OECD definition is as follows:

> *"The goods and services industry includes activities that produce goods and services used to measure, prevent, limit, minimize or correct damage to the environment, such as pollution of water, air and soil, as well as waste, noise and ecosystem issues. Such industry includes cleaner technologies, products and services that reduce environmental risks, minimize pollution and save resources. "(Ibid., 2006)*

The above definition does not consider environmental goods and services from forests and other types of services. According to Bruschweiler et al. (2004), this is due to the prevailing view that these types of goods are free, although these biogeochemical processes are absolutely necessary for the handling of life and productive processes. The unexpressed demand and the perception of infinite

[1] BRUSCHWEILER S., et al., 2004, L'eau et la forêt: gestion d'une interrelation, Rapports Développement et Environnement n°19, Berne, Geographica Bernensia.
[2] OCDE, 2006, Biens et services environnementaux. Pour une ouverture des marchés au service de l'environnement et du développement, Paris, OCDE.

resources did not prompt the creation of a market. They are not governed by "market laws" either, but they nevertheless remain more and more subject to the system of institutionalization of private property. Most natural resources are common resources, i.e. they do not have a well-defined owner, but are in fact the property of a more or less precise group (Rotillon and Bomtems[1], 1998). Such goods and services are often found on a large spatial and temporal scale, making it difficult to establish cause and effect between them and the benefits they generate for humanity (Ibid, 2004).

Before industrialization, common resources were very plentiful and often used satisfactorily. Hardin's "tragedy of the commons" was not yet relevant, as the managerial group was sufficiently stable and small to be able to effectively punish antisocial behavior. This phrase symbolizes the belief in environmental degradation, or even resource depletion, that stems from the use by many people of a common resource. By way of clarification for classical economics "[…] *resources are the elements which make it possible to produce goods*"., And "*Goods are the elements capable of satisfying the aspirations of men* [...]" (Gehanne, 1995[2]). According to this current of thought, economic growth is there to meet unlimited needs with limited resources. Yet before the arrival of modern economic society no one suggested that unlimited needs were an inherent human quality (Sachs, 1993[3]). In addition, Sachs (1980) criticizes the waste of resources, human in the South with disguised unemployment and materials in the North, through the "acquisitive society" and its "superfluous and artificial" consumption, as being one of the main reasons for the "bad-development "which we are witnessing today.

In this sense, the value of environmental goods and services increases with demographic pressure on resources, because it is necessary to produce more in order to meet so-called “infinite” needs. Classical and neoclassical economists propose equally classical economic mechanisms of supply and demand. In contrast, in Payments for Ecosystems Services (PES), a market would be established and serve as platforms (Ibid, 2004). In this case, the demand for the services would be expressed as a value for which payment or some other form of compensation would be given (Ibid., 2004). These calculations, once internalized, will be additional costs for the owner or manager of one or more resources, which must be compensated by the users of that resource.

Not long ago, ecosystems related goods and services were priceless. That is to say, either they entered the economic system as free gifts from nature, or they were protected for reasons of heritage and / or scarcity, and their price was therefore not measurable (Pillet, 2006[4]). The environmental economics approach leads to the notion of total economic value which integrates the long term as well as the "non-use" of the environment into economic policy decisions (Ibid., 2006). For economists of this current, one of the factors of environmental degradation is constituted by the fact that the markets undervalue the prices of natural resources or even consider "the free use of resources" (Barde, 1992[5]). which leads to their overexploitation (Ibid, 1998).

[1] ROTILLON, G. & BOMTEMS, P., 1998, Economie de l’environnement, Paris, Editions la découverte.
[2] GEHANNE J.-C., 1995, Dictionnaire thématique de sciences économiques et sociales 2 : Croissance et déséquilibres, Paris, Dunod.
3 SACHS W., 1993, Global Ecology, Halifax, Fernwood Books Ltd.
4 PILLET G., 2006, Economie de l’environnement. Ecologie de l’économie, Bâle-Genève-Munich, Helbing & Lichtenhahn.
5 BARDE J.-P., 1992 [1991], Economie et politique de l’environnement, Paris, PUF

6.2. Rational for economic valuation

The rational for economic valuation requires to first identify the causality links and characteristics of a certain context. The contextualization shall allow for the identification of the variables of interest and isolate the phenomenon that needs to be studied. The variables of interest in an ecosystem's services approach are mainly positive or negative externalities. An externality is the consequence of economic decisions by an agent that are not accounted for, for instance, a coal mill produces air pollution as a negative externality, meanwhile, a farmer when planting and using multiple species have a positive externality for biodiversity.

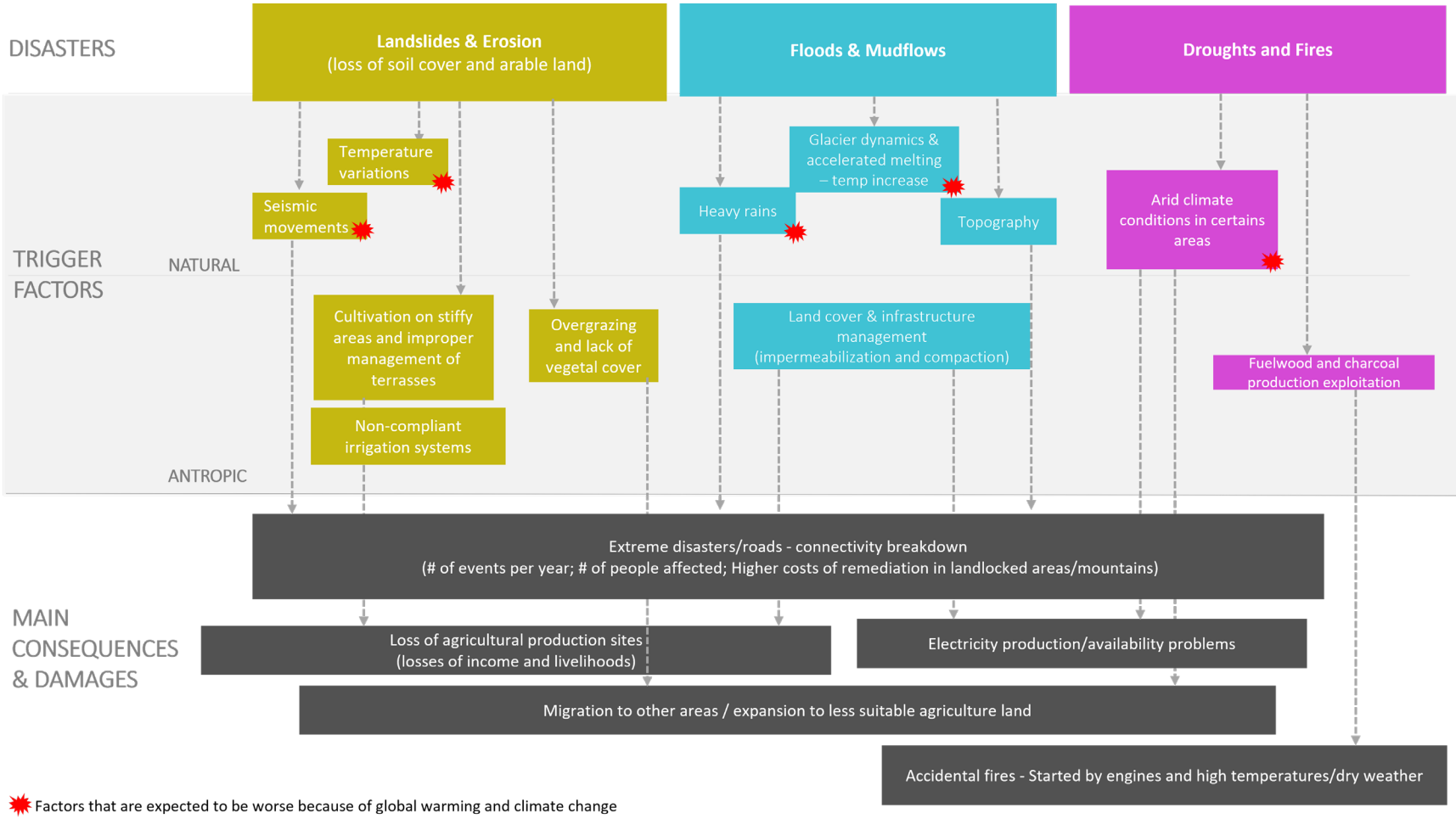
Then, the second stage consists in identifying the physical values for the positive and negative externalities. That is, identify in common metrics (like tons, kilos, cubic meters, frequencies) the ecosystem services we will be looking into. Only then we can convert such values using economic valuation methods.

Figure 01: Economic valuation rational

Following such approach an effort was done to identify the physical values of the externalities. Given the limited time, remote sensing was a key tool to give a first indication of available land under each category and allow for large estimates of soil losses and remediation costs, as well as the potential cost-benefit of restoration. The values presented in this report shall be completed with field data validation and verification by local agents throughout time, more precisely, through the implementation of land cover inventories, and monitoring system that will allow to quantify the effects of maintenance and vegetation evolvements.

Additionally, given the topics complexity, a theoretical framework was created to illustrate and increase the understanding of correlations between different events and factors. The intention is to describe the main disaster groups and to give indications about their key trigger factors and consequences/damages, making a distinction between natural and anthropic factors. This distinction is of great importance to allow the understanding of which factors land cover play a role, and therefore can have either a direct or indirect impact.

Figure 02: Mind map – Main disasters groups, trigger factors and consequences & damages



6.3. Landslides and Soil Erosion

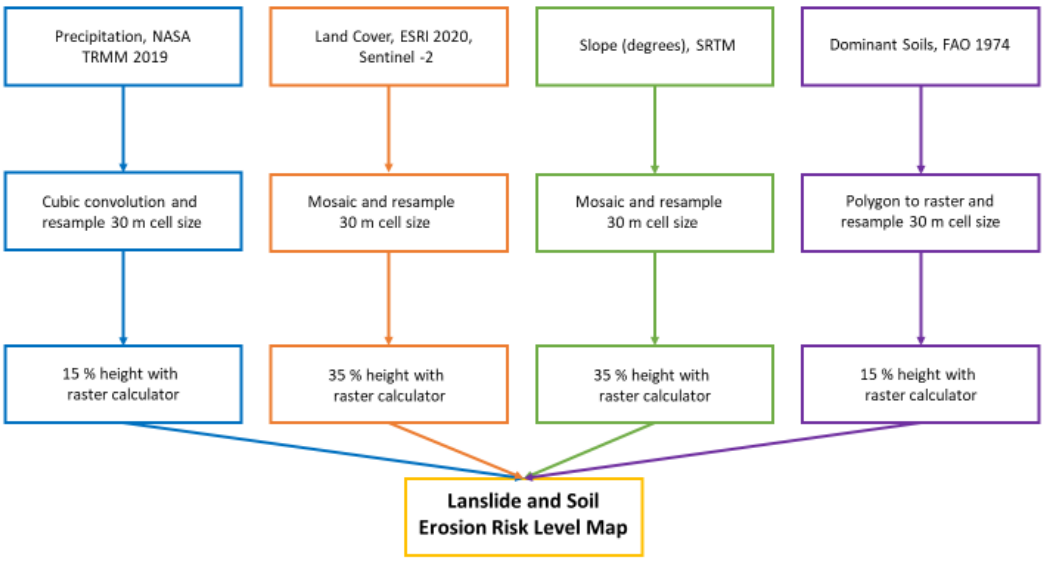
To support the illustration and the relevance of spatializing the priority zones, as well as to quantify land cover today, a landslide and soil erosion risk map was done. An effort was made to better seize the complexity of the first category of disasters, that is, Landslides and soil erosion. For that, "landslide and soil erosion risk" map was done based on the multicriterial analysis technique, where 4 parameters were described (precipitation, land cover, slope and dominant soils), all with 30 meters of spatial resolution. Each class inside the map graded from 1 to 10, from the minimum to maximum. For Erosion degree, as an example, very high slopes are considered grade 10, while water class is considered as grade 1. After each class graduation, each category was classified with a weight based on the importance of the data. The data with higher weight were slope and land cover, with 35% each, followed by precipitation and soil typology, with 15% each. Finally, the 30 meters raster files were processed with the raster calculator equation below:

Pixel level at landslide map = *Land Cover pixel level *0,35 + Slope pixel level * 0,35 + Precipitation pixel level * 0,15 + Dominant Soil pixel level * 0,15*

The approach was developed based on international literature methods of multicriteria analysis and for the soil erosion layer, concepts from the Universal Soil Loss Equation (USLE) were used. This is an empirically based equation developed by Wischmeier and D. Smith from the U.S. Department of Agriculture in the USA in the late 1950s, derived from a large mass of field data, especially erosion plots and rainfall simulator experiments, and computes sheet and rill erosion as follows: A=RKLSCP where A is computed soil loss, R is the rainfall-runoff erosivity factor, K is a soil erodibility factor, L is the slope length factor, S is the slope steepness factor, C is a cover management factor, and P is a supporting practices factor[1].

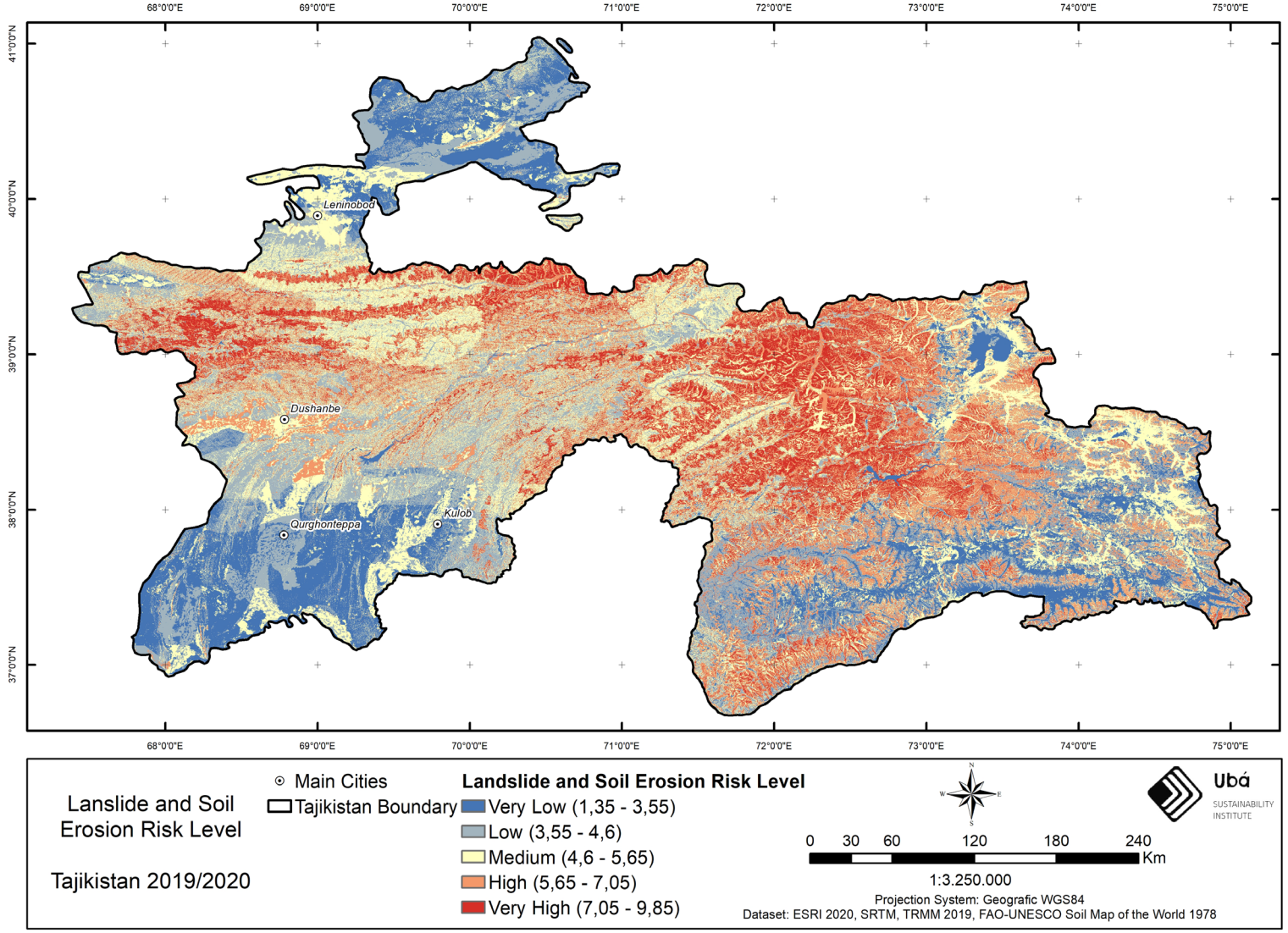
[1] FAO, Universal Soil Loss Equation

Figure 03: Methodology for Landslide and Soil Erosion Risk Level map



The resulting map gives indications of the prioritary areas and surface estimates considering recent information from land use cover from high resolution imagery. This map is intended to be a tool for decision-making with regards to areas that are more proned to landslides and erosion, and where land cover – when fitting their natural occurrence, could be deployed more strongly. In addition, it allowed to have physical values to support the economic valuation.

Map 7 : Landslides and Soil Erosion Risk Level/ Tajikistan 2019/2020



Soil losses are a major concern for agriculture, as pedogenesis is very long and that 25 to 40 billion tonnes of topsoil are lost every year. Soil erosion entails important damages both on-site and off-site and can represent a total annual cost of US$ 400 billion (FAO, Global Soil Partnership, 2013)[1]. It is a major issue, as pedogenesis is very long (thousands of years are needed to form only a few centimeters of soil depth) and that 25 to 40 billion tonnes of topsoil are lost every year (Ibid, 2015). Excessive erosion on bare soil and monocultures has huge consequences for farmers and communities: loss of production means, fertility decrease, landslides increased risks, sediments accumulation in rivers and infra-structures, water pollution, soil particles windstorms.

Trees reduce erosion, thanks to 3 different processes: - branches and leaves slow raindrops speed and reduce the splash effect (when raindrops hit the ground, soil is exposed with an explosive effect, launching soil particles into the air); - trees increase soil water holding capacity [see water services] so less soil particles are removed by friction (laminar erosion); - trees form natural barriers against wind, decreasing its impacts.

On the mechanical side, trees stabilize soil layers through the binding action of their roots, which provide considerable cohesion. On the hydrological side, trees play a key role in water interception (fog, rain and runoff), and a greater amount of rainfall is then needed to trigger landslides.

According to UNDP (2012)[2], estimations suggests that 87,9% of the total area of Tajikistan and 97,9% of agricultural lands suffer from some level of erosion. Regarding irrigation, 97% of lands are degraded by non-compliant irrigation systems. In addition, Tajikistan's intrinsic characteristics of having its territory mostly covered by mountains, it is highly vulnerable to disasters related to seismic movements. Scientific knowledge has grown towards the fact that there are correlations between global warming and seismic movements.

A study from Bathurst et al.,2010 used mathematical modelling showed that planting trees on a grassland field could reduce the occurrence of landslides by 2/3[3] in Latin America. Obviously, such a rate depends considerably on natural factors and each locality's specificities. However, it gives an idea of how powerful adding land cover can be to avoid landslides. In the situation of Tajikistan, it is important to mention the difficulty of isolating the natural factors for seismic movements and the share of the disasters due to lack of land cover. What is certain, is that, by adding a land cover layer, the situations could only be improved, not only with regards to the climate induced disasters frequency, but also food security since soil erosion is critical, and that 1/3 of the country's economy depends on agriculture.

Erosion has on-site and off-site damages. That is, the main on-site impact of soil erosion is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil, and the

[1] Global Soil Partnership Endorses Guidelines on Sustainable Soil Management http://www.fao.org/global-soil-partnership/resources/highlights/detail/en/c/416516/ (2017).

[2] BANN, Camille; SHUKUROV, Rakhmon; BOZIEV, Lutfullo; RAKHMATOVA, Dilorom. The Economics of Land Degradation for the Agriculture Sector in Tajikistan – A Scoping Study. Dushanbe: UNDP-UNEP Poverty Environment Initiative In Tajikistan, 2011.

[3] Bathurst et al., 2010. Modelling the effect of forest cover on shallow landslides at the river basin scale.

reduced water-holding capacity of many eroded soils. Such losses could be extrapolated to each Derkhkan family's losses for several generations, even more considering that the majority of the soils in Tajikistan are Lithosols, and therefore, once that first layer of fertility is lost, mostly of the productive capacity is also lost. According to the calculations of scientists of the Institute of Soil Science and Agrochemistry of the Tajik Academy of Agricultural Sciences, the yield loss on heavily eroded soils is 9.7 centners/ hectare (970 kg per ha).

In monetary terms, although outdated, an extensive exercise was done by Pimentel et al. in 1995[1] to illustrate the costs of soil erosion in the USA using the replacement cost method. Both together, on-site and off-site resulted in 44 399 million dollars per year. The authors concluded that for each $1 invested in soil conservation measures, $5.24 would be saved of remediation costs and food supply losses.

In Tajikistan, according to the recent study from Khudaybergenova et al, 2019[2], the minimum total economic cost of land degradation in Tajikistan in 2019 was between USD $538,674,221 and USD $772,465,936 which are equivalent to 7.59 percent and 10.88 percent of GDP, respectively. While these estimates are conservative, the actual cost of land degradation in Tajikistan could be much higher. The major economic cost is related to crop and crop residue loss in crop lands including those abandoned or fallowed to regenerate (7.45% of GDP) followed by biomass loss in natural pastures (1.73% of GDP). Costs related to land degradation-induced damages on infrastructure, loss of woody biomass, and natural disasters constitute 0.82%, 0.55% and 0.35% of GDP respectively.

To support with some indication of the extension of efforts that would be necessary, we mapped the areas that could be suitable for forest restoration (below 3.200 m of altitude) and calculated the extend of areas per class of risk.

Table 6: Area estimate per risk category

Up to 3.200 m Altitude			
Risk Class	**Area Km2**	**Hectares**	**Area %**
Very Low	12 640	1 264 010	19
Low	20 101	2 010 092	30
Medium	22 919	2 291 940	34
High	9 836	983 569	15
Very High	1 061	106 079	2
Total	**66 557**	**6 655 690**	**100**

Source: This study.

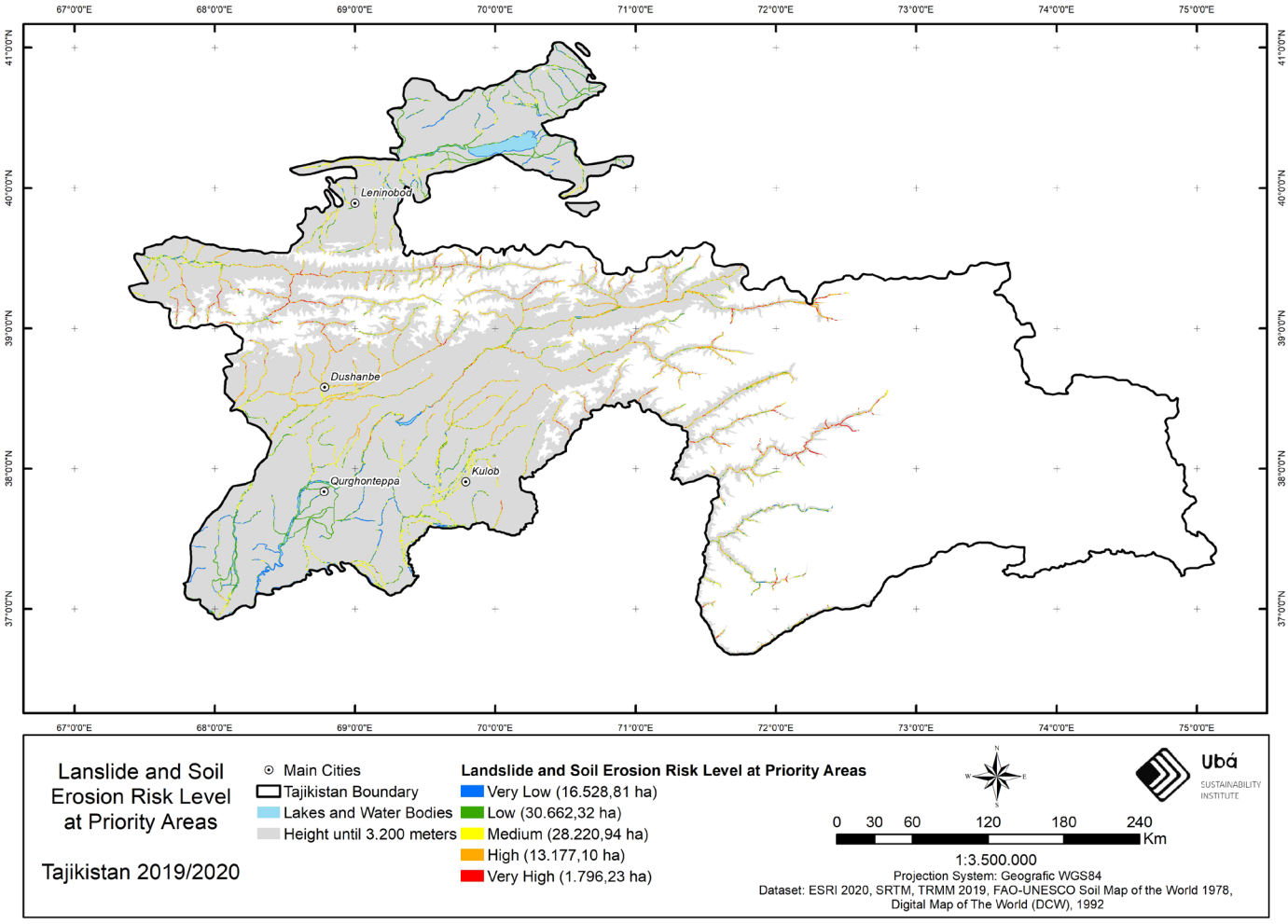
The above table indicates that if the country is willing to reinforce its land cover as positive agenda, it could target 5% of its territory. Also, it could be possible to give priority to the higher risk bound, totaling approximately 1.1 million hectares.

1 Pimentel et al., 1995. Environmental and economic costs of soil erosion and conservation benefits

2 Sanobar Khudaybergenova, Yigezu Yigezu, Akmal Akramkhanov, Tanzila Ergasheva, Murod Ergashev. (16/12/2019). CoED Leaflet: Estimating costs of environmental degradation in the mountains of Tajikistan EN.

Another exercise was done as well to identify the extend of areas that would be priority to protect riverain areas, as a main action to prevent floods and mudflows. For that, a 50 m margin was done around the main river courses, resulting in 1.796 ha of very high risk areas, 13.117 ha of high and 28.220 hectares of medium risk areas.

Map 8: Landslide and Soil erosion risk level in buffer areas (50 m margin of main water courses)



Source: This study.

6.4. Floods & Mudflows, Fire and Droughts

Water regulation provides essential services for the development of cultures such as: fog and water retention, salinity management, resilience to extreme flood and drought events, etc. Mass deforestation tends to disrupt the hydrological cycle: it leads to a much drier soils and climate and threatens crop sustainability[1]. Land cove and mostly trees play a key role in regulating the hydrologic cycle and avoid extreme climatic events: - Increased soil moisture protect plants from drought periods; - Soils are able to store larger amounts of water and then reduce the flooding risks.

Future precipitation projections are expected to show large shifts in terms of variation, intensity, and geographical distribution. Summers are expected to be wetter and winters drier, which can lead to both flooding and longer droughts. Many small glaciers in Tajikistan will completely disappear in 30 to 40 years if the current rate of glacier degradation continues. Glaciers have suffered a reduction in comparison with the last decades of 1%[2], which can lead to floods, GLOFs and change in river flow.

By 2030, the average annual temperature in most regions of Tajikistan is expected to increase by 0.2-0.4 °C. This perspective coincides with the trends observed in the country over the past 15-20 years. Climate risks and their impact on key socio-economic sectors in Tajikistan are clear. The country has up to 500 different natural disasters per year, resulting in losses and losses of between $ 20 million and $ 100 million annually. Melting glaciers, fluctuations in the water level and flow of major rivers and their impact on hydroelectric power generation and agriculture are just a few examples of climate impacts in Tajikistan. For comparison – in previous decades, the total area of glaciers was at the level of 6% of the total territory of the country, while by 2013, this figure was approximately 5%. This trend leads to changes in water resources and river flow. For example, the river flow in the Aral Sea basin, which originates in Tajikistan, currently amounts to 53 cubic kilometers, which is 4 cubic kilometers less than the figure recorded fifty years ago. Climate risks seriously threaten the development of agriculture. For example, the 2001-2002 drought caused a critical 30% to 40% drop in crop yields in the most arid areas, while the 2008 drought caused a 40% drop in the country's yield[3].

Drought is one of the most severe meteorological phenomena, and in extreme cases can lead to significant material damage. It is estimated that the 2000-2001 drought in Tajikistan and neighboring countries was the most significant natural disaster in the last decade. Due to climate warming, the assessment of drought dynamics, its long-term forecasting and cooperation of countries on environmental issues play an important role. Due to a warming climate, it is likely that droughts in Tajikistan will occur with greater intensity and frequency. The Government of Tajikistan recognizes the need to reduce the vulnerability of the agricultural sector to climate change, especially given that agriculture contributes significantly to GDP and employment in the country: it accounts for 18-22 % of GDP and employs more than 60% of the population of Tajikistan.

[1] Global Water Intelligence 2012 Water Tariff Survey, September 2012, Global Water Intelligence vol 13 issue 9 pp37-41
[2] MUSTAEVA, Nailya; WYES, Heinrich; MOHR, Benjamin; KAYUMOV, Abdulkhamid. Tajikistan: Country situation assessment. Pathways To Resilience In Semi-Arid Economies (Prise), 2015
3 Expert view

Watersheds with conventional monocultures have very low water yields: evapotranspiration is close from zero,soils are compacted, infiltration rate is low, the amount of runoff is high, etc. The result is that few "green water" is available for farmers. Clean cut of trees for agriculture (leaving bare soils) leads to rising water tables and this results in increased discharge of salt into streams and soil. Soluble sodium, magnesium and calcium salts accumulate to the point that soil fertility is severely reduced. This phenomenon also happens when the irrigation is too extensive. Countries most affected by soil salinity are Australia, Tunisia, Egypt, Iraq, Iran, Pakistan and the US region of California[1]. Conventional monocultures have low water yields and infiltration capacity. Hydrological cycles are not regulated in such areas and crops are very sensitive to extreme climatic events, such as drougths and floods.

Revegetation is an effective option for addressing the problems of salinisation. Trees provide important services in terms of hydrological cycle regulation by capturing a great amount of runoff water. They prevent soils from water saturation and avoid the rise of salts naturally accumulated in soil lower layers[2]. A study documented that reforestation can be substantially successful in lowering a saline groundwater table: for instance, an extensive reforestation allowed to decline by 5.5 m (relative to the ground level) and by 7.3m (relative to a nearby pasture control site) the saline groundwater table[3]. Another study give indications on how effective reforestation could be in crop yields. A decrease was estimated for the nine leading crops in the study area. On average, 16% of farmers' income is lost in the case of slight salinisation, 39% of income is lost for moderate salinisation and about 78% of income is lost in the case of severe salinisation. We assume that in a case of severe salinisation, reforestation can decrease the economic impact by 50%[4].

1 Darmendrail et al., 2004. Assessing the Economic Impacts of Soil Degradation. Final Report. Volume II: Case Studies and Database Research

2 Ibid 2004

3 Bari et al., 1992. Lowering of a shallow, saline water table by extensive eucalypt reforestation.

4 Heaney et al., 2000. Targetting reforestation for salinity management.

7. Conclusions

In recent years, an increase in the frequency and intensity of dangerous weather events and heavy precipitation has already led to an increase in natural disasters in Tajikistan. The number of natural disasters recorded in the country is about 3.000 per year (CES[1], 2009). Mudslides, landslides and floods are the most common natural disasters in Tajikistan, mainly occurring in spring and early summer (April-June). The authorities registered an annual cost of disaster relief of 1.6 percent of GDP. To that, we add intangible aspects as the number of lives lost, as well as land and livelihoods. In addition, low social security and low banking (liquidity) of rural living populations, makes them even more vulnerable to natural disasters, considering that all their wealth/belongings is roughtly in their land (husbandry and material goods).

Needless to say that floods, mudslides and landslides annually lead to the destruction of agricultural crops and cause significant dammage to arable land. In most cases, the second sowing of agricultural crops is carried out in the fields, which requires significant costs. Such impacts lead to a decrease in the level of agricultural production and a reduction in the family budget. The same can be said about droughts. Such impacts over poor rural population increases their vulnerability and push them even more into precarity. For example, the 2001-2002 drought caused a critical 30% to 40% drop in crop yields in the most arid areas, while the 2008 drought caused a 40% drop in the country's yield[2].

Maintaining land cover would increase the maintenance of key strategic resources, soil and water, followed by biodiversity. The later are key not only from a DRR perspective, but also in terms of the adaptative capacity of Tajikistan's population in the long term.

As an essai of quantification of the different ecosystems services that could positively impact the country's situation through reforestation and increase in land cover, a recap table was build.

[1] Committee on Emergency Situations

2 Expert view

Table 7: Recap table of main conclusions and valuation

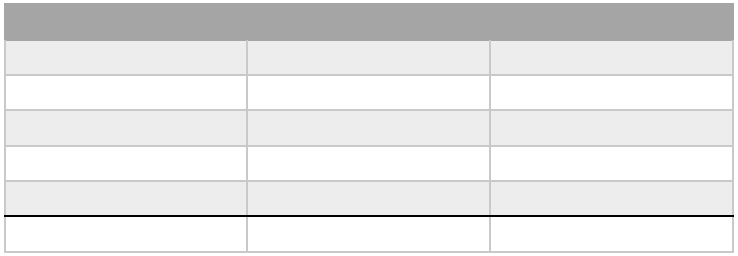
Degradation/ Threat	Land cover influence	Tangible value	Intangible value
Soil erosion & Loss of arable land	-Soil stabilization and protection of first layer (fertility)	**Reducing tons or centimeters of topsoil losses and maintenance of agricultural productivity** > Soils heavily eroded are losing **970 kg/ hectare** (the Institute of Soil Science and Agrochemistry of the Tajik Academy of Agricultural Sciences). According to UNDP (2012)[1], estimations suggests that 87,9% of the total area of Tajikistan and 97,9% of agricultural lands suffer from some level of erosion. Regarding irrigation, 97% of lands are degraded by non-compliant irrigation systems. - Considering that approximately 75% of Tajikistan soils are Lithosols, with 10 cm depth, such soil losses could represent the end of arable land in a few decennies. And of course, this would generate drastic reductions to the national GDP and for livelihoods. - The recent study from Khudaybergenova et al, 2019[2], the minimum total economic cost of land degradation in Tajikistan in 2019 was between USD $538,674,221 and USD $772,465,936 which are equivalent to 7.59 percent and 10.88 percent of GDP, respectively. While these estimates are conservative, the actual cost of land degradation in Tajikistan could be much higher. The major economic cost is related to crop and crop residue loss in crop lands including those abandoned or fallowed to regenerate (7.45% of	- Completely loss of productive capacity and key ressources for economic and food souveraignity; - Bequest value of soil and arable land for next generations; - Diffuse downstream damages to small infrastructure and reduction of water quality and quantity. - Migration of population to other lands/countries.

[1] BANN, Camille; SHUKUROV, Rakhmon; BOZIEV, Lutfullo; RAKHMATOVA, Dilorom. The Economics of Land Degradation for the Agriculture Sector in Tajikistan – A Scoping Study. Dushanbe: UNDP-UNEP Poverty Environment Initiative In Tajikistan, 2011.

[2] Sanobar Khudaybergenova, Yigezu Yigezu, Akmal Akramkhanov, Tanzila Ergasheva, Murod Ergashev. (16/12/2019). CoED Leaflet: Estimating costs of environmental degradation in the mountains of Tajikistan EN.

		GDP) followed by biomass loss in natural pastures (1.73% of GDP). Costs related to land degradation-induced damages on infrastructure, loss of woody biomass, and natural disasters constitute 0.82%, 0.55% and 0.35% of GDP respectively.	
Landslides, Floods and Mudflows	To a certain extend, excluding seismic mouvements, land cover stabilizes the soil and reduces water speed	Reduction in number of events and avoidance of remediation costs >A study from Bathurst et al.,2010 used mathematical modelling showed that planting trees on a grassland field could reduce the occurrence of landslides by 2/3[1] in Latin America. Extrapollating that figure for illustrating purposes, applied to the Tajik context, this could represent a reduction from 13 landslides that occurred in 2019, to 5 events in the year, reducing remediation expenses. From 2017 to 2020 material damages caused by natural disasters, identified by the State Commission for Emergency situations was to the amount of 155.05 Milion TJS, however State Commission for Emergency situations allocated 14.8 Milion TJS[2]. Mudslides, landslides and floods are the most common natural disasters in Tajikistan, mainly occurring in spring and early summer (April-June). The authorities registered an annual cost of disaster relief of 1.6 percent of GDP. By 2060, Tajikistan is expected to lose $136 million annually due to natural disasters[3]. Approximately 2% of the current national GDP	In disasters, a few aspects are uncountable under an economic lens, that is: the Loss of lives, livelihoods and families left without resources – given lack of insurance, liquidity and social security. In addition, one impact that is complex to estimate is the level of migration of population due to such extreme events.

[1] Bathurst et al., 2010. Modelling the effect of forest cover on shallow landslides at the river basin scale.
[2] Overview of the emergency situations in the Republic of Tajikistan, 2021
[3] Bahodur Sheralizoda at 6.11.2021

		(an estimate that excludes inflation and eventual losses of productive resources).	
Water regulation & Droughts	-Increases water filtration and microclimatic capacity of water reception - Reduces watertable and salinity in soils	Improvement of water availability and quality conditions > Watersheds with conventional monocultures and bare soils have very low water yields: evapotranspiration is close from zero,soils are compacted, infiltration rate is low, the amount of runoff is high, etc. The result is that few "green water" is available for farmers. Revegetation is an effective option for addressing the problems of salinisation; whereas trees provide important services in terms of hydrological cycle regulation by capturing a great amount of runoff water. They prevent soils from water saturation and avoid the rise of salts naturally accumulated in soil lower layers. A theorectical exercise was conducted to estimate the surface that would be required to be reforested in order to increase water courses and implement buffer zones, protecting water resources (50 m borders of the main watercourses).  Considering those assumptions, targeting an initial 15.000 hectares (Very high and High categories) would reduce water erosion and create buffer zones in such areas; supporting water filtration and infiltration. A second stage would be to implement reforestation in	- Water is directly linked to wellbeing and living conditions; - Water is also important for scenic beauty and as a support for all living beings

		Medium to Low risk categories, increasing their resilience, a total of 58.886 hectares. Although it is extremely hard to estimate the stocks and flows of water resources that are very site-specific, a study[1] analyzed 145 experiments to assess the effects of afforestation and deforestation on water yields. A 100% deforestation of hardwood forests as juniper, oak, aspen and juniper increases 200 to 215 mm the water run off, increasing laminar erosion. Finally, Tajikistan taxes system is intimately linked to water availability, notably for irrigation. Water depletion has both negative effects over state income and agricultural production. In 2001-2002 drought caused a critical 30% to 40% drop in crop yields in the most arid areas, while the 2008 drought caused a 40% drop in the country's yield[2].	
Climate change mitigation & carbon storage	- Forests have an impact in air humidity, in carbon storage and climate change mitigation	**Contribution to climate mitigation targets (carbon storage and Greenhouse Gases emissions)** According to Tajikistan NDC, the following sequestration rates (UNDP supported study) are considered for the country's vegetation per management unit:	- Forests, shrubs and grasslands have positive impacts in biodiversity, as well as spiritual and Non-Timber Forest Products (nuts, fruits, medicinals) livelihoods in harsh environmental conditions.

[1] Sahin et al., 1996. The effects of afforestation and deforestation on water yields.
[2] Expert view

Carbon mitigation potential per activity		
Reforestation / Afforestation	13,60	tCO2e/ha*year
Natural regeneration	9,20	tCO2e/ha*year
Active forest regeneration	11,90	tCO2e/ha*year
Forest management improvement	2,00	tCO2e/ha*year
Improve pasture productivity	1,30	tCO2e/ha*year

Considering a theoretical exercise of having 6.65 million hectares to be reforested, applying the Reforestation/Afforestation rates displayed above, a total gross contribution of 90 million tonnes of CO_2e per year could be sequestered and stored in the living biomass. For the 90 385 hectares of prioritary areas, a total gross carbon sequestration rate of 1.2 million tonnes of CO_2e per year could be achieved.

This study intends to contribute to the understanding of how forests and lanc cover influences Disaster Risk Reduction in the context of climate change. In the case of Tajikistan, its extremelly exposure to such events, added to its sensitivity, creates a delicate situation in terms of reverting the critical situation of its environmental resources. Clearly, either through a national economic strategy lens, or a smallfarmers lens, an effective management of forests, shrubs and all other land cover are highly recommended – not only in full plots, but through hedgerows and agroforestry/sylvopasture systems. Grazing and pasture rotation, as well as planting of fuelwood destinated plots would also be welcome in order to reduce pressure over the existing vegetation.

In terms of monetary valuation there is a challenge to define the exact costs and losses, since many of the methods for economic quantification are based on a private-property rational. An underlying factor of degradation may be that the land are not fully owned by its occupants, and therefore, it creates a sense of non-belonging. The responsibility of each agent becomes blur and difficult to define, through a model of pollutor-pays principle, or land value losses. In very disaster-prone areas, where land tenure rights are either legally secure (de jure) or socially legitimate (de facto), people have confidence in undertaking disaster mitigation and preventive actions, and have confidence they can return to their land after a disaster. If, however, their land tenure rights are not secure, they face a real risk of either the government preventing them from rebuilding in the same place, or of being the victims of land-grabbing. Improved tenure security, and therefore access to land, provides an incentive for landholders to invest in measures to improve their land, such as soil protection, tree planting, pasture improvement, irrigation or sustainable cropping [1].

To the current situation, it adds up the complexity of climate change future projections for the region. By 2030, the average annual temperature in most regions of Tajikistan is expected to increase by 0.2-0.4 C. This perspective coincides with the trends observed in the country over the past 15-20 years. Climate risks and their impact on key socio-economic sectors in Tajikistan are clear. The country has up to 500 different natural disasters per year, resulting in losses and losses of between $ 20 million and $ 100 million annually.

Melting glaciers, fluctuations in the water level and flow of major rivers and their impact on hydroelectric power generation and agriculture are just a few examples of climate impacts in Tajikistan. The country is a water tower in Central Asia, with 60% of glaciers and one of the largest glaciers outside of the polar region.

For comparison – in previous decades, the total area of glaciers was at the level of 6% of the total territory of the country, while by 2013, this figure was approximately 5%. This trend leads to changes in water resources and river flow. For example, the river flow in the Aral Sea basin, which originates in Tajikistan, currently amounts to 53 cubic kilometers, which is 4 cubic kilometers less than the figure recorded fifty years ago[2].

[1] Mitchell, David & Myers, Matt & Grant, Donald. (2015). Land valuation: a key tool for disaster risk management. Land Tenure Journal.

[2] TAJIKISTAN: Situational analysis of socio-economic development in the context of climate change. Report of CAREC and the PRISE research project in Tajikistan

In conclusion, considering a range of costs for reforestation from $200 – 2 232 TJS to $3.000 – 33 480 TJS per hectare, starting with low cost techniques as assisted natural regeneration and management of forests patches, going up to complex plantations in steep slope and in semi-arid regions. Applied to the estimates of 90.385 hectares of priority areas (buffer zones around main water courses below 3 500m of altitude) to be restored for water and soil conservation, a cost range of $18 Million -200 TJS up to $271 Million- 3 billion TJS would be necessary as an effort to increase the adaptative capacity and reduce disasters. Therefore, this would allow to avoid remediation costs estimated between $ 20 million – 223 million TJS up to $ 100 milion – 1.1 billion TJS of tangible dammage annually. That without accounting for permanent losses of intangible aspects and a continous environmental degradation that is priceless. In addition, such plantations would also contribute to climate change mitigation efforts, sequestering a total gross carbon sequestration rate of 1.2 million tonnes of CO2e per year could be achieved.

In terms of impact on the GDP, the study from Khudaybergenova S., Yigezu Y., Akramkhanov A., Ergasheva T. and Ergashev M. (expert contributor of this study) to the CoED, has achieved to estimate a minimum total economic cost of land degradation in Tajikistan in 2019 between USD $538.674.221 and USD $772.465.936 which are equivalent to 7.59 % and 10.88 % of GDP, respectively. While these estimates are conservative, the actual cost of land degradation in Tajikistan could be much higher. The major economic cost is related to crop and crop residue loss in crop lands including those abandoned or fallowed to regenerate (7.45% of GDP) followed by biomass loss in natural pastures (1.73% of GDP).

Such indicators are of concern and are certainly low if we consider irreversible problems of soil fertility losses, salinization and water scarcity, affecting the country's main domestic source of income – that is 18-22% of the country's GDP – agriculture and its dependent population -1.5 million people employment.

8. Study Limitations

The main limitations for the study implementation, were the following:

- Limited time for the data collection and discussions with governmental agencies, and consultation of key organizations and experts;
- Limited sources of national datasets for the remote sensinsg and issues with outdated information, difference with spatial resolution and scale of the different maps available;
- Forest classes may include perenials. In general further validation of classes of land use, and soil types are needed;
- In terms of the physical evaluation, it is challenging to dissociate natural from anthropic triggers factors causing natural disasters;
- Still on the physical evaluation, further studies would be welcome to validate remote sensing assumptions and categories;
- In terms of the economic valuations, ownership by State of most of the resources makes it hard to assess private costs for damages applying the classical tools for monetary valuation; also, tenurial rights are quite complex and could be better understood in order to create positive incentives for sustainable management of land cover;
- Finally, in terms of the economic evaluation, it would be welcome to differentiate the emergency costs and losses, from the underlying and average and long term dammages (that is, families and communities that are displaced and lost all their goods/wealth) and how that will impact society in the long term.

9. Study Implications

We expect that the current research could build the ground for the Tajik context to:

- Support decision-making with new remote sensing information;
- Share recommandations on mechanisms to create incentives and current governance aspects that could be increasing degradation factors;
- Support funding requests and pledges from the national government and insist on the relevance of the Forestry Department and the need to add more trees/shrubs in the landscape;
- Point out the differences between underlying factors of vulnerability and anthropic action for climate change;
- Point out the eventual losses in the future related to the current tax system and vulnerability of rural population with relation to liquidity and their adaptative capacity.

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ANNEXES

Annex I : Methodological framework

(In English)

Categories	Subcategories	Key questions
Environmental	Land cover	What is the current country land cover? Can you please describe the current land cover? Does the country has a national land cover assessment? Is it a regular study? Do you monitor the historical evolvement of the land cover? If so, who does it and with wich frequency? Can we have acess to that information? What is the national definition of the different land cover present in Tajikistan? For instance, what is forest, what is pasture, etc? Who manages the maps? Can we have acess to the files? Do you undertake national inventories and assessments on the land cover and biomass?
	Biomes	Does the country has a national biome classification? Can you please share the main biomes in the country? Who does it? Who manages that classification? Can we have access to that description? Can we have the maps?
	Topography and Relief	Does the country has a national map of the topography and relief of its territory? Is it historically monitored? By that we mean, is the relief monitored - for instance, when there is a landslide, do you compute that event somewhere? With what frequency?
	Geology (soil types and deepness)	What are the main soil types in the country? What are the more frequent deepness of the soil in Tajikistan? What are the soils that are more vulnerable to erosion? Does the country has a national soil typology and deepness map and monitoring system? Is there an agency responsible for conducting soil sampling and analysing soil quality, and eventually soil organic carbon? Is there an agency responsible for analysing the soil erosion and losses? Is there a historical analysis? What is the current status? Is erosion a problem?
	Climate	What are the current climatic zones in the country? Does the country has a national meteorological analysis center or department? With what frequency that data is analyzed? Who is responsible for that information? Are there historical information available? Are there special agencies that monitor meteorological changes and eventual increases in rainfall, wind, etc? Do you monitor extreme climate events? What are the existing climate types in Tajikistan? How do we expect the climate to change in the next years?
	Rainfall	What are the current rainfall in the different areas in the country? Is rainfall monitored? Does the country has a national meteorological analysis center or department? With what frequency that data is analyzed? Who is responsible for that information? Are there historical information available on rainfall evolvement? Are there special agencies that monitor extreme rains, or storms risks ? Do you monitor extreme climate events? How do we expect rainfall to change in the next years? Do you have any early warning systems at your disposal?
	Water availability	What is the current situation on water availability in the country? Are there often droughts? If so, what is the historical tendency? Does the country have specific agencies for water quality and quantity monitoring? What is the main source of water in the country? Tap water or rainfed? Are there water and sewage treatment services? Who is responsible for monitoring water availability? Who decides who should use and give regulation to manage disputes? Is irrigation common? And where?
	River basins	How many river basins are there in the country? Is there/Are there a riverbasin that are more important for the country? If so, which one are they, and why? What is the current river basin distribution in the country? Does the country have an official map? Is it actualized? Are there specific agencies or decentralization systems to manage water through river basin comittees for example? Are there specific regulation towards river basins management and water withdrawn and disposal in rivers? Are there specific laws that prevent deforestation or plantations in water courses and in riparian zones? Is there information related to the variations in water quantity and quality in the different river basins? Is there any information on historical events of floods or droughts? And is there any prediction system in place for floods and droughts too?
	Disasters (frequency and intensity) - primarily floods, mudflows, landslides and droughts	Were there any disasters in the history of Tajikistan that were relevant and documented? Is there an agency/institution that monitores and document such events? Who is that?
	Fires incidence (frequency and intensity)	Is fire a common threat? Why? What are the main drivers? Is there a specific season? Are there historical data on fire risks and events? Are there organizations, like fireman associations or other that may have information on fire events?
	Carbon sequestration and storage potential	Do you know the carbon storage and sequestration potential of Tajikistan forests? Are there any studies or agencies/organizations/universities working on this?
	Forests and restoration	Can you please describe the costs for reforestation and forest restoration? Does the government has a national plan for reforestation and land restoration?
	Forestry degradation and deforestation drivers	What are the main drivers of forests, shrubs and pastureland degradation and deforestation? Are there agencies/institutions that monitor that aspects? How the landscape has evolved and how those drivers will behave in the next years? What is the current regulation with regards to deforestation and degradation of current land cover in the country (federal, regional and district level)? Are there any specific measures for overgrazing and pastureland control? What are the numbers in terms of number of animals per hectare or per familly? How is this evolving throughout the time?

Legal/Institutional	Land tenure & legal frameworks for terracing and other actions that can prevent extreme events in the forestry sector	What are the land tenure typologies in Tajikistan (private, public, communal, etc)? Can you please describe how well those categories are defined, and how, historically they have evolved? Are there land titles in Tajikistan? How do you prove ownership? Is there a national system that allows to identify to who belongs a certain area? Who are the organizations responsible for that? Who regulates terracing and other infra-structure activities that could prevent disasters? As well as other activities that may change the landscape (like deforestation permits, etc)?
	Legal/Regulatory frameworks related to land cover management and usage (ex. 2013 national law on pastures, etc)	What are the existing regulation over forests, pastureland, shrubs and other relevant cover?
	Tax mechanisms	Are there tax mechanisms in rural and urban areas? Is that something landowners have to pay annually ? How much?
	Institutional Extreme events risks levels monitoring organizations and governmental/institutionalized coping mechanisms	Are there institutionalized support for victims of natural disasters? Does the government gives any aid? Are there organizations responsible for monitoring extreme events? And the costs of such? Is there specific regulation on climate-disasters?
	Banking and investment system and capacity in the country	What is the current banking system in Tajikistan? Are there insurances available for farmers or individuals? Does bank accounts have enough capilarity in rural areas?
	National insurance schemes if existing	Are there national insurance schemes? Do they cover climate-induced disasters?

Social	Energy sources and usages (special attention to fuelwood)	What are the main energy sources in the country? Is fuelwood a common energy source? Is that regulated (for example, some species are not allowed to be cutted, a certian quantity per family per area? Who decided that ? The village leader? How much does fuelwood represents in the average family economy?
	Population size, identities/ethnical, structure,	What is the current population size and distribution in the country? What are the demographic trends (past and present)? Are there specific ethnies or groups that entail a different relationship with the forests/srhubs? Who monitors that information and with which frequency? What is the average family structure (as an exemple, 2 adults + 3 children, + 1 elder)?
	Purchase Power Parity (PPP) levels in the country	What are the PPP level in the country per region? What is the average income per region? What are the average cost of living per region?
	Main sources of country's income	What are the main sources of the country's economy? Who displays such information? Is it accessible? What is the part the economy depends on land and agriculture? And that historically?
	Potable water and sanitation conditions	cf water availability
	Transport/roads conditions in the country	What is the transport and roads conditions in the country? How those roads are maintained? Are there impact studies when those roads are implemented? How those transport conditions may react to disasters? Can they help or worsen the situation of local victims? Is there a plan for disaster risk reduction?
	Evidence of remediation costs after disasters	Are there any evidence of remediation and compensation costs for disasters and victims? When infrastructure was damaged, were they replaced/rebuilt? Is so, who paid for that? What is the process?
	Social security with regards to extreme events and insurances	Are there any social security mechanisms to support victims from climate-induced disasters?
	Opportunity costs of typical economic activities	What are the main economic activities per region? Can we establish an opportunity costs for each or the main activities in case of a disaster, so that we can estimate the costs if a person have to stop working. Are there available studies on that?
	Evidence of damages by extreme events and how much they cost to people	Are there national evidence on the number of extreme events, and the remediation costs for infrastructure and for people?

1. Перечень ключевой информации			
Категории	Подкатегории	Ключевые вопросы	Потенциальные организации / агентства
Окружающая среда	Земельный покров	Каков растительный покров страны в настоящее время? Не могли бы вы описать нынешний растительный покров? Есть ли в стране национальная оценка растительного покрова? Исследование на регулярной основе? Вы отслеживаете историческую эволюцию земного покрова? Если да, то кто это делает и с какой периодичностью? Можем ли мы получить доступ к этой информации? Каково национальное определение различных видов земельного покрова в Таджикистане? Например, что такое лес, что такое пастбище и т. д.? Кто управляет картами? Можно ли получить доступ к файлам? Проводите ли вы национальные кадастры и оценки земного покрова и биомассы?	Министерство сельского хозяйства Республики Таджикистан Агентство лесного хозяйства при Правительстве Республики Таджикистан Государственный комитет по земельному управлению и геодезии Республики Таджикистан Органы местной власти
	Биомы	Есть ли в стране национальная классификация биомов? Не могли бы вы рассказать об основных биомах страны? Кто этим занимается? Кто управляет этой классификацией? Можем ли мы получить доступ к этому описанию? Можно карты?	Те же, что и выше + Комитет охраны окружающей среды при Правительстве Республики Таджикистан
	Топография и рельеф	Есть ли в стране национальная карта топографии и рельефа ее территории? Это исторически отслеживается? Под этим мы подразумеваем, отслеживается ли рельеф -	Те же, что и выше

		например, когда есть оползень, вы где-нибудь вычисляете это событие? С какой периодичностью?	
	Геология (типы почв и их глубина)	Какие основные типы почв в стране? Какие глубины почвы чаще встречаются в Таджикистане? Какие почвы более уязвимы для эрозии? Имеется ли в стране национальная типология почв, карта глубины и система мониторинга? Есть ли агентство, ответственное за отбор проб почвы и анализ качества почвы и, в конечном итоге, органического углерода почвы? Есть ли агентство, ответственное за анализ эрозии и потерь почвы? Есть исторический анализ? Каков текущий статус? Эрозия - проблема?	Те же, что и выше + Главное управление геологии при Правительстве Республики Таджикистан
	Климат	Какие сейчас климатические зоны в стране? Есть ли в стране национальный центр или отдел метеорологического анализа? С какой частотой анализируются эти данные? Кто отвечает за эту информацию? Есть ли историческая информация? Существуют ли специальные агентства, которые отслеживают метеорологические изменения и возможное увеличение количества осадков, ветра и т. Д.? Вы отслеживаете экстремальные климатические явления? Какие типы климата существуют в Таджикистане? Как мы	Те же, что и выше + Комитет охраны окружающей среды при Правительстве Республики Таджикистан Агентство гидрометеорологии Комитета по охране окружающей среды при Правительстве Республики Таджикистан

		ожидаем изменения климата в ближайшие годы?	
	Осадки	Каковы сейчас осадки в разных районах страны? Отслеживается ли количество осадков? Есть ли в стране национальный центр или отдел метеорологического анализа? С какой частотой анализируются эти данные? Кто отвечает за эту информацию? Имеется ли историческая информация об изменении количества осадков? Существуют ли специальные агентства, которые контролируют сильные дожди или риски штормов? Вы отслеживаете экстремальные климатические явления? Как мы ожидаем изменения количества осадков в следующие годы? Есть ли в вашем распоряжении какие-либо системы раннего предупреждения?	Комитет охраны окружающей среды при Правительстве Республики Таджикистан Агентство гидрометеорологии Комитета по охране окружающей среды при Правительстве Республики Таджикистан
	Доступность воды	Какова текущая ситуация с водообеспеченностью в стране? Часто бывают засухи? Если да, то какова историческая тенденция? Есть ли в стране специальные агентства по мониторингу качества и количества воды? Какой основной источник воды в стране? Водопроводная вода или богарная вода? Есть ли услуги по очистке воды и сточных вод? Кто отвечает за мониторинг наличия воды? Кто решает, кто должен использовать и регулировать разрешение споров? Распространено ли орошение? И	Агентство мелиорации и ирригации при Правительстве Республики Таджикистан Комитет охраны окружающей среды при Правительстве Республики Таджикистан

		где?	
	Речные бассейны	Сколько бассейнов рек в стране? Есть ли бассейны рек, которые важнее для страны? Если да, то какие и почему? Каково нынешнее распределение речных бассейнов в стране? Есть ли у страны официальная карта? Это актуально? Существуют ли специальные агентства или системы децентрализации для управления водными ресурсами, например, через бассейновые комитеты? Существуют ли особые правила управления речными бассейнами и водозабора и сброса в реки? Существуют ли особые законы, предотвращающие вырубку лесов или вырубку плантаций в водотоках и прибрежных зонах? Есть ли информация, связанная с различиями в количестве и качестве воды в различных речных бассейнах? Есть ли информация об исторических событиях наводнения или засухи? И есть ли система прогнозирования наводнений и засух?	Министерство энергетики и водных ресурсов Республики Таджикистан Комитет охраны окружающей среды при Правительстве Республики Таджикистан Агентство мелиорации и ирригации при Правительстве Республики Таджикистан Комитет по чрезвычайным ситуациям и гражданской обороне при Правительстве Республики Таджикистан
	Стихийные бедствия (частота и интенсивность) - в основном наводнения, сели, оползни и засухи.	Были ли в истории Таджикистана какие-либо катастрофы, которые были актуальны и задокументированы? Есть ли агентство / учреждение, которое отслеживает и документирует такие события? Кто это?	Комитет по чрезвычайным ситуациям и гражданской обороне при Правительстве Республики Таджикистан
	Частота возникновения	Пожар - общая угроза? Почему? Какие основные причины? Есть	Агентство лесного хозяйства при Правительстве

	пожаров (частота и интенсивность)	ли конкретный сезон? Есть ли исторические данные о пожарных рисках и событиях? Существуют ли организации, например ассоциации пожарных или другие, которые могут располагать информацией о пожарах?	Республики Таджикистан Комитет охраны окружающей среды при Правительстве Республики Таджикистан Комитет по чрезвычайным ситуациям и гражданской обороне при Правительстве Республики Таджикистан
	Возможности связывания и хранения углерода	Знаете ли вы о потенциале накопления и поглощения углерода лесами Таджикистана? Работают ли над этим какие-либо исследования или агентства / организации / университеты?	Комитет по охране окружающей среды при Правительстве Республики Таджикистан Агентство лесного хозяйства при Правительстве Республики Таджикистан
	Леса и лесовосстановление	Расскажите, пожалуйста, о затратах на лесовосстановление и лесовосстановление? Есть ли у правительства национальный план лесовосстановления и восстановления земель?	Агентство лесного хозяйства при Правительстве Республики Таджикистан Комитет по охране окружающей среды при Правительстве Республики Таджикистан
	Факторы деградации лесного хозяйства и обезлесения	Каковы основные движущие силы деградации и обезлесения лесов, кустарников и пастбищ? Существуют ли агентства / учреждения, которые отслеживают эти аспекты? Как изменился ландшафт и как эти факторы будут проявлять себя в следующие годы? Каковы действующие правила в отношении обезлесения и деградации существующего земного покрова в стране (федеральный, региональный и районный уровень)? Существуют ли какие-либо конкретные меры по борьбе с чрезмерным выпасом пастбищ и пастбищами?	Агентство лесного хозяйства при Правительстве Республики Таджикистан Комитет по охране окружающей среды при Правительстве Республики Таджикистан

		Каковы числа в пересчете на количество животных на гектар или на семью? Как это развивается с течением времени?	
Правовые / институциональные аспекты	Землевладение и правовая база для террасирования и других действий, которые могут предотвратить экстремальные явления в лесном секторе	Каковы типологии землепользования в Таджикистане (частное, государственное, коммунальное и т. д.)? Не могли бы вы описать, насколько хорошо определены эти категории и как исторически они развивались? Есть ли в Таджикистане право собственности на землю? Как вы подтверждаете право собственности? Существует ли национальная система, позволяющая определить, кому принадлежит определенная территория? Кто за это отвечает? Кто регулирует террасирование и другую инфраструктурную деятельность, которая может предотвратить бедствия? А также другие действия, которые могут изменить ландшафт (например, разрешения на вырубку лесов и т.д.)?	Агентство лесного хозяйства при Правительстве Республики Таджикистан Комитет по охране окружающей среды при Правительстве Республики Таджикистан Государственный комитет по земельному управлению и геодезии Республики Таджикистан
	Правовая / нормативная база, связанная с управлением и использованием земельного покрова (например, национальный закон о пастбищах 2013 г. и т. д.)	Каковы существующие правила в отношении лесов, пастбищ, кустарников и других соответствующих покрытий?	Те же, что и выше

	Механизмы налогообложения	Существуют ли налоговые механизмы в сельской и городской местности? Это что-то, что землевладельцы должны платить ежегодно? Сколько?	Налоговый комитет при Правительстве Республики Таджикистан
	Институциональные организации, занимающиеся мониторингом уровней рисков экстремальных явлений, и правительственные / институциональные механизмы преодоления последствий	Имеется ли институциональная поддержка для жертв стихийных бедствий? Предоставляет ли правительство какую-либо помощь? Есть ли организации, ответственные за мониторинг экстремальных явлений? А затраты на такие? Есть ли особые правила по климатическим бедствиям?	Комитет по чрезвычайным ситуациям и гражданской обороне при Правительстве Республики Таджикистан
	Банковско-инвестиционная система и потенциал в стране	Какова нынешняя банковская система в Таджикистане? Есть ли страховки для фермеров или частных лиц? Достаточно ли капитализации банковских счетов в сельской местности?	Министерство финансов Республики Таджикистан
	Национальные схемы страхования, если они существуют	Существуют ли национальные схемы страхования? Охватывают ли они стихийные бедствия, вызванные климатом?	Национальный банк Таджикистана
Социальные аспекты	Источники энергии и их использование (особое внимание уделяется топливной древесине)	Какие основные источники энергии в стране? Дрова - распространенный источник энергии? Это регулируется (например, некоторые виды запрещены к вырубке, определенное количество на семью на территорию? Кто это решил? Глава деревни? Сколько дров составляет экономия средней семьи?	Министерство энергетики и водных ресурсов Республики Таджикистан

	Численность населения, идентичность / этническая принадлежность, структура	Какова в настоящее время численность и распределение населения в стране? Каковы демографические тенденции (прошлые и настоящие)? Существуют ли определенные этносы или группы, которые влекут за собой другие отношения с лесами / срубами? Кто и с какой периодичностью отслеживает эту информацию? Каков средний состав семьи (например, 2 взрослых + 3 ребенка + 1 пожилой)?	Агентство по статистике при Президенте Республики Таджикистан
	Уровень паритета покупательной способности (ППС) в стране	Каков уровень ППС в стране по регионам? Какой средний доход по региону? Какова средняя стоимость жизни по региону?	Министерство финансов Республики Таджикистан Агентство по статистике при Президенте Республики Таджикистан
	Основные источники дохода страны	Каковы основные источники экономики страны? Кто отображает такую информацию? Это доступно? Какая часть экономики зависит от земли и сельского хозяйства? А что исторически?	Министерство финансов Республики Таджикистан
	Питьевая вода и санитарные условия	Доступность питьевой воды	Министерство энергетики и водных ресурсов Республики Таджикистан
	Транспорт / состояние дорог в стране	Какое состояние транспорта и дорог в стране? Как поддерживаются эти дороги? Проводятся ли исследования воздействия, когда эти дороги будут построены? Как такие условия транспорта могут реагировать на стихийные бедствия? Могут ли они помочь или ухудшить положение местных жертв? Есть ли план по снижению риска бедствий?	Министерство транспорта Республики Таджикистан

	Доказательства затрат на восстановление после стихийных бедствий	Есть ли какие-либо доказательства затрат на восстановление и компенсацию последствий стихийных бедствий и пострадавшим? Когда инфраструктура была повреждена, были ли они заменены / восстановлены? Кто за это заплатил? Каков процесс?	Комитет по чрезвычайным ситуациям и гражданской обороне при Правительстве Республики Таджикистан
	Социальное обеспечение на случай чрезвычайных ситуаций и страхование	Существуют ли какие-либо механизмы социальной защиты для поддержки жертв климатических бедствий?	Министерство здравоохранения и социальной защиты населения Республики Таджикистан Комитет по чрезвычайным ситуациям и гражданской обороне при Правительстве Республики Таджикистан
	Альтернативные издержки типичной экономической деятельности	Каковы основные виды экономической деятельности по регионам? Можем ли мы установить альтернативные издержки для каждого или основных видов деятельности в случае бедствия, чтобы мы могли оценить издержки, если человеку придется прекратить работу. Есть ли на этот счет исследования?	Министерство экономического развития и торговли Республики Таджикистан
	Доказательства ущерба, нанесенного экстремальными явлениями, и его стоимости для людей.	Имеются ли национальные данные о количестве экстремальных явлений и затратах на восстановление инфраструктуры и людей?	Министерство финансов Республики Таджикистан Комитет по чрезвычайным ситуациям и гражданской обороне при Правительстве Республики Таджикистан

ANNEX II : Soil classification FAO

In addition, following soil typologies from the the FAO's Soil Map of The World (1974)[1], the other soil types found in Tajikistan's are:

- Solonchaks: Soils, exclusive of those formed from recent alluvial deposits, having a high salinity, and having no diagnostic horizons other than (unless buried by 50 cm or more new material) an A horizon, a histic H horizon, a cambic B horizon, a calcic or a gypsic horizon.
- Gleyic Solonchaks: Solonchaks showing hydromorphic properties within 50 cm of the surface.
- Dunes Or Shifting Sands
- Calcic Cambisols: Cambisols having an ochric A horizon and showing one or more of the following: a calcic horizon, a gypsic horizon or concentrations of soft powdery lime within 125 cm of the surface;" calcareous at least between 20 and 50 cm from the surface; lacking vertic properties; lacking hydromorphic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.
- Chromic Cambisols: Cambisols having an ochric A horizon and a base saturation (by NI140Ac) of 50 percent or more at least between 20 and 50 cm from the surface but which are not calcareous within this same depth; having a strong brown to red " cambie B horizon; lacking ferralic properties in the cambic B horizon; lacking vertic properties; lacking hydromorphic properties within 100 cm of the surface; lacking permafrost within 200 cm of the surface.
- Cambic Arenosols: Arenosols showing colouring or alteration characteristic of a cambic B horizon immediately below the A horizon; lacking lamellae of clay accumulation; lacking ferralic properties.
- Calcic Xerosols: Xerosols having a calcic horizon within 125 cm of the surface; lacking an argillic B horizon overlying the calcic horizon
- Calcaric Gleysols : Gleysols which have a calcic or a gypsic horizon within 125 cm of the surface and/or are calcareous at least between 20 and 50 cm from the surface; having no diagnostic horizons other than an ochric A horizon and a cambie B horizon; lacking plinthite within 125 cm of the surface; lacking permafrost within 200 cm of the surface.
- Calcaric Fluvisols : Fluvisols which are calcareous at least between 20 and 50 cm from the surface; lacking a sulfuric horizon and sulfidic material within 125 cm of the surface.

[1] FAO, Soil map of the world 1: 5 000 000. Paris: United Nations Educational, Scientific And Cultural Organization, 1974.

ANNEX III : Relevant legal information

The legal and regulatory framework regardind forests, pastures, shrubs and other appropriate soils is set out in the national legislation of the Republic of Tajikistan in the following legal and regulatory instruments:

1) The Forestry Code of the Republic of Tajikistan of 2 August 2011, which governs forest management in general, the protection and defense of the land of the Forest Fund and the Unified Forest Fund, and the competence and powers of State authorities
2) Law of the Republic of Tajikistan «On pastures» of 20.06.2019, which gives a legal definition of «pasture area», it also reflects the issues of definition of pasture boundaries, procedure of pasture management, competences and powers of state authorities in use and protection of pastures.
3) The Law of the Republic of Tajikistan «On Liability for Waste of Crops and Damage of Crops, Mullet and Other Plantations, and Shrubs» of 5 March 2007, which aims to protect crops, mulberry and other plantings, Determination of responsibility for expenditure in the territory of the Republic of Tajikistan.
4) Land Code of 13 December 1996. The Code regulates the relationship between land users and public authorities, etc. of the subjects of land legal relations. Establishes the rights and obligations of land users in the area of land protection, in particular the direct obligation of land users to prevent soil degradation and to prevent the cutting down of protected forests.