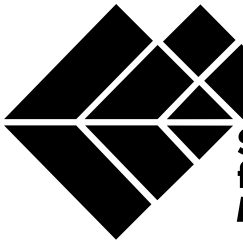
Scientific Network for the Caucasus Mountain Region

THE CAUCASUS REGIONAL RESEARCH AGENDA 2020-2030

Key to Sustainable Regional Development



Scientific Network
for the Caucasus
Mountain Region

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Key to Sustainable Regional Development

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Executive summary A. Introduction: The need for regional research and data exchange in the Caucasus B. Caucasus mountain research as a common cause	Nina Shatberashvili, Sustainable Caucasus (Coordination Unit of the SNC-mt), Ilia State University Joseph Salukvadze, Tbilisi State University
B1. Climate Change	Nina Shatberashvili, Sustainable Caucasus (Coordination Unit of the SNC-mt), Ilia State University
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B3. Forestry conservation and development	Merab Machavariani, independent expert, Georgia; Malkhaz Dzneladze, independent expert, Georgia; Armen Gevorgyan, Armenian Academy of Science, Coordination Unit of the SNC-mt
B4. Water resources and management	Rovshan Abbasov, Khazer University
B5. Land use and land cover change	Kamran Shayesteh, Malayer University; Mamuka Gvilava, GeoGraphic
B6. Natural hazards and risks	Hakan Yigitbasioglu, Ankara University
B7. Population and cultural diversity	Raisa Gracheva and Olga Glezer, Institute of Geography, Russian Academy of Science, Zurab Davitashvili, Tbilisi State University
B8. Tourism and recreation	Mehmet Somuncu, Ankara University
B9. Socio-economic development and planning	Joseph Salukvadze, Tbilisi State University, Rovshan Karimov, Institute of Geography, Azerbaijan National Academy of Science
B10. Mountain cryosphere	Tatiana Khromova and Gennady Nosenko, Institute of Geography, Russian Academy of Science; Levan Tielidze, Institute of Geography, Tbilisi State University
B11. Cross-cutting issues C. Conclusion: The way forward	Nina Shatberashvili, Sustainable Caucasus (Coordination Unit of the SNC-mt), Ilia State University Joseph Salukvadze, Tbilisi State University

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Maps included here are available, along with other digital maps, in the Caucasus Spatial Data Infrastructure (C-SDI) platform at http://sustainable-caucasus.unepgrid.ch

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FNSNF
Swiss National Science Foundation

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Agency for Development and Cooperation SDC

UN environment

SUSTAINABLE CAUCASUS

CONTENTS

TABLES:

MAPS:

ACRONYMS

BOKU	University of Natural Resources and Life Sciences, Vienna
C-RRA	Caucasus Regional Research Agenda
CBD	Convention on Biological Diversity
CCI	Climate change initiative
CEO	Caucasus Environmental Outlook
CEPF	Critical Ecosystem Partnership Fund
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMF	Caucasus Mountain Forum
CNF	Caucasus Nature Fund
DEMs	Digital elevation models
DRM	Disaster risk management
DRR	Disaster risk reduction
EIA	Environmental impact assessments
ESA	European Space Agency
EU	European Union
FAO	UN Food and Agriculture Organization
FBD	Fine beam dual
FLEG	Forest Law Enforcement and Governance, (a World Bank programme)
GDP	Gross domestic product
GEO	Group of Earth Observation
GEO-GNOME	GEO Global Network for Observation and Information in Mountain Environments
GEOSS	Global Earth Observation System of Systems
GHS	Global Human Settlement (European Commission)
GIS	Geographic information system
GIZ	German Development Agency
GLIMS	Global Land Ice Measurements from Space
GLOCHAMORE	Global Change in Mountain Regions
GRID	Global Resource Information Database
GTOS	Global Terrestrial Observing System
HCVF	High conservation value forests
HFA	Hyogo Framework for Action
ICIMOD	International Centre for Integrated Mountain Development
ILM	Integrated land management
IUCN	International Union for Conservation of Nature
INDCs	Intended Nationally Determined Contributions
INSPIRE	Infrastructure for Spatial Information in the European Community
ISCAR	International Scientific Committee on Research in the Alps
IWRM	Integrated water resources management

MAB-6	Man and the Biosphere Project 6
MDGs	Millennium Development Goals
MRI	Mountain Research Initiative
MRV	Measurement, Reporting and Verification
LULC	Land Use/Land Cover
LULUCF	Land Use, Land-use Change and Forestry
NALAG	National Association of Local Authorities of Georgia
RRA	Regional Research Agenda
RS	Remote Sensing
SCOPES	Scientific Co-operation between Eastern Europe and Switzerland
SDC	Swiss Development Cooperation
SDGs	Sustainable Development Goals
SDI	Spatial Data Infrastructure
SEA	Strategic Environmental Assessments
S4C	Science for the Carpathians
SMD	Sustainable Mountain Development
SFM	Sustainable forest management
SNC-mt	Scientific Network for the Caucasus Mountain Region
SNSF	Swiss National Science Foundation
SSG	Scientific Steering Group
Sustainable Caucasus	The Caucasus Network for Sustainable Development of Mountain Regions, Coordination Unit of SNC-mt
TEEB	The Economics of Ecosystems and Biodiversity
UNDP	United Nations Development Programme
UNECE	UN Economic Commission for Europe
UNEP	United Nations Environment Programme (UN Environment)
UNFF	United Nations Forum on Forests
UN Environment	United Nations Environment Programme (alternative name for UNEP)
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
UNCED	United Nations Conference on Environment and Development
UNIGE	University of Geneva
UNISDR	United Nations International Strategy for Disaster Reduction
UNWTO	UN World Tourism Organization
USAID	United States Agency for International Development
USSR	Union of Soviet Socialist Republics
WWF	World Wide Fund for Nature

PREFACE

Over the course of the past three decades, mountain regions and sustainable mountain development (SMD) have come to occupy an important place on international political agendas. At the 1992 United Nations Conference on Environment and Development (UNCED), the adoption of Agenda 21 Chapter 13 “Managing Fragile Ecosystems: Sustainable Mountain Development” broke new ground in addressing environment and development challenges in complex social-ecological regions.

SMD has continued to find global support, as evidenced by the 2002 International Year of Mountains and specific references to mountains in the Sustainable Development Goals (SDGs); the recent IPCC Special Report on Oceans and Cryosphere similarly drew special attention to climate change impacts in mountains. All of these processes testified not only to the special role of mountains as homes to diverse cultures and as providers of key material and immaterial resources, but also as places that are disproportionately vulnerable to the consequences of human-induced climate change. Attention to the special role of mountains has historically benefitted enormously from sustained interaction between scientists, practitioners, and policy makers. The Caucasus Regional Research Agenda (C-RRA) is but the latest sign of these crucial and productive interactions.

While international attention to SMD has generated tangible impacts at the global level, the many mountain regions and associated institutional processes has made this possible; it is thus no surprise that the 2030 Agenda highlights the importance of regions. In the European Alps, for example, efforts at regional cooperation date back to the creation of the International Committee for the Protection of the Alps in the 1950s; the Alpine Convention, which has inspired transboundary mountain cooperation around the world, was signed a year before UNCED, the same year activists of the green movements from Caucasus countries met in Tbilisi to lay the foundation for regional environmental cooperation during the post-Soviet period. Political support for Alpine cooperation in turn has benefited from the Man and the Biosphere Project 6 (MAB-6) on ‘Impact of human activities on mountain and tundra ecosystems’ in the 1980s. MAB-6 involved scientists in mountain regions around the world and helped establish early links between Alpine and Caucasus researchers.

Indeed, regional scientific initiatives have typically accompanied governance processes. Sometimes such initiatives existed prior to the emergence of a governance arrangement, often in the form of academic societies. Other times, regional scientific initiatives were expressly created to support a governance arrangement, either with direct support from governance actors or with their tacit approval. But in still other cases, scientists have organised in the absence or the aftermath of a failed governance process. This is what has occurred in the Caucasus, where regional political cooperation has stagnated for a decade. Scientists and scientific institutions have joined the Scientific Network for the Caucasus Mountain Region (SNC-mt) seeking to maintain and revitalise prior regional networks or create new ones, always with the intention of producing and disseminating societally relevant knowledge about this unique mountain region, and perhaps also with the hope that regional political cooperation may one day follow.

Around the world, the regional, national, and local relationships between scientists, practitioners and policy makers have taken very different forms. This diversity is a positive sign as it permits context-specific approaches, experimentation, and learning. Anticipation of such learning through the periodic identification of the state of and gaps in knowledge about the science and practice of sustainable mountain development is a key objective of the Caucasus Regional Research Agenda (C-RRA). As Co-chairs of the Second Caucasus Mountain Forum hosted at Ankara University, it is our distinguished honour and pleasure to bear witness to the adoption of the C-RRA and address this preface in our names.

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EXECUTIVE SUMMARY

The Caucasus is a unique region, rich in cultural history, diverse landscapes, and bio- and agro-diversity. WWF Caucasus defines the ecoregion as covering six countries: Armenia, Azerbaijan and Georgia in their entirety, and parts of the territories of Iran, the Russian Federation and Turkey. The Caucasus ecoregion is recognised as one of 35 "priority places" by WWF and one of 34 "biodiversity hotspots" by Conservation International.[1]

The collapse of the Soviet Union marked a new period of cardinal geopolitical transformation of the Caucasus region, causing dramatic changes in perception and deployment of this space in regional and global systems and revealing the importance of interaction and cooperation between the former Soviet republics and Iran and Turkey, which had heretofore been cut off from the "Soviet Caucasus" by the "Iron Curtain". Although violent ethnopolitical conflicts (that today remain unresolved) have reshaped and fragmented the inner territory of the Caucasus, reducing its socio-economic and resource potential, the Caucasus region has continued to gain importance in recent decades as an important east-west and north-south transit corridor that will require the full utilisation of the national economic capacities of each country and the synergy of their combined efforts.

Recent economic development in the region carries with it a considerable environmental threat, however. During the last decades, the major causes of environmental impacts have continued to evolve and include rapid economic growth, poor spatial planning and inefficient social policies whose ineffectiveness is evident in the high degree of poverty caused by the uneven distribution of economic gains. In many places, especially in rural areas, this inequality has meant a direct dependence on natural resources, which has increased pressure on the environment to undesirable levels. Other factors have compounded the issue include a lack of awareness of the importance of biodiversity conservation, lack of transparency in the development of relevant strategies and projects, inefficiency of spatial planning and environmental assessment instruments, inadequacy of national systems for monitoring natural resource management, and so on.

Moreover, present economic and socio-political realities in the region undermine the cohesiveness of the Caucasus space, while the above-mentioned conflicts between and inside certain countries further weaken opportunities for regional cooperation.

Ensuring the sustainable development of Caucasus mountain regions and the improvement of mountain population welfare requires strong regional cooperation and exchange among different stakeholders including, in particular, scientists. The six Caucasus mountain countries have different histories, potentials and aspirations that predefine their unequal interests and capacities both in research and policy making. However, regional exchange of knowledge, information and practice, as well as combined efforts in research and development may bring significant benefits to all of them.

Contemporary interdisciplinary mountain research is relatively new. Mountain research related international processes, institutions and global and regional networks, as well as the desire of Caucasus scientists for regional cooperation inspired the establishment of the Scientific Network for the Caucasus Mountain Region (SNC-mt) in 2015. The SNC-mt negotiations had started in 2013 and, from the very beginning, were supported by the University of Geneva and UN Environment. Since then, SNC-mt has expanded the number of its international and regional partners through cooperation with the Mountain Research Initiative (MRI), GRID-Arendal, GRID-Geneva and others.

The first project of the SNC-mt: "Supporting Sustainable Mountain Development in the Caucasus (Sustainable Caucasus)" funded by the Swiss National Science Foundation (SNSF) and the Swiss Agency for Development and Cooperation (SDC) under the SCOPES programme, built the capacities of the Network and safeguarded the traditional organisation of the Summer School for mid-career scientists as well as Caucasus Mountain Forums (CMF) and the on-line cooperation platform — Caucasus Spatial Data Infrastructure (Caucasus-SDI).[2] The Caucasus Regional Research Agenda (C-RRA) elaboration process was also started under the umbrella of this project.

1 Zazanashvili N, Garforth M, Jungius H, Gamkrelidze T. 2012. *Ecoregion Conservation Plan for the Caucasus. Revised and updated edition.* WWF Caucasus.

2 The Caucasus Spatial Data Infrastructure C-SDI, http://sustainable-caucasus.grid.unep.ch

The Caucasus RRA process followed the example of sister networks Science for the Carpathians (S4C) and the International Scientific Committee on Research in the Alps (ISCAR). The purpose of the C-RRA elaboration was to establish a collaborative process for identifying the current state of knowledge in core issue areas related to sustainable mountain development in the Caucasus region, along with key challenges and opportunities, and priority gaps for scientific research and development.

The first draft of the ten thematic chapters of the Caucasus Regional Research Agenda was available at the First Caucasus Mountain Forum in November 2016. The first such forum held in Tbilisi, Georgia, brought together over 150 participants from more than 20 countries of Europe, Asia and Africa. This second version of the C-RRA incorporates comments both from the Forum participants and those who submitted their comments via the Online Platform during the two years since the First Caucasus Mountain Forum.

Priority areas of the Caucasus Regional Research Agenda for research and development are as follows:

B1. CLIMATE CHANGE

Recent studies and reports, including UNFCCC National Communications of the Caucasus countries, indicate that climate change has an effect on economic sectors and ecosystems and that the effects are bidirectional with economic sectors affecting climate change and ecosystems and vice versa. Concerned sectors include agriculture, renewable energy, forestry, and infrastructure as well as water and forest ecosystems. Mitigation and adaptation research remains insufficient and often fragmented. There is a large gap in research on ecosystem adaptation, as well as assessments and studies of how to institutionalise, organise and monitor the deployment of climate adaptation and mitigation measures. Above all, there is a lack of regional studies of climate change effects on shared ecosystems and resources critical for economic development and growth in areas of the public commons such as water resources. The increase of natural disaster frequency under climate change is another priority topic reflected under different development strategies of the countries in question and may have a significant impact on regional infrastructure and therefore on sustainable regional economic development. Moreover, there is a significant gap in the study of climate change impacts on human health in the Caucasus region, in spite of its significant importance for human security.

B2. BIODIVERSITY

The Caucasus Ecoregional Conservation Plan, (WWF Caucasus), the only regional policy document recognised by the six Caucasus countries, contains four components that are directly linked to mountain ecosystems, including plans for forest, high mountain and some freshwater ecosystems, as well as for priority species. A few additional activities are also proposed as priority areas for regional research and study of the conservation of relict Caucasus biodiversity and agrarian diversity, including: modern data collection methods; monitoring pilot landscapes and animal species using remote sensing along with field observations; establishment of online databases that attract contributors from different countries, which thus allows a reduction in paper reports of limited use, exploring the influence of climate change on mountain biodiversity, fostering multidisciplinary studies on biodiversity and ecosystem services.

B3. FORESTRY CONSERVATION AND DEVELOPMENT

Three main threats to the region's forests include: (i) unsustainable logging for industrial timber and firewood, (ii) unsustainable grazing and (iii) inappropriate operational practices. Numerous socio-economic aspects predefine the use of certain customs among stakeholders involved in forest resources utilisation. Lack of understanding of factors that shape the nature of forest assets makes it less likely that non-governmental stakeholders will be able to influence forest policy and practices in an appropriate direction. Sectoral policy holders generally do not recognise the validity of existing alternative perspectives and stakeholders and tend to act without regard for the needs and views of stakeholders outside of the government. Climate change significantly influences forested-areas transformations, especially in mountain regions. Currently, there is

no process for defining national sustainable forest management (SFM) standards, and no mechanisms for passing any credible information about the sustainability of forest products produced in the region along the value chain. Lack of information therefore prevents supply chain actors from supporting SFM. However, well-justified national and, more importantly, regional multidisciplinary scientific research and study may open a window of opportunity for improvement of management practices in the Caucasus.

B4. WATER RESOURCES AND MANAGEMENT

Quantity and quality of both surface and ground waters are the main water-related problems in the transboundary context. A lack of knowledge may lead each of the Caucasus countries and the entire region to serious water scarcity in the future. Recent studies demonstrate that most of the countries of the region are already suffering from increased temperatures and glacier retreat due to climate change, causing water shortages and intensification of desertification processes that are likely to worsen over time. This is of special concern for Armenia, Azerbaijan, Iran and Turkey. Protection and sustainable use of regional transboundary water resources is also essential for ecosystem functioning, biodiversity and habitat protection. Research at the national and regional levels shall therefore target support in solving the abovementioned problems through the introduction of integrated basin management principles, enhancement of cooperation between upstream and downstream water users as well as protection of freshwater, wetland, lake, river and marine ecosystems.

B5: LAND USE AND LAND COVER CHANGE

Current transformation of land cover of the Caucasus is linked with a wide range of issues primarily related to socio-economic development including: rapid urbanisation, agricultural development and population migration and growth. Mountain regions, including the Caucasus mountains, present unique challenges for scientific studies and the use of modern methodologies and technologies such as Geographic information systems (GIS) and Remote sensing (RS). A key research focus shall be the identification and interdisciplinary study of the drivers of land-use change and land-use practices to ensure utilisation of sustainable methods in regional rural planning and development.

B6: NATURAL HAZARDS AND RISKS

In the regional context, safeguarding infrastructure to decrease economic losses and provide better protection for human lives and improved human security is of utmost importance. Establishing reliable datasets and analytical tools for recording, analysis and DRR planning for mountain regions of the Caucasus as a basis for further research is also critical. Both national and regional research efforts shall target the establishment of inclusive and comprehensive DRM platforms and practices that consider recommendations from recent international directives such as the Sendai Framework.

B7. POPULATION AND CULTURAL DIVERSITY

Regional research of demographic data presents a number of challenges due to the lack of adequate, comparable and reliable data and specific statistics. The region needs comprehensive scientific research to identify the most acute problems as well as paths to their resolution, which might be closely linked to other research areas, such as socio-economic development, environmental protection, and climate change. In such circumstances, indirect but reliable estimations based on various statistical sources in order to attempt to assess population size and trends and demographic structures are of great value. Despite ongoing globalisation and modernisation, national and local cultures in Caucasus are of high value to the populations and are considered an intrinsic part of economic development, providing a basis for both socially and environmentally sustainable development. In the regional context, it is essential to establish research and dialog for the better preservation and development of Caucasus cultural heritage and diversity. For researchers and practitioners, it is a worthwhile challenge to ensure that culture remains an integral part of development concepts since valuing such traditions and cultures can provide meaning to the sustainable development of the entire Caucasus mountain region.

B8: TOURISM AND RECREATION

Tourism development holds great opportunities for overall economic growth and further promotion of this economic sector is essential. Research shall be targeted at ensuring existing and new policies and practices leading to security and sustainability in terms of tourism's impact on the mountain environment and community life. This shall imply the sustainable use of natural and cultural resources, building local tourism supply chains, wider involvement of local communities and community planning, local awareness and confidence building, strong local institutions and policies, and a vision for the long-term sustainability of the tourism industry and related economic sectors.

B9. SOCIO-ECONOMIC DEVELOPMENT AND PLANNING

A number of programmes and legislative acts aiming at improving mountain residents' quality of life were adopted In the Caucasus countries in recent years. However, these have mostly been formal policy statements that are rarely based on scientific research, evidence and findings. Therefore, Caucasus socio-economic development research requires improvement to provide a solid empirical and analytical framework targeted at better demographic figures, connectivity, productivity, liveability and other essential aspects of socio-economic development. Such research should enable informed and efficient decision-making both at national and regional levels. Moreover, socio-economic development and planning research should be specifically targeted at meeting the "Sustainable Development Goals" (SDG) and the implementation of Agenda 2030.

B10. MOUNTAIN CRYOSPHERE

Changes in the mountain cryosphere and the recorded retreat of glaciers may have an effect on water resources, land cover, forests and biodiversity, as well as aggravating risks of natural disasters. These changes might have a significant impact on traditional livelihood practices and more globally on the region's transformation. An unbiased assessment and study of glaciers and snow cover requires an effective system of monitoring including in situ and remote sensing, through the coordinated efforts of all Caucasus countries.

A. INTRODUCTION: THE NEED FOR REGIONAL RESEARCH AND DATA EXCHANGE IN THE CAUCASUS

A1. CAUCASUS REGIONAL DEVELOPMENT TRENDS OF RECENT DECADES

The Caucasus is a unique region, rich in natural heritage, varied landscapes, bio- and agro-diversity, as well as cultural history. The Caucasus ecoregion entirely or partly covers territories of the following six countries: Armenia, Azerbaijan, Georgia, Iran, the Russian Federation and Turkey. The region is referred to as a "priority place" for conservation by WWF as well as a "biodiversity hotspot" by Conservation International[3].

Similarly to other ecoregions, the Caucasus Ecoregion functions as a common conservation unit including similar biological communities, and its boundaries roughly coincide with the areas in which key ecological processes most strongly interact. Ecoregions are defined as "relatively large areas of land or water that contain a geographically distinct assemblage of natural communities and they share the majority of their species, dynamics, and environmental conditions".[4] Therefore, many intrusive economic and social processes that occur in these spaces may be interrupting the balanced functioning of ecosystems in the Caucasus ecoregion.

Economic growth of the countries of the region is a precondition for the increased importance of the Caucasus as a transit corridor and the full utilisation of the national economic capacities of each country. However, economic development simultaneously poses a considerable environmental threat.

During the last 40 years, the major causes of environmental impacts have been evolving. For example, the main sources of air pollution are no longer stationary sources (such as factories) as they were during the Soviet period but are now mobile facilities (e.g. automobiles). The major sources of water pollution are no longer industry and agriculture, today municipal water sources create the most pollution. Soil contamination from fertilisers and pesticides decried during the 1990s[5] is gradually lessening, however agricultural production itself has also been gradually declining since the collapse of the Soviet Union, both in terms of output levels and share of GDP.

Today, the region's natural heritage is facing serious threats and biodiversity is being impacted at an alarming rate. The root causes of these threats are complex[6]:

- Rapid economic growth dominates the political agenda at the expense of environmental and social concerns;
- Poverty and the resulting direct dependence on natural resources for livelihoods are forcing residents of rural areas to overuse forests and pastures and to poach wild animals;
- Awareness of the importance of biodiversity conservation remains very limited;
- Lack of transparency in the development of strategies and projects and a lack of spatial planning and environmental assessment instruments leads to a corresponding lack of accountability for the negative impacts of economic development on natural conditions and biodiversity;
- Insufficient efficiency of coordination and interaction of political administrations at different levels (federal/central, regional and local), under-financed sector administrations, capacity gaps, and an unclear delineation of responsibilities result in poor coordination between government agencies. Approaches are neither integrated nor cross-sectoral;
- Adequate systems for monitoring natural resources management and sector-based studies are not in place;

3 Zazanashvili N, Garforth M, Jungius H, Gamkrelidze T. 2012. *Ecoregion Conservation Plan for the Caucasus. Revised and updated edition.* WWF Caucasus.

4 Krever V., Zazanashvili N., Jungius H., Williams, L. and Petelin, D. 2001. *Biodiversity of the Caucasus Ecoregion. An Analysis of Biodiversity and Current Threats and Initial Investment Portfolio*. WWF.

5 UNEP. 2002. *Caucasus Environment Outlook.* GRID-Tbilisi: Tbilisi.

6 Zazanashvili N, Garforth M, Jungius H, Gamkrelidze T. 2012. *Ecoregion Conservation Plan for the Caucasus. Revised and updated edition.* WWF Caucasus.

- Misconceptions and misunderstanding persist about the contributions and benefits of ecosystem provisioning that would regulate and support economic growth, poverty alleviation and sustainable development; and
- There is only limited awareness of the significant benefits and values of Protected Areas at local and national levels.

Caucasus mountains' "contemporary perceptions" started to evolve after the collapse of the Soviet Union. During the Soviet era, the conventional soviet paradigm considered the Greater Caucasus as a space limited to only those geographical areas under Soviet jurisdiction. Therefore, those parts of Iran and Turkey's territories covered by the Lesser Caucasus started to be recognised and referred to as part of the Caucasus region only a few decades ago. Furthermore, the Caucasus countries of the former Soviet Union gradually started to re-interpret their historical, cultural, geographic and geopolitical 'habitat' as belonging to the crossroads between Asia and Europe (e.g. the 'Silk Road'). Indeed, due to its geographical location between the Caspian Sea and the Black Sea, the region plays an important geopolitical role in the modern world.

The proof of the latter can be found in the Caucasus Convention elaboration process that started in the very late 1990s with the participation of the four countries that had been in the Soviet sphere (Armenia, Azerbaijan, Georgia and the Russian Federation)[7]. Upon the continuation of these talks, Iran and Turkey became involved after 2005[8].

Over the last 30 years, the Caucasus region has undergone a number of armed conflicts that have challenged peace and stability in the region and resulted in over 1 million refugees and/or internally displaced persons[9]. Regional cooperation was, of course, extremely complicated during such conflicts.

In spite of this history, the most recent decades have demonstrated the recognition, on behalf of the Caucasus countries, that strengthening socio-economic and human ties and joint efforts for environmental protection, are of growing importance and beneficial for all. To ensure sustainable human development, especially of local populations and mountain communities, it is necessary to exchange information and knowledge and, where possible, to cooperate to safeguard the sustainable development of the entire region. The role of scientists in establishing common ground for academic knowledge and filling information gaps about the region cannot be underestimated.

Different histories and contemporary aspirations predefine the distinct interests and capacities of the six Caucasus countries both in research and in policy making; however, the necessity of cooperation and knowledge exchange has become widely recognised and is now practically unchallenged. Support may even be provided by some countries to address the knowledge and capacity gaps of neighbouring countries.

A2. GLOBAL AND REGIONAL RESEARCH

Mountain research as such has existed for about half a century[10], while interdisciplinary mountain research is relatively new[11]. Agenda 21[12] (Earth Summit in Rio de Janeiro 1992) included a chapter dedicated to mountains, and the year 2002 was declared the International Year of Mountains. Such occasions significantly contributed to the promotion of mountain research and development among global actors and stakeholders.

7 Briefing Paper: Second Meeting on Development of a Legal Instrument for the Protection of Mountain Ecosystems in Caucasus, 2002, Tbilisi.

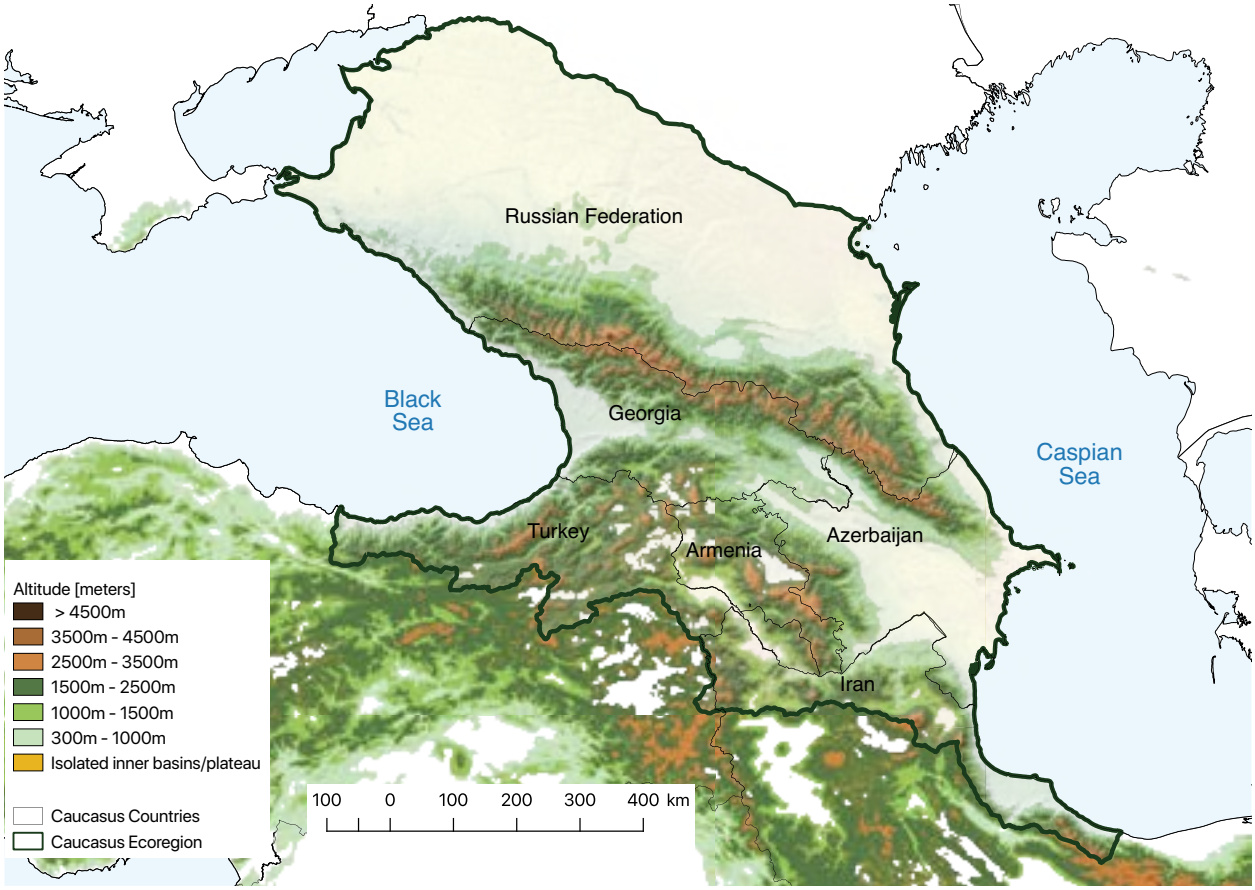
8 Vaduz Ministerial Statement on the occasion of a meeting of the six Caucasus countries (Armenia, Azerbaijan, Georgia, Iran, the Russian Federation and Turkey) in Vaduz, Liechtenstein, in the presence of UNEP, 16 November 2007, available on-line at: http://mountainlex.alpconv.org/images/documents/international/vaduz_ministerial_statement.pdf

9 Internal Displacement Monitoring Centre, Country Profiles. 2018. http://www.internal-displacement.org/countries

10 Neustadtl S.J., 1977. Montology: The Ecology of Mountains. *Technology Review*. 79 8: pp. 64–66.

11 Debarbieux B., Price, M. F. 2008. Representing Mountains: From Local and National to Global Common Good. *Geopolitics*. 13 1: pp. 148–168.

12 United Nations Conference on Environment & Development. 1992. Agenda 21: The Rio Declaration on Environment and Development.



Map A1.1: Caucasus mountains
Source: Ilias university of Bern, based on the mountain definition by Kapos et al., 2000

Currently, dozens of peer-reviewed international and regional journals are fully focused on mountain research, while a number of global research programmes recognise mountains as a special discipline by keeping separate platforms both for mountain knowledge and data (i.e. Diversitas, the Global Terrestrial Observing System or the Terrestrial Ecosystem Monitoring Sites[13], Group of Earth Observations)[14]. The Mountain Research Initiative (MRI), formally established in 2001[15], contributed significantly to mountain research through cooperation and exchange among different mountain regions and was of particular support to mountain research initiatives such as Science for the Carpathians (S4C). The greater Caucasus region, including all the six countries, later joined the international mountain research family as a full member after the formal establishment of the Scientific Network for the Caucasus Mountain Region (SNC-mt) in 2015 when the Memorandum of establishment was signed by several regional leading research institutes and universities[16]. The aspiration of the Caucasus scientists for cooperation predated the establishment of the SNC-mt. The process of establishing SNC-mt was backed by the University of Geneva and UN Environment as of 2013. SNC-mt is organised as an open network of researchers and other stakeholders interested in disciplinary, interdisciplinary and transdisciplinary research and collaboration, building research capacity in the Caucasus region and linking research to the needs of sustainable development and environmental protection.

13 B Debarbieux B., Price, M. F. 2008. Representing Mountains: From Local and National to Global Common Good. *Geopolitics*. 13 1: pp. 148–168.

14 The Group on Earth Observations: www.earthobservations.org

15 Björnsen Gurung, A., 2011. *Science Networks for Global Change in Mountain Regions: The Mountain Research Initiative,* Chapter 23.

16 The Memorandum on SNC-mt Establishment. 2015. http://caucasus-mt.net/memorandum-of-understanding

Since 2013, SNC-mt has expanded the number of its international and regional partners to include the Mountain Research Initiative (MRI), GRID-Arendal and GRID-Geneva, University of Natural Resources and Life Sciences, Vienna (BOKU), European Academy of Bozen/Bolzano (EURAC), as well as universities and research institutes of the region such as the Institute of Earth Science and Seismic Monitoring Centre, Ilia State University; Institute of Geography, Tbilisi State University; Emergency Academy of Republic of Armenia; and the University of Architecture and Construction of Azerbaijan.

Funded by the Swiss National Science Foundation (SNSF) and the Swiss Agency for Development and Cooperation (SDC) under the SCOPES programme, the first project of the SNC-mt "Supporting Sustainable Mountain Development in the Caucasus (Sustainable Caucasus)" included the first Caucasus Mountain Forum, held in November 2016[17]; the Summer School for mid-career scientists organised in September 2016[18]); the on-line cooperation platform, Caucasus Spatial Data Infrastructure (Caucasus-SDI)[19] as a tool for science-policy-practice interface; different activities related to scientific excellence; and the elaboration of the Caucasus Regional Research Agenda (C-RRA)[20].

The SNC-mt initiated the Caucasus Regional Research Agenda (C-RRA) following the example of its counterparts in the Carpathians (Science for the Carpathians, S4C) and the Himalayas (International Centre for Integrated Mountain Development, ICIMOD) and the International Scientific Committee on Research (ISCAR) in the Alps. The Research Strategy of the Global Change and Mountain Regions project (GLOCHAMORE) served as a framing and guiding instrument[21].

The purpose of the Caucasus RRA elaboration was to establish a collaborative process for identifying the current state of knowledge in core issue areas related to sustainable mountain development in the Caucasus region, key challenges and opportunities, and priority gaps for scientific research and development. Moreover, the SNC-mt sees the C-RRA as a document that will help scientists and other interested stakeholders to gain insight into research needs and priorities and undertake projects with colleagues from neighbouring countries to expand knowledge and exchange information for the establishment of a shared, scientifically-justified comprehension of sustainable-development perspectives in the Caucasus ecoregion.

The process of the C-RRA elaboration started back in 2014 when two Georgian Universities: Ilia State University and Tbilisi State University started collection and analysis of state-of-the-art Caucasus research under the SCOPES project. Today, the SNC-mt online cooperation platform presents the most comprehensive database on research institutions, universities, scientists and their work[22]. This effort forms the backbone for elaboration of the thematic sections of the given document by experts from founding institutions and other SNC-mt partners such as Ankara University, Malayer University, Ilia State University, Tbilisi State University, Institutes of Geography of Azerbaijan and the Russian Federation, GeoGraphic (Georgia) and GeoRisk (Armenia) with backstopping from the University of Geneva and SNC-mt at the Sustainable Caucasus serving as a coordination unit (secretariat).

The first draft of the ten thematic chapters of the Caucasus Regional Research Agenda was available at the First Caucasus Mountain Forum (CMF) in November 2016 held in Tbilisi, Georgia, which gathered over 150 participants from more than 20 countries of Europe, Asia and Africa.

This current version of the C-RRA incorporates comments both from the Forum participants and those who were not able to participate but who shared their thoughts via the Online Platform that hosted the C-RRA thematic topics for over two years (2016-2018). The illustrative maps for the C-RRA were later elaborated by GRID-Geneva based on evaluable global and regional spatial information sources.

17 The First Caucasus Mountain Forum. 2016. http://caucasus-mt.net/Caucasus-Mountain-Forum-2016

18 The First Caucasus Summer School. 2016 http://caucasus-mt.net/Summer-school-2016

19 The Caucasus Spatial Data Infrastructure C-SDI. 2016. http://sustainable-caucasus.grid.unep.ch

20 The Caucasus Regional Research Agenda (C-RRA) for 2020-2030. 2019. http://caucasus-mt.net/regional-research-agenda

21 GLOCHAMORE. 2005. *Global Change and Mountain Regions Research Strategy.*

22 SNC-mt Resources. http://caucasus-mt.net/resources

B. CAUCASUS MOUNTAIN RESEARCH AS A COMMON CAUSE

The Caucasus Regional Research Agenda thematic topics were defined based on results of Caucasus research data collection from regional and international scientists published in peer-reviewed journals of two Georgian universities: Ilia State University and Tbilisi State University, under the SCOPES project "Supporting Sustainable Mountain Development in the Caucasus" funded by the Swiss National Science Foundation and the Swiss Agency for Development and Cooperation and currently available on the SNC-mt Online Cooperation Platform[23]. The collected information was analysed at the meetings of the SNC-mt Scientific Steering Group (2014-2015), which defined the ten core research branches and number of cross-cutting issues as presented below based on available information and taking into consideration the relevant international processes as well as the needs of participating countries' policy interests in economic, social and environmental fields.

The thematic chapters presented below were drafted by leading regional scientists from Ankara University, Malayer University, Ilia State University, Tbilisi State University, Institutes of Geography of Academies of Sciences of Azerbaijan and the Russian Federation, Khazer University (Azerbaijan) GeoGraphic (Georgia) and GeoRisk (Academy of Science of the Republic of Armenia) and prominent regional experts with backstopping from the University of Geneva, Tbilisi State University and the SNC-mt coordination unit (secretariat) at the Sustainable Caucasus.

The First Caucasus Mountain Forum (2016) participants provided comments on draft thematic chapters both during and after the CMF. The research branches presented in this document incorporate the comments and vision of regional and international experts as well provided through written suggestions via the SNC-mt Online Platform.

[23] The Caucasus Regional Research Agenda (C-RRA) for 2020-2030. 2019. http://caucasus-mt.net/regional-research-agenda

B1. CLIMATE CHANGE

RATIONALE

Climate change is a global process that is increasingly affecting Caucasus mountain regions and ecosystems. According to most forecasts and analyses of historical climate data, the gradual increase of temperatures, precipitation and evaporation will continue; the frequency and intensity of extreme events and natural disasters triggered by climate change will also augment; forest area distribution will continue to change; erosion and other land-degradation processes will be intensified; plant-growing seasons will shift and some diseases will spread. Glaciers will also continue to retreat, thus reducing water availability for domestic use and economic development, especially in arid and semi-arid zones. According to ice melt indicators published by the Earth Policy Institute, during the last century, the glacial volume in the Caucasus declined by 50%, while some studies showed that 94% of glaciers had retreated up to 38 m/year[24,25]. These phenomena have gradual — and in some cases irreversible — effects on the region's national economies and transboundary ecosystems.

All six countries of the region have demonstrated their political commitment to making progress in climate change mitigation and adaptation in their Intended Nationally Determined Contributions (INDCs) submitted to the UNFCCC Secretariat[26]. Most INDCs attend to both mitigation and adaptation measures. All countries designate mitigation as a priority: Armenia, Azerbaijan, Georgia and Iran also highlight adaptation. However, only very few countries have National Adaptation Strategies[27], although all countries are committed to implement relevant SDGs such as the Goal 13 of Agenda 2030.

Recent studies and reports, including UNFCCC National Communications, suggest that climate change already has already had an effect on economic sectors and ecosystems that are bidirectional, since economic sectors in turn affect climate change and ecosystems. Sectors concerned include: agriculture, renewable energy, forestry, and infrastructure as well as water and forest ecosystems. The same studies also conclude that progress in mitigation and adaptation research remains insufficient and often fragmented[28]. Moreover, for key climate-change indicators such as mean annual and summer temperatures, or precipitation and evaporation changes, data is inadequate for comparisons at the ecoregional level; the same applies even at the sub-regional level of the South Caucasus, where climate research is relatively unified[29]. This relates to studies of adaptation and climate change impacts on different economic sectors and ecosystems. There is also a large gap in research on ecosystem adaptation, as well as assessments and studies of how to institutionalise, organise and monitor the deployment of adaptation and mitigation measures.

24 Stokes C.R., Gurney, S. D., Shahgedanova, M. and Popovnin, V. 2006. Late-20th-century changes in glacier extent in the Caucasus Mountains, Russia/Georgia. *Journal of Glaciology,* 52, 176

25 Sylvén M., Reinvang R., Andersone-Lilley Z. 2008. *Climate Change in Southern Caucasus: Impacts on nature, people and society.* WWF Norway/WWF Caucasus.

26 INDCs as communicated by Parties. See most recent list at: http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx. Accessed 4 October 2019

27 The Ministry of Environment and Urban Planning MoEUP, Turkey, 2011. *Turkey's National Climate Change Adaptation Strategy and Action Plan*. Ankara.

28 Shatberashvili N. Rucevska I. Jørstad H. Artsivadze K. Mehdiyev B. Aliyev M. Fayvush G. Dzneladze M. Jurek M. Kirkfeldt T. and Semernya L. 2015. *Outlook on climate change adaptation in the South Caucasus mountains.* United Nations Environment Programme, GRID-Arendal and Sustainable Caucasus. Nairobi, Arendal and Tbilisi. www.grida.no, www.unep.org, www.sd-caucasus.com, pp. 74-75, 77.

29 Shatberashvili N. Rucevska I. Jørstad H. Artsivadze K. Mehdiyev B. Aliyev M. Fayvush G. Dzneladze M. Jurek M. Kirkfeldt T. and Semernya L. 2015. *Outlook on climate change adaptation in the South Caucasus mountains.* United Nations Environment Programme, GRID-Arendal and Sustainable Caucasus. Nairobi, Arendal and Tbilisi. www.grida.no, www.unep.org, www.sd-caucasus.com, pp. 74-75, 77.

Above all, there is a lack of *regional* studies of climate change effects on shared ecosystems and resources critical for economic development and growth in areas of the public commons such as water resources. This is of particular urgency for Armenia, Azerbaijan, Iran and Turkey, where droughts and water scarcity have reached a critical point[30]. The increase of natural disaster frequency under climate change is another priority topic reflected under different development strategies of the countries in question that may have a significant impact on regional infrastructure and therefore on sustainable economic development. Different aspects of the impact of climate change on forest ecosystems and biodiversity, in particular on certain species, are indicated as priority topics for research under the first and second editions of Ecoregional Conservation Plans[31]. Moreover, there is a significant gap in the study of climate-change impacts on human health in the Caucasus region, though the issue is of significant importance for human security[32]. Therefore, to promote both national and regional climate change research, the following principal research topics are proposed for the Caucasus Regional Research Agenda:

PROPOSED TOPICS FOR REGIONAL RESEARCH

B1.a. Observation, modelling, mapping, monitoring and Measurement, Reporting and Verification (MRV)
B1.b. Impact of and vulnerability to climate change for ecosystems, economic sectors and human health (Adaptation)
B1.c. Impact of human activities on climate change (Mitigation)
B1.d. Institutionalisation and organisational structures for climate change mitigation and adaptation

B1.A. OBSERVATION, MODELLING, MAPPING, MONITORING AND MEASUREMENT, REPORTING AND VERIFICATION (MRV)

- Effectiveness and efficiency of observation systems, modelling, mapping and monitoring to record and analyse climate change
- Applicability of climate models, as well as enhancement of their projections' accuracy and sufficiency of their response to monitoring and research needs in regional contexts
- Effectiveness of applicability of European indicators considering state-of-the-art technologies and observation capacities and availability of historical data in the countries of the region
- Common standards and approaches to GIS mapping for research, analysis and observation
- Common climate-change observation monitoring methods
- Measurement, Reporting and Verification (MRV) system application

30 The Ministry of Nature Protection MoNP-Armenia. 2015. *The Third National Communications of Armenia to UNFCCC*; The Ministry of Ecology and Natural Resources MoENR-Azerbaijan. 2015. *The Third National Communications of Azerbaijan to UNFCCC*; The Department of Environment-Iran. 2015. *The Intended Nationally Determined Contribution INDC of Iran*; MoEUP-Turkey, 2011. *Turkey's National Climate Change Adaptation Strategy and Action Plan*. MoEUP: Ankara.

31 Williams L., Zazanashvili N., Sanadiradze G., and Kandaurov A. 2006. *Ecoregional Conservation Plan for the Caucasus*. WWF Caucasus. Zazanashvili N, Garforth M, Jungius H, Gamkrelidze T. 2012. *Ecoregion Conservation Plan for the Caucasus. Revised and updated edition.* WWF Caucasus.

32 Field C.B. et al. 2014. Technical summary. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*., Cambridge University Press: Cambridge, United Kingdom, pp. 35-94.

B1.B. IMPACT OF AND VULNERABILITY TO CLIMATE CHANGE FOR ECOSYSTEMS, ECONOMIC SECTORS AND HUMAN HEALTH (ADAPTATION)

- Impact of climate change on mountain ecosystems, biodiversity and environment (forest, pastures, protected areas, etc.)
- Impact of climate change and triggered natural phenomena on different economic sectors (agriculture, energy, forestry, tourism, etc.) and social protection systems as well as on infrastructure (roads, ports, pipelines)
- Water ecosystem vulnerability and water availability for sustainable development under climate change
- Study of spatial adaptation solutions and their perspectives at national and regional levels
- Climate-triggered natural disasters and their impact on sustainable development at the national and regional levels
- Evaluation, analysis and applicability of innovative adaptation technologies, methods and approaches
- Methods of calculating potential losses, including financial ones, from negative impacts of climate change
- Evaluation and analysis of direct climate-induced impacts on human health

B1.C. IMPACTS OF HUMAN ACTIVITIES ON CLIMATE CHANGE (MITIGATION)

- Transport and its impact on climate change and optimisation methods to reduce GHG emissions
- Effectiveness and applicability of internationally recognised measures to reduce emissions from the Land Use, Land-use Change and Forestry (LULUCF) sector, as well as methodologies and technologies of emissions measurement from the sector
- Role and capacities of the industrial sector, including energy, in implementing mitigation measures
- Study of prospects for undertaking precise commitments to reduce emissions within growing national economies, especially former Non-Annex I countries
- Evaluation and analysis of mitigation technologies, methods and approaches applicable to the countries of the region

B1.D. INSTITUTIONAL AND ORGANISATIONAL STRUCTURES FOR CLIMATE CHANGE MITIGATION AND ADAPTATION

- Analysis of effectiveness of existing institutional and organisational arrangements for observation, research, implementation and monitoring of climate change in the region
- Analysis of applicability of different schemes of institutional and organisational structures for proper observation, research, implementation and monitoring of climate change in the region

B2. BIODIVERSITY

RATIONALE

The Caucasus ecoregion is on the list of 34 global biodiversity hotspots[33] and is one out of just seven hotspots located in the Northern Hemisphere in a non-tropical area. This is a politically complex region, covering all or parts of Armenia, Azerbaijan, Georgia, Iran, the Russian Federation, and Turkey. The region is highly diverse in terms of climates and, as a result, diverse landscapes and vegetation are present – from the semi-deserts in the west to temperate (or even subtropical) rainforests along the south-eastern coast of the Black Sea. The region has significant species diversity that is atypical for a non-tropical region. This is because (1) the region's mountain terrain, together with its position between the Black and Caspian seas, results in significant climatic and landscape diversity, (2) the region is located at the crossroads of three biogeographic units (Euro-Siberian, Mediterranean, and Irano-Turanian[34]) within the Palaearctic realm and (3) the region hosts multiple Tertiary refugia where biological communities survived glacial waves and other global climate disturbances[35]. The region hosts about 6,400 species of vascular plants, 20 to 25% of which are endemic to the region. There are almost 400 species of birds, 131 mammal species, 86 species of reptiles, 17 of amphibians, and 127 freshwater fish species. Of these species, 13% of mammal, 18% of amphibian, and 23% of reptile species are regionally endemic[36]. More detailed information about species diversity is available for Georgia[37], which hosts the majority of regional species. The country comprises roughly 1% of world fauna and flora of different groups. Remarkably, both the highest diversity and level of endemism are characteristic of forest landscapes that are associated with the refugial areas of the Caucasus.

In addition to high diversity and the significant level of endemism of wild animal and plant species, the Caucasus, located north of the Fertile Crescent area, hosts an unusually rich diversity of cultivated plants and animals. Specifically, the region is known as an area for grape culture and also shows a high diversity of cultivated wheat and other cereals; it also has indigenous breeds of domesticated animals such as pigs and cows. Whereas lowland areas switched largely to cultivation of common breeds, unique local breeds are still raised in high-mountain regions, especially in the Greater Caucasus Mountains.

Biodiversity of the Caucasus is an essential component of human well-being, both as a natural resource and for its importance in a wild landscape or living space. Extensive agriculture and semi-nomadic sheep breeding are still important livelihood strategies among rural populations in mountain areas. The population of the Greater Caucasus is largely dependent on ecosystem services provided by forest landscapes: timber is harvested for firewood, housing construction, and for commercial purposes. Fisheries are particularly important in the uplands south of the Lesser Caucasus ridges, and angling trout is an important leisure activity for both urban and rural populations. Hunting, including of large game and birds, as well as falconry, are common leisure activities, though they do not provide an important income source for local populations. Harvesting plants and mushrooms for food and trade has variable importance throughout the region. Mushroom collecting is of limited importance (and is more common in the humid western Caucasus) – and only a few mushroom species are used for food. Other plant species are traditionally used for food in some areas – such as *Staphilea pinnata* flowers – but may not be known as food sources elsewhere. Last but not least, recreational tourism is an important income source for some regions within the Caucasus.

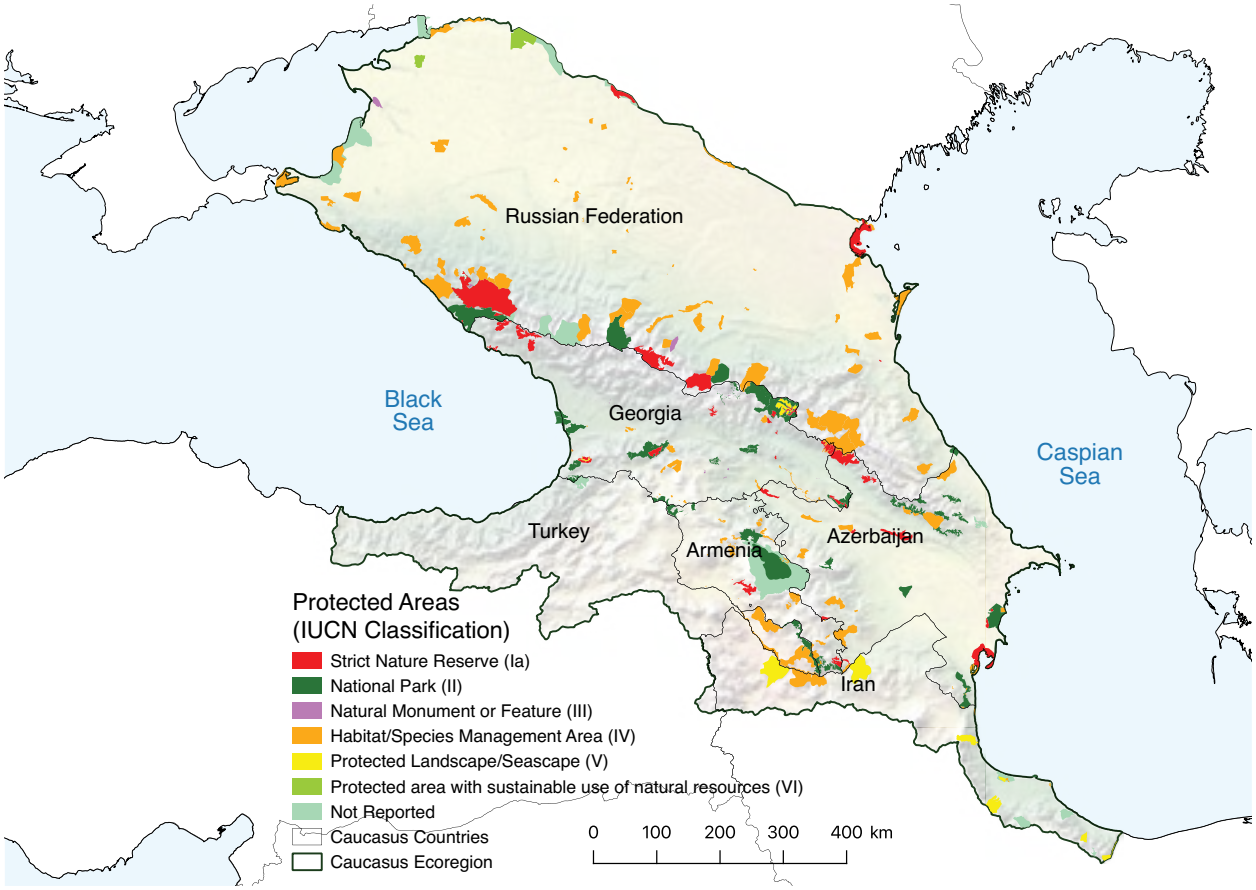
33 Zazanashvili, N., Sanadiradze, G., Bukhnikashvili, A., Kandaurov, A., Tarkhnishvili, D. 2004. *Hotspots revisited, Earth's biologically richest and most endangered terrestrial ecoregions*. CEMEX pp. 148–153.

34 Gabrielian, G.K. 1986. *The Physical Geography of Transcaucasia*. University of Yerevan, Yerevan (in Russian).

35 Tarkhnishvili, D. 2014. *Historical Biogeography of the Caucasus.* NOVA scientific publishers: New York ;
Kobakhidze, N. 2015. Sustainable Management of Biodiversity: Impact analyses on status of biodiversity in Armenia, Azerbaijan and Georgia, and at regional level (South Caucasus), December. Ministry of Environment and Natural Resources Protection, Georgia and GIZ: Tbilisi.

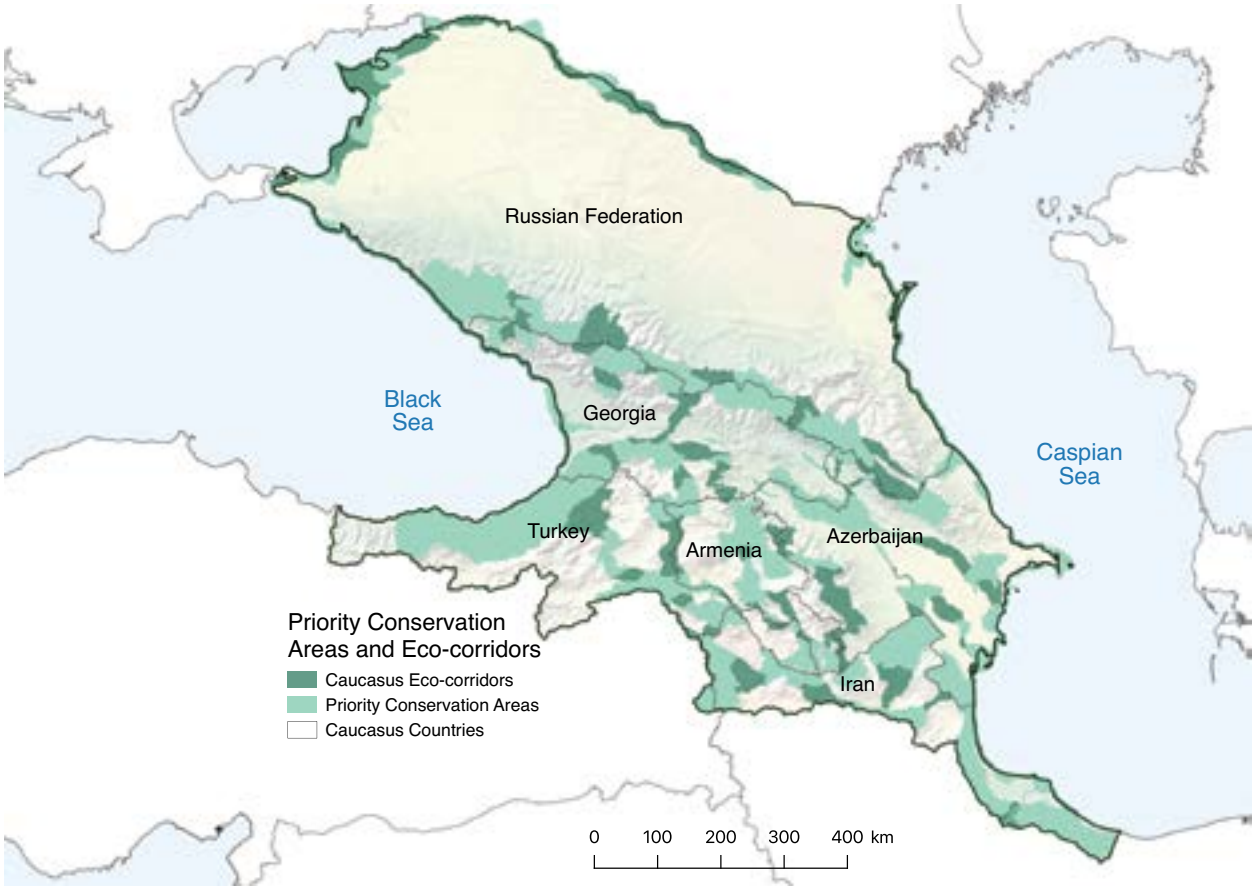
36 Kobakhidze, N. 2015. Sustainable Management of Biodiversity: Impact analyses on status of biodiversity in Armenia, Azerbaijan and Georgia, and at regional level (South Caucasus), December. Ministry of Environment and Natural Resources Protection, Georgia and GIZ: Tbilisi

37 Tarkhnishvili, D., Chaladze, G. eds., 2013. *Georgian biodiversity database*. http://www.biodiversity-georgia.net



Map B2.1: Protected areas of the Caucasus
Source: Protected Planet: www.protectedplanet.net

A conservation strategy for the Caucasus should not be entirely based on ecosystem services since hundreds of rare relict and endemic species found in the mountains, such as the Caucasian salamander (*Mertensiella caucasica*), the Long-clawed mole vole (*Prometheomys schaposchnikowi*) or Smirnow's Rhododendron (*Rhododendron smirnowi*), would remain unprotected as well as charismatic mammals such as the West Asian leopard (*Panthera pardus tuliana*) or the East Caucasian tur (*Capra caucasica cylindricosrnis*).



Map B2.2: Caucasus priority conservation areas and eco-corridors Source: WWF Caucasus

There are substantial efforts for regional conservation. The WWF Caucasus office develops and monitors the execution of the Ecoregional Conservation Plan for the Caucasus. The first edition of the plan was issued in 2006[38] and had been developed by the Regional Biodiversity Council, a volunteer group with representatives from the academic sector, leading NGOs, and governmental institutions of the six countries of the region. Currently, the development of the third version of the plan is underway. The CEPF (Critical Ecosystem Partnership Fund) developed a large-scale project in partnership with the WWF Caucasus Office for endorsing conservation-oriented studies of biodiversity. Other regional non-governmental organisations include the local office of IUCN and the Caucasus Nature Fund (CNF). Additionally, multiple national organisations and academic institutions from Armenia, Azerbaijan, and Georgia, such as the Centre for Biodiversity Research and Conservation (NACRES) (Georgia); Ilia State University (Georgia), Institute of Zoology of Armenian Academy of Sciences, and Baku State University (Azerbaijan) are involved in research and other conservation-related activities, producing multiple action plans, assisting governments in planning and implementing conservation arrangements, and producing peer-reviewed scientific publications focusing on regional issues. Multiple local and international funding organisms, such as the German Development Agency (GIZ), finance multivariate observations on biodiversity, including inventories and monitoring activities.

38 Williams L., Zazanashvili N., Sanadiradze G., and Kandaurov A. 2006. *Ecoregional Conservation Plan for the Caucasus*. WWF Caucasus.

At the same time, an overarching vision for biodiversity conservation for the Caucasus Mountain region is still lacking. Such a vision must integrate popular ideas about human-nature interactions, consider important ecosystem services, recognise the essential need to protect flagship animals and landscapes, and take account of scientific knowledge on regional biodiversity across geological time, which is necessary for properly considering the unique endemic biodiversity complex as well as agricultural diversity.

The internationally recognised conservation action plan for the Caucasus[39] includes six components, four of which are directly linked to mountain ecosystems, including plans for forest, high mountain and some freshwater ecosystems, as well as priority species. A few additional activities are to be recommended that are not directly linked to the enumerated action plans but that are particularly important for the conservation of relict Caucasus biodiversity and agrarian diversity, they include:

- Moving towards more modern methods of data collection, including broad use of molecular markers, modelling, and long-term observation of animals using radio tracking (instead of re-using existent knowledge on biodiversity obtained in previous decades with traditional methods)
- Identifying trends in regional biodiversity by monitoring pilot landscapes and animal species using remote sensing along with field observations
- Switching to broad and open online databases attracting contributors from the different countries and moving away from reports of limited use
- Exploring the influence of climate change on mountain biodiversity
- Fostering multidisciplinary studies on biodiversity and ecosystem services

PROPOSED TOPICS FOR REGIONAL RESEARCH

B.2.a. Research on forest ecosystems and ecological services related to forests and sustainability
B.2.b. Research on high mountain ecosystems, mountain pasture dynamics, and range management
B.2.c. Research on mountain lakes, wetlands, and river ecosystems as well as their sustainability and associated ecological services
B.2.d. Priority species research

B2.A. RESEARCH ON FOREST ECOSYSTEMS AND ECOLOGICAL SERVICES RELATED TO FORESTS AND SUSTAINABILITY

- Application of modern analytical tools, combining remote sensing and research on land, for improved description and taxation of the regional forests
- Exploring natural factors (climate change and diseases) critical for forest quality, growth rates, and related species diversity
- Exploring anthropogenic influence on the Caucasus mountain forests with a historical dynamic – addressing challenges related to the industrial development of the region
- Multidisciplinary studies of ecological services provided by mountain forests to the local populations and viability of forest ecosystems
- Community studies of forest plants
- Barcoding of plants and animals of the Caucasus Mountain Forests
- Population genetic and phylogeographic studies of important forest tree species
- Population genetic and phylogeographic studies of endemic and relict mountain forest animals and plants
- Reconstruct forest distribution dynamics from the geological past, modelling forest refugia, and predicting forest dynamics in conditions of global climate change

[39] Williams L., Zazanashvili N., Sanadiradze G., and Kandaurov A. 2006. *Ecoregional Conservation Plan for the Caucasus*. WWF Caucasus.

B2.B. RESEARCH ON HIGH MOUNTAIN ECOSYSTEMS, MOUNTAIN PASTURE DYNAMICS, AND RANGE MANAGEMENT

- Application of modern analytical tools, combining remote sensing and field research, for improved descriptions of mountain grasslands and pastures
- Exploring natural factors (climate change and diseases) critical to high-mountain vegetation dynamics
- Exploring anthropogenic influence on high-mountain pastures; study erosion
- Multidisciplinary studies of effectiveness of the use of mountain grasslands as pastures and the sustainability of high-mountain vegetation
- Ecological studies of high-mountain plant assemblages
- Barcoding plants and animals of the Caucasus Uplands
- Population genetic and phylogeographic studies of flagship mountain forest species
- Reconstruct the distribution dynamics of grasslands in the geological past, predicting dynamics of high mountain ecosystems in conditions of global climate change

B2.C. RESEARCH ON MOUNTAIN LAKES, WETLANDS, AND RIVER ECOSYSTEMS AS WELL AS THEIR SUSTAINABILITY AND ASSOCIATED ECOLOGICAL SERVICES

- Monitor biodiversity of mountain wetlands, lakes and rivers
- Exploring anthropogenic influence on the high mountain aquatic ecosystems; studies of water pollution.
- Studies of invasive and introduced species of fish and aquatic invertebrates with ecological and genetic methods
- Multidisciplinary studies of effectiveness of use of mountain wetlands, rivers, and lakes from perspective of (1) fishery, (2) energetics, (3) tourism/recreation considering sustainability of resource exploitation
- Ecological studies of aquatic communities
- Barcoding of aquatic biological species
- Reconstruct aquatic communities in geological past, predicting dynamics of the aquatic ecosystems in conditions of global climate change.
- Use aquatic macrofauna as indicators of water pollution; community studies of aquatic invertebrates.

B2.D. PRIORITY SPECIES RESEARCH

- Development of monitoring systems for rare and endangered large-bodied animal populations dependent on mountains, specifically large carnivores and ungulates (West Asian leopard, brown bear, turs, bezoar goat, mouflon, chamois, red deer)
- Population genetic studies and habitat modelling of Caucasian brown bear, tur, bezoar goat, mouflon, chamois, and red deer
- Monitor temporary stopover aggregations of migratory water birds in mountain lakes
- Monitor and model breeding sites of protected birds of prey
- Complex population genetic and population ecological study of trout and Black Sea salmon
- Full taxonomic inventories and barcoding of animals, plants, and fungi at selected sites throughout the region, with the accent on protected areas.
- Population genetic studies of resident galliform birds – black grouse, partridge, chukar, Caucasian and Caspian snowcock, francolin
- Population genetic and phylogeographic studies of relict small vertebrates and invertebrates, emphasizing those included on the IUCN Red List under NT (Near Threatened), VU (Vulnerable) categories and higher: endemic snails, endemic butterflies, mountain vipers, rock lizards, Caucasian salamanders, endemic species of shrews, snow voles, long-clawed mole voles and others
- Monitoring and ecological studies of bats

B3. FORESTRY CONSERVATION AND DEVELOPMENT

RATIONALE

Forests cover 11,178,189 hectares or 19.09% of the region40, constituting the most important biome for biodiversity conservation in the Caucasus. Forest ecosystems harbour many endemic and relict species of woody plants and herbs, and they are important habitats for rare and endangered animals. Mountain forests, which make up the greater part of the forest biome in the region, play a critical role in preventing soil erosion and regulating water flow.

Broadleaf, coniferous, timberline, arid open woodland, and lowland forests are the main types of forests in the Caucasus, distributed according to elevation, soil conditions, and climate. Broadleaf forests account for more than two-thirds of the region's forests; they consist primarily of Oriental beech, oak, hornbeam (i.e. *Carpinus caucasica, Carpinus orientalis, Carpinus betulus*), and chestnut. Beech forests are the main source for the region's timber industry. Careless clear cutting of mountain beech stands has permanently damaged a significant portion of valuable beech forests in the North Caucasus[41].

Oak forests used to be widespread throughout the Caucasus – 14 of the 17 oak species found in the Caucasus are endemic to the region[42]. Chestnut forests are found on acidic soils in the Colchic foothills and in the northwestern Caucasus and are often mixed in with hornbeam and beech forests. Coniferous forests are made up primarily of Oriental spruce, Caucasian fir, and Caucasian pine. Dark coniferous forests (spruce and fir) are found in the western part of the Lesser Caucasus Range, and on both sides of the western and central Greater Caucasus mountain range. Coniferous forests grow in wide bands generally between 900 m and 2,150 m above sea level, often on steep, rocky slopes where they play an important role in protecting soil from erosion. Conifers are logged for paper production and timber, which has resulted in a severe depletion of forest reserves. Poor forest health has led to fungal and bark beetle invasions that can spread and destroy entire stretches of spruce forests. Timberline forests, growing in high-altitude conditions, consist of trees that grow in crooked, dwarfed, and sparse formations. These tree forms are found particularly in areas with snowy winters or dry continental weather. Birch (*Betula* spp.), mountain ash (*Sorbus caucasigena*), beech, Eastern oak, Trautvetter maple (*Acer trautvetteri*), and pine are all generally common at or near timberline. Arid open woodlands, consisting of juniper and pistachio species, form on dry, rocky slopes in the eastern and southern Caucasus. Lowland forests are found in floodplains and on low river terraces, generally growing on alluvial, swampy, or moist soils. Very few such forests have been preserved to this day; some stands remain only in the Lenkaran and Colchic Lowlands and in the Kura, Iori, Samur and Alazan-Agrichay river valleys.

Most of the focal species of animals are associated with forest ecosystems, to varying degrees. Since forests of the western Caucasus and Talysh are largely isolated from other large forest massifs in Europe and Central Asia, they contain most of the regional endemic species of the Caucasus region. These forests, located mainly in the northern part of Iran, are also known as the Caspian forests or Hyrcanian forests – they belong to the end of the third geological era. The Caspian forests are known as the oldest forests in the world and extend to a maximum altitude of 2,800 meters above sea level[43].

Forest cover is closely linked to precipitation and climate, and thus the lower limits of woodlands vary considerably. Trees grow at sea level as well in those areas where the average annual precipitation is high enough (for example, in the Colchic in Georgia, and in the Hyrcanian floristic region in Azerbaijan and Iran). In the dry regions of the Aras Basin, forests retreat almost to the subalpine belt.

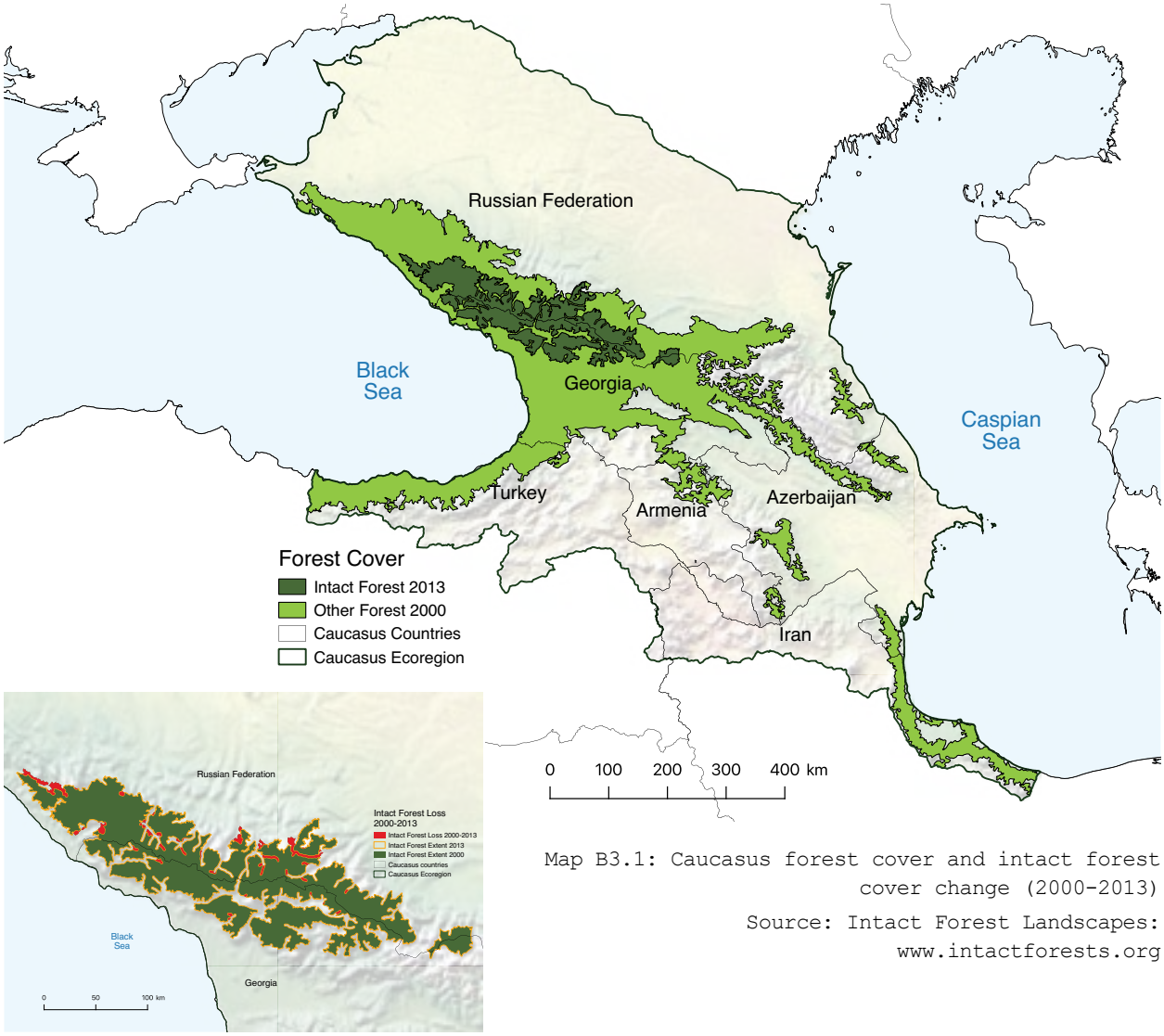
40 Williams L., Zazanashvili N., Sanadiradze G., and Kandaurov A. 2006. *Ecoregional Conservation Plan for the Caucasus*. WWF Caucasus.

41 Williams L., Zazanashvili N., Sanadiradze G., and Kandaurov A. 2006. *Ecoregional Conservation Plan for the Caucasus*. WWF Caucasus.

42 Critical Ecosystems Partnership Fund (CEPF). 2005. *The Caucas*us Biodiversity Hotspot. https://www.cepf.net/sites/default/files/final.caucasus.ep_.pdf

43 Zazanashvili N, Garforth M, Jungius H, Gamkrelidze T. 2012. *Ecoregion Conservation Plan for the Caucasus. Revised and updated edition.* WWF Caucasus.

The most significant forests for biodiversity conservation can be grouped into four primary geographical areas: 1) the Greater Caucasus Mountains, 2) the Lesser Caucasus Mountains, 3) the Talysh-Gilan Mountains, and 4) the Kura-Aras and Iori Basins. These areas should be the focus of forest conservation activities and can be targeted for creating ecological networks. Currently, only 13.21% of forests in the Caucasus are preserved in protected areas: 16.3% of forests in the Greater Caucasus Mountains, 9.11% of the Lesser Caucasus Mountains, 9.52% of forests in the Talysh-Gilan Mountains and about 13% in the Kura-Araks and Iori Basin. In the long-term, at least an additional 10% of the forests in the region should be granted protection (IUCN I-IV)[44].



Map B3.1: Caucasus forest cover and intact forest cover change (2000-2013)

Source: Intact Forest Landscapes: www.intactforests.org

Agricultural development has resulted in a significant decrease of broadleaf forests in the region, which had generally occupied land favourable for growing grapes, fruit trees, and other crops. Many forests were also felled to clear land for grazing. The area covered by chestnut forests has significantly decreased as a result of chestnut blight disease and unsustainable management, including intensive logging of this valuable species over the centuries. In northeastern Turkey, broadleaf forests are cleared for tea and hazelnut plantations. In northwestern Iran, only 12% of Arasbaran broadleaf forests remain, noted for their high

44 Williams L., Zazanashvili N., Sanadiradze G., and Kandaurov A. 2006. *Ecoregional Conservation Plan for the Caucasus*. WWF Caucasus.

number of endemic species. Illegal logging, firewood harvesting, and the timber trade threaten biodiversity in the region's forests and lead to habitat degradation. While *legal* logging has actually decreased in some areas in the past few years (in the North Caucasus, for example, only 30–50% of the originally planned area is being logged), *illegal* logging has increased. In Georgia in recent years, illegal logging (including firewood harvesting) was several times higher than official quotas according to experts. In Armenia, as a result of the energy crisis, 27,000 ha of forest were cut between 1992 and 1995 comprising 8% of the entire forest cover of that country. Firewood harvesting has increased nearly three times in some areas compared to a decade ago as a result of energy shortages and the economic crisis. Rural populations are largely dependent on firewood consumption for heating and cooking. Illegal timber export has also been considered a serious problem, particularly for Georgia and Russia, but official estimates of exports are not available. Illegal logging leads to a decline in species composition, forest degradation, and overall habitat loss, impacting a number of plant and animal species. Firewood collection and consumption lead to forest degradation and the disappearance of certain species and contributes to forest fires and global warming. The regions most impacted by unsustainable logging and firewood harvesting are: the Greater Caucasus mountain range and the Lesser Caucasus mountain chains, including the Eastern Black Sea Mountains (Pontic Mountains) in northeastern Turkey, the Meskheti and Trialeti ridges in Georgia, the Shakhdag, Sevan (Areguni), Pambak, Khalal, Ijevan and Zangezur mountain ranges in the northeastern part of Armenia[45].

Several global and regional agreements (see list in Table B3.1) as well as other mechanisms aimed at developing sustainable forest management include: (a) UN Forum on Forests (UNFF, a high-level intergovernmental policy forum, composed of all UN member states) which, in 2006, at its sixth session, agreed on four shared Global Objectives on Forests; (b) United Nations Food and Agriculture Organisation (FAO) is one of the leading UN organisations that deals with sustainable forestry issues around the world through its normative work, field programmes, direct country support and contributions to global partnerships; and (c) Forest Law Enforcement and Governance (FLEG) processes. The Europe and North Asia FLEG Ministerial Conference brought together nearly 300 participants representing 43 governments, the private sector, civil society and international organisations and approved the St. Petersburg Declaration on Forest Law Enforcement and Governance in Europe and North Asia, which includes an indicative list of actions intended to serve as a general framework for possible actions to be undertaken by governments and civil society. (d) Moreover, UN Agenda 2030 guides the most recent global forest management needs under SDG15.

Table B3.1: List of Conventions related to forest management and protection in the Caucasus

	Armenia	Azerbaijan	Georgia	Iran	Russian Federation	Turkey
Convention on Biological Diversity (CBD), 1992	√	√	√	√	√	√
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973	√	√	√	√	√	√
United Nations Convention to Combat Desertification (UNCCD), 1994	√	√	√	√	√	√
Kyoto Protocol to the UNFCCC Convention, 1997	√	√	√	√	√	√
Cartagena Protocol on Biosafety, 2000	√	√	√	√		√

45 Williams L., Zazanashvili N., Sanadiradze G., and Kandaurov A. 2006. *Ecoregional Conservation Plan for the Caucasus*. WWF Caucasus.

The forests of Armenia, Azerbaijan, Georgia, the Russian Federation and most forests in Turkey are state property. Three main threats to the region's forests include: unsustainable logging for industrial timber and firewood, unsustainable grazing and inappropriate operational practices. These threats each have some distinct underlying cause or causes: international and domestic demand for industrial timber lead to the unsustainable logging of industrial timber; demand for energy for heating and cooking and no alternative to firewood or inability to pay for any alternative leads to firewood collection; rural poverty; lack of awareness among graziers, and the lack of alternative livelihood opportunities lead to unsustainable grazing. Factors that shape the nature of forest assets are not understood by some of the stakeholders that have the greatest influence on the nature of these assets – including government officials and forest users. This lack of understanding makes it less likely that stakeholders will be able to influence forest policy and practices in an appropriate direction. Tenure of the local forest lands is not clear. This causes a lack of clearly designated responsible parties, accountable for the conditions of the forested areas. Sectoral policy holders generally do not recognise multiple and opposing existing valid perspectives and stakeholders and tend to act without regard for the needs and views of stakeholders outside of the government. There is no process for defining national sustainable forest management (SFM) standards. There are no mechanisms for sharing credible information about the sustainability of forest products produced in the region up the supply chain. Lack of information prevents supply chain actors from supporting SFM.

PROPOSED TOPICS FOR REGIONAL RESEARCH

B.3.a. Restoration of shared (transboundary) forest landscapes
B.3.b. Protected forest areas network
B.3.c. Sustainable forest management (SFM) standards and guidelines
B.3.d. Forest inventory and new technologies
B.3.e. Forests' protective functions
B.3.f. Forests and people
B.3.g. Forests and climate change
B.3.h. Ecosystem services, biodiversity, and biological invasions

B3.A. RESTORATION AND PROTECTION OF SHARED (TRANSBOUNDARY) FOREST LANDSCAPES

B3.B. PROTECTED FOREST AREAS NETWORK

- Priority forest conservation areas
- Protected forest area network and 'wildlife corridors' for animal migration
- System of 'eco-nets' and forest landscape restoration transboundary programmes

B3.C. SUSTAINABLE FOREST MANAGEMENT (SFM) STANDARDS AND GUIDELINES

- National forestry standards, including community forest management standards
- SFM regional model standards and management planning and practice guidelines
- Applicability of internationally recognised certification schemes

B3.D. FOREST INVENTORY AND NEW TECHNOLOGIES

- Development of operational GIS data base in forestry sector
- Establishment of a regional information exchange network
- Testing modern technologies such as Light Detection and Ranging (LiDAR) Drones
- Development of regional forest Spatial Data Infrastructure (SDI)
- Fine Beam Dual (FBD) monitoring system, regional exchange of data on FBD to ensure efficiency of protection measures and evidence-based decision making

B3.E. FORESTS' PROTECTIVE FUNCTIONS

- Forests and water
- Forests and erosion
- Forest lands damaged by fire, pests and diseases
- Forest restoration

B3.F. FORESTS AND PEOPLE

- Forests and forest-based products for a greener future
- Supply chain actors and sustainably managed forests
- Grazing and forests
- Multipurpose use of forest resources for community forest management
- Educational programmes for community-based sustainable tourism in areas adjacent to mountain forests
- Forest enterprises and timber markets
- Incentives for forest users to follow SFM
- Rural poverty and alternative livelihood opportunities
- Forest management practices in the ecoregion

B3.G. FORESTS AND CLIMATE CHANGE

- Assessment of forest vulnerability and enabling environments for integrating climate change risks into management of forest ecosystems
- Assessment of carbon-absorption capacities in forest areas
- Enhancement of resilience of mountain forest ecosystems in the region due to adaptation measures

B3.H. ECOSYSTEM SERVICES, BIODIVERSITY AND BIOLOGICAL INVASIONS

- Studies and assessment of High Conservation Value Forests (HCVF) and ecosystem services of Caucasian mountain forests
- Forest fires, pests and diseases
- Identify and assess current and potential threats to forest biodiversity

B4 . WATER RESOURCES AND MANAGEMENT

RATIONALE

Water is an essential resource for life, ecosystem functioning and almost any economic activity (agriculture, energy generation, production and processing, etc.). The Caucasus ecoregion has three water basins: the Caspian Sea, the Black Sea and the Sea of Azov. The majority of rivers flow into the Caspian Sea. Rivers such as the Kura, Aras, Terek and Sulak flow through the most arid and sensitive ecosystems. The transboundary water bodies of the Caucasus include the Kura and Aras rivers as well as Çoruh, Psou, Terek, Iori, and Alazani rivers, and Kartsakhi, Jandar and other lakes. The length of the Kura and Aras rivers, two of the longest rivers of the Caucasus, exceeds 2000 km (Kura 1,364 km; Aras 1,264 km)[46]. The annual average flow of the Caucasus rivers varies between 1,000-2,000 mm (Adjara and the Greater Caucasus) to 50 mm and lower in the Kura-Aras lowland, Caspian lowland, Stavropol upland and northern part of Kuban steppe.[47]

The Caucasus region has several lakes, the largest of which is Lake Sevan with an area of 1,245 sq. km (2014)[48] and maximum depth of 83 m. There are several salt lakes around the Sea of Azov as well. Wetlands and freshwater habitats cover 11.72% of the Caucasus ecosystem[49], where the eleven Ramsar Sites (Wetlands of International Importance) are located[50].

Map B4.1: Caucasus dams and rivers
Source: HydroSHEDS: www.hydrosheds.org and GWSP: www.gwsp.org

46 Kerres, M. 2010. *Adaptation to Climate Change in the Kura-Aras River Basin*: *River Basin Snapshot: Draft for Discussion. Unpublished manuscript* BMZ/KfW. https://iwlearn.net/resolveuid/166c61b7bbfc4def7dffa12d5102d4b3

47 UNEP. 2002. *Caucasus Environment Outlook. GRID-Tbilisi: Tbilisi*

48 European Environmental Agency et al. 2014. *Building a SEIS for Lake Sevan, Armenia.*

49 Williams L., Zazanashvili N., Sanadiradze G., and Kandaurov A. 2006. *Ecoregional Conservation Plan for the Caucasus*. WWF Caucasus.

50 Ramsar Convention Sites' map: https://rsis.ramsar.org

Each country has its own legal framework that regulates protection and use of water resources and a comprehensive legally binding document on protection and use of transboundary rivers and lakes, ratified by all states of the Caucasus does not yet exist. Only Azerbaijan and the Russian Federation have signed and ratified the Convention of the UN Economic Commission for Europe (UNECE) on the Protection and Use of Transboundary Watercourses and International Lakes[51]. They also signed the UN Protocols on Water and Health and on Civil Liability and Compensation. At the same time, Azerbaijan, Iran and the Russian Federation are parties to the Caspian Convention (the Framework Convention for the Protection of the Marine Environment of the Caspian Sea, also called the Tehran Convention)[52], while Georgia, Turkey and the Russian Federation cooperate under the Black Sea Regional Convention (The Convention on the Protection of the Black Sea Against Pollution)[53]. UN Agenda 2030 SDG6 further defines priorities in the water sector and sanitation.

Water resources are distributed unevenly among countries of the Caucasus with Georgia as the country of the ecoregion with the greatest water resources[54]. In the South Caucasus, excessive and unsustainable use of water resources is a common practice due to the gradual increase of demand by both household and industrial sectors, high level of leakage in water supply systems and overuse of water for agricultural purposes. For example, flood irrigation is the main method used in agriculture of all countries, which causes immense water loss. The scarcity of clean water resources caused by industrial pollution, mining activities, dam construction and, in general, the unsustainable use of water resources can generate tension among various water consumers both at national and regional levels.

The main water-related problems in the transboundary context are quantity and quality of both surface and ground waters. Groundwater quality and quantity are not sufficiently studied in most of the Caucasus countries. As knowledge about water resource utilisation in all the countries of the region is relatively low, in all respects, this lack of awareness may cause serious water scarcity in the future. This can be aggravated by climate-change impacts. Recent studies demonstrate that most of the countries of the region are already suffering and will further suffer from increased temperatures and glacier retreat due to climate change, causing water shortages and intensification of desertification processes[55]. This is of special concern for Armenia, Azerbaijan, Iran and Turkey. Protection and sustainable use of transboundary water resources of the region is also essential for ecosystem functioning, biodiversity and habitat protection. To solve the abovementioned problems, the following approaches should be introduced into the socio-economic paradigm of the Caucasus countries: (a) Introduction of integrated basin management principles both at the national and regional levels; (b) Cooperation between upstream and downstream water users; (c) Introduction of water-saving technologies; (d) Promotion of natural-hazard prevention practices; (e) Protection of freshwater, wetland, lake, river and marine ecosystems; etc.

PROPOSED TOPICS FOR REGIONAL RESEARCH

B.4.a. Biophysical and social dimensions of water systems
B.4.b. Institutional and economic dimensions of water systems
B.4.c. Integrative instruments and interventions

51 United Nations Economic Commission for Europe. 1992. The Convention on the Protection and Use of Transboundary Watercourses and International Lakes. Convention adopted by UNECE on 17 March 1992: http://www.unece.org/env/water.html

52 Framework Convention for the Protection of the Marine Environment of the Caspian Sea, the Tehran Convention: http://www.tehranconvention.org/

53 The Convention on the Protection of the *Black Sea* Against Pollution (Bucharest Convention). Ratified by all six legislative assemblies of the Black Sea countries (Bulgaria, Georgia, Romania, the Russian Federation, Turkey, Ukraine) in 1994. http://www.blacksea-commission.org/_convention.asp

54 Ubilava M., *Water Management in the South Caucasus*; Water balance in the South Caucasus. Unpublished paper presented at Integrated Water Management of Transboundary Catchments conference, FEEM, Venice Italy 2004.

55 MoNP-Armenia 2015. *The Third National Communications of Armenia to UNFCCC*; MoENR-Azerbaijan 2015. *The Third National Communications of Azerbaijan to UNFCCC*; The Ministry of Environment and Natural Resources Protection MoENRP-Georgia, 2015. *The Third National Communication of Georgia to UNFCCC;* The Department of Environment-Iran 2017. *The Third National Communications of Iran to UNFCCC*; The Ministry of Natural Resources and Ecology-the Russian Federation 2013. *The Sixth National Communication of the Russian Federation to UNFCCC* and MoEUP-Turkey 2016. *The Sixth National Communication of Turkey to UNFCCC.*

B4.A. BIOPHYSICAL AND SOCIAL DIMENSIONS OF WATER SYSTEMS

- Monitoring of quality and quantity of transboundary rivers and groundwater
- Integrated modelling of transboundary river systems, including small mountain streams
- Modelling of coupled socio-ecological systems
- Water, sanitation and society
- Water storage, water conservation and society
- Anticipating climate-change adaptation of water-surface and groundwater resources
- Water, environment and spatial planning
- Understanding conflict and cooperation through studying interdependencies

B4.B. INSTITUTIONAL AND ECONOMIC DIMENSIONS OF WATER SYSTEMS

- Water operators and water-supply fees
- Performance and benchmarking of water and wastewater utilities
- Performance of water management and policy-making organisations and river-management bodies
- Investments in infrastructure for urban water and sanitation
- Applicability and effectiveness of existing wastewater treatment technologies and economic implications of their utilisation
- Economic and financial analyses of water systems
- Hydropower vs. environment
- Irrigation vs. hydropower
- Development and application of modelling tools for allocating scarce water resources among competing users
- The economic and financial analysis of centralised versus decentralised wastewater treatment and water supplies
- The economics of separating grey and brown water
- Economic valuation of aquatic ecosystem services
- Effectiveness of national and international legal frameworks for solving existing and potential transboundary river problems in the Caucasus
- Effectiveness and applicability of methods for assessment of environmental and economic values, and ecosystem services of water bodies
- Water-saving technologies in agriculture
- Supply and demand management in irrigation and residential water provision
- Hazard management and disaster-risk reduction

B4.C. INTEGRATIVE INSTRUMENTS AND INTERVENTIONS

- Applicability of different technological and analytical tools and models in the Caucasus
- Use of information and tools in planning and policy: Decision-support systems (DSS), operational tools, integrated assessment of water use and policy, environmental assessment of water use and policy (Environmental Impact Assessments or EIA, Strategic Environmental Assessments or SEA), incentive-based policy instruments and water-use efficiency, water, environment and spatial planning, spatial planning and Integrated Natural Resources Management, wetland governance, early warning systems, Integrated Water Resources Management (IWRM)
- Economic perspectives of water policy and management under climate change, especially in transboundary context
- Capacity-building interventions to support transboundary water management and IWRM
- Aquatic ecosystem management and protection

B5. LAND USE AND LAND COVER CHANGE

RATIONALE

'Land use' describes the way and the purposes for which human beings employ the land and its resources. 'Land cover' refers to physical characteristics of the land including human-made structures, which make up the earth's landscape. Historically, land-use and land-cover changes have occurred primarily in response to population growth, technological advances, and economic opportunity. Human activities have directly or indirectly modified the natural environment. This is due to the fact that production demands by humans cannot be fulfilled without modification or conversion of land cover. Of the challenges facing the earth over the next century, land-use and land-cover changes are likely to be one of the most significant.

Functionally, mountains play a critical role in the environmental and economic processes of the planet. Mountain regions present opportunities for different fields of land sciences because they are exceptionally diverse. The degradation of mountain ecosystems threatens to seriously worsen already existing global environmental problems including floods, landslides, and famine. Climate change, pollution, armed conflict, population growth, deforestation, and exploitative agricultural, mining, and tourism practices, are among a growing list of problems confronting the 'water towers of the world'[56], prompting warnings that catastrophic flooding, landslides, avalanches, fires, and famines will become more frequent and that many unique animals and plants will disappear. Therefore, many studies have focused on processes of land-use and land-cover change on mountains throughout the world to understand related ecological, economic and social problems.

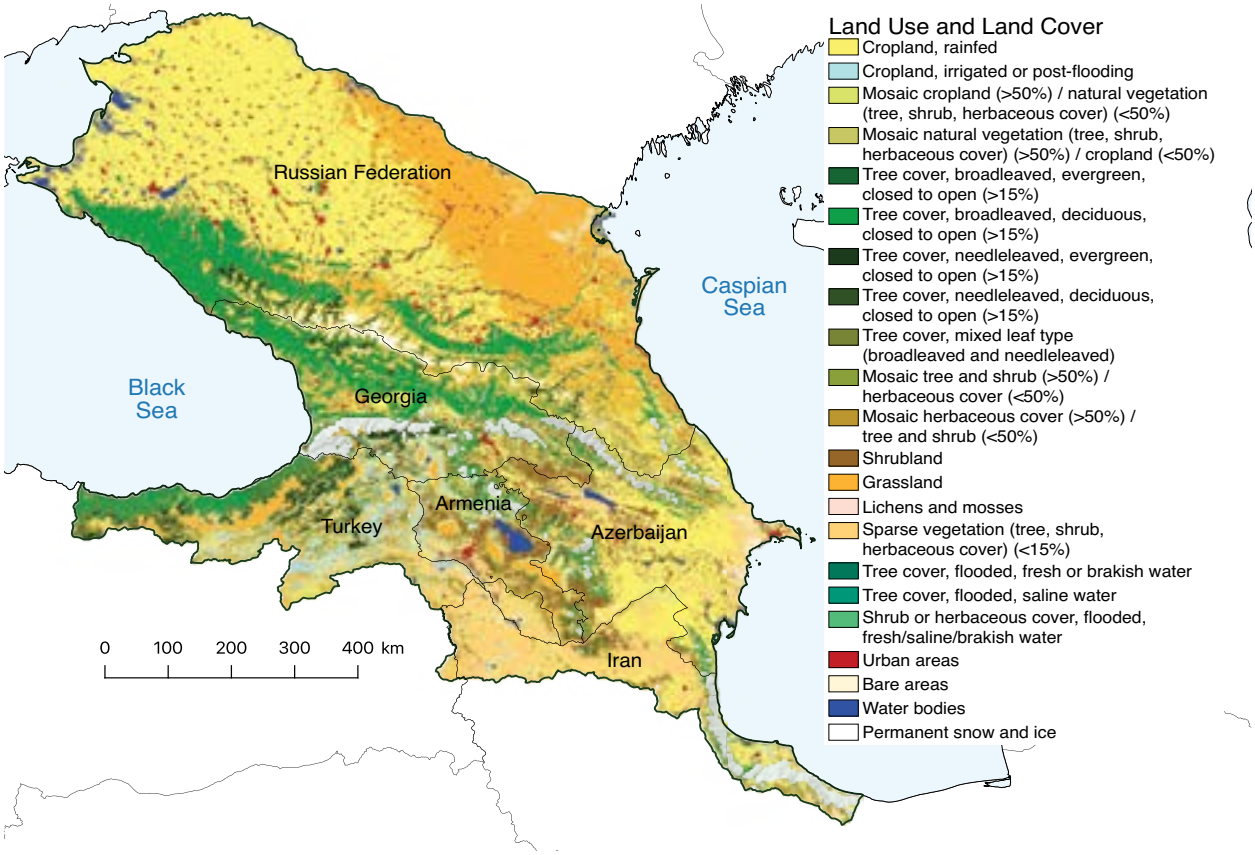
The Caucasus territory is defined as a Biodiversity Hotspot Area by the Critical Ecosystems Partnership Fund (CEPF). The Caucasus Hotspot Area, a total of 532,658km^2, lies between the shores of the Black and Caspian seas and comprises savannas, arid woodlands and forests. The territory is home to a large number of endemic plant species and includes Georgia, Armenia, Azerbaijan and the north Caucasus portion of the Russian Federation, as well as parts of Turkey and Iran.[57] After the 1990s, land-use conversion of forests and other natural areas have occurred rapidly and widely in the Caucasus region. However, together with vast areas where anthropogenic impacts on land cover reached large scales and frequently caused undesirable alteration of land uses, in some other areas (e.g. Georgia, western North Caucasus regions of the Russian Federation) due to population decline and insufficient economic activities, traditional cultural forms of land use have retreated, giving way to 'wilder' forms of land cover. Hence, the situation differs significantly from place to place in the Caucasus Mountain Region. Nevertheless, the problem of soil degradation is common and very acute in almost all parts of the region and consequently this issue deserves special attention and the active involvement of professionals.

The biological diversity of the Caucasus Mountains has a global importance. However, during the last decades, the region has experienced a rapid change in land-use and land-cover patterns that have environmental, economic and social effects. For better management of land use and improvement of land cover, the application of integrated land management (ILM) approaches and systems will be needed. ILM involves strategic planning for the management and reduction of the human-caused footprint on public land and, therefore, is considered an efficient way for achieving sustainability and security in land use.

Mountain regions, including the Caucasus Mountain Region, present unique challenges for scientific studies and the use of modern methodologies and technologies such as geographic information systems (GIS) and remote sensing (RS). The main goal is to study land use in the Caucasus mountain region to increase understanding of the drivers of land-use change.

56 The Mountain Partnership. 2014. *Mountains as the water towers of the world: A call for action on the sustainable development goals SDGs.* Policy brief.

57 Critical Ecosystems Partnership Fund (CEPF). 2005. *The Caucasus Hotspot Briefing Book.*



Map B5.1: Caucasus land cover
Source: ESA: www.esa-landcover-cci.org and Land Cover CCI: ftp://anon-ftp.ceda.ac.uk/neodc/esacci/land_cover/docs/ESACCI-LC-PUG-v2.5.pdf

PROPOSED TOPICS FOR REGIONAL RESEARCH

B.5.a. Observation of land use/land cover (LULC) in the region
B.5.b. Monitoring
B.5.c. Impacts and Consequences
B.5.d. Modelling
B.5.e. Synthesis

B5.A. OBSERVATION OF LAND USE/LAND COVER (LULC) IN THE REGION:

- Define the right scale and spatial resolution for preparing LULC maps.
- Define a conceptual framework of causes and drivers of LULC for LULC characterisation, mapping, and monitoring. This includes techniques using remote-sensing technology, or empirical methods that can both be done on different scales
- Use satellite imagery to develop a regional LULC map for the Caucasus Mountains
- Habitat changes and effects on biodiversity or behaviour
- Spatial relationships between humans and biodiversity, identify overlap on Caucasus mountains
- Connect remote-sensing data with social-science approaches

B5.B. MONITORING:

- Monitor past and current trends of LULC
- Prepare high-resolution map of LULC changes at 30 m (or less) spatial resolution for the last three decades
- Compare the rates of different disturbances like deforestation in areas within and outside biosphere reserves, national forests, and protected areas, establishing the role of protected areas and indigenous lands

B5.C. IMPACTS AND CONSEQUENCES:

- Negative environmental impacts from LULC changes
- Agricultural LULC changes as a driver of global change
- Understand and simulate economic consequences of LULC changes
- The interaction of land use and land cover with the climate system (e.g. carbon cycle feedbacks)
- The provision of ecosystem goods and services by different land-cover types (e.g. food production)
- Relation between demographic changes and LULC
- Effects of in- and out-migration on LULC
- Urbanisation
- The impact of international markets and international trade systems on land conversion to agriculture and its consequences
- Declining soil fertility caused by LULC changes
- Shifting cultivation as a response to LULC changes
- Effects of LULC changes on hydrology

B5.D. MODELLING:

- Models for assimilating human and environmental data
- Models for testing alternative hypotheses about system structure and function
- Models for projecting future LULC
- How to establish common and scientifically sound protocols in order to communicate models and results among researchers
- Analysis of the accuracy of and uncertainty inherent in LULC models
- Verification and validation of LULC models

B5.E. SYNTHESIS:

- The effects of land use practices on ecosystems
- Opportunities and limitations for managing LULC
- How to quantify changes

B6. NATURAL HAZARDS AND RISKS

RATIONALE

Natural hazards are natural phenomena that may have negative effects on humans or the environment. The INSPIRE Directive[58] classifies natural hazards the following way: *meteorological /climatological* (droughts, extreme temperatures, lightning, storm surges, tornados, hurricanes and strong winds); *geological/ hydrological* (earthquakes, floods, landslides, snow avalanches, subsidence and collapses, tsunamis, volcanic events, etc.); *fires* (forest fires or wild fires, underground fires); *biological* (allergens, infestation, etc.); *epidemic* (an outbreak of a disease that spreads rapidly among individuals in an area or population); and *cosmic* (magnetic disruption, meteorite impact, solar and cosmic radiations, etc.)[59]. Most common natural disasters for the Caucasus region are meteorological/climatological or geological/hydrological including earthquakes as well as forest fires. This classification is fully in line with internationally recognized classifications[60] defined in consultation with the United Nations Development Programme (UNDP), Asian Disaster Risk Centre (ADRC), and the United Nations International Strategy for Disaster Reduction (UNISDR)[61].

There are several global, regional and national databases. However, a problem of common to all of these is their reliability, which may either be insufficient for research needs of natural disasters in mountain regions, or insufficiently detailed for analysis of sustainable development in mountain regions[62]. Furthermore, existing global databases cannot be efficiently utilised for proper decision making in the disaster risk reduction (DRR) sector at the regional level, including at the level of the Caucasus region. In the case of the Caucasus region, even with the availability of international instruments like the UNISDR that has been established to support and coordinate DRR efforts, the six countries of the region are not comparable in terms of their capacities to tackle natural hazards[63]. In spite of this fact, all Caucasus countries are undertaking research and recording natural hazards at the national level (in both GIS and database formats), but these information sets are far from being comparable. Moreover, until now, very little effort has been made to establish common comparable datasets on natural disasters in mountain regions of the Caucasus.

Based on the information available on the web page of the UNISDR (2014) in the form of Hyogo Framework for Action (HFA) Progress Reports, five reporting countries of the Caucasus region (Armenia, Georgia, Iran, the Russian Federation and Turkey) still lack important tools for establishing reliable national DRR systems such as a unified methodology for natural hazard mapping and analysis, unified methodology for calculation of financial losses for natural hazards, and regional cooperation systems with neighbouring Caucasus countries including early warning and data exchange – the latter being crucial for risk prevention, however, due to regional conflicts, the establishment of common institutionalised networks or management schemes has not been possible.

While global assessments and databases cannot be used for detailed sustainable-development decision making at the national and regional levels, they do provide a certain idea of the vulnerability of the Caucasus region to natural hazards in a global context and reveal overall trends. The INFORM risk index identifies countries at risk in terms of humanitarian crises and disasters that could overwhelm national response capacity. This index is made up of three dimensions – hazards and exposure, vulnerability, and lack of coping capacity. The Caucasus countries have average scores, ranging from 3.8 in Armenia to 5 in Turkey[64], out of a maximum of ten. For the index component on natural hazard risk, Caucasus countries rank from

58 Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE): https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32007L0002

59 INSPIRE code list register. Natural Hazard Category: http://inspire.ec.europa.eu/codelist/NaturalHazardCategoryValue

60 The Emergency Events Database EM-DAT: www.emdat.be/classification and other sources.

61 Ma S., Singh R.B., Huggel C. eds. 2018. *Climate Change, Extreme Events and Disaster Risk Reduction: Towards Sustainable Development Goals*. p. 9.

62 Ma S., Singh R.B., Huggel C. eds. 2018. *Climate Change, Extreme Events and Disaster Risk Reduction: Towards Sustainable Development Goals*. p. 9.

63 United Nations International Strategy for Disaster Reduction. Countries and National Platforms: www.unisdr.org/partners/countries

64 Index for Risk Management INFORM: www.inform-index.org/Results/Global

4.2 (Armenia) to 6.9 (Iran). However, some natural disasters that are common in the region such as debris flows, flash floods, landslides, forest fires, etc. are not taken into consideration and some countries that have only a small proportion of their national territory in the Caucasus Mountains are included. When analyses focus on Caucasus mountain region vulnerability and not on countrywide ratings, the results are quite different. In the INFORM database for example, which covers earthquakes, Armenia is only in fourth place (earthquake probability) with a ranking of 8 out of 10, while an analysis of the Caucasus mountain region that excludes non-Caucasus parts of the respective countries is in second place.

Table B6.1: Number of fatalities as a result of earthquakes in the Caucasus countries between 1900 and 2000

Country	Fatalities
Armenia	25,300-52,890
Azerbaijan	608-3108
Georgia	389-407
Iran (Lesser Caucasus and adjacent areas)	37,791-54,431
Russian Federation (North Caucasus)	13
Turkey (Lesser Caucasus and adjacent areas)	approx. 4,000

Data source: Wikipedia (Table prepared by the authors)

The Caucasus Mountain Region is particularly prone to natural hazards, including earthquakes, floods, flash floods, mudflows, landslides, avalanches, etc. Exposure to climate change has a trigger and/or acceleration effect on most of these natural hazards. All these climate hazards affect an increasing number of people and settlements and lead to financial losses. For example, in Georgia, 2,050 settlements, not including the capital of Tbilisi, are prone to different natural hazards[65], while in Azerbaijan, in 2010 alone, the Kura river floods led to more than 400 million AZN in expenditures (approximately USD 500 million at historical exchange rates) to tackle disaster-related problems and to take adaptive or preventive measures to reduce future flooding risks[66]. In Armenia, the regions affected by landslides occupy 500 km^2 (2% of the total area of the country[67]). Before the mid-1980s, 1,130 mudflows occurred in Armenia, Azerbaijan, Georgia and the Russian Federation. Of these, 936 mudflows were registered in the South Caucasus, and 194 in the North Caucasus (the Russian Federation)[68]. In 2015, in the city of Hopa in the Artvin province of Turkey, a massive flood claimed the lives of 11 people and left a significant number of buildings in ruins, several major roads in the affected areas were closed, and power and communication networks were also badly affected by floodwaters and landslides. In the past decade, floods have claimed more than 100 lives[69]. The Iranian part of the Caucasus Ecoregion is especially vulnerable to earthquakes (see Table B6.1), although adjacent territories are affected by regular floods and flash floods (in April 2017, flash floods took the lives of 48 people in northwest Iran)[70]. In the Georgian capital of Tbilisi in June 2015, dozens of people were killed, and thousands affected by the major landslide triggered by the Vere flash flood[71].

65 USAID/NALAG 2016. *The Georgian Road Map on Climate Change Adaptation.*

66 Shatberashvili, N.; Rucevska, I.; Jørstad, H.; Artsivadze, K.; Mehdiyev, B.; Aliyev, M.; Fayvush, G.; Dzneladze, M.; Jurek, M.; Kirkfeldt, T. & Semernya, L. (2015). *Outlook on climate change adaptation in the South Caucasus mountains.* United Nations Environment Programme, GRID-Arendal and Sustainable Caucasus. Nairobi, Arendal and Tbilisi. www.grida.no, www.unep. org, www.sd-caucasus.com.

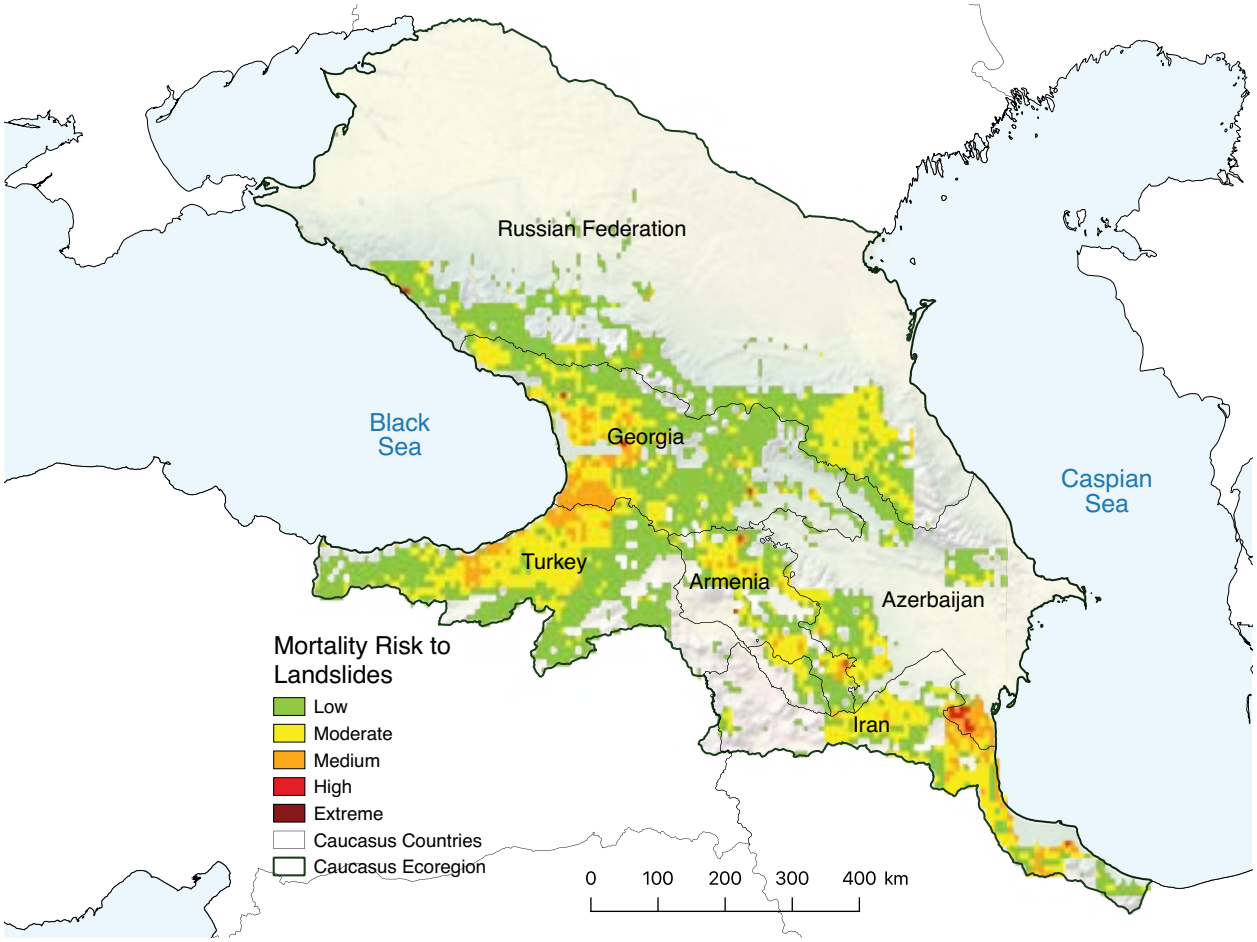
67 The Caucasus Spatial Data Infrastructure C-SDI: http://sustainable-caucasus.grid.unep.ch/maps/458

68 UNEP. 2002. *Caucasus Environment Outlook. GRID-Tbilisi: Tbilisi.*

69 FloodList web page: http://floodlist.com/asia/turkey-floods-at-least-7-killed-in-artvin-province-after-220-mm-of-rain-in-24-hours

70 FloodList web page: http://floodlist.com/asia/iran-floods-north-west-april-2017

71 UN Office for the Coordination of Humanitarian Affairs OCHA. ReliefWeb: https://reliefweb.int/disaster/fl-2015-000071-geo



Map B6.1: Caucasus mortality risk due to landslides
Source: Preview Global Risk Data Platform: http://preview.grid.unep.ch

The need for the introduction of DRR mechanisms and the imperative of building resilient communities is attracting growing recognition by governments and international organisations[72]. Improving the capacity of national institutions and local communities to prepare for and respond to natural disasters is a priority for humanitarian action in the EU region and for other international organisations such as the Swiss Agency for Development and Cooperation (SDC), UNDP, the Government of the Netherlands, etc. Noteworthy for instance, is the recent experience of Georgia with hazard mapping, piloted in mountain areas with support of the SDC. Moreover, key development-policy documents of the Caucasus countries identify natural hazards as an increasing threat to infrastructure and human settlements[73].

Therefore, in the regional context, a safeguard of infrastructure to decrease economic losses and provide better protection for human lives and improved human security is of utmost importance as is the establishment of reliable datasets and analytical tools for recording, analysis and DRR planning, specifically for mountain regions of the Caucasus as a basis for further research for development. Other topics relevant for research in the regional context in the DRR sector are presented below.

72 UNISDR web page: https://www.unisdr.org/who-we-are/history

73 Shatberashvili, N.; Rucevska, I.; Jørstad, H.; Artsivadze, K.; Mehdiyev, B.; Aliyev, M.; Fayvush, G.; Dzneladze, M.; Jurek, M.; Kirkfeldt, T. & Semernya, L. (2015). *Outlook on climate change adaptation in the South Caucasus mountains.* United Nations Environment Programme, GRID-Arendal and Sustainable Caucasus. Nairobi, Arendal and Tbilisi. www.grida.no, www.unep. org, www.sd-caucasus.com.

PROPOSED TOPICS FOR REGIONAL RESEARCH

B6.a. Hazard observation, mapping, monitoring and Measurement, Reporting and Verification (MRV)
B6.b. Impacts of natural hazards on settlements and infrastructure, human health, economic sectors and the environment
B6.c. Decreasing the damage by and increasing the protection from natural hazards
B6.d. Effects of climate change on natural hazards and modelling
B6.e. Institutional effectiveness for natural hazard prevention

B6.A. HAZARD OBSERVATION, MAPPING, MONITORING AND MEASUREMENT, REPORTING AND VERIFICATION (MRV)

- Effectiveness and efficiency of observation systems, mapping and monitoring of natural hazard areas
- Monitoring and research in regional context for risk-prone areas
- Effectiveness of applicability of indicators using state-of-the-art and/or other technologies, observation capacities and availability of historical data in the countries of the region
- Development of common standards and approaches to GIS mapping for research, analysis and observation
- Natural hazard observation, monitoring and modelling methods
- Application of remote-sensing data and tools for hazard observation (e.g. data-cube based)
- Development of common/compatible hazard mapping systems and methodologies

B6.B. IMPACTS OF NATURAL HAZARDS ON SETTLEMENTS AND INFRASTRUCTURE, HUMAN HEALTH, ECONOMIC SECTORS AND THE ENVIRONMENT

- Impact of natural hazards on settlements and infrastructure (roads, ports, pipelines)
- Impact of natural hazards on mountain ecosystems, biodiversity and environment (forest, pastures, protected areas, etc.)
- Impact of natural hazards on economic sectors (agriculture, energy, forestry, tourism, etc.)
- Spatial adaptation solutions and their perspectives at national and regional levels
- Natural disasters and their impact on sustainable development at the national and regional levels
- Evaluation and analysis of innovative adaptation technologies, methods and approaches as well as their applicability

B6.C. DECREASING THE DAMAGE BY AND INCREASING THE PROTECTION FROM NATURAL HAZARDS

- Natural hazard impact assessment
- Approaches, methods and standards for prevention of natural hazards on infrastructure and settlements (spatial and urban planning, design, construction, etc.)
- Common DRR approaches and methodologies
- Land-use planning for risk-prone areas
- Preventive measures for protection and reduction of damage to existing infrastructure (especially infrastructure of common interest to several countries) and settlements
- Social protection and compensation systems
- Methods of calculating potential losses, including financial ones, from negative impacts of natural hazards

B6.D. EFFECTS OF CLIMATE CHANGE ON NATURAL HAZARDS AND MODELLING

- Assessments of climate change impact on natural hazards (e.g. landslides, flash floods, floods, storms, forest fires)
- Scenarios and modelling of climate change impact on natural hazards, especially in areas of human settlements and infrastructure

B6.E. INSTITUTIONAL EFFECTIVENESS FOR NATURAL HAZARD PREVENTION

- Increase institutional effectiveness for natural hazard prevention both in the regional and national context
- Development of regional natural hazard data-sharing infrastructure and early warning systems

B7. POPULATION AND CULTURAL DIVERSITY

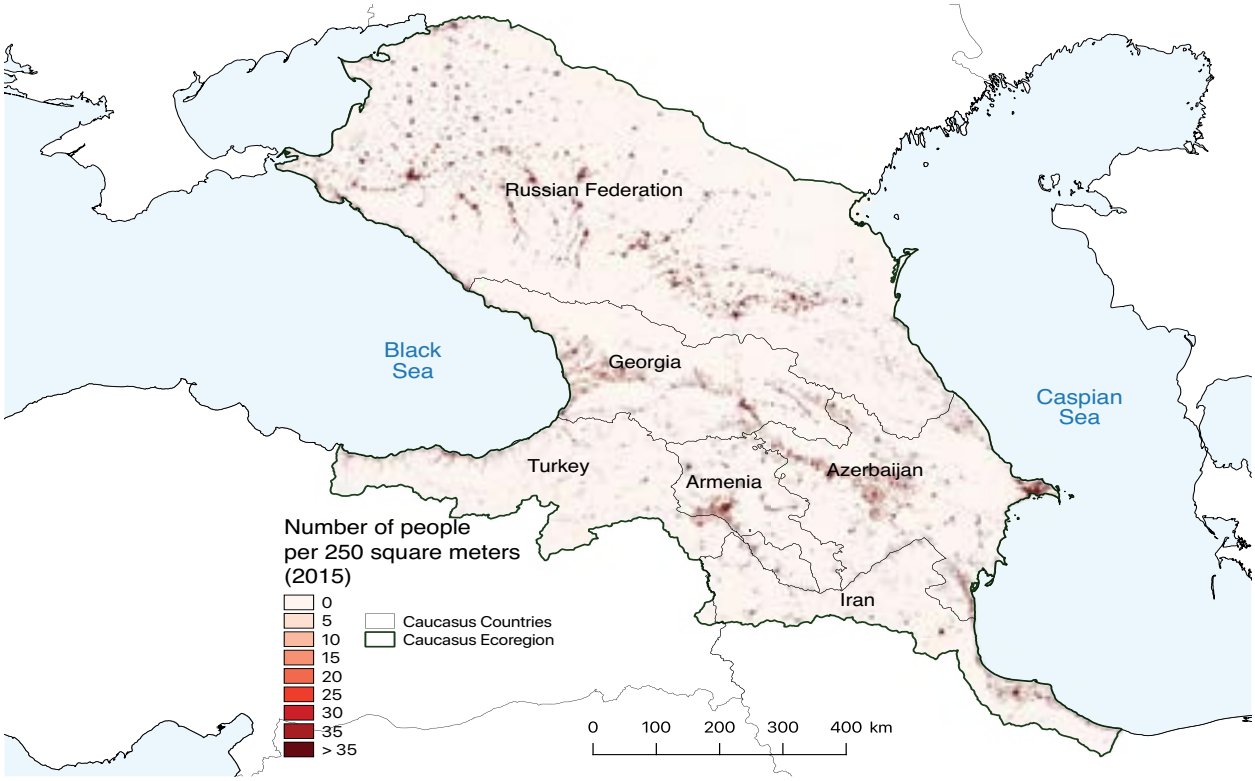
RATIONALE

Population: Although the Caucasus mountains are relatively sparsely inhabited, the Caucasus ecoregion is a highly populated macroregion with about 40 million inhabitants[74] and average population density of about 72 persons per km^2 in six countries – Armenia, Azerbaijan, Georgia and parts of Iran, the Russian Federation (RF) and Turkey. The region is diverse in terms of demography and settlement patterns. Certain differences are notable between, on the one hand, Armenia, Azerbaijan, Georgia and the North Caucasus (the Russian Federation), which were previously part of the Soviet Union, and Iran and Turkey. Additionally, there are other points of distinction. Over the last 25 years, population has increased in Turkey, Iran, Azerbaijan, and the North Caucasus area of the Russian Federation and decreased in Georgia and Armenia. This is due to natural increase rates and migration in the various countries. Birth rates are the highest (17–24‰) and death rates the lowest (3.5–6‰) in eastern North Caucasus, Turkey, Iran, and Azerbaijan. The lowest birth rates (about 13‰) are in Armenia and western North Caucasus (the federal subjects of Krasnodar and Stavropol, the Republics of Adygea and Karachay-Cherkessia); the highest mortality rates (13‰) are in Krasnodar, the Republic of Adygea, and Georgia. As a result, the eastern North Caucasus regions, Turkey, Iran, and Azerbaijan, have the highest rate of natural increase, while this index is very low in western North Caucasus and in Georgia. Rates of natural increase are closely connected and affected by the age structure of the population. Hence, the largest share of young people (<15 years) and the smallest share of elderly people (>65 years) are observed in Turkey, Iran, and Azerbaijan; Georgia and some North Caucasus regions show quite distinct compositions. In general, one can observe different stages of demographic transitions in the countries of the region; the demographic pattern of Georgia and partially of Armenia and the Russian Federation, with lower birth and natural increase rates and aging populations more closely resembles that of most European countries.

Migration is another process influencing population dynamics. Turkey receives large migration inflows from Georgia, Iran, and Azerbaijan and attracts considerable illegal immigration. Other countries also experience emigration, which was extremely high in Georgia and Armenia in the 1990s for instance. As for the North Caucasus, its western regions receive migration flows from other parts of the Russian Federation, while populations of its eastern regions emigrate to other parts of the country. Internal migration plays a significant role in redistribution of population within each country, with most people moving from rural to urban areas. In mountain areas, out-migration is the main process that determines population dynamics. People move to lowlands and primarily to urban areas. Shares of urban population vary greatly from 71–75% in Iran and Turkey to 53–64% in other countries. While mountain areas are much less urbanised, when urban areas do exist in mountain areas, they of course have a higher population density than in other mountain territories. Urbanisation causes spatial concentration and polarisation of populations and many mountain areas face desertification, though some are still overpopulated.

Mountain areas are quite unique in terms of demographic and socioeconomic processes. Mountain populations are to be found primarily in rural areas and have populations that are older than that of other regions of the same country. Lower or even negative rates of natural increase preside as well as higher infant mortality rates, greater out-migration to cities, and lower population density. Relatively high unemployment, poor transport infrastructure, insufficient provision of public services and only very basic communal utilities are typical of mountain regions. For this reason, mountain populations have a lower standard of living, lack spatial interrelations and are insufficiently integrated into regional socioeconomic spaces. Therefore, mountain regions experience depopulation processes and social problems.

[74] These and following calculations by authors are based on official statistical data of the six countries and borders of the Caucasus ecoregion.



Map B7.1: Caucasus population density
Source: GHS, http://ghsl.jrc.ec.europa.eu/ghs_pop.php

The existing trends of population dynamics in the mountain regions of all Caucasian countries – population aging and decline, migration outflows caused by urbanisation, etc. – create a need for the reconsideration and reconceptualisation of the main challenges for the future development agenda. At present, demographic factors play a key role at local, national and regional levels and quantitative and qualitative characteristics of demographic potential should be taken into account. Without an adequate and global understanding of demographic challenges, long-term planning will be of little value. Ongoing demographic changes influence all of the concerns and objectives of international and national development agendas and shape economic development, employment, income distribution, poverty, and social protection as well as health care, education, and housing. The demographic situation influences the sustainability of urban settlements and rural areas as well as environmental conditions and determines trajectories of change.

Meanwhile, there is a lack of essential, adequate, and reliable demographic data for the region. In some countries, censuses are held irregularly, and census figures do not include statistics on several important individual characteristics, (e.g., ethnicity, migrations, etc.) Moreover, both census data and administrative records of different countries are not comparable. In such circumstances, indirect reliable estimations based on various statistical sources for the correct assessment of population size as a whole and of demographic structures are of great value. It is also obvious that the region needs comprehensive scientific research to identify the most acute problems and identification of paths to their resolution.

Cultural diversity: Culture as a system of knowledge, experience, religion, skills, values and attitudes shared by a relatively large group of people, and material objects acquired over generations is the intrinsic basis of life in human society. UNESCO ensures that the role of culture is recognised through a majority of the Sustainable Development Goals adopted by the United Nations General Assembly in the "2030 Agenda for Sustainable Development" (September 2015)[75]. From cultural heritage to cultural and creative industries, culture is both an enabler and a driver of the economic, social and environmental dimensions of sustainable development.

Integrating cultural specificities into the conception and practice of development ensures the involvement of local populations and a desirable outcome for development efforts. This is especially crucial for mountain regions that are searching for paths to development while being affected by globalisation.

The recognition of culture as an important factor in creating appropriate and effective development programmes implies, first of all, taking into account cultural differences and regional and local cultural specificities including traditional knowledge systems and environmental management practices. At the same time, reference to cultural achievements of universal value and the creative use of cultural knowledge is imperative for local development of sustainable tourism, environmentally friendly land use, communications, mining, energy and other mountain industries and revitalisation of settlements with historic cultural heritage.

The relation between culture and sustainable development should be considered in two ways: first, in terms of cultural heritage preservation and development; and, second, in terms of ensuring that culture is a driver for socio-economic development and environmental protection. The latter can be reached when culture finds its place in public policies, particularly those related to education, the economy, science, communication, environment, social cohesion and international cooperation, through which cultural diversity and sustainable development can be protected.

The Caucasian region is a land of diverse cultures. Historically, the Caucasus was home to many ethnic, religious and cultural groups that coexisted for centuries. Due to its geopolitical importance, it has also been a space of strong political interest and influence of several political powers, all of which have had a significant impact on local populations and cultures. The Silk Road, an ancient network of trade routes, was central to cultural interaction through the Caucasus, connecting East and West. At the same time, mountain ranges acted as natural barriers allowing many groups to maintain their unique cultural features.

As a result, the region harbours more than 50 separate peoples whose languages belong to five families[76], with marked differences within each; some of these languages are common only to the Caucasus. Language communities range from a few hundred speakers to large linguistic groups numbering millions.

The Caucasus is also a region of religious diversity. Eastern Orthodox Christians, Oriental Orthodox Christians (including the Armenian Apostolic Church), Sunni Muslims, Shia Muslims, and adherents of other confessions, including Catholicism, Protestantism, Judaism and such ancient religions as Zoroastrianism all live here.

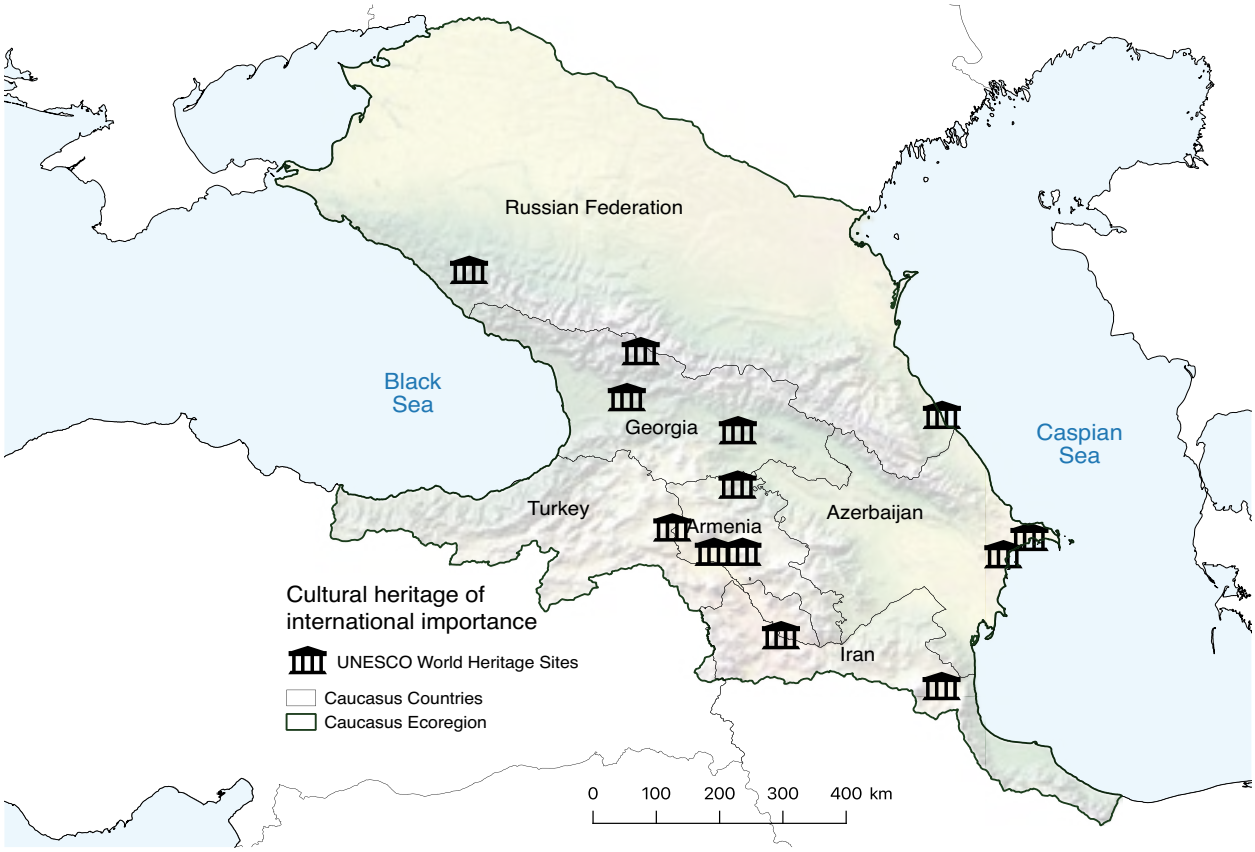
75 United Nations. 2015. *Transforming Our World: The 2030 Agenda for Sustainable Development*. Resolution adopted by the General Assembly on 25 September 2015. New York. www.un.org/ga/search/view_doc.asp?symbol=A/ RES/70/1&Lang=E. Accessed 3 October 2019; United Nations Economic, Social and Cultural Organization. 2005. *Convention on the Protection and Promotion of the Diversity of Cultural Expressions.* Convention adopted by UNESCO General Conference on 20 October 2005. Paris. https://en.unesco.org/creativity/convention/texts. Accessed 3 October 2019.; United Nations Economic, Social and Cultural Organization. 1972. *Convention Concerning the Protection of the World Cultural and Natural Heritage.* Convention adopted by the UNESCO General Conference on 16 November 1972. http://whc.unesco.org/archive/convention-en.pdf Accessed 3 October 2019. *;* United Cities and Local Governments. 2010. *Culture: Fourth Pillar of Sustainable Development*. Policy statement approved by the Executive Bureau of UCLG on 17 November 2010 in the framework of The World Summit of Local and Regional Leaders, Mexico.

76 Alekseyev M. E.; Klimov G. A.; Starostin S. A. and Testelets Y. G., 2001. *Languages of the World: Caucasus Languages* (in Russian); Wixman R., 1980. Language aspects of ethnic patterns and processes in the North Caucasus. Research Paper 191. Chicago: The University of Chicago, Department of Geography.

A variety of local customary practices and traditions still play a role in several Caucasian mountain communities, particularly in rural mountain areas with fairly conservative populations. Such customary rules regulate society and private life. The natural environment of the Caucasus and the geographical complexity within its mountain ranges, plateaus and intermountain basins, humid and arid zones, forests, grasslands and dry steppes also determine the specifics of local traditions, especially related to the environment and natural resources.

Despite changes in national borders, each country and ethnic group has been able to maintain its culture as a national heritage, preserving its sense of ethnic and national identity. Specific cultures of the Caucasus are often not limited to national territories and instead spill over borders. Certain aspects of these cultures (art, literature, cuisine, working practices, etc.) had and still have an influence on other cultures of other countries of the region. Cultural heritage in both movable and immovable objects and intangible cultural heritage is an issue of common interest for countries of the Caucasus. Some progress in the preservation of cultural heritage of universal value has occurred in the recent decade. Moreover, cultural diversity and cultural heritage are also an important precondition of economic development for the entire region.

Recently, globalisation and modernisation have contributed to unifying the cultural diversity of the region. Nevertheless, national and local cultures of the Caucasus are among the main population values and can be considered an intrinsic part of economic development, linking socially and environmentally sustainable development. In the regional context, it is essential to establish a dialog and research for the preservation and development of cultural diversity of the Caucasus for future generations. For researchers and practitioners, it is a challenge to ensure that culture is an integral part of development concepts as a means of sustainable development of the Caucasus Mountain Region.



Map B7.2: Caucasus cultural heritage of universal value
Source: UNESCO, https://www.whc.unesco.org/en/list/

PROPOSED TOPICS FOR REGIONAL RESEARCH

B7.a. Conceptual research
B7.b. Demographic situation
B7.c. Settlement patterns and infrastructure
B7.d. Cultural diversity

B7.A. CONCEPTUAL RESEARCH

- Demographic characteristics that shape the main opportunities for local and regional development
- Demographic characteristics that shape the main risks and challenges for local and regional development
- Role of cultural diversity in a modern set of values and its role in regional, national and local development
- Comparable statistical data, survey and monitoring – all based on European and/or internationally recognised methodology, including territorial divisions
- Comparable statistical and survey data on cultural heritage based on internationally recognised classifications, including type, importance and value
- Utilisation and creation of spatial data, where possible, on the issues

B7.B. DEMOGRAPHIC SITUATION

- Population dynamics and their components (natural increase and net migration) and depopulation
- Aging of population and distortion of age-sex composition
- Migration flows by type (in-, out-, inner, emigration and immigration)
- Ethnic changes and trends

B7.C. SETTLEMENT PATTERNS AND INFRASTRUCTURE

- Transformation of settlement networks, their structure by size; shrinking of social space, abandoned settlements
- Spatial transformations of administrative-territorial and municipal structures
- Role of transport infrastructure, public services, and basic communal utility provision in spatial transformation and migration
- Improvement of connectivity at local and regional levels; accessibility of centres, and transport infrastructure as a basis for ending out-migration and depopulation
- Strategies and planning for sustainable development of mountain areas as a tool for improvement of the demographic situation and migration

B7.D. CULTURAL DIVERSITY

- Building resilient mountain communities as an integral part of cultural landscapes of universal value
- Cultural mountain landscapes as a resource for economic growth, especially in the context of tourism development
- Protection of immovable and movable cultural heritage objects, including heritage objects of universal value as a potential for economic development and growth, including their role in tourism promotion
- Identification and study of the impacts of different natural phenomena (climate change, natural disasters, etc.) on cultural objects
- Role of intangible cultural heritage of the region in socio-economic development
- Preservation of centuries-old agricultural traditions vs. integration into the global tourist trend; defining areas with different human priorities and capacities
- Potential for preservation of traditional mountain farming and traditional ways of life as a basis for tourism development
- Importance of preservation of endangered languages for protection of cultural diversity
- New socio-ecological systems and human-environment relations in rural mountain recreational areas
- Role of traditional institutes of mountain communities: increasing or decreasing? a step backwards or a path to sustainability?
- Customary rights and ethics of mountain communities concerning environmental protection

B8. TOURISM AND RECREATION

RATIONALE

Tourism is one of the largest and fastest growing sectors of global industry. Many tourist destinations are located in mountain regions. About 15–20% of the tourist industry or USD 70-90 billion per year is generated by mountain tourism[77]. The Alps alone account for an estimated 7-10% of annual global tourism turnover[78].

The tourism sector plays an important role in enhancing the economic growth of a country. Often tourism becomes the main driver of economic growth in mountain areas, encouraging the development of other economic sectors as well (e.g. agriculture, trade, services, etc.). Domestic and international tourism are important factors of economic development of the Caucasus countries. At the same time, there are various factors and conditions that need thorough consideration to make tourism development a lasting success. These range from favourable weather conditions to reliable transportation infrastructure, from diverse and high-quality services to social and political stability, and also include some minimal administrative elements, such as the means for issuing visas and other permits.

Tourism may bring many benefits to mountain regions such as improvement to infrastructure for assuring better connectivity and accessibility. Tourism creates jobs and businesses and opens the region to the outside world. Moreover, tourism provides the means of promoting natural and cultural heritage, which are essential tourism resources. This helps to highlight their value and the importance of their preservation to local and national stakeholders. On the other hand, tourism carries risks of harming ecological goods and traditional values, compromising cultural identities, and increasing social inequalities. Tourism affects mountains in many ways. There are direct and indirect benefits to many sectors and communities inside and outside resort areas. However, often a considerable share of tourism revenue is not retained and reinvested in the region but goes instead to areas outside the mountains. In addition, tourist activities have biophysical impacts. For example, paths and ski runs may modify sensitive alpine areas, tourists leave their traces along mountain trails and wildlife may be disturbed. On the social and cultural side, tourists may disrupt traditions, influence mountain communities with their numbers and lifestyles, and attract service providers from outside the mountains to earn profits and use the resources of mountain resorts. Therefore, it is important to counterbalance the possible negative impacts on mountain areas with positive influences, including economic benefits and equitable socio-cultural development.

The Caucasus, with its high-elevation mountains, is a unique natural and cultural region of great beauty and environmental value. The mountains act as a major natural, economic, cultural, recreational and living environment in the region, and are shared by numerous people and countries. The Caucasus Mountain Region is an important reservoir for biodiversity and habitats. A great number of protected areas are located in the region – nature reserves, wilderness areas, national parks, protected landscapes, cultural and natural monuments. Diverse movable and immovable cultural heritage is a special feature in a region populated by more than 50 ethnic groups. A significant share of this potential is located in the mountain regions of the Caucasus; however, from a socio-economic point of view, mountain areas are the poorest places within the Caucasus countries.

77 Williams W.P., Singh T.V. Schlüter R. 2001. Mountain Ecotourism: Creating a Sustainable Future. In Weaver D.B. *The Encyclopedia of Ecotourism*. Wallingford, England: CABI Publishing.

78 The Mountain Institute in partnership with National Council for Social Studies. 1999. *Mountains: Global Resource. A special supplement to Social Education.* http://www.socialstudies.org/sites/default/files/publications/se/6305/mountains.pdf

The region has the potential to become a prime tourism destination in the world and today, the Caucasus is an emerging tourist destination, though not all places throughout the region have equally developed tourism sectors. Due to political tensions reflected in closed borders in certain cross-border destinations, it is not always possible to promote tourism. This is especially true for border regions of the former Soviet Republics, such as between Georgia and the Russian Federation and between Armenia and Azerbaijan. However, new opportunities for cross-border tourism are emerging in border regions between Armenia and Iran, Azerbaijan and Iran and Georgia and Turkey, which could not have existed during the Cold War period when many areas and regions were not open to visitors (most parts of Samtskhe-Javakheti and Adjara in Georgia, the Meghri district in Armenia, Nakhichevan in Azerbaijan, etc.). Indeed, the tourism sector is growing and the number of international tourists[79] along with tourism revenues are increasing in all countries of the Caucasus region (see Table B8.1).

However, despite constant growth in the sector, there are a number of constraints that need attention from scientists, development workers and decision makers such as (a) insufficient infrastructure and maintenance, (b) disregard of safety requirements, (c) weak competitiveness in the international tourism market, (d) the unstable political situation in the Caucasus countries, (d) a lack of strategic planning of the sector, especially with a view to utilisation of regional benefits and opportunities, (e) little experience in reorienting existing institutions and resources of the tourism sector to meet modern standards and demands, etc. The countries of the Caucasus region have gradually begun to overcome these problems. However, research and planning is still very much in the hands of the private sector (tourism agencies, hotel owners, etc.).

Table B8.1: International tourism in the countries affiliated with the Caucasus Region[80]

Country	International tourist arrivals (in thousands)		Change 2010 to 2016 (in%)	International tourism receipts in 2016 (USD million)
	2010	2016		
Armenia	687	1,260	+83.4	968
Azerbaijan	1,280	2,045	+59.8	2,714
Georgia	1,067	2,715	+154.4	2,166
Iran	2,938	4,942	+68.2	3,868*
The Russian Federation	22,281	24,551	+10.2	7,788
Turkey	31,364	39,478*	+25.9	18,743

Note: * = 2015 Data

Source: UN World Tourism Organization (UNWTO), Tourism Highlights. 2017 Edition, pp 8-9
https://www.e-unwto.org/doi/pdf/10.18111/9789284419029

In the context of regional tourism development in cross-border and transboundary areas, common thematic tourist routes have great potential such as on traditional medicine, viticulture, cheese-making, folklore, vernacular architecture and handicrafts (cultural diversity and affinities thereof), shared history (e.g. Kura-Araxes Culture tours, Silk Road, etc.), and shared and/or cultural and natural heritage of universal value.

79 In the Soviet era, international tourists came to Armenia, Azerbaijan, Georgia and the Russian Federation from Soviet-bloc countries.

80 Although areas in the Caucasus region include only small portions of the territories of Iran, the Russian Federation and Turkey, the table shows total figures for the tourism sectors of the aforementioned countries due to the lack of data for Caucasus regions of these countries alone.

In recent years, there has been strong growth in mountain tourism, especially activities related to skiing, which has become economically very important not only at the local and regional levels, but also internationally. A total of 367.3 km² of slopes of the Caucasus Mountains already accommodate about 30 ski resorts and this number is growing. Some ski resorts in the Caucasus Mountains are located as high as 3840 m above sea level; 132 ski lifts transport guests[81] to ski slopes. The Caucasus Mountains attract many tourists and sportsmen, with several peaks over 4,000 and 5,000 meters. However, it should be noted that climate change may become a threat to winter tourism in the Caucasus Mountains as in other mountainous areas around the world. Climate change poses a threat to all aspects of life, with the tourism industry as one of the most vulnerable sectors of the economy. Within the tourism industry, winter sport tourism is the most directly and the most immediately affected subsector. Therefore, scientists and decision-makers need to support diversification of the tourism sector and consider interrelations with other economic sectors (e.g. agriculture) also highly affected by climate change.

There are great opportunities for the development of mountain tourism in the Caucasus, including such attractive, relatively new sectors as ecotourism and agro-tourism. As long as plans and policies are designed and implemented, they must ensure security and sustainability in terms of tourism's impact on the mountain environment and community life. This calls for the correct use of natural and cultural resources, wider involvement of local communities and community planning, local awareness and confidence building, strong local institutions and policies, and a vision for the long-term sustainability of the tourism industry. To this end, the National Tourism Administrations of the Caucasus countries should conduct a mission to ensure sustainable tourism development in the region with the involvement of scientists, practitioners and local communities. Promotion and sustainable development of the tourism industry implies potential for economic growth that would improve the welfare of mountain populations and, in such a way, support the implementation of the relevant Sustainable Development Goals (SDGs). In order to promote sustainable tourism development at the regional and national levels, the following research topics are proposed for the Caucasus Research Agenda for the coming years:

PROPOSED TOPICS FOR REGIONAL RESEARCH

B8.a. Tourism, recreation and sustainable development
B8.b. Impact of climate change on tourism and recreation/ impacts of tourism and recreation on climate change
B8.c. Environmental and social impact of tourism and recreation activities
B8.d. Governance, policy and economy in tourism and recreation

B8.A. TOURISM, RECREATION AND SUSTAINABLE DEVELOPMENT

- Prospects and strategies for sustainable nature-based tourism and sports in the Caucasus
- Sustainable tourism and its compatibility with local, national and regional economic development and potential for economic growth in the Caucasus
- Sustainable tourism and the elimination of regional disparities
- Sustainable tourism planning
- Sustainable tourism management in mountain destinations
- Sustainable management of winter resorts

[81] Ski Resorts Caucasus Mountains: http://www.skiresort.info/ski-resorts/caucasus-mountains/

B8.B. IMPACTS OF CLIMATE CHANGE ON TOURISM AND RECREATION / IMPACTS OF TOURISM AND RECREATION ON CLIMATE CHANGE

- Determine how climate change is considered by the tourism industry
- Evaluation and analysis of distinctions between impacts of climate on tourists versus the impact on the tourism industry
- Evaluation and analysis of the role of weather and longer-term expectations of climate change on destination choices
- Identify which climate related-criteria people use to make choices about tourism destinations
- Analysis of climate-change impacts on the tourism industry to share with decision makers and practitioners in the sector
- Establishment of a tourism climate index (both national and regional) that integrates all possible facets of the climate
- Evaluation of tourism industry vulnerability to climate change considering the sector's sensitivity, adaptive capacity and the climate change impact on the industry
- Relationships between weather, climate and tourism as well as recreation
- Tourism, recreation and climate-change adaptation, including aspects of the sector's safety and security
- Contribution of regional tourism and recreation to global climate change and possible solutions for mitigation of effects
- Assessing tourists' and local people's perceptions of climate change on mountain landscapes

B8.C. ENVIRONMENTAL AND SOCIAL IMPACTS OF TOURISM AND RECREATION ACTIVITIES

- State of the environment of the Caucasus mountain region
- Environmental conservation in mountains, potential impacts of tourism
- Environmental management for alpine tourism and resorts in the Caucasus
- Society and culture in mountain regions, potential impacts of tourism
- Relationships between culture and tourism in the Caucasus tourist areas
- Protection of cultural heritage in mountain areas, including heritage of universal value and its contribution to tourism industry development both in national and regional contexts
- Evaluation and analysis of biophysical resources of mountains that have been degraded due to tourism activities
- LULC changes due to tourism and recreation
- Role of protected areas (both national and cross-border) in conservation of mountain environments and biodiversity and their impact on the economic and social development of mountain communities

B8.D. GOVERNANCE, POLICY AND ECONOMY IN TOURISM AND RECREATION

- Governance and co-operation in tourism and recreation
- Investment climate and business environment
- Cluster policy and economic policy on national and regional levels
- Planning and governance in tourism and recreation
- Interactions between urbanisation and mountain tourism
- Spatial planning of the sector both in regional and national contexts
- Accessibility and tourist transport infrastructures in high mountain areas
- Evaluation and analysis of how tourism and recreation affect mountain communities and societies – positively or negatively
- Evaluation of competitiveness of existing and new tourist models in the context of globalization

B9. SOCIO-ECONOMIC DEVELOPMENT AND PLANNING

RATIONALE

Mountains have historically been places for human habitation and economic activities, where people have developed distinctive cultural and socioeconomic ways of life and have better preserved them than in more economically vibrant, but changing, lowland regions. Along with the beauty of natural landscapes and their inherent natural diversity, this is why the anthropogenic specificity of mountain environments evokes significant interest, including on the part of scientists.

However, mountain settlements are poor in economic terms compared to resource-rich and more readily accessible lowland and coastal areas, due to the limited economic capacity of mountain regions, combined with insufficient connectivity, land scarcity, harsh climatic conditions, etc. This is particularly true in the less developed regions of the world such as Caucasus. Mountains lack employment opportunities, they are insufficiently served by physical and social infrastructure and communal utilities, and do not have modern facilities for education and leisure. These insufficiencies, in turn, serve as 'push factors' for local populations to massively emigrate from mountain regions. The result is the depopulation and abandonment of picturesque mountain settlements that are quite commonly places of high cultural and architectural value. Therefore, although worldwide mountains cover 25 percent of the earth's land surface, they are home to only one tenth of the world's population. Furthermore, around 40 percent of mountain populations in developing and transition countries or about 300 million people (many of whom are indigenous people) are food insecure with half of them suffering from chronic hunger[82].

Over the last 25 years, the post-Soviet countries of the Caucasus region (Armenia, Azerbaijan, Georgia and the Russian Federation including the North Caucasus republics) have passed through a long and painful transition on the way to the establishment of free-market economies. At the early stages, this process was characterised by challenges such as a lack of necessary financial resources, inflation, a lack of up-to-date equipment and technical infrastructure for industry, increased unemployment, shortages of land and other resources, insufficient diversification of industry and low productivity. Such a decline was especially dramatic in the mountain regions of the Caucasus countries. As a result, mountainous areas in the region have become places of depopulation, and stagnant, shrinking or depressed economies.

The Caucasus provinces of two other countries, Iran and Turkey, also went through changes, changing from closed-border regions to economically growing areas along open borders with new neighbouring states. During Soviet times, the areas of these countries that are in the Caucasus were spatially enclosed peripheral regions and therefore underdeveloped territories[83]. However, other state borders of the new Caucasus countries have turned into barriers for cross-border socio-economic development due to ethno-political conflicts. They have transformed respective regions of the North Caucasus republics, Georgia, Armenia and Azerbaijan into depraved periphery areas and have interrupted traditional socio-economic relations that have existed over the centuries. Furthermore, the difficult political situation in the Caucasus region, as well as unresolved or so-called "frozen" conflicts stand as a serious impediment to the solution of most socio-economic problems. As a result, new political fragmentation of the region occurred after the collapse of the Soviet Union; divisions between and within countries have further aggravated existing difficulties in terms of transport connectivity, regional and international cooperation and establishment of strong mechanisms of economic integration, cross-border interaction and collaboration for the solution of common environmental problems.

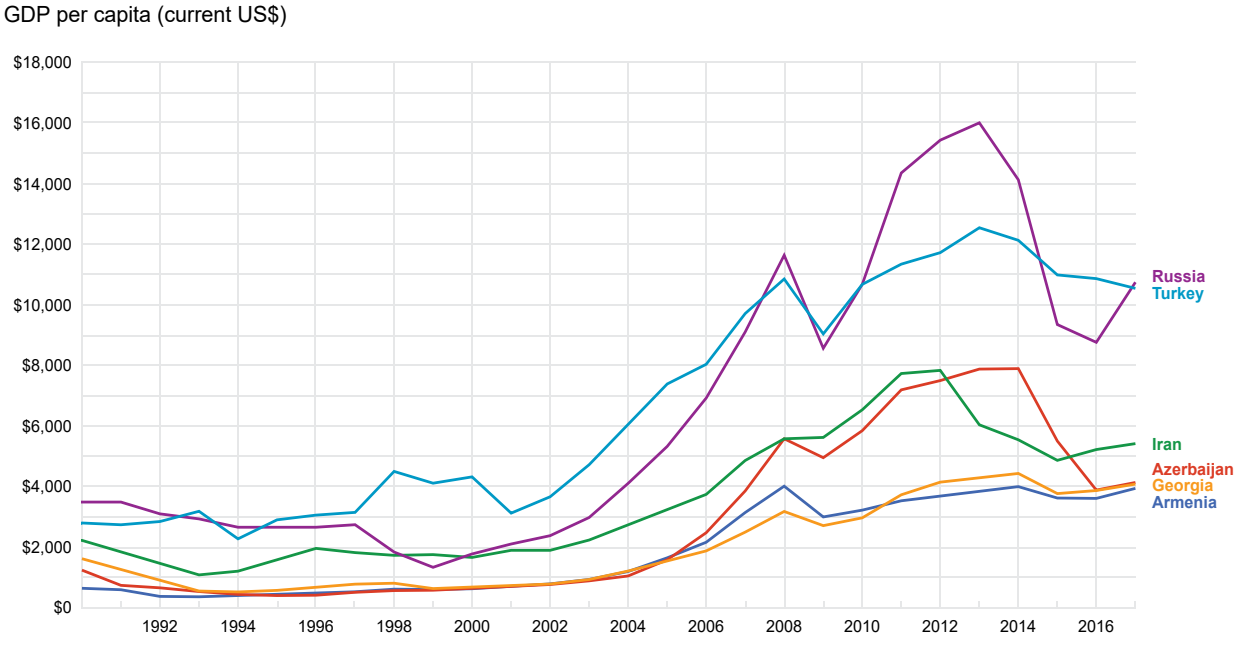
82 Mountains and the Sustainable Development Goals: Call for Action. 2015. Mountain Partnership Secretariat. FAO document. http://www.mountainpartnership.org/fileadmin/templates/mountain_partnership/doc/Mountains_and_the_SDGs.pdf

83 Except for one part of the Armenia-Turkey border

The existence of all of these problems has pushed the countries of Caucasus to make great efforts to develop more efficient economies. Compared to the 1990s and the early 2000s, considerable achievements have been seen, such as growth of per capita GDP (see Pic. 1), increased economic production, growth of new jobs and higher employment rates, upgraded infrastructure, etc. This was the result of increasing investments in certain economic sectors along with economic reforms and the implementation of relevant governmental development programmes.

Nevertheless, despite an overall economic improvement, most mountain areas in the Caucasus countries benefited very little from the above-mentioned economic growth and continue lagging behind urban areas and vast lowland provinces with intensive agriculture. Indeed, mountain settlements have continued losing population and earning lower per capita income compared to the average national rates[84]. Such a situation makes the future outlook for mountain settlements uncertain and maintains the quality of life of mountain populations below national standards. Additionally, even in the relatively well-off towns and villages with a growing tourism sector, development that is sporadic and unplanned is the norm; the construction of new buildings is often done in a chaotic fashion and does not respect the environment, reinforcing erosion and disturbing the spatial order and inherent value of the landscape of many otherwise picturesque and environmentally sensitive places[85].

Table B9.1: Growth of per capita GDP of the Caucasus countries over the last 26 years



** The data for Iran, the Russian Federation and Turkey are for these countries as a whole and not only their territories located in the Caucasus*

84 The National statistical offices web pages: Armstat - www.armstat.am/en, Azerstat - www.stat.gov.az/?lang=en , and Geostat - www.geostat.ge/index.php?action=0&lang=eng

85 Latocha A. 2010. Spatial planning in mountain regions – present trends, threats and opportunities Sudety Mountains case study. *The Problems of Landscape Ecology*, 28. pp. 55–64.

Dramatic socio-economic differences between mountainous areas and other settled territories are becoming more fully recognised by international organisations and national governments, including those of the Caucasus countries.

Socio-economic goals to improve people's lives, including in mountain regions, were declared by the United Nations in 'The Millennium Development Goals' (MDGs) and the more recent 'Sustainable Development Goals' (SDG)[86] that aim to end poverty**,** protect the planet**,** and ensure prosperity for all in the new sustainable development agenda for the period until 2030. The universally recognised statements in the above-mentioned documents have been translated into several studies and research that focus on mountain regions[87].

In the Caucasus countries in recent years, several programmes and legislative acts aiming to improve the quality of life in mountainous countries were adopted[88]. Nevertheless, often these documents are of a declarative character and are not science- and evidence-based. Therefore, the state of research in the field of socio-economic development and planning in the region needs to be improved in order to provide a solid empirical and analytical framework for policy decisions targeted at improving demography, connectivity, productivity, liveability and other essential aspects of the Caucasus mountain regions, not only on a national basis but on a region-wide basis as well.

PROPOSED TOPICS FOR REGIONAL RESEARCH

B9.a. Demographic stagnation and depopulation
B9.b. Settlements and infrastructure in mountainous regions
B9.c. Economic issues and energy generation
B9.d. Socio-economic transformation of the region over the last decades

B9.A. DEMOGRAPHIC STAGNATION AND DEPOPULATION

- Socio-economic conditions influencing population dynamics of mountain regions, including depopulation, aging of populations and distortion of age-sex composition, migration from and to mountain areas, etc.
- Ethnic changes
- Balanced regional development and resilience of mountain settlements

B9.B. SETTLEMENTS AND INFRASTRUCTURE IN MOUNTAINOUS REGIONS

- Shrinking and abandoned settlements
- Integrated planning for sustainable mountain regions and settlements
- Provision of public services and basic communal utilities
- Improvement of connectivity, accessibility and transport networks
- Trans-border infrastructure and its safety
- Social infrastructure (school and preschool education, healthcare, etc.) and social security

86 United Nations. 2015. *Transforming Our World: The 2030 Agenda for Sustainable Development.* Resolution adopted by the General Assembly on 25 September 2015. New York. www.un.org/ga/search/view_doc.asp?symbol=A/ RES/70/1&Lang=E. Accessed 3 October 2019

87 Rudaz G., Balsiger J., Debarbieux B., 2014. *Mountlennium: Reaching Millennium Development Goals through Regional Mountain Governance*. SNIS working paper: http://www.snis.ch/system/files/debarbieux_workingpaper.pdf

88 In 2014, Georgia adopted the Regional Development Programme of Georgia 2015-2017 Decree of the Government of Georgia #1215 with several references to mountain regions; and also adopted the Law of Georgia on the Development of High Mountainous Regions in 2016; Shatberashvili N. Rucevska I. Jørstad H. Artsivadze K. Mehdiyev B. Aliyev M. Fayvush G. Dzneladze M. Jurek M. Kirkfeldt T. and Semernya L. 2015. *Outlook on climate change adaptation in the South Caucasus mountains.* United Nations Environment Programme, GRID-Arendal and Sustainable Caucasus. Nairobi, Arendal and Tbilisi. www.grida.no, www.unep. org, www.sd-caucasus.com. pp. 42-49.

B9.C. ECONOMIC ISSUES AND ENERGY GENERATION

- Energy sources and supply and potential for alternative-energy generation
- Potential for the tourism and hospitality industry including cross-border tourism
- Efficient and sustainable use of recreational resources
- Sustainability of mining activities in mountain regions
- Planning and deployment of sustainable forestry
- Investment opportunities in mountain areas
- Development of market-oriented sustainable agriculture
- Improvement of tertiary sector
- Development/implementation of ICT
- Cross-border cooperation in mountain areas

B9.D. SOCIO-ECONOMIC TRANSFORMATION OF THE REGION OVER THE LAST DECADES

- Provision of precise and internationally comparable statistical and survey data, including regional statistics (based on Nomenclature territorial units for statistics of EU or on comparable statistical standards)
- Development of spatial data infrastructure (based on GIS and remote sensing) for mountain regions and settlements
- Analysis of trends of socio-economic transformation of the region

B10. MOUNTAIN CRYOSPHERE

RATIONALE

Cryosphere components play an important role in the mountain environment. Since mountain glaciers are dynamically unstable systems, they reveal rapid reactions to climate change[89]. Glacier recession results in landscape changes in the glacial zone, creates new lakes and activates natural disaster processes, catastrophic mudflows, ice avalanches, outburst floods, etc. The presence of snow and glaciers in itself is a threat to human life, economic activity and infrastructure. Economic and recreational human activity in mountain regions requires relevant information on snow and ice objects and processes[90]. The absence or inadequacy of such information results in financial and human losses.

Predictions of mountain glacier change require the use of the following main tools: remote sensing observations using satellite and airborne imagery and data; direct observations through field measurements; and numerical glacier-climate modelling. Integrating these approaches provides increased understanding on how and why individual glaciers change, the resulting hydrological changes and the drivers of regional trends. The outputs from glacier climate models can be used to quantify the contribution of melt water to the hydrological budgets of given catchments and make predictions of how this contribution will evolve alongside precipitation changes as glaciers shrink. Predictions of glacier change are also useful to inform assessments of hazard risks in deglaciating landscapes, such as landslides and glacier outburst floods. Changes in glacier mass and melt water production can be linked to climate change using numerical models. Some of these models consider instantaneous changes in mass balance in response to climate forcing, allowing them to be applied regionally and even globally. Dynamic glacier models capture the physics of ice flow as well as the relationship between mass balance and climatic drivers and better represent glacier response over time.

In the middle of the 20th century there were about 1500 glaciers in the Caucasus with a total area of about 1400 km^2. Today the analysis of space images shows that the number of glaciers in the Caucasus and their area has been significantly reduced. The area of glaciers decreased by 36% in Georgia for the period 1960-2014[91]. Similar losses of up to 27% of glacier area for the period 1958-2015 are also likely in the Russian part of the Caucasus[92]. But what is even more important is that the rate of glacier area reduction has increased under the conditions of modern climate change and in the last decade has reached the rate of about 5% per year[93].

89 IPCC 2013. Climate Change 2013: *The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on* Climate *Change*.

90 World Glacier Monitoring Service. 2015. *Global Glacier Change Bulletin No. 1* 2012-2013. Zemp, M., Gärtner-Roer, I., Nussbaumer, S. U., Hüsler, F., Machguth, H., Mölg, N., Paul, F., and Hoelzle, M. eds., ICSUWDS/IUGGIACS/ UNEP/UNESCO/WMO, Zurich, Switzerland.

91 Tielidze L.G. 2016. Glacier change over the last century, Caucasus Mountains, Georgia, observed from old topographical maps, Landsat and ASTER satellite imagery, *The Cryosphere,* 10, pp. 713-725, https://doi.org/10.5194/tc-10-713-2016.

92 Khromova T., Nosenko G., Muraviev A., Nikitin S., Chernova L. Zverkova N. 2016. Chapter 2 - Mountain Area Glaciers of Russia in the 20th and the Beginning of the 21st Centuries. Developments in Earth Surface Processes. In *Mountain Ice and Water - Investigations of the Hydrologic Cycle in Alpine Environments, Vol.21* pp.47-129: https://www.sciencedirect.com/science/article/pii/B9780444637871000020

93 Shahgedanova M. et al. 2014. Deglaciation of the Caucasus Mountains, Russia/Georgia, in the 21st century observed with ASTER satellite imagery and aerial photography. *The Cryosphere.* 8(6):2367–2379. DOI 10.5194/tc-8-2367-2014

Map B10.1: Caucasus cryosphere (polygons)
Source: GLIMS: www.glims.org/maps/glims

The main parts of Caucasus glaciation are now in Georgia and Russia, but these glaciers have an impact on all countries in the region through river runoff. Glaciers are an important source of water for agricultural production in countries of the Caucasus region, and runoff in large glacier-fed rivers (Kuban, Terek, Kodori, Enguri, Rioni, Tskhenistskali and Nenskra) supplies several hydroelectric power stations. Glacial meltwaters are one of the main factors in river runoff formation in the region. Glacial meltwater is also important in terms of water supply in the mountainous regions of Russia, Georgia, Armenia, Turkey and Iran. Mountain glaciers of the Caucasus are important reservoirs of water for populations living downstream, often providing melt water during seasonal droughts. The majority of these glaciers are changing at unprecedented rates, resulting in interannual and seasonal variations in water availability and unstable and potentially hazardous mountain environments at risk of flooding that pose a threat to human lives and infrastructure. The mountains are the source of major rivers and these glaciers are an important buffer against drought. It is necessary to understand the daily volatility of glacial waters for mountaineering, tourism and livestock and other sectors of operation in mountainous areas.

In mountainous regions (Dombay, Elbrus, Svaneti, Kazbegi, Racha and Abkhazeti), in addition to tourism and recreation, a role of glacial landscapes exists in the development of recreational facilities. Also, glacier outburst floods and related debris flows are a significant hazard in Georgia and the Russian Federation. Unfortunately, such hazards are relatively common in this region and have led to major loss of life. On 20 September 2002, for example, near the Kolka Glacier (North Ossetia), a catastrophic ice-debris flow killed over 100 people, and on 17 May 2014, on Devdoraki Glacier (Georgia) a catastrophic rock-ice avalanche and glacial mudflow killed nine people. Currently, the Kolka Glacier is in the self-regeneration process (40% of the previous volume) and the organisation of monitoring and forecasting of further events is becoming crucial. Future trends in glacier variations are thus a topic of considerable interest to the region.

One of the urgent aims of research is to study the current trends in the evolution of mountain cryosphere components in conditions of global climate warming. Current and potential changes in the mountain cryosphere may affect the state of water resources, land cover, forests and biodiversity, as well as change natural-hazard risks. Moreover, these changes may result in a global transformation of conventional land-use practices, and significantly impact the socio-economic development of the region in the tourism and recreation sectors, renewable energy (and energy supply in general), agriculture, and forestry.

An unbiased assessment of current and future development of glaciers and snow cover requires an effective system of monitoring including *in situ* and remote-sensing studies[94]. This task requires the coordinated efforts of all countries in the region. The socioeconomic impacts of such efforts will include: robust regional predictions of glacier change during the 21st century and the impacts of these changes on water supplies; a base for effective communication of the potential risks of glacier change with policy makers in the region; opening a dialogue with end users affected by glacier change and hazards to communicate realistic predictions with respect to their livelihoods; development of strategies for maintaining sustainable water and energy supplies in the Caucasus region.

PROPOSED TOPICS FOR REGIONAL RESEARCH

B.10.a. Glaciers as indicators of climate change
B.10.b. The role of snow and ice in the formation of water resources
B.10.c. Natural hazards of glacial genesis (avalanches, mudflows, surges, glacial lake outburst floods)
B.10.d. Development of glacial and nival zones for sport, tourism and recreation

B10.A. GLACIERS AS INDICATORS OF CLIMATE CHANGE

- Usage of modern field and remote-sensing methods for obtaining information about the Caucasus glaciers
- Development of a test “glacier network”. Research on the mass-balance changes in Caucasus glaciers using World Glacier Monitoring Service (WGMS) standards. Use of data on glacier mass balance in the planning of economic development for the territory and environmental protection efforts
- Estimation of the current glaciation size of Caucasian Mountains and changes over the past decade. Evaluation of glacier-system stability during recent climate change

94 Haeberli W. 2006. Mountain glaciers in global climate-related observing systems. In Huber U.M., Reasoner, M.A. and Bugmann, H.K. eds. *Global Change and Mountain Regions. A State of Knowledge Overview,* Dordrecht: Kluwer Academic, pp. 169–175.

B10.B. THE ROLE OF SNOW AND ICE IN THE FORMATION OF WATER RESOURCES

- Inventory of glaciers using space imagery, digital elevation models (DEMs) and GIS technology
- Assessment of changes in the resource potential of the Caucasus glaciers in modern climate conditions
- Monitoring seasonal dynamics of snow cover and water-equivalent evaluation using space survey and ground-based validation
- Understanding and modelling interrelations between atmosphere and cryosphere in terms of the hydrological system of the Caucasian Mountains

B10.C. NATURAL HAZARDS OF GLACIAL GENESIS (MUDFLOWS, SURGES, GLACIAL LAKE OUTBURST FLOODS)

- Understanding cryospheric risks and hazards through scientific investigation and the accumulation of environmental knowledge
- Development of methodology for the application of satellite observations from space for use in glacial disaster monitoring
- Zoning of the territory in terms of natural hazards of glacial genesis and risk types
- Using satellite imagery and digital-elevation models to assess the possible consequences of the damage and the development of measures to prevent them

B10.D. DEVELOPMENT OF GLACIAL AND NIVAL ZONES FOR SPORT, TOURISM AND RECREATION

- Analysis of opportunities and conditions for infrastructure development of recreational facilities that exist in the glacial and nival zone highlands using satellite imagery and digital elevation models
- Assessment of potential threats to recreational activities on the part of natural glacial processes
- Recommendations to prevent threats

B11. CROSS-CUTTING ISSUES

After thorough consultations with the Caucasus research community, in addition to the ten main research chapters several cross-cutting research topics have been identified. These topics demonstrate the importance of interdisciplinary study for establishing a solid scientific ground in decision-making and management improvement, which should be oriented towards balanced economic growth in the Caucasus region. The cross-cutting topics are targeted at safeguarding the uninterrupted provision of natural resources and ecosystem services important for human development and a decent quality of life.

These cross-cutting issues include but are not limited to: multidisciplinary research topics like soil sustainable management; air pollution levels and promotion of renewable energy sources, both conventional and innovative; ecosystem services and the economics of ecosystems and biodiversity (TEEB); and landscape ecology and infrastructure.

Additionally, cross-cutting studies shall cover the important issue of governance and decision-making effectiveness. A precondition for harmonised development of the region is the analysis of best possible governance solutions from other mountain regions and building knowledge among the Caucasus academic society about best practices in different fields of mountain activities.

Transboundary cooperation and its effectiveness at different administrative levels, as well as between different stakeholders, especially among scientists, is considered as a top priority for keeping the integrity of the Caucasus ecoregion as well as a guarantee of its sustainable development.

C. CONCLUSION: THE WAY FORWARD

The Caucasus Regional Research Agenda can be seen a guiding document for implementation of the core cross-cutting provision of Agenda 2030, which calls for research promotion, technology and innovation development as well as cooperation between scientists and practitioners. A number of other international thematic guiding and policy documents and their recent decisions such as the Convention on Biological Diversity, the UNFCCC and the Sendai Framework call for the same action and, moreover, for establishment of open source knowledge and data platforms for boosting progressive research and development for a better future for all of mankind.

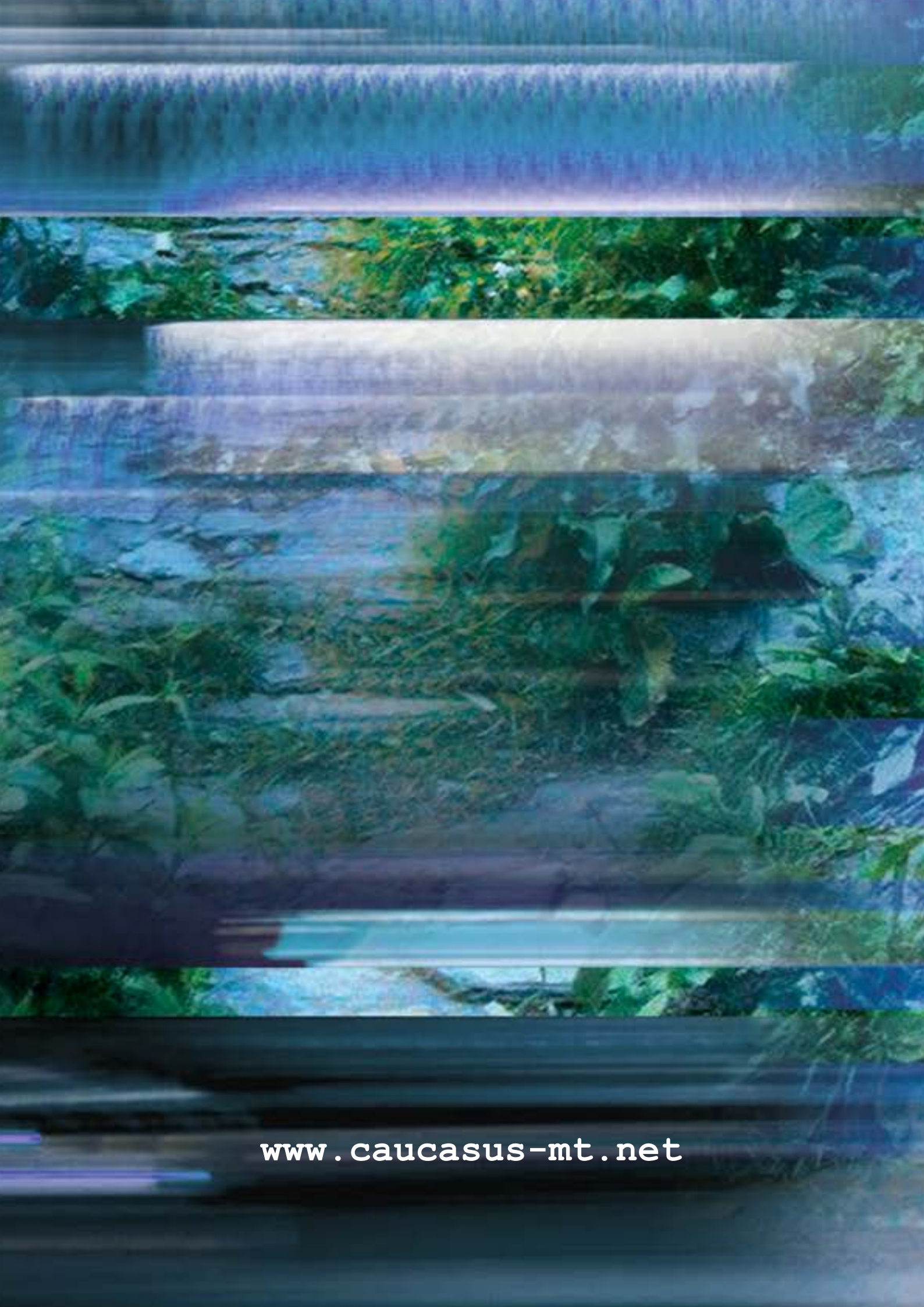
Caucasus Environmental Outlook (second edition) and Caucasus SDI, both under development by the SNC-mt, consider the Caucasus RRA as a framing document for such knowledge and a data tool for research and study.

Formal approval of the C-RRA took place at the Second Caucasus Mountain Forum in Ankara, Turkey in November 2019. In the aftermath of the Forum, which takes place every two years, the progress and effectiveness of decisions and resolutions will be assessed in order to reconfirm or select new thematic research areas, as well as decide on updates of and/or amendments to the document.

Resources for the C-RRA implementation and utilisation as a guiding document for research are to be provided from conventional sources such as national science foundations and research funds through pairing of donations by interested research institutions and universities from the Caucasus region and abroad, as well as via joint research projects. Promotion and facilitation of the C-RRA implementation will be driven by the SNC-mt's Scientific Steering Group and its coordination unit (Sustainable Caucasus).

Moreover, it is assumed that the Caucasus Regional Research Agenda will be considered by practitioners as a document that identifies areas where common practical actions are required to fulfil the potential of the joint research undertaken and that they will indeed be taken, despite political constraints, in order to overcome existing gaps preventing the Caucasus region from achieving sustainable development.

The SNC-mt Scientific Steering Group and its coordination unit (Sustainable Caucasus) with assistance from international partners and donor institutions through existing and new initiatives will enhance the RRA as an instrument for policy making, regional and inter-regional cooperation, knowledge and data exchange and communication of best practices. In order to achieve the sustainable development of the Caucasus region it is important that the C-RRA implementation is conducted through cooperation with a wider audience, regional teaching-leaning practice improvement, science-practitioner dialog promotion and consequent decision-making.


www.caucasus-mt.net