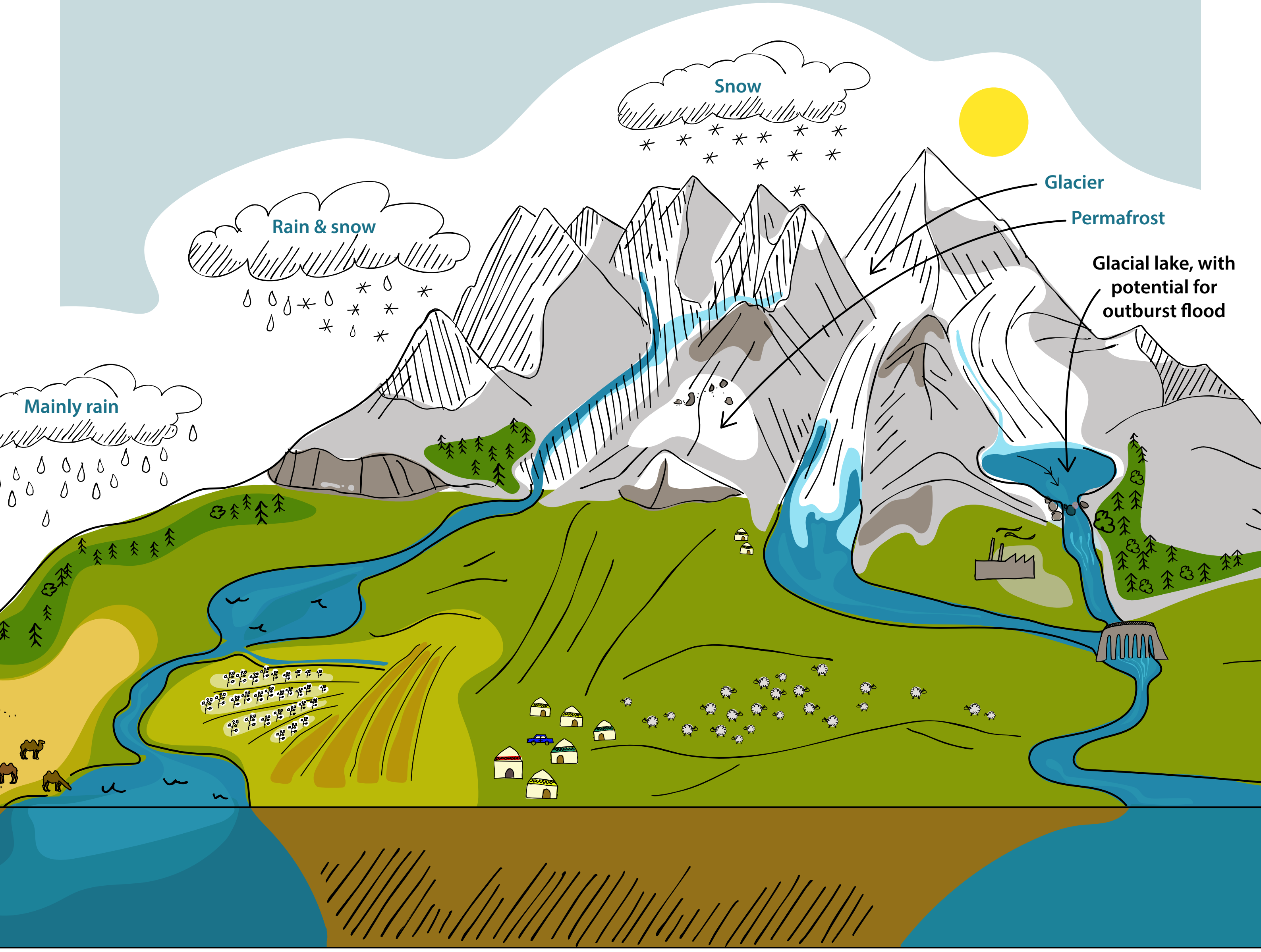
Managing disaster risks and water under climate change
in Central Asia and Caucasus



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Foreword

This publication is the result of a joint learning journey involving three thematic networks – Climate Change and Environment, Disaster Risk Reduction, and Water – and interested SDC offices and partners from Central Asia and the Caucasus. The basic idea was to create the opportunity for participants to address common challenges in a collaborative manner while focusing on a specific region or context.

When the Climate Change and Environment Network initiates such a learning journey, we typically contact other potentially interested thematic networks, and explore the interest of SDC field offices in specific regions of interest. What follows these initial steps is the joint identification of a topic or challenge as an entry point of shared interest and the development of a short concept statement, after which authors with relevant expertise develop 'thematic input papers' that become the focus of a moderated global e-discussion. A 'synthesis paper' based on the e-discussion serves as an input for a thematic workshop in the focus region with participants predominantly from the region. As a result of the workshop, a final publication is shared as widely as possible including on the websites of the thematic networks, SDC field offices and partners involved.

Thanks to the strong involvement of the Swiss Cooperation Office in Tajikistan, a series of 'thematic input papers' and a 'background paper' were assigned to author groups from Central Asia. These papers informed a global e-discussion and a subsequent workshop in Khorog (Pamirs, Tajikistan) in autumn 2018. Roughly 30 participants discussed the papers in the specific local context.

This compilation presents the conclusions emerging from the discussions and the workshop, along with the three thematic input papers and the background paper. A Russian version of all materials will be made available to ease the access for local partners based in Central Asia and the Caucasus.

Daniel Maselli,
Focal Point Climate Change and Environment Network
April 2019

Key messages

Authors: Jonathan Demenge (SDC backstopper Dushanbe), Svetlana Jumaeva (SDC Dushanbe), Jacqueline Schmid (SDC Berne), Daniel Maselli (SDC Berne)

1. The impacts of climate change on natural hazards and water availability must be well understood, communicated and integrated into decision making and planning. Integration of scientific knowledge on the effects of climate change is a prerequisite for taking well-informed development decisions. Access to reliable and timely information is essential for effective natural resources management and for apprehending upcoming climate change challenges. In turn, the availability of such information requires the establishment of sound and reliable monitoring networks and information systems. Effective communication on potential solutions and their contribution to economic development is also fundamental.

2. DRR matters. Natural events can disrupt the environment, put communities at further risk, displace populations and destroy development achievements. Reducing disaster risks is necessary not just in order to save lives and livelihoods, but also to contribute to poverty alleviation, to sustainable development and to building resilience.

A systematic approach to reducing risks of natural disasters should work to prevent disasters, to enable the effective management of disasters and to avoid creating new risks and vulnerabilities. This approach should include the assessment of all risks and corresponding hazards, including impact of climate change on the magnitude and frequency of hazards, and should provide for the evaluation of vulnerabilities and coping capacities. An in-depth assessment of all prevailing risks and their complex interconnectedness provides the basis on which to decide which risks to address.

Box 1. The 2015 Barsem event: Climate-related disaster preparedness and response

In July 2015, an extraordinary heatwave triggered the melting of high elevation permafrost in the Western Pamirs. The saturated and weakened slopes above the village of Barsem in the Badakhshan region finally let loose a massive debris flow that engulfed part of the village and blocked the Gunt River. Eighty-eight houses were destroyed, transmission lines were damaged, the Pamir Highway was blocked, and the debris formed a large dam that created a massive lake that threatened a power plant, villages and the city of Khorog. Specific measures had to be taken to reduce the exposure and vulnerability of people, assets and infrastructure, and to rehabilitate and rebuild what had been destroyed. The event was also a test of disaster preparedness.

Thanks to preparation and a well-functioning early warning system, no lives were lost in the event and recovery took place efficiently. Barsem was already being closely monitored by the Aga Khan Agency for Habitat (AKAH). Risk assessments and scenarios were completed and integrated into the village development plan, and hazard maps had been disseminated to each household.

All over Badakhshan, Community Emergency Response Teams comprising 3,500 trained volunteers can be rapidly mobilised, and emergency stockpiles located in strategic locations can be used in rescue operations on both sides of the Tajik-Afghan border.* The model is currently being replicated across Tajikistan with the help of AKAH, which is also involved in monitoring 227 glacial lakes in Badakhshan. Several projects implemented by the Aga Khan Development Network and its partners take a watershed management approach, and apply Integrated Water Resource Management and DRR principles to increase community resilience.

The event was a wake-up call for the private sector. Pamir Energy (the operator of the energy grid) responded to its US $12 million losses by incorporating DRR into its core business by creating a DRR business unit, and by consistently investing in DRR measures.

* The Badakhshan to Badakhshan agreement, which allows rapid emergency response across the Tajik–Afghan border is a good example of transboundary cooperation in disaster management.

3. A proactive approach to DRR and climate change is financially sound. Investments in DRR and climate change adaptation decrease the costs of catastrophic events and disaster recovery, improve community resilience and directly contribute to development. Communities, institutions and private entities at the local, national or regional level need to integrate DRR and climate change adaptation into their development and business plans.

4. Cross-sectoral and integrated approaches are needed. The issues related to agricultural practices, infrastructure, drinking water supply, sanitation and energy cross departmental lines, and require the collaboration of the agencies involved in water, energy, agriculture, housing and urban planning, and disaster management. Synergies across DRR, climate change and natural resource management should be harnessed and fostered through the adoption of integrated watershed management, ecosystem-based approaches, and integrated disaster risk management.

5. A culture of cooperation must be rebuilt. Central Asian countries and communities should recognize the potential of regional approaches and increased cooperation in finding mutually beneficial solutions to shared challenges. The region as a whole, the individual countries and specific communities may all benefit from the identification of entry points for cooperation, the facilitation of dialogue between technical experts and political leaders, and the reform and empowerment of existing institutions.

6. Local cross-border perspectives should be adopted. The resolution of local issues in water management, natural resource management and DRR often depend on regional and transboundary cooperation. At the same time, the resolution of regional issues may occur at the local level. Flexible local governance with strong public participation can be effective approaches in the search for solutions.

Box 2. Benefits of local governance models

- Reduce the risk of decontextualisation
- Provide customized solutions
- Create ownership for the solution
- Develop an effective vertical lobbying channel for influencing policymakers and decision makers
- Conduct effective and transparent evaluations of project impacts
- Improve infrastructure operation and maintenance

7. Existing technical innovations need to be used and disseminated. The region is host to pilot projects on efficient irrigation techniques, the selection of high-value, drought resistant crops that use less water, and techniques such as agroforestry and community pasture management to reverse soil degradation and increase groundwater recharge. These projects and their results need to be disseminated on a wider scale and supported by progressive policies and pricing mechanisms based on the true value of resources.

8. Private sector expansion can be part of the solution. Most water and natural resources management issues are the responsibility of the public sector. The limited role of the private sector in Central Asia can expand to include individual entrepreneurs acting as pioneers in testing technical innovations and promoting cost-effective solutions.

9. Governance is key to climate change adaptation, integrated disaster risk management, and water management. Responding to climate and disaster risk challenges calls for collective action, adequate policy instruments and functioning institutions; for the use of local knowledge and the participation of communities in decision processes; and for the capacity to mobilise material and funding that go beyond local means. Hence, the role of governments is instrumental in:

- Mainstreaming DRR, climate change and integrated water resources management into policies and institutions
- Integrating urban resilience into urban development processes and strengthening organizational capacities of municipalities
- Harmonising data collection methods and knowledge and making it available to all concerned partners
- Building national capacities and investing in education and training
- Reforming governance processes for the effective implementation of existing treaties, policies and good practices, and for accountability
- Orienting the action of international partners towards the successful integration of climate change and disaster risk and water management

Box 3. Pamir Energy: Integrating DRR into a business model

Founded in 2002 as a public–private partnership with the government of Tajikistan, Pamir Energy is today the main electricity provider in the Badakhshan region, with 100% of its electricity coming from hydropower. With the support of international development partners (including the Swiss State Secretariat for Economic Affairs), Pamir Energy has rehabilitated outdated and non-functioning infrastructure inherited from the Soviet era, cut electricity losses by more than a third, increased electricity coverage to 96% of the population, convinced people to pay for electricity through a transparent billing system and the introduction of individual meters, and transformed itself into a sustainable and cost-efficient business. By providing reliable, affordable and clean energy, Pamir Energy has helped reverse deforestation while contributing to business development and poverty reduction. Targeted support mechanisms put in place to guarantee access to electricity for the poor are being gradually phased out. The company has initiated campaigns to raise awareness and change behaviour to encourage collective responsibility for reasonable use of energy, and has promoted the installation of energy-saving systems. Today it supplies 220,000 people in the Tajik region of Badakhshan, and since 2012, through a cross-border energy project, 35,000 people in Afghanistan.

Most importantly, Pamir Energy has put DRR at the heart of its plans by integrating DRR into its business model through the 4R approach:

- Robustness (to withstand hundred-year events)
- Redundancy (alternatives and back-ups)
- Resourcefulness (development of knowledge and human resources)
- Rapidity of response

The company has invested significantly in risk assessment and prevention, and has embraced the concept of "build-back better" as part of its approach. Pamir Energy has also integrated climate change into its development plan by investing in solar off-grid projects. Each year, Pamir Energy devotes US $300,000 to DRR. By comparison, reconstruction of only transmission lines after the Barsem event of 2015 cost US $425,000, and the Barsem event along with other flooding and landslides events across the Gorno-Badakhshan Autonomous Oblast during the same summer caused property damages of US $12 million including business interruption. Operating in a risky environment, the investment in DRR makes perfect economic sense.

Thematic Input Paper 1

State of the knowledge on water resources and natural hazards under climate change in Central Asia and South Caucasus

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1. Background/Scope

Climate change is expected to have profound impacts on water resources and natural hazards in Central Asia and South Caucasus. It is critical that we understand such impacts, particularly in the context of rapid socio-economic change that will have implications for the vulnerability of populations in the region. This paper aims to provide a synthesis of the scientific evidence of these changes, their magnitudes and expected consequences. These two distinct regions have extremely heterogeneous climates controlled by elevation and latitude and by location on the continent. Given the large spatial extent of the regions, local climates are highly variable.

The paper starts from an analysis of observed and projected changes in term of the atmospheric drivers of change, e.g. air temperature and precipitation anomalies at the global and regional level. Observed climate change refers to measurements taken at individual stations, satellite data and data obtained from assimilated meteorological data (reanalysis data). Climate projections are obtained by using quantitative methods to simulate the response of the main earth's system components (air, land, oceans, cryosphere) to an increase in greenhouse gas (GHG) concentrations. Climate scenarios to simulate future GHG concentrations are given by the Representative Concentration Pathways (RCPs). In this paper we will refer to results for the RCP2.6 and RCP8.5 scenarios. RCP2.6 represents a mitigation scenario aiming at keeping the level of global mean temperature increase to 2 °C above the pre-industrial level, whereas RCP8.5 represents a scenario of business as usual with an expected average temperature increase to 4 °C above the pre-industrial level. We then assess the state of knowledge on climate change impacts on water resources, weather extremes and mass movements. We discuss implications of climate change for the management of water resources and natural hazards through a risk perspective. We synthesise knowledge from peer review literature and to a certain extent key literature of international organisations. We have used available datasets to generate new graphs on climate and glacier changes in the region. The reviewed literature is necessarily biased towards Central Asia due to considerably less literature being available for the South Caucasus region.

2. Regional profiles

Central Asia consists of the former Soviet republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Central Asia covers an area of 4 million square kilometres and has a population of 60 million people and a population density of just 15 people/km^2. It has a varied topography characterised by vast deserts, grassy steppes and high, glaciated mountain ranges. Mountains cover approximately 20% of the area, with Tajikistan and Kyrgyzstan being the most mountainous countries (>90% of their territories). Major mountain ranges are the Tien Shan and the Pamir-Alai. The Tien Shan mountain range spans from Uzbekistan to Kyrgyzstan, and in the south-east from Kazakhstan to China (Xinjiang). Major river systems of the region include the Amu Darya and the Syr Darya. Major water bodies are the Aral Sea, Lake Balkhash and Issyk Kul Lake, which are part of the west-central Asia endorheic basin that also includes the Caspian Sea (Figure 1).

The climate of the region is extremely heterogeneous and strongly controlled by latitude, altitude and location on the continent. Mean annual air temperatures (MAATs) are around +5 °C in northern Kazakhstan to +20 °C in southern Uzbekistan, whereas MAAT is strongly sub-zero in many parts of the Tien Shan and Pamir (Figure 3A). Precipitation is controlled by the same factors, with arid interior regions of Uzbekistan and Turkmenistan (200mm) whereas northern parts of Kazakhstan are more humid (600–700mm).

Figure 1: Water Resources in Central Asia

Precipitation hotspots of up to 2,000mm can be found in the Tien Shan and Pamir mountains whereas regions to the east of the main ranges and bordering China are more arid (Figure 3A).

South Caucasus consists of the former Soviet states of Armenia, Azerbaijan and Georgia, and sits between the Black Sea (west) and Caspian Sea (east). The Caucasus area of 186,100km^2 is home to a population of 16 million people. The Caucasus Mountains are the divide between Europe and Asia and greatly influence the climate of the region. The region shows a marked topography within a very narrow distance. The highest point is Mount Shkhara at 5,201m, and the lowest point is -28m. The climate is extremely diverse varying with both longitude and altitude. The Great Caucasus range protects the region from the direct penetration of cold air masses from the north and strongly dictates the precipitation rates. Precipitation decreases from west to east and generally mountain areas receive more precipitation than low-lying areas. The region shows an extreme precipitation gradient west to east with 2,393mm/year in Batumi (humid subtropical) and 258mm/year in Baku (cold semi-arid), while mean annual air temperatures are quite similar at 14.2 °C and 15.1 °C, respectively. The largest rivers are the Mtkvari, the Kura and the Araks, with lengths of 1,564, 1,515 and 1,072 kilometres, respectively (Figure 2).

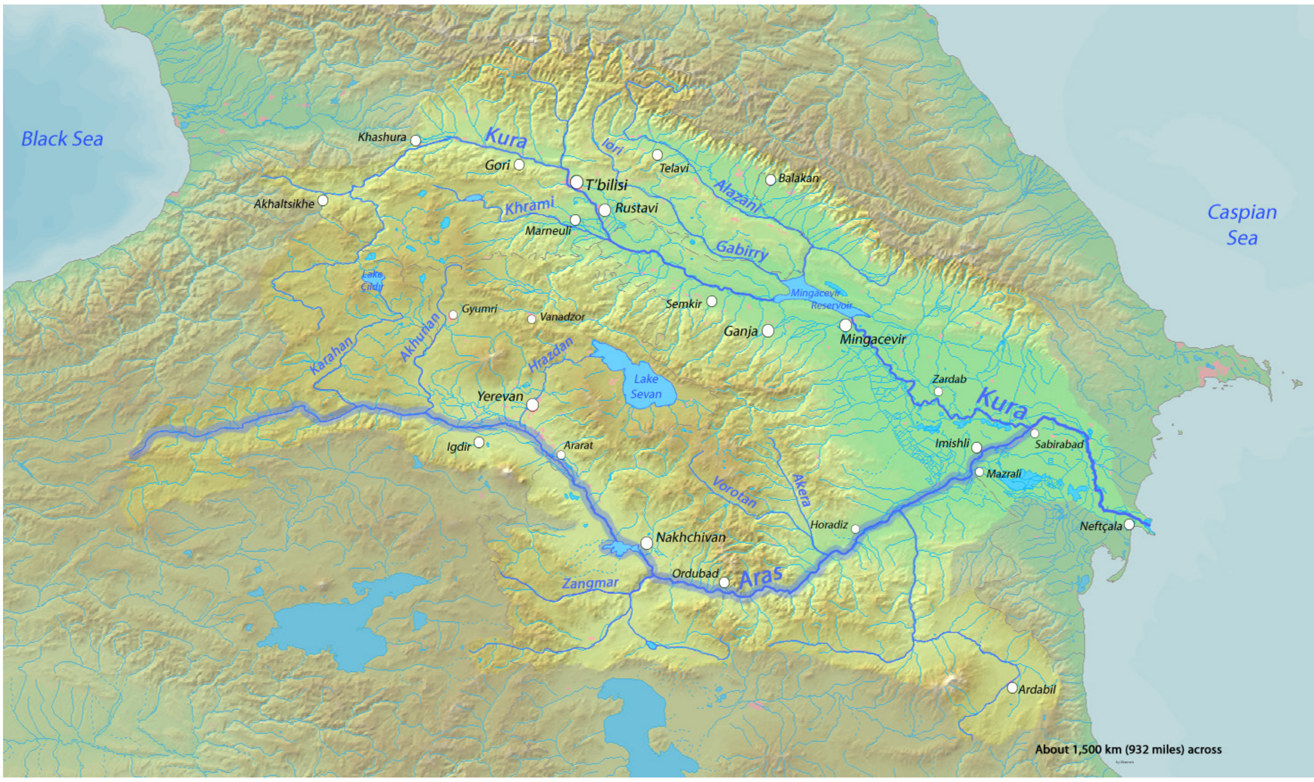

Figure 2: Hydrographic map of Caucasus
Source: Shannon/Wikimedia Commons, http://www.glimpsefromtheglobe.com/topics/politics-and-governance/forecasting-water-wars-in-the-caucasus/

3. State of knowledge

3.1. Observed climate change

Mean annual air temperature has increased over the past century over most of the South Caucasus and Central Asia regions. The numbers of cold days and nights have decreased and the numbers of warm days and nights have increased across most of Asia since about 1950, and heat-wave frequency has increased since the middle of the 20th century in large parts of Asia (Hijioka et al. 2014).

In line with observed northern hemisphere warming, large trends (>2 °C per 50 years) in the second half of the 20th century were observed in the northern Asian sector (Hijioka et al. 2014). Most studies focusing on Central Asia mountain regions also document mean-annual (Hijioka et al. 2014) and summertime (e.g., Shahgedanova et al. 2010) warming, with slight cooling in the central and eastern Pamir (Aizen 2011b), which is shown in Figure 3B. The warming trend in mean annual air temperature appears to be less pronounced at high altitudes than in the lower elevation plains and protected intramontane valleys (Unger-Shayesteh et al. 2013). For the winter months, however, a stronger warming trend can be detected at higher elevations of the Tien Shan Mountains (Kriegel et al. 2013; Mannig et al. 2013; Zhang et al. 2009).

Precipitation trends, including extremes, are characterised by strong variability, with both increasing and decreasing trends observed in different parts of the region. In southern Central Asia, a weak downward trend in mean precipitation was observed in recent decades, although with an increase in intense weather events (IPCC AR5, Figure 3B). In mountain regions, precipitation increases have been detected (e.g., Braun et al. 2009; Glazyrin and Tadzhibaeva 2011).

Reanalysis data from the European Centre for Medium-Range Weather Forecasts (ERA-Interim[1]) shows widespread warming across the region (Figure 3B). Localised cooling is seen in locations such as the Pamir (in agreement with Aizen 2011). Precipitation anomalies show general drying trends in the west of the region around the Caspian Sea and Caucasus and in western China. Very localised wet anomalies can be seen in north-east Kazakhstan (in agreement with projected changes).

1. https://www.ecmwf.int/en/forecasts/datasets/archive-datasets/reanalysis-datasets/era-interim

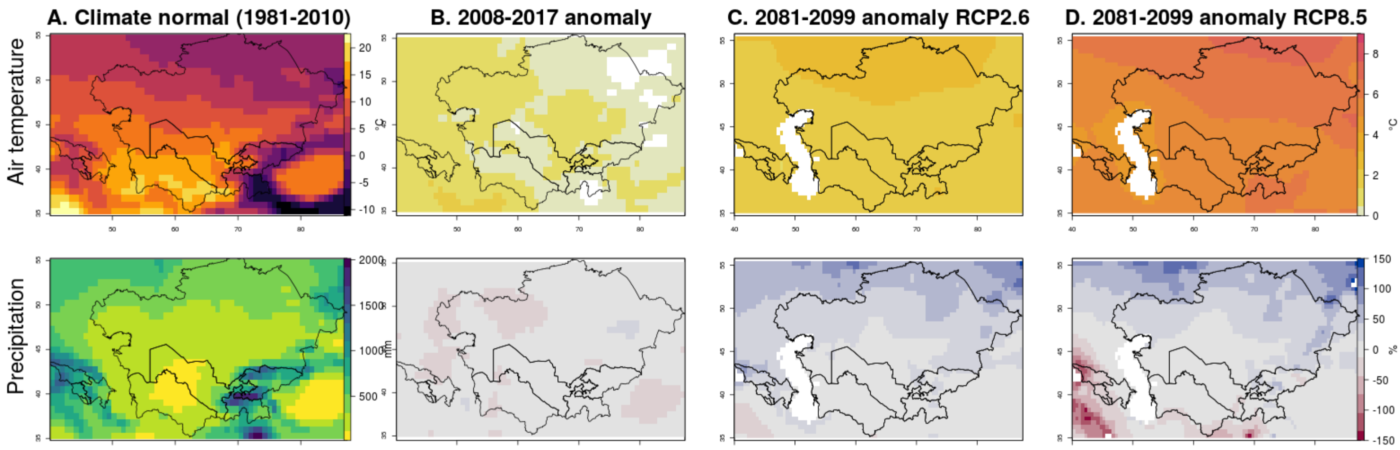

Figure 3: Observed and projected climate change in Caucasus and Central Asia as reported by ERA-Interim reanalysis for climate normals[5] (A) and current anomaly (B) and GCM multi-model means (Hempel et al. 2013) for RCP2.6 (C) and RCP8.5 (D) (projected changes 2081–2099). Cooling of up to 1 °C is shown in white in panel (B). Note all temperature scales are in °C, precipitation normal is in mm whereas precipitation anomalies are in % change.

3.2. Projected climate change

Warming across the Central Asia land area is projected to be higher than the global mean. The multi-model mean[2] summer warming for 2071–2099 is about 2.5–6.5 °C above 1951–1980, in a 2–4 °C world (Reyer et al. 2017, Figure 3). In line with the broad IPCC findings,[3] results from the ISIMIP[4] project (Figure 3) show widespread warming of 2–3 °C in RCP2.6, with a latitudinal trend. In RCP8.5 warming is much more intense at 6–8 °C and additional warming hotspots over the high altitude regions of the Pamir and Southern Tien Shan.

Projected future changes in annual precipitation exhibit a south-west to north-east dipole pattern, with regions in the south-west becoming drier and regions in the north-east becoming wetter (Figure 3D). The "dry-getting-drier and wet-getting-wetter" under climate change is a good first order approximation for the region. Increased wetness in the north-east is the most pronounced signal, in agreement with the strong global precipitation increases projected for high latitude regions in winters. The increase/decrease in precipitation is far more pronounced during the winter (DJF) than during summer (JJA) (Mannig et al. 2013). The multi-model mean drying signal in the south-west, including the Caucasus region, is very weak (almost flat) under low-emissions scenarios (2 °C world), and the models disagree about the direction of change. There is robust model agreement, however, that under the high-emissions scenario (4 °C world), the Caucasus region, Turkmenistan and Uzbekistan will receive less rain, with the multi-model mean annual precipitation dropping by about 20%.

3.3. Changing water towers

High mountain areas of the world are often referred to as "water towers" due to their critical role in supplying lowland regions with water. This is especially true for the large irrigated regions of both Central Asia and Caucasus. Here, seasonal storage of freshwater as snow and inter-annual storage as glacier ice provides a critical water reserve that supplies agricultural and domestic water during dry summer seasons, and replenishes groundwater reserves. Therefore, understanding projected changes in high mountain water resources is critical, particularly in the regions that have seasonal precipitation regimes (southern Central Asia).

Glaciers: Clear evidence from observations shows that glaciers are retreating throughout Central Asia (WGMS 2018) and Caucasus (WGMS 2018; Tielzide 2016; Bondyrev et al. 2015; Shahgedanova et al. 2005) as a response to rising global air temperatures (Figure 4). Where multiple surveys are available, most show accelerating loss. Rates between -0.05% yr^{-1} and -0.76% yr^{-1} have been reported in the Altai (Surazakov et al. 2007; Shahgedanova et al. 2010) and Tien Shan (Lettenmaier et al. 2009; Sorg et al. 2012), and between -0.13% yr^{-1} and -0.30% yr^{-1} in the Pamir (Konovalov

2. Results from multiple models are averaged to account for uncertainties related to different modelling schemes.
3. WG1AR5: Annex I: Atlas of Global and Regional Climate Projections (http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_AnnexI_FINAL.pdf)
4. A community driven modelling effort to provide cross-sectoral impacts of climate change based on the RCP scenarios www.isimip.org
5. Climate is commonly described using the long-term averages of meteorological parameters (such as temperature, precipitation and hours of sunshine), as well as the differences from these averages. The 30-year average and 30-year averaging period are used as standard for climate normals worldwide.

and Desinov 2007; Aizen 2011). Tielzide (2016) found that the area of Georgian glaciers declined by 42.0 ± 2.0% between 1911 and 2014, with highest retreat rate seen in the eastern region (67.3 ± 2.0%). These ranges reflect varying sub-regional distributions of glacier size (smaller glaciers shrink faster) and debris cover (which slows shrinkage), but also varying proportions of ice at high altitudes, where as yet warming has produced little increase in melt (Narama et al. 2010). Marzeion et al. (2012) found 21st century volume losses could be 50% for RCP2.6, and 67% for RCP8.5. The concept of peak water (Huss and Hock 2018 and references therein) is important in understanding glacial contributions to surface run-off. As melt rates increase, run-off will also increase until a certain tipping point when the glacial mass is reduced to such an extent that run-off starts to decline. The study of Huss and Hock (2018) found that for the basins of the Aral Sea this point is approximately mid-century. For Caucasus this point is now and glacial discharge is likely decreasing over widespread areas (Huss & Hock 2018). In addition, the Amu Darya will likely see greater losses compared to the Syr Darya or Naryn in Central Asia due to its higher glaciated area (World Bank 2015). More immediately, glacial retreat creates a hazard due to the formation of moraine-dammed glacial lakes with the possibility of outburst floods (GLOFs) (Bolch et al. 2011; Kapitsa et al. 2017).

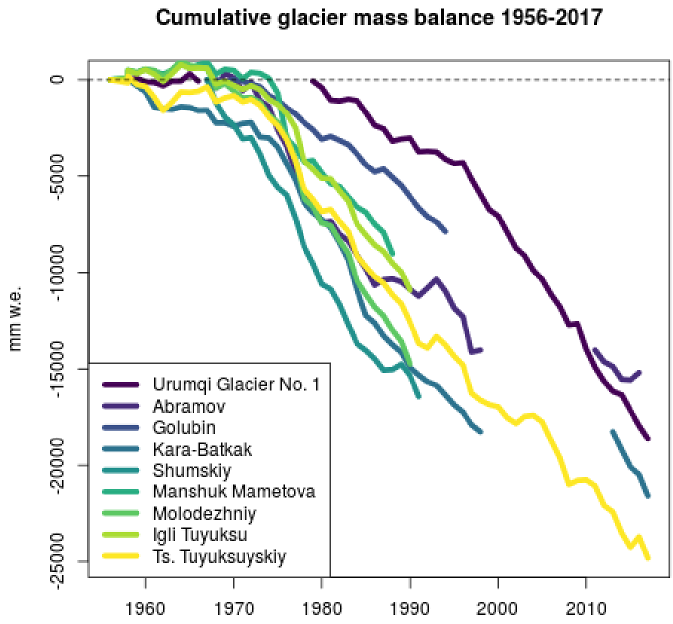

Figure 4: Changes in mass balance of Central Asian glaciers over the past half century
(credit: WGMS)

Seasonal snow cover: Over large parts of southern Central Asia seasonal snow cover contributes significantly to the annual water budget because precipitation is seasonal and falls mainly during autumn to spring, largely as snow in mountain regions. Reductions in seasonal snow cover are expected to accompany observed warming in the mountains of Central Asia and Caucasus as a higher proportion of winter PR falls as rain (Lemke et al. 2007). Zhou et al. (2017) found significant decreases in the number of snow-on-ground days throughout the Pamir and Tien Shan in an analysis of trends from 1986 to 2008. Peters et al. (2015) found that snow cover changes in the central Tien Shan (1986–2012) show a slight decrease in altitudes up to 4,000m and an opposite trend above that level, but significant gradients were found only at high elevations. Global projections estimate an increase in the snow line of around 150m per 1 °C warming (Christensen et al. 2007). Expected changes in seasonality of snow melt will result in earlier run-off and reduced water availability in summer/late summer (Barnett et al. 2005) when demand in the large irrigated zones of Central Asia is highest, particularly in unregulated catchments. Changes in seasonal snow cover are projected to enhance warming in mountain regions through snow-albedo effects (Christensen et al. 2007). In the Amu Darya basin, studies have found that increasing glacial run-off will buffer decreasing snowpack until mid-century when peak water is expected in many areas (Huss & Hock 2017, Figure 3). The second half of the century, however, will then see decreasing run-off as both snow and glacial components decline.

3.4. Extreme weather events

The effects of climate change are projected to cause shifts in present day climate into new regimes, where what we consider to be extreme events today will be increasingly common in the future.

Heat Extremes: Reyer et al. (2017) found that threshold-exceeding heat extremes strongly increase in southern regions in a 4 °C world with respect to the reference period 1951–1980. Heat extremes can be quantified as 3- and 5-sigma events (considering that monthly temperatures are close to a normal distribution, 3- and 5-sigma events represent 3 and 5 standard deviations over the mean temperature, respectively). In a region from eastern Caucasus to central China they found 80% of summer months to exceed 3-sigma events and 40% to exceed 5-sigma events. To put this in context, air temperatures experienced during the warmest 10% of summer nights during the 1961–1990 period are expected to occur in about 30% (2 ˚C world) or 90% (4 ˚C world) of summer nights by the end of the century in regions approximately below 50° latitude (Sillmann et al. 2013). This will likely increase heat stress considerably in human populations, livestock and agricultural crops as well as enhance drought impacts.

Precipitation Extremes: No clear trend in precipitation extremes can be found in the observation record (Dai 2013; Donat et al. 2013), but a moderate drought risk is projected until the end of the century with a 10% decrease in soil moisture in southerly regions of Central Asia and Caucasus.

Although Sillmann et al. (2013) found no significant change in the index "consecutive drought days" in their study Central Asia model domain (includes Caucasus), changes in soil moisture in northern Central Asia are likely to be slightly positive, but warming will have a large influence on soil moisture due to enhanced evapotranspiration. Reyer et al. (2017) found significant increases in land area classified as both arid (19.6, 11.6) and hyper arid (22.4, 14.4) in both 2 °C and 4 °C worlds. Specifically, under a 4 °C world significant increases in aridity in already drought-prone regions such as southern Kazakhstan, Uzbekistan and Turkmenistan can be expected, with serious implications for agriculture and food security. Although drought projections remain uncertain, at least in the precipitation signal, regional water availability will be strongly affected by changes in river run-off due to glacier melting and changes in seasonal snow storage (next section). Atmospheric warming speeds up the hydrological cycle and is expected to increase the frequency of intense precipitation events throughout the region (Sillmann et al. 2013). Mountainous regions of Central Asia are very prone to the flash flooding that can occur after intense precipitation events particularly in steep rocky catchments with narrow canyon outlets. There are many well-documented cases of entire villages being destroyed by this type of event such as the seven-lakes event in 1992 in the Fan mountains in Tajikistan.

3.5. Mass movements

Mass movements are complex phenomena with possible climate triggers e.g. glacier lake outburst floods, debris flows, rock fall and ice or snow avalanches. In general warming in high mountain regions can lead to destabilisation of steep slopes due to loss of mechanical strength e.g. permafrost debris or rock slopes. While climate induced permafrost degradation (observed at GTNP[6] sites in Tien Shan e.g. Marchenko et al. 2007) can be a key driver of such events, disentangling the climate signal from normal erosional processes in mountain areas is not straightforward. There is, however, increasing evidence that increased incidence of thermally induced slope instabilities should be expected as high mountain regions warm. A second class of more mechanical mass wasting is debutressing due to glacial retreat that leaves over-steep slopes eroded by the former glacier flow. These slopes are inherently unstable and prone to collapse. Snow avalanches are significant hazards in both Central Asia and Caucasus and can threaten exposed infrastructure and settlements. The impact of climate change on snow avalanches is complex and uncertain. Reduced average snowpack depths would serve to reduce frequency of large events. There is some evidence of large precipitation events in winter becoming more frequent. Such events would promote large avalanches even with a background of lower average snow depths. Mass movements often result in compound events, which can impact distant low-lying regions (Mergelli et al. 2018). Compound events are usually associated with different interacting physical processes over multiple temporal and spatial scales (Zscheischleret al. 2018), e.g. a glacier lake outburst flood triggered by an impact wave from an ice avalanche upstream, in turn triggering a debris flow with entrainment of material. Earthquakes can often be the trigger of such compound processes and while not coupled to climate can trigger mass movements on slopes destabilised by warming.

Box 1: Compound events on Mount Kazbek Massif, Caucasus

On 17 May 2014 an ice avalanche released from the Devdoraki Glacier on Mt. Kazbek (5,033m) in Georgia. The ice avalanche triggered a massive mud and debris flow. The flow travelled downstream to the Tergi River, which was temporarily blocked and gave rise to a 20–30m deep lake with a water volume of 150,000m^3. The debris covered a highway of international importance between Georgia and Russia, and an international gas pipeline and the building site of a new hydropower plant were damaged. The disaster claimed the lives of nine people and created disruption in the downstream communities (Tielidze 2017). This is the same region where in September 2002 a hanging glacier released ice and rock onto the Kolka glacier triggering a massive avalanche of ice, snow and rocks into the river in the valley. The avalanche swallowed the village below and several other settlements.

6. Global Terrestrial Network for Permafrost mandated by Global Climate Observing System/WMO

4. Knowledge gaps and challenges

4.1. Models

Climate projections simulate the response of the climate system to a scenario of future greenhouse gas emissions and are derived using climate models. Climate models can be understood as numerical representations of the climate system based on biological, chemical and physical properties of the atmosphere, cryosphere, land and ocean components including their interactions and feedback. The most advanced climate models are General Circulation Models (GCMs), with a spatial resolution of 100–300km, as used by the IPCC and the literature in this review to assess climate change at the global scale. Coarse resolution means that topographic features even as large as the Pamir Tien Shan are not well resolved and therefore surface processes are not well represented leading to generally greater uncertainties in mountain regions as compared to low-lying regions. Our projections may also be informed by observations in the case of debiasing, which is also problematic in mountain regions where observations are sparse and not representative of larger regions. Regional Climate Models can address the resolution problem to some extent by downscaling but are still prone to uncertainties related to surface process representations.

4.2. Observations and networks

In situ measurements and monitoring of glaciers, snow and permafrost constitute the data basis for ascertaining and processing changes in upstream and downstream systems due to climate change. Thus, long-term and continuous in situ observations and measurements are of paramount importance in addressing climate change impacts on water resources and natural hazards. Continuous in situ measurements and monitoring in remote areas such as the mountain areas of Central Asia and Caucasus are challenging tasks due to the difficult access, complex topography, financial and logistic constraints, political instability and lack of appropriate infrastructure (Hoelzle et al. 2017). Several studies have reported the lack of appropriate and reliable datasets as one of the most important constraints to understanding patterns of changes in Central Asia (Unger-Shayesteh et al. 2013; Hoelzle et al. 2017). Most areas of the Asian region lack sufficient observational records to draw conclusions about trends in annual PR over the past century (Hijioka et al. 2013; Figure 24-2; Table SM24-2). If weather stations are present at all, they are usually located at lower elevations where most of the population lives. There are very few datasets above 3,000m and virtually none above 5,000m. Remote sensing data as well as model-assimilated observations (from reanalysis data) are used to fill the observational gap. Their products are becoming increasingly popular and show increased skill. The relatively short time series and coarse resolution, however, do not allow for robust assessments of changes in mountain areas, where the complex topography requires finer resolutions (< 5km) (Prein et al. 2015). This makes the need for denser observational networks in remote mountain areas ever more urgent.

Management of extreme events and mass movements requires monitoring, recording and reporting of events over relatively long timescales and standardised data reporting. In locations where resources are scarce and funds are limited, this is often not a priority. Permafrost monitoring is also very important for understanding slope stability and the influence of permafrost on water resources. Permafrost monitoring is patchy in the regions with only five permafrost boreholes in Central Asia (all with discontinuous measurements) and none in Caucasus (Biskaborn et al. 2015).
Considerable work has been undertaken since the 1990s to address these gaps. Steps include re-establishing monitoring sites and building capacities and innovations through international projects such as Central Asia Water,[7] an international consortium of German and Central Asia institutions, the Capacity Building and Twinning Climate Observing System of the Swiss Agency for Development and Cooperation,[8] the Water Management in the South Caucasus project of the United States Agency for International Development, and the Central Asia Hydrometeorology Modernization Project[9] of the World Bank.

7. http://cawater-info.net/
8. https://www.meteoschweiz.admin.ch/home/forschung-und-zusammenarbeit/projekte.subpage.html/de/data/projects/2011/catcos.html
9. http://projects.worldbank.org/P120788/central-asia-hydrometeorology-modernization-project?lang=en

5. Implications for water and disaster risk management

5.1 The risk perspective: Hazard, exposure and vulnerability

The IPCC risk framework in the background of Figure 5 (IPCC 2012, 2014) provides a useful approach for discerning the different drivers of climate risks for a country or a region. It recognises that climate impacts and risks emerge from the complex interplay of multiple factors, not least the past and current pathways of socio-economic and political development. This perspective is useful for addressing current and future management issues since it distinguishes the physical causes of risks (hazards as discussed in the previous section) from causes related to exposure (number of people, infrastructure) and past and present pathways of development (vulnerability) (Allen et al. 2018). In this section we look at the risks associated with changes in water resources and changes in the natural disaster landscape as a consequence of climate change, and highlight the contributions of exposure and vulnerability to climate-related risks (Figure 5).

5.2 Water availability and management

Due to the semi-arid to arid climate, Central Asia and part of South Caucasus are heavily dependent on fresh water supplies from snow and glacier melt for irrigation, hydropower and domestic use. Changes in timing (seasonality) and amounts of fresh water can have serious implications for the future management of irrigated agriculture and energy generation from hydropower. This effect will be most strongly felt in the large irrigation zones of Central Asia, but also in potential upstream hydroelectric schemes such as the Nurek dam in Tajikistan. Mankin et al. (2015) conducted a global study of sensitivity of individual basins to changes in snow supply under climate change projections. They found that currently the basins of Central Asia significantly depend on snow melt to serve summer demand (demand refers to surface and subsurface water consumption from agricultural, industrial and domestic use), whereas Caucasus rainfall is sufficient to meet demand. In addition, they found a high risk that snow melt will no longer meet summer demand by mid-century in central Asian basins. They also found evidence for a shift from sufficient to insufficient rainfall run-off to meet water demand in the Caucasus region by 2080.

Given the already very high level of water stress in many parts of Central Asia, observed and projected air temperature increases and precipitation decreases in the western part of Kazakhstan, Uzbekistan and Turkmenistan (Figure 3) could exacerbate the problems of water shortage and distribution (Lioubimtseva and Henebry 2009). Considering the dependence of Uzbekistan's economy on its irrigated agriculture, which consumes more than 90% of the available water resources of the Amu Darya basin, climate change impacts on river flows would also strongly affect the economy (Schlüter et al. 2010).

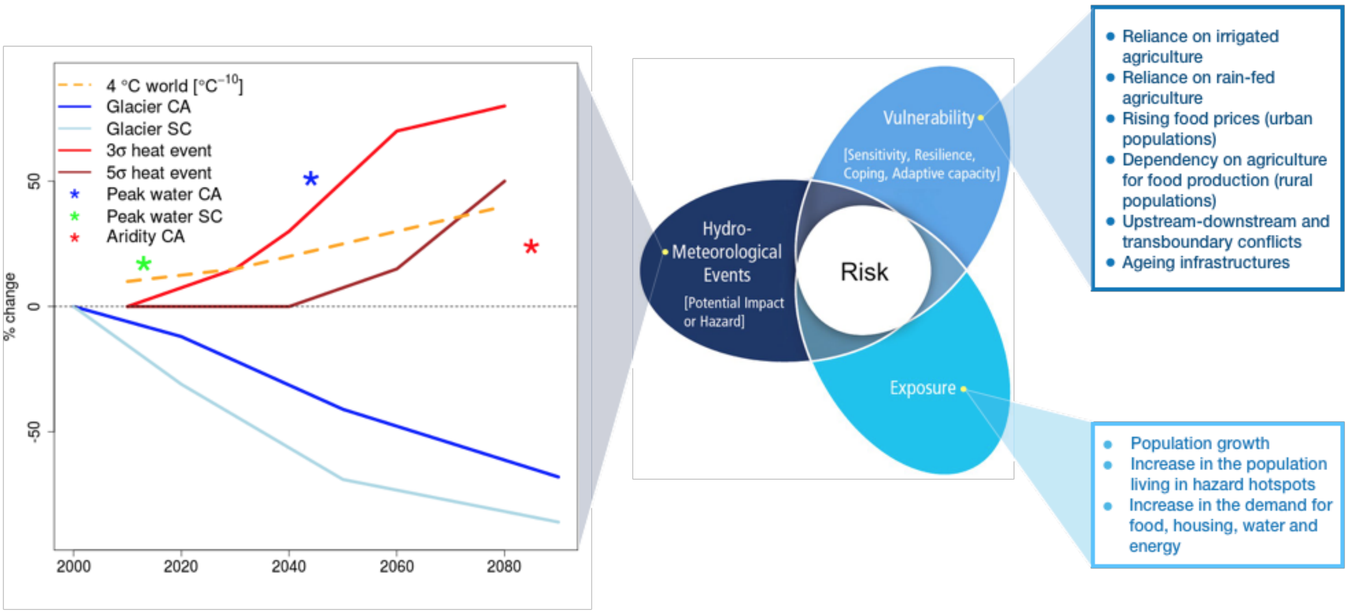

Figure 5: The risk concept adapted from the IPCC (2012, 2014) highlights the interactions between hazard, exposure and vulnerability as components of risk. The hazard box (left side) synthesises the main trends from current observations and projections until the second half of the century as reported in this paper. The right side summarises main elements of current vulnerability and exposure common to both regions as collected from the reviewed literature.

Recent studies have demonstrated that the risk of water scarcity in the region is strongly associated with high water demand driven by socio-economic pressure and demographic trends (increased exposure) (Luck et al. 2015). In Central Asia, inefficient water usage for irrigation and degradation of croplands has already resulted in a 30% decline in crop productivity since the 1990s (Conrad et al. 2013). Depending on the climate scenarios, agriculture productivity might decline by as much as 20–50% by 2050 (compared to a 2000–2009 baseline) in Uzbekistan and up to 30% in Tajikistan if appropriate adaptation measures are not implemented (Reyers et al. 2017). Loss of agricultural productivity combined with soaring population and food prices can have direct impacts on food security for large sections of the population. In the already water stressed and drought-prone areas of the Ararat valley in Armenia, climate change is expected to lead to enhanced TA and reduced PR resulting in more frequent drought conditions. Furthermore, an expected reduction in the flow of a major river (Arpy River) and a decrease in groundwater levels will pose serious challenge for a country dependent on agriculture for more than 20% of its GDP (Melkonyan 2015). In parts of Azerbaijan existing water stress due to inefficient use, unequal distribution and seasonal fluctuations are already causing major concerns. Improved water use efficiency in irrigation, changing or rotating crop systems and water reuse might ease water stress and improve agriculture productivity (Aleksandrova et al. 2014).

5.3 Management of upstream-downstream hazards

The presence of a marked downstream–upstream topography renders the two regions particularly prone to gravitational hazards such as landslides, debris flows, mudflows, ice, snow or rock avalanches and GLOFs. While it is still statistically difficult to directly link such events and the frequency of occurrence to shifts in global climate, there is growing evidence from the Alps (Huggel et al. 2012) and a sound physical basis for increased occurrence of mass movements in high mountain regions. As permafrost slopes warm they become less stable and as glaciers recede they leave behind inherently unstable slopes that have become overly steepened, and large amounts of sediments that can be mobilised in large destructive debris flows. The sequence of processes leading to these types of hazards needs to be reasonably well understood to devise appropriate adaptation and disaster risk reduction strategies. Several other contributing effects or confounders play a role in the dynamics of disasters generated by gravitational hazards, such as the increased number of people and assets in hotspot areas (exposure) as well as lack of appropriate risk preparedness and information (vulnerability). It is thus of paramount importance to intensify the development of soft, no-regrets adaptation measures that are flexible and robust and that allow for adaptive management (Hallegatte 2009), hazard, exposure and vulnerability mapping, capacity building and training, and Early Warning Systems.

Box 2: Transboundary processes and management challenges

The Syr Darya River basin originates in the Tian Shan Mountains in Kyrgyzstan, flows across Tajikistan, Uzbekistan and Kazakhstan, and ends at the Aral Sea. During the Soviet era extensive irrigation in the downstream countries of Uzbekistan and Kazakhstan was developed. Upstream countries provided water for spring and summer irrigation to the downstream countries and received fossil fuel in exchange. After the breakup of the Soviet Union, Kyrgyzstan, which is poor in fossil fuels, started storing water in spring and summer to be used in the fall and winter for hydropower generation. The downstream countries, however, still need large amount of water during April-September for irrigation. Projections show that for the Aral Sea basin peak water could be reached in 2030±5 (RCP2.6) and 2044±15 (RCP8.5) followed by a steady decline in glacier run-off (Huss & Hock 2018). The impacts of glacier melting and reduced snow cover will be felt both upstream and downstream. Additionally, studies on cooperation regimes indicate that Central Asia has a moderate to high risk of conflicts due to reduced water availability (Bocchiola et al. 2017). The major challenge for the region is thus to manage the diverging needs of the upstream and downstream countries through appropriate transboundary cooperation. To facilitate transboundary cooperation, dynamics of water flows and management need to be well understood to devise appropriate adaptation solutions for the region (Bocchiola et al. 2017). Furthermore, the establishment of the Interstate Commission for Water Coordination of Central Asia[10] located in Tashkent shows a willingness to address current and future challenges in water resource management in the region.

10. http://www.icwc-aral.uz/

6. Key messages

- Climate change is well underway in both regions, positive air temperature anomalies are observed throughout both regions and drying trends are seen in the western regions of Central Asia and Caucasus. Warming is projected to continue throughout the region and, depending on scenario, ranges from a "manageable" 2–3 °C to a dangerous 5–8 °C. Particular hotspots of air temperature increases are northern regions of Kazakhstan and Pamirs and southern Tian Shan.
- Drying trends are likely in south-western parts of Uzbekistan and Turkmenistan and Caucasus, increasing the risk of more frequent and longer periods of drought.
- Caucasus will likely no longer rely on sufficient rainfall to meet summer demand by late century with increased dependence on depleted snow and glacier meltwater resources.
- Significant increases in heat stress in human populations, livestock and crops are very likely throughout both regions during summer months.
- Glaciers are retreating in both regions and will continue to retreat over this century. Peak water has likely already been reached in Caucasus and will be reached by mid-century in Central Asia. Glacial water resources will decrease after this tipping point. The risk of glacial lake outburst flooding is expected to increase.
- Decreasing precipitation, increasing evapotranspiration and reduced run-off from snow and glacial melt will likely combine to severely reduce water resources particularly in irrigated zones of Central Asia in the second half of this century.
- Permafrost mountain slopes throughout both regions will experience thawing during this century over wide areas, increasing the chance of mass movement events such as rockfall, ice avalanches and debris flows. These high mountain events can often travel long distances and affect low-lying communities through complex process chains.
- Lack of adequate monitoring of key environmental variables is a key limitation in understanding past and future trends. Investment in monitoring networks also requires capacity in data management and interpretation as well as maintenance of systems.
- Climate change risks need to be assessed within the specific exposure and vulnerability context of the region in order to devise appropriate adaptation solutions for water and disaster management.

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Thematic Input Paper 2

Actors, Approaches and Cooperation Related to Water Management and Natural Hazards under Climate Change in Central Asia and Caucasus

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1. Introduction

The objective of this thematic input paper is to provide a multi-dimensional overview of the diverse approaches, actors' interactions and cooperation related to water resources management and disaster risk reduction in the context of the challenges posed by climate change in the Central Asia and South Caucasus regions. The first parts of the paper set the scene of the current socio-economic and geopolitical background, presenting the current challenges for sustainable growth for both regions. The ensuing sections provide an overview and a detailed analysis of the institutional frameworks and key stakeholders at the regional, national and local levels.

In 1991, the dissolution of the Soviet Union led to the emergence of new political and socio-economic dynamics shifting from a centralised command system to a market oriented economy. In this context, each of the 15 post-Soviet states advanced its own approach to building long-term development strategies, resulting in a diversity of models, stakeholders and positions.

Although both regions are considered to be well endowed in water resources, these resources are unevenly distributed, exacerbating strong transboundary inter-dependence and tensions. Low levels of cooperation have so far hindered the rational and efficient management of this important resource, impacting on different sectors of the economies at the local, national and regional levels as well as intensifying competing interests between upstream and downstream countries.

In the Central Asia Region, the upstream countries of Tajikistan and Kyrgyzstan[1] are considered to be rich in water resources and are willing to invest in hydropower production for domestic needs (with a peak use in winter for heating needs) and for export. On the other hand, the downstream countries of Kazakhstan, Turkmenistan and Uzbekistan have tremendous water needs for irrigated agriculture (with a peak use in the spring and summer months). Tensions have increased since Tajikistan and the Kyrgyz Republic accelerated their hydropower production potential, competing with the downstream countries on seasonal water allocations for irrigation.

In the South Caucasus region, challenges are exacerbated by the presence of unresolved territorial disputes and geopolitical struggles (i.e. status of Abkhazia and South Ossetia, and the Nagorno-Karabakh conflict) which fuels mistrust between the parties, affects economic development and sustains high levels of poverty. The geopolitical situation results in the lack of transboundary cooperation on critical issues, especially on Integrated Water Resources Management.

In both regions, the expected effects of climate change, including increasing temperatures, extreme weather events and glacial melt, will have a major influence on water availability. While Central Asia will experience the "drier getting drier and wetter getting wetter" effects (Scenario RCP 8.5, cf. thematic input paper 1), the Caucasus is likely to no longer get sufficient rainfall to meet summer demand. In

1. Afghanistan is the most upstream country on the Amu Darya River. Afghanistan is getting more and more engaged in natural resources management issues in the region, for now, on a bilateral basis with Uzbekistan, Turkmenistan and Tajikistan.

both regions, melting glaciers are an alarming issue; while increasing the water flow for the time being, melting is expected to increase the risks of lake outbursts and floods in a few decades. Central Asia is currently home to 70 million ethnically and linguistically diverse people. By 2050, the population in the Central Asia region is expected to rise to 95 million people, increasing the pressure on natural resources, thus reducing the per capita water availability by more than 30% (World Bank, 2014).

2. Current socio-economic and political context

Water Resources are conducive to the economic and social development in the Central Asia and South Caucasus regions. The management of water, as one of the most important elements for the livelihoods of the people in Central Asia, has to be seen not merely as a technical process, but as a political, social, and economic process that is closely connected to the overall socio-political systems and development policies of the state, as well as environmental conditions. For instance, in Central Asia, over 8.4 million hectares of irrigated agriculture contribute around 20% to GDP and employ a large percentage of the population (FAO, Aquastat). In South Caucasus, 2.1 million hectares of arable land dedicated to irrigated agriculture (FAO/Aquastat) contribute around 14% to GDP in Armenia, 7% in Azerbaijan and 6% in Georgia (WB, 2017). Overall, depending on the country, 30% to 40% of the working population in South Caucasus earns their livelihood in the agricultural sector.

Box 1. Dams in Central Asia

In the Central Asia region, the Soviet Union had built a number of large dams, particularly in Tajikistan and Kyrgyzstan, to store irrigation water and produce electricity. The irrigation system was also vastly expanded across the region to scale up cotton and food production. In the long term, this expansion has taxed water sources heavily and led to problems in water and soil quality, as well as new swamps emerging as the water table changes.

Large-scale water infrastructure was also expected to civilise a region considered backward. The political prestige of such projects frequently seemed to determine how potential benefits were assessed, and led to underplaying financial, social and environmental risks: these tendencies are also evident today. In the Perestroika era, the catastrophic shrinking of the Aral Sea caused by diverting river water to fields was one of the environmental issues that caused public outrage and a loss of faith in Soviet governance.

Countries from the Central Asia and South Caucasus regions are still transitioning from historical water resources management models to their own. Many challenges arose from the post-Soviet transition, as the old economic and political ties established by the USSR ceased to exist, and with them, the centralised Soviet resource distribution system that managed the exchange and allocation of water, energy and food supplies among the republics. The consequences included a progressive degradation of essential infrastructure (e.g. water, sanitation, energy, central heating and solid waste), the weakening of institutions in charge of managing and regulating natural resources, and the accumulation of gaps in the educational and professional systems. Also, despite multiple ongoing initiatives to reform the water sector, Integrated Water Resources Management policies are not consistently implemented through the region, mostly due to technical and institutional capacities and lack of investments.

The whole new set of international relations is influencing an original culture of regional cooperation in the water sector. In Central Asia, the policy instruments put in place (e.g. the Almaty Agreement of 1992 for cooperation, joint management, utilisation and protection of interstate water resources for the Aral Sea basin) did not provide the necessary tools to modernise the sector, prolonging the Soviet legacy in terms of water allocations originally designed to sustain the irrigation flow regime. In a study by Adelphi and CAREC and supported by SDC, the cost for inaction has been estimated at US $4.5 billion per year. In Central Asia, the recent evolutions in political relations have positively influenced cooperation in the water sector. In particular, the political shift in Uzbekistan undertaken under the new presidency (2017) is creating a more favourable environment for discussions, at least on a bilateral basis with neighbour countries on trade (i.e. energy, goods, etc.), environment, security cooperation, etc. Although fragile, this development is seen as a window of opportunity to pursue the modernisation of the water and environment sector overall. This context is amplified by the geo-economic changes driven by China's Belt and Road initiative; "In Central Asia, the Belt could potentially stimulate greater cooperative efforts and political will among the states to effectively address underlying regional hazards in the interest of mutual economic benefit" (SIPRI note, Richard Ghiasy and Jiayi Zhou, 2016). Other major projects, i.e. the Turkmenistan–Afghanistan–Pakistan–India Pipeline and the Central Asia–South Asia Transmission line (CASA 1000), provide further evidence of the increasing east–south connectivity as well as additional efforts to develop cooperation in the water–energy nexus.

Box 2. Influence of international relations on transboundary water resources management in South Caucasus

The Kura Araks River basin covers most of Armenia, Azerbaijan and Georgia, as well as adjacent areas of Turkey and Iran. Given the stalemate situation regarding Nagorno-Karabakh between Armenia, on the one hand, and Azerbaijan and Turkey, on the other, the joint transboundary management of this river basin, including the monitoring of its contamination and the mutual flushing of dams is a major challenge. No joint agreement exists, and Georgia is the only country that has open communication lines with all other riparian states. Azerbaijan as the country furthest downstream prioritises its interests in pipeline transit (Baku-Tbilisi-Ceyhan oil and Baku-Tbilisi-Erzurum gas pipelines) and acquiesces to pollution caused in Georgia.

In South Caucasus, the absence of a framework has caused existing gaps to remain unresolved issues, amplified in the framework of the tense political context (cf. Box 2), but cooperation at the technical level with the participation of experts from all the countries has resulted in positive achievements such as the NATO–OSCE South Caucasus River Monitoring Project.

The Caspian Sea emerges as a strategic area; pipeline projects crossing the Caspian Sea (linking Turkmenistan to Azerbaijan) have now become more likely to be implemented in the nearer future. The five Caspian littoral states – Russia, Kazakhstan, Turkmenistan, Iran and Azerbaijan – signed an agreement on 10 August 2018 in Aktau, Kazakhstan, after decades of dispute. The division of the seabed still requires further agreements. Environmental protection clauses, in theory further strengthening the 2003 Tehran Convention, might only serve as a fig leaf for the littoral states' main approach of seeing the Caspian as a reservoir of exploitable hydrocarbon resources rather than a unique water ecosystem vital for fishing and desalinised water supply on a small scale.

3. Institutional arrangements

3.1 Institutional Framework in Central Asia

Regional level:

The legal and institutional framework for water resources management was established in the early days of independence. It consists of a robust set of agreements of various kinds (i.e. from binding to declarative) as well as regional institutions that demonstrated at that time the willingness of the countries to maintain the pre-established interstate relationships under the Soviet Union framework (Figure 1).

The International Fund for Saving the Aral Sea (IFAS), which coordinates regional actions in the water and environment sectors, is considered the main umbrella institution. Established at the highest level by the five Central Asia heads of state, the platform comprises several technical and working entities. Particularly relevant for the water sector, the *Interstate Commission for Water Coordination (ICWC)* is responsible for developing, approving and implementing annual water consumption limits for each riparian

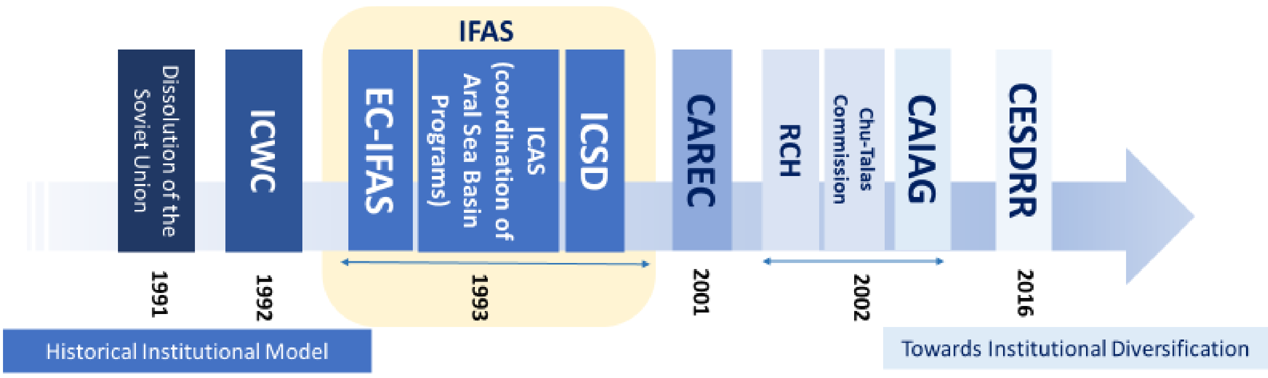

Figure 1: Chronology of Central Asia Water Related Institutions[2]

2. ICWC – Interstate Commission for Water Coordination; ICSD – Interstate Commission for Sustainable Development; CAREC – Central Asia Regional Ecological Center; RCH – Regional Center of Hydrology; CAIAG – Central Asia Institute for Geosciences; CESDRR – Center for Emergency Situations and Disaster Risk Management

republic on the Syr Darya and Amu Darya rivers. The Executive Committee of IFAS (EC-IFAS) is also serving as a regional platform for dialogue and coordination on water and environmental issues among the countries of the Aral Sea basin, and oversees the implementation of the Aral Sea Basin Program (ASBP). The chairmanship and location of IFAS rotates every three years among the country's five presidents. The chairmanship is currently in Turkmenistan.

After more than two decades since IFAS was established, multiple institutional and legal discrepancies in the IFAS constituency, as well as the lack of political willingness to properly invest and use the structure for the common good of the region, have weakened the original mandate of the organisation. The IFAS system has been unable to address critical issues of cooperation or to foresee the modernisation of the water sector, including promoting IWRM principles and the river basin approach. Several attempts to make this system more comprehensive, transparent, and efficient have failed (Discussion paper, UNECE, GIZ, EC-IFAS, 2010). In 2017, Kyrgyzstan withdrew from IFAS and is now actively pushing for a reform of the system at the highest level. This question remains on the work programme of the EC-IFAS chairmanship. The resolution will determine the current convening power of IFAS and its ability to facilitate dialogue of the highest importance in the region.

Regarding disaster risk management, the complex Central Asian geography creates a need for enhanced coordination among the countries. Formally established in 2016, the Centre for Emergency Situations and Disaster Risk Reduction (CESDRR) for Central Asia and South Caucasus is one of the most recent regional institutions that facilitate dialogue and strategic planning for disaster risk management. Among other issues, the Centre aims at consolidating efforts and mobilising support resources for preparedness and effective response to emergencies. It also helps Governments with policy guidance as well as planning and implementation of the Sendai Framework for DRR. Kazakhstan and Kyrgyzstan have signed the agreement for the establishment of the Centre, and provide funding to cover operating costs. Afghanistan has been granted the status of observer. Tajikistan is planning to join the organisation but lacks financial resources. Other countries from Central Asia and Caucasus participate in the activities of the Centre but discussions are still ongoing regarding their effective engagement.

National level:

On water resources management, the Central Asian countries are conscious of the necessity to modernise the existing foundations for natural resources management to adjust to upcoming challenges, including those related to climate change. For instance, Integrated Water Resources Management (IWRM) is perceived as a primary instrument for modernisation. Indeed, each country has undertaken several initiatives to reform the water sector in this regard and to integrate key IWRM principles. **In Kazakhstan**, agriculture is a key driver for the national economy and growth. Impacted by the economic crisis in Russia, the drop of oil prices and the overall decrease of fossil resources, Kazakhstan is urged to diversify its economy. In the context of Kazakhstan, investing in agriculture also means increasing water productivity and enabling a more efficient use of water resources (e.g. use of high-value crops, introduction of water-saving technologies, rehabilitation of key infrastructure). A new water resources management strategy up to 2020 and an agriculture programme for 2017–2021 have been adopted. **Kyrgyzstan** seeks to develop its hydropower potential by optimising the cascade in the upper Naryn River, and has undertaken a series of reforms on tariffs, transmission, distribution and winter heating. It is a stakeholder of the CASA 1000 project. At the same time, water supply and sanitation are becoming high priorities. Finally, the Government is still undertaking efforts and investments to achieve the full implementation of the Water Code, in particular through the Project *National Water Resources Management (World Bank and SDC)*. **In Tajikistan**, the water-energy nexus is at the heart of the national agenda. Highly dependent on energy resources as part of the regional distribution grid put in place during the Soviet era, and with connectivity to the Central Asia Power System cut in 2009, Tajikistan invests in energy security. Also, a structural reform was started in 2006 with the implementation of a strategy for the establishment of a stable institutional system, supporting new approaches to the resolution of management issues affecting the socio-economic development of the country. A revision of the water code is pending, consolidating the river basin approach in the country. Water quality and sanitation are growing priorities in the context of climate change. **In Turkmenistan**, a new Water Code was introduced in 2016, allowing water usage by different organisations, including the private sector. The efficient management of the Karakum canal – one of the longest canals in the world – is on the priority list of the Government (estimated 80% of water loss). At the same time, Turkmenistan invests in desalinisation due to lack of good quality freshwater supply in some areas. Given the extreme arid conditions for agriculture, Turkmenistan is interested in high-value crop investments. **In Uzbekistan**, the state is also undertaking a vast multi-sectoral reform programme that concerns the water sector as well as the agriculture and the energy sectors. There is no full clarity about the definitive arrangements, although several transformations are expected at the local level.

Implementing reforms, national strategies or complying with international standards, however, remain challenging in each country. Indeed, heterogeneous levels of capacities at the sub-national level, insufficient and non-continuous budget mobilisation, and low communication quality do not create an enabling environment for effective and sustainable implementation of the reform.

The governments also often use reform processes to strengthen and sometime overuse top-down approaches in the provinces, and therefore strengthen their power base. The central authorities are not properly informed about the reality of needs on the ground, and local authorities are uninformed about the long-term vision. Despite the success of a few pilot projects at the local level, achieving these reforms at the national level would require, among other things, robust strategies, implementation plans and long-term support programmes.

Regarding disaster risk reduction: The Ministries of Emergency Situations are the main institutions in charge of disaster risk management except for Turkmenistan, where the Ministry of Defence is responsible. The National Hydrometeorological Services (NHMS) are key institutions in charge of hydrological and meteorological monitoring and forecasting. The mountainous conditions in the Central Asia region present significant forecasting challenges and the NHMS across the region are not currently able to provide adequate weather, water and climate services. Under-financing has resulted in obsolete or broken equipment, poor telecommunications, incomplete training and other issues. Access to timely and reliable information on climate and water in all the Central Asia countries makes anticipating extreme weather or planning water resources use challenging.

The institutional frameworks for water, DRR and climate are fragmented; the existing institutions are generally disconnected, and cross-sectoral exchanges are limited. Huge efforts of coordination have to be undertaken to reach a harmonised standard for natural resources management. One of the major areas of improvement lies in the establishment of sound and reliable information systems with effective standards of coordination across sectors and stakeholders.

Local Level:

Among those dealing with water-related challenges at the local level – including the provision of drinking water, irrigation management, land use management, and DRR – are local administrations, organisations such as Water Users/Consumers Associations (WUAs/WCAs), private entrepreneurs, and self-organised community bodies.

In areas such as the Ferghana Valley, the fragmentation of local networks and inter-ethnic family ties through border closures and states fostering distrust between ethnic groups have widely damaged collective water-management practices (which were always subject to negotiation, and sometimes force). There is little possibility, and these days little immediate interest, for example, in interactions between Kyrgyz and Uzbek farming communities using the same canal. Frequently, neither side even has up-to-date information on current water infrastructure (closing, opening canals, expanding fields, deterioration of infrastructure) on the other side of the border, let alone an agreement on water consumption. Where innovations that are considered unfair – e.g. drawing more water – are obvious, these frequently become part of broader tensions around territorial claims, particularly in the poorest areas. To date, despite rhetoric to the contrary, the process of disengagement and zero-sum thinking at national levels on these issues persists. Access to dinking water is also an issue: overall, households in urban centres have piped water, though the quality is often questionable and treatment plants are non-existent or performance highly reduced. In many city outskirts and the countryside, less than half of households are connected, and in some areas of the Ferghana Valley and elsewhere people buy their drinking water and have it delivered by truck (if they can afford this).

Box 3. Governance features and interaction with Local Users in Water Resources Management: the Syr Darya Delta (A. Samakov 2018)

The local district in Kazaly is a branch of the Kanzsushar National State Company, responsible for maintaining irrigation infrastructure and providing water to farmers. In this small district of about 76,000 inhabitants, livelihoods depend on the water supply from the Syr Darya River for activities such as herding, gardening, and reed harvesting. The main crop produced is rice. Challenges pertaining to water uses in Kazaly mainly relate to the very low pricing of water. Water users are supposed to pay monthly for their water allocation, but in practice, water fees are collected at the end of the harvest, when farmers have ready cash. Water users pay about 0.2 KZT (0.0005 EUR) for a cubic metre of water. Subsidies specified in regulations that were revoked in 2016 are still implemented at the local level, a reflection of the poor communications between levels of government. Water managers understand that local users wouldn't be able to pay for all the water they are currently using even though the water fee is low and additionally subsidised. If farmers had to pay for every litre of water used, agriculture would no longer be viable in Kazaly.

Box 4. Water Consumers Associations in the Bukhara Region, Uzbekistan

(Hamidov et al. 2015)

Uzbekistan's irrigation management was reformed top-down in the 2000s without the engagement of local resource users. Due to the absence of a proper legal framework, some WCAs were and still are lacking financial, technical, legal, and/or administrative support. The Bukhara region presents very challenging characteristics, suffering from frequent water shortages and severely salinized soil and groundwater, among other issues. Against this challenging background for the organisation of collective action for canal maintenance and water distribution, several WCAs in the region have demonstrated their effectiveness. Three conditions appeared to be important: (i) appropriate chairmanship skills including good water management knowledge, long-term experience, etc., (ii) a combination of the above-mentioned skills with effective participatory governance, and (iii) good cooperation of the water users with state actors in Uzbekistan.

For two decades, everyday life in rural Central Asia has been remarkably influenced by the introduction of **Water Users/Consumers Associations**. Responding to donors' demands to reduce government spending and decentralise resource management, governments started in 1996 to transfer the management of on-farm irrigation systems to WUAs/WCAs in a process supported by several development organisations such as the World Bank, the Asian Development Bank and USAID. WUAs/WCAs serve the purpose of regulating water management at the farmstead level through intense participation of the users in decision-making processes (IBRD 1993; Salman 1997; Wegerich 2000; Sehring 2007; Roudik & Vodyanyk 2013; Shenav & Domullodzhanov 2017).

To date, the application of local management entities such as WUAs/WCAs as a one-size-fits-all model has produced highly variable results. WUAs/WCAs are frequently simply viewed as the pretext for a new 'tax', with little confidence that the collected money will result in better maintenance of irrigation infrastructure. In the case of Uzbekistan, this kind of governance has been relatively effective in controlling and thus capping agricultural water consumption. In terms of the democratic aspirations of WUAs, there is little positive effect visible. For example, the many female-headed farming households (often husbands and fathers are away as migrant workers) are often not adequately represented on these bodies, and thus disadvantaged in their water allocation rights.[3] In countries such as Kyrgyzstan, the introduction of WUAs/WCAs is often unpopular with farmers who prefer locally established informal (though not necessarily more equitable) modes of agreeing on water distribution.

Throughout the region, the key role of the village water manager persists, with or without WUAs/WCAs. Though not necessarily formally elected, these figures are collectively chosen and are broadly, if not completely, trusted. Village level agreements to engage in collective repair or maintenance of canals were historically common and persist to this day in many places. These systems of self-governance are, however, rivalled by an expectation that higher levels of government should provide infrastructure and water services.

Zinzani (2015a, 2015b and 2016) and Hamidov et al. (2015) provide examples of top-down WUAs/WCAs, their modes of operation, and different outcomes for Kazakhstan and Uzbekistan, as do Sehring (2009) and Isabekova (2013) for Kyrgyzstan and Tajikistan. Despite the widespread perception of tense transboundary water relations at the regional and national levels in Central Asia, some promising cases of local cooperation on water management and water sharing across national boundaries are in place and are finely adjusted to the local socio-environmental conditions (Stucker et al. 2012).

3.2 Institutional Framework for South Caucasus

The Caucasus institutional arrangements for DRR and the water sector – including policies and legislation for water resources use in agriculture and potable water supply and sewerage – reflect the Soviet period.

Regional Level:

Regarding water resources management, the complex geopolitical situation following the dissolution of the Soviet Union prevented productive interstate cooperation, especially on transboundary water resources management.

3. "In Kazakhstan, women's employment in agriculture has doubled between 1998 and 2003. In Tajikistan, it is now estimated that women are at the head of around 20 percent of the small private farms that replaced the huge collective farms of the Soviet era. In Uzbekistan, women outnumbered men in agricultural employment by 2008, with one-third of all working women employed in the sector": https://thediplomat.com/2018/06/the-impact-of-migration-on-water-scarcity-in-central-asia/

The Kura-Aras River basin is the main source of water for Armenia, Azerbaijan and eastern Georgia and is a critical area for interstate cooperation. Several ongoing initiatives seek to maintain water quality and quantity in the basin, meeting the required standards at the community and ecosystem levels.

Given the lack of a joint regional agreement, several bilateral agreements regulate transboundary water management and environment protection between the South Caucasus countries; among these are the Agreement on Environmental Cooperation between the Government of Georgia and the Government of the Republic of Armenia (1997), and the Agreement on Environmental Cooperation between the Government of Georgia and the Government of the Republic of Azerbaijan (1997). Water diplomacy continues between Georgia and Azerbaijan (EUWI-EECCA 2016), including through the assessment of political and economic benefits of transboundary cooperation. International organisations have launched several joint projects to stimulate cooperation and to compensate for the absence of a regional agreement. Regional experts from OSCE and NATO with the cooperation of NGOs, for example, launched the South Caucasus River Monitoring project, the first South Caucasus transboundary water project, in 2002.

There is currently no interstate organisation in charge of water and environmental issues. The Regional Environmental Centre for the Caucasus (REC Caucasus) is the only multilateral entity supporting the implementation of environmental projects in the region. As a non-profit organisation with stakeholders from Armenia, Azerbaijan and Georgia, REC Caucasus has a mission to promote cooperation among NGOs, governments, business, local communities, and other environmental stakeholders at the national and regional levels, to facilitate the free exchange of information in accordance with International standards (e.g. Aarhus Convention), and to introduce and support the implementation of global, European, regional and national environmental policies. Since 2000, REC Caucasus has provided a gateway for dialogue, networking and cooperation among all environmental stakeholders at various levels.

Regarding disaster risk reduction, ministerial meetings supported by UNDP and UNISDR promote regional cooperation among South Caucasus (and Central Asia) republics. These meetings aim at strengthening cooperation in early warnings and information management for large-scale and transboundary disasters, and at harmonising the legal base and bilateral and multilateral agreements. Examples of cooperation include the "Prevention, preparedness and response of human-made and natural disasters (Eastern region)" programme in the framework of EU European neighbourhood and cooperation (2011–2014) engaging Armenia, Georgia, Moldova, Belorussia, Ukraine and Azerbaijan, and the "Strengthening Bio-Safety and Bio-Security Capabilities in South Caucasus and in Central Asian Countries" programme, funded under the European Union's Instrument for Stability (2013-2015). Armenia, Georgia, Azerbaijan, Uzbekistan and Tajikistan are involved in the programme.

National level:

Primary legislation (i.e. water law, water code and related regulations) is in place in all the South Caucasus republics. The existing legal framework needs to be clarified with regard to implementation mechanisms for the provision of lower level administration entities with the necessary competencies, and to the overall allocation of resources. Water resources management capacities vary considerably among the three countries regarding the supply of potable water and sewerage and the monitoring of river contamination. The latter is a concern to all three countries of South Caucasus while water management and irrigation systems are high priorities for Azerbaijan and Armenia. Other important issues include the condition of the networks, which suffer high water losses and require continuous replacement and repairs, and illegal connections to the network.

In Armenia, extensive efforts to support the irrigation and agriculture sectors are ongoing. One of the major shifts for irrigated agriculture was the creation of WUAs (i.e. Law on Water Users Associations, 2002), which have been central in promoting shared public interest in the operation and maintenance of irrigation systems and in promoting community-driven development approaches. The development of robust information systems in support of sound decision making was made a priority. The Irrigation System Enhancement Project (World Bank) supports the development of supervisory control and data acquisition systems, as well as water measurement and water flow control models. A national financing strategy was developed in 2016 for rural Water Supply and Sanitation (WSS) to meet the targets of the Sustainable Development Goals with the objective of closing the financing gap for operation and maintenance (EUWI-EECCA 2016). Several pilots have also been developed on river basin management planning and payment for ecosystem services. **In Azerbaijan**, the national water strategy was drafted and submitted to the Government in 2016 (EUWI-EECCA 2016). The strategy aims at developing water resources management and water protection, as well as water supply and sanitation in Azerbaijan, to meet EU standards and objectives. Azerbaijan is also undertaking large investments to improve access to clean drinking water – a major challenge in the country. The Second National Water Supply and Sanitation Project supported by the World Bank has been underway since 2008, and additional policymaking efforts have been undertaken to monitor the performance in the WSS sector.

In Georgia, the Law on Water (1997) is the main legal basis for water management. A new law on water resources management, proposed in 2018, is based on the EU Water Framework Directive requirements, and includes several by-laws. This is a big step forward, although experts anticipate that the implementation of regulatory measures for water consumption by different stakeholders, which will be provided by the law, will lack strength (Kakha Bakhtadze).

Regarding the disaster risk management arrangements, the Caucasus region has high risk of exposure and vulnerability due to the frequency and intensity of natural hazards, and has insufficient capacities for risk management. The abundant natural and technological hazards and risks range from nuclear power plant management in Armenia to oil industry infrastructure in Azerbaijan. The institutional frameworks currently in place provide regulation of governmental participation and the engagement of a wider circle of stakeholders from public, business, academia, and NGOs. The most significant natural disasters include earthquakes (one of the strongest happened in 1988; Spitak earthquake in Armenia), but they are not climate-driven. Floods, droughts and forest wildfires are of minor significance and often of local impact.

Local level:

In Armenia, WUAs have yielded considerable results, bringing recovery to Armenia's irrigation system. The success was mainly brought about through the improved efficiency and reliability of irrigation networks. WUAs were less successful in Azerbaijan and even less so in Georgia, where irrigation was less efficiently used. Despite efforts by World Bank projects, for instance in the Marneuli area, Georgia's most important agricultural area that depends on irrigation, the WUA model did not work. In the first place, the Georgian irrigation system had suffered a more significant degradation compared to Azerbaijan and especially Armenia. Then, the centralisation and privatisation of large water maintenance companies favoured private hydroelectric dams to the detriment of small irrigation systems. Finally, because large farms provide more reliable revenues, the government also focused on large farms in an attempt to raise production levels (Welton et al. 2013).

Specifically related to DRR at the local level in Armenia, Oxfam in partnership with the oxYGen Foundation is implementing a programme, "Supporting Community Resilience in the South Caucasus", funded by the European Commission under DG European Civil Protection and Humanitarian Aid Operations Programme (DG ECHO). According to oxYGen (2019), "The project increases disaster resilience of local communities by supporting strategies that enable them to prepare for, mitigate and respond to disasters." Among the implementing activities are the establishment of an inclusive Green Lab, supporting the development of DRR and emergency situation plans in all educational institutions of the target province, awareness raising seminars on first aid, climate change adaptation, inclusiveness and gender in DRR, behavioural rules in emergency situations and other DRR topics, and implementation of small-scale mitigation projects. A wider collaboration network includes local NGOs, a volunteer rescue team, provincial municipalities, regional rescue services, etc.

4. Conclusion

The countries of Central Asia and South Caucasus seek greater water security to support the competing needs of energy, agriculture, human consumption and the environment. There is a general awareness of the growing demand for water, while supply of water is constrained and possibly diminishing through climate change impacts, pollution of water supplies, etc. Countries increasingly diversify agricultural crop patterns to shift resources to less water-intensive and more valuable crops and to diversify their economies; these shifts are accompanied by varying degrees of reforms in the water and energy sectors. In Central Asia and in South Caucasus, there is a clear willingness to modernise the water and environment sectors, but many problems remain. Weak institutional frameworks, low technical capacities and financial resources and overall implementation processes all remain challenging and require a long-term strategic approach in consideration of the climate change risks and vulnerabilities. Finally, as there is a growing understanding that national solutions alone might not be sufficient to address upcoming challenges, developing trends include investments in renewable energies and in disaster prevention infrastructure, and opening up new trade opportunities beyond territorial borders.

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Thematic Input Paper 3

Pathways to sustainable solutions for managing water and reducing disaster risks under climate change in Central Asia and Caucasus

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1. Introduction

Thematic Input Paper 2 reflects on two realities: on one hand, the willingness to modernise different sectors of the economy in the pressing context of climate change, and on the other, the incapacity to break with the historical Soviet governance model (e.g. rigid institutional structures, radical vertical management, low level of initiative, etc.) as well as post-Soviet patterns marked by authoritarian jurisdictions with little concern for equitability and collective resources. Adjusting the way we manage natural resources in a changing climate requires new sets of competencies, specialists across a range of disciplines, and increased levels of coordination among actors. Based on the background provided in paper 2, paper 3 examines potential pathways for sustainable solutions relevant for the Central Asia and Caucasus regions.

2. Pathways to Sustainable Solutions

2.1 Towards integrated levels of governance

Political actors and development practitioners often lack detailed knowledge about locally grounded, contextualised, well-functioning resource governance and management arrangements. Likewise, there is a poor understanding at the local level of long-term strategies and objectives endorsed at national and transnational levels. The pathway towards integrated levels of governance consists of promoting better vertical integration and balanced participation between the policymaking and decision making levels (i.e. central authorities) and executive or management levels (i.e. local entities).

Raising public awareness of water resources management: The good status of natural resources is the responsibility of all. The level of awareness about the importance of water is relatively low in the CIS countries. Water as a resource should not only be thought of in terms of a natural resource and its environmental aspects but as a common good. Raising public awareness in this direction would emphasise fair distribution, reasonable use, protection of water resources, and improved understanding of the ecological issues. This could be done through training or media campaigns using national or local NGOs. Engaging and stimulating discussions with different water users on the ground is equally important to further managing the competing uses of water resources (e.g. consumer needs, agriculture, fishing, industry, energy, etc.) and to assessing their respective needs and priorities. In Central Asia, agriculture accounts for about 89% of water withdrawals, with wheat, cotton and rice being the most water-intensive crops. Turkmenistan and Uzbekistan are by far the largest water consumers (FAO Aquastat). Irrigated agriculture is also a major source of pollution (fertilisers, pesticides, salinity leaching back into the water courses). Other sources of pollution include open mines (both operating and abandoned) and industries close to water sources, as well as household use e.g. towns pumping sewage straight back into major rivers. Because of the sensitivity of this issue, there are very few reliable accounts of types and sources of pollution. Promoting widespread awareness of actual water quality would be an excellent contribution, but such a programme would have to be implemented in a sensitive way, e.g. through citizen science programmes, in order not to create a further spiral of blame around water quantity and quality.

Promoting flexible governance models at the local level: Globally, a major paradigm shift is currently underway. Natural resources management is not the exclusive domain of the public sphere anymore. Participatory management,

Box 1. Raising awareness - Caucasus

In Caucasus, the main water users are irrigation followed by households and industry. In Armenia, the biggest polluter is the mining industry. Apart from irrigated agriculture, fish farms (around 250 fish farms with a total surface area of more than 3,500 hectares) are the biggest water consumers. Water uses and supply changed after the dissolution of the Soviet Union. The abrupt de-industrialisation has contributed to maintaining the illusion of low pollution levels in major rivers of the region. The role of chemicals and fertilisers, household waste water, and new industrial activities such as mining, however, have been largely absent from public discussions. There is a clear evidence of continuing river contamination (i.e. tailings, chemical dumps, direct discharge of waste water, etc.). Due to low levels of awareness, people engaged in agricultural activities use contaminated water on the land. This contaminated water can ultimately flow across cities and villages. Raising awareness among local communities, promoting social activism and citizen engagement have proven to be very effective tools. **NGOs such as Green Alternative in Georgia** combine campaign work with capacity building of local groups, facilitating direct engagement of local communities in environmental discussions. Current campaigns focus on hydropower development projects, which pose significant threats to the environment and local communities.

The Global Environment Facility Small Grants Programme in Armenia supports grassroots initiatives building links between Civil Society Organisations (CSOs) and the Government. The Air-Aid project by the Aires Development Foundation (2017–2018) uses the latest advanced technologies to increase the links between participating organisations, CSOs and government agencies. The project uses an open source platform directly linked to relevant units within the Ministry of Nature Protection. The project developed and integrated participatory approaches in environmental monitoring within the Ministry's relevant departments with a clear positive impact on public accountability of the state institution, and contributed to closer three-tier interactions (Government-CSO-Citizen).

stakeholder's involvement in decision making, and community level management models are becoming increasingly important (Pahl-Wostl et al. 2007). Indeed, there is no "silver bullet" measure to solve water-related challenges (e.g. water over-allocation, unreliable water supply, water quality deterioration, flood damage, ecosystem degradation, etc.). Asymmetrical power relations and diversity are basic features of human societies. Therefore, representatives of different social categories including elites and decision makers and representatives of marginalised social groups such as women, youth, and deprived persons must be consulted and included in decision making and implementation. In-depth and differentiated understanding of local and regional governance and management practices, power relations, livelihoods, as well as adaptation and coping strategies, is necessary before specific instruments will be developed. Finally, the development of instruments and measures that contribute to understanding the problems as well as contextualised and locally accepted solutions should be pursued in a participatory way. Examples below are illustrative of how this can work in practice.

In Tajikistan, an especially promising example is the Water User Association, Ob Umed (Water is hope), of Porshinev Municipality, which was awarded the UNDP Equator Prize in 2014 for its efforts to "meet climate and development challenges through the conservation and sustainable use of nature" (UNDP 2016). This WUA was initiated by local efforts and supported by the Mountain Societies Development Support Programme, an initiative of the Aga Khan Foundation. This local-specific water use and management arrangement is based on several key elements including the application of historical environmental knowledge, transparent and inclusive decision making processes, collaborative action, as well as low membership fees and widely accepted burden sharing (collective repair and maintenance work). At the transboundary level, Stucker et al. (2012) report on the case of cross-boundary cooperation of Kyrgyz and Tajik water users on the Khojabakirgansai, a small tributary of the Syr Darya in the Ferghana Valley shared with Kyrgyzstan. Livelihoods in this area are particularly vulnerable to water variability caused by hazards related to climate change (e.g. shifting precipitation regimes, changes in run-off regimes including flash floods,

Box 2. Benefits of local governance models

- Reduced risk of decontextualisation
- Customised solutions to the local context
- Real ownership for the solution achieved
- Effective vertical lobbying channel, influencing policy and decision makers
- Effective and transparent evaluation impact of the projects
- Improved infrastructure operation and maintenance

variability in the water volume, etc.). In the awareness of interdependence, the water users rely on a well-functioning, mutually agreed upon institutional framework, apply collaborative measures for water supply and infrastructure maintenance, and operate transboundary early warning systems to handle water-related hazards such as floods following heavy rainfalls.

In Armenia and in a different context, grass-root entities and NGOs could successfully challenge state institutions and operating companies (e.g. mining, water supply) and influence policy decisions. In the midst of the recent changes in the Government, public accountability has become central in the policy apparatus. As a result, a moratorium was imposed by the Government on all new mining explorations for six months until proper environmental checks and impact assessments are done. Prior to the recent changes in the Government, corruption and the intermingling of the state and business interests prevented the effective enforcement of environmental legislation, leading to negligence and multiple violations. The recent transformations in society have demonstrated that when political will is backed by the majority of the population, changes may happen in a relatively short period of time (e.g. enforcing fines, disrupting the business-as-usual approaches of the industry, engaging environmentalists and the CSO community to review existing regulations, banning plastic, etc.).

2.2 Stepping out of the national zone

Historically, Central Asia and Caucasus were integrated regions characterised by the mobility of people and the exchange of commodities and ideas. Closed state borders and national solutions are more recent phenomena that do not meet the complex challenges the regions are currently facing. Just as running water and climate change know no boundaries, the societies of both regions should recognise the potential of regional integration and increased cooperation, and focus on mutual solutions to shared challenges. Questions of interstate cooperation are highly political and motivated or influenced by the broader geo-political and economic context. Rebuilding a culture of cooperation could include the following:

- *Facilitating dialogue between the technical and political spheres at the national and regional levels.* What is obvious in terms of cooperation benefits for the stakeholders working in the water and environment sector is not always evident for political or financial decision makers. For instance, the increasing role of the ministries of foreign affairs in the water sector (in particular in Central Asia) has increased the politicisation of the water sector, creating more sensitivity on the topic.
- *Using already existing institutions.* The development of new institutions runs the risk of enlarging the existing institutional thicket, complicating coordinated actions as well as creating additional influence zones potentially leading to conflicts of interest. If necessary, the existing bodies should be restructured or reorganised to enable solution-oriented and multilateral negotiations of common visions for the region.
- *Identifying entry points for cooperation.* Entry points can evolve and differ by sector and level – e.g. DRR, information exchange, education, research, etc. Experience has shown that initiatives do not have to be significant to generate positive impacts and serve as catalysts for major changes. For instance, pilot projects provide an ideal format for experiencing and testing what is working or not. Also, focusing on small transboundary areas provides a more manageable framework sometimes less embedded in larger political stakes (e.g. experience on Isfara river basin, Chu-Talas, etc.).
- *Providing access to global experiences.* Challenges in the Central Asia and Caucasus regions are specific but not unique. Other regions in the world have their own challenges and might provide inspiring knowledge and experiences. Targeted audiences would include the general public and policymakers, and the communication means could include mass media, cinema, literature, or art projects such as documentaries on successful grassroots initiatives in other parts of the world.

2.3 Cross-cutting pathways

Climate commitments and ecosystem approaches: The Central Asia and Caucasus countries have signed the Paris Agreement and have announced their commitments through their nationally determined contributions to reduce greenhouse emissions and promote renewable energy investments. Decentralised action such as individual cities initiating climate actions, rather than whole nations, could be also envisaged. Large cities both in Switzerland and Central Asia are significant players, especially where broader accords fail: maybe these could be linked, also globally, in a network of mutual commitment. If integrated with economic benefits of some kind, this could be attractive to Central Asia cities, and foster new kinds of networks at the regional level.

Ecosystem based approaches complement integrated water resources management practices, bringing the flexibility required to address climate change challenges, including through the introduction of flexible financial mechanisms and investments. Providing a holistic umbrella, investments developed under this approach would provide different alternatives to larger infrastructure, by nature more sensitive in a transboundary context, taking into consideration the environmental requirements. Ecosystem

Box 3. Reducing water-related natural disasters through Integrated Watershed Management. Ecosystem based approach: the case of Aksu transboundary watershed. Case Study by Ilhom Gulomjanov, ACTED.

The Aksu watershed is a transboundary basin shared by Kyrgyzstan and Tajikistan. The local population is exposed to the constant threat of mudflows; soils are highly degraded due to human activities – deforestation, pasture degradation, inappropriate agricultural techniques – and natural erosion, and are easily washed away during extreme rainfalls, creating mudflows, destroying downstream infrastructures and shattering lives.

The project was implemented in the framework of the DIPECHO X programme, funded by ECHO and the National Water Resources Management Project implemented by a consortium of HELVETAS, GIZ and ACTED, and funded by SDC in Tajikistan since 2014. The project is anchored in the ongoing Tajik Water Reform launched in 2014, shifting water management from administrative boundaries towards hydrographical boundaries (i.e. river basins and watersheds).

ACTED adopted a dual approach, building the local disaster preparedness capacities and introducing DRR and mitigation methods. The innovative approach combines integrative and participatory planning activities with technical activities, each supporting the other. It is especially innovative in Tajikistan, where natural resources management is vertical and administrative, excluding ground level, day-to-day users.

The Aksu Watershed Dialogue serves as a coordination platform gathering key stakeholders in the watershed (about 30–35 farmers, breeders, representatives of the district, local forest administration and local water management administration). The platform conducted a participatory assessment of the state of the watershed. Experts issued recommendations segregating short-term measures (e.g. riverbank reinforcement, diversions, etc.) and long-term measures, (e.g. substitution of perennial grasses for grains on the slopes to stop erosion, and the planting of trees to enhance reforestation). Measures were then further organised into an action plan.

This approach demonstrated the following benefits:

- Capitalising on local knowledge, building on stakeholders' expertise, generating legitimacy and allowing the decisions to be made together
- Targeting concrete ways to use natural resources
- Ensuring the commitment of local stakeholders, responding to their direct and future needs through enhancing livelihoods and reducing risks

approaches and services are also increasingly used for DRR, locally developed for local communities as part of their livelihood strategies (NIDM, 2012).

Knowledge is a prerequisite for action: Access to reliable and timely information is essential for effective natural resources management and for apprehending upcoming climate change challenges. Developing solid information systems requires long-term investment programmes supporting institutional frameworks and infrastructure, and needs to be integrated into key strategies at the national and regional levels. Monitoring, recording and reporting of events over relatively long timescales and standardised data reporting are key measures in the context of variable climate and increased risks of disasters (TIP1). The benefits of investing in needed equipment and other resources, however, are not obvious to higher authorities – or the costs simply exceed the limited financial resources – thus, investments in monitoring networks and information systems are not always a priority (TIP1). When developed effectively, data management enables better planning, use and distribution of natural resources in the short and long terms, accounts for the effects of climate variability and enables planners to develop corresponding DRR strategies. Furthermore, effective data management can pave the way for innovative institutional coordination, increase transparency in the use of natural resources and facilitate the development of inclusive approaches at the local level:

- Large-scale data collection, processing and analysis capabilities add to the national and regional capacities in terms of modelling and forecasting, and contribute to informed, evidence-based decision-making.

- When solidly rooted at the national level, natural resources information management can become an important driver for transboundary cooperation. Kazakhstan and the Kyrgyz Republic are undertaking joint activities on the Chu-Talas River basin, in particular conducting automatic accounting of the main water intake facilities, developing a database for the annual distribution of water resources in the basin, and creating an information-analytical bulletin called "Operational Hydrological Data Basins Chu-Talas".

- Information management activities can foster inter-sectoral and inter-institutional cooperation, bridging the coordination gaps within the various institutions, including those responsible for environmental issues or for responding to disasters.

Box 4: Data management for Disaster Risk Reduction

"The International Charter Space and Major Disasters" supported by the UN Office for Outer Space Affairs and Sentinel Asia is a voluntary initiative led by the Asia-Pacific Regional Space Agency Forum. The initiative provides satellite data to those affected by natural or man-made disasters through registered organisations, for use in monitoring and response activities. The platforms aim at mobilising all relevant agencies, their know-how and their satellites through a single access point on a 24/7 basis at no cost to member countries. A greater engagement of the South Caucasus and Central Asia republics in these initiatives would significantly reinforce the capabilities of the countries in acquisition, processing and analysis of critical data for disaster risk reduction. Copernicus, the European Earth Observation Programme Management Service also includes tools for monitoring floods, droughts and wildfires and is currently a major stakeholder in the Caucasus region.

Stimulating research and innovations and reforming education: The dissolution of the Soviet Union had a terrible impact on the education systems in the Central Asia and Caucasus regions. The effects are still influencing the quality of education as well as all current scientific and research activities and the human resources capacities in the economy and administration. The link between the institutions in charge of natural resources management and the research and education entities needs to be re-established to properly prepare the future generation of specialists. Scientific cooperation and the education sector are also excellent drivers for interstate cooperation, as well as vectors for youth empowerment and innovation. In our ultra-connected and fast-developing world of technologies, both regions are striving to modernise this area. Related projects have demonstrated encouraging and fast results. In the Central Asia region, several institutions of higher education such as the Nazarbayev University, the American University of Central Asia, the Kazakh-German University, and the University of Central Asia have been active stakeholders in this sphere.

Box 5: Social Innovation Pathway in Armenia.

UNDP, through the Kolba Innovation Lab and Social Start-up Incubator has recently organised several successful social innovation camps and hackathons (e.g. Smart City, Open Data), harnessing the power of communities (i.e. creative thinkers, designers, programmers, architects) to tackle environmental, climate change, agriculture, urban development and DRR issues through intense idea and product/service prototype generation exercises (in a 24 hour format). The latest (July 2018) hackathon by the UNDP Wildfire Management Project in collaboration with the UNDP Impact Aim Venture Accelerator focused on development of innovative solutions for facing challenges in the forestry and agriculture sectors within the context of climate change. Governmental agencies, including the Ministries of Nature Protection and Emergency Situations have actively supported the events.

3. Opportunities

3.1 Opportunities in Central Asia

Food security is a priority for all the Central Asia countries: As such, agriculture is a key sector in the countries' economies. For instance, Kazakhstan and Uzbekistan have adopted irrigation and agriculture strategies that include modernisation focusing on efficient irrigation techniques (e.g. drip irrigation), and the use of high-value and less-water-intensive crops. Pilots in Uzbekistan, co-led by the Government and the International Water Management Institute are treating soil degradation through the use of liquorice plants. Pilots for groundwater recharge will be also implemented (i.e. Ferghana Valley – Phase II project – World Bank). There is a lot of space for implementing these strategies, including piloting various solutions and encouraging or subsidising farmers to plant alternative crops (e.g. drought-resistant), or loans for planting poplars (excellent building material). This modernisation is not expected to happen from one day to another and concepts and ideas for incentivising the community of users need to be proposed and tested.

Strengthening transboundary ties and regional integration: Despite multiple institutional challenges (i.e. IFAS), there is a long history for transboundary cooperation in the Central Asia region. Reforming the existing institutions is a high-level political process, which the development community can hardly influence, but realistic mechanisms through which all parties involved could contribute to the maintenance of existing upstream water infrastructure, so

Box 6: The "Social Life" of a River: Environmental histories and conflict resolution along the Naryn-Syr Darya

The water allocation of the Naryn and Syr Darya Rivers – the longest river in Central Asia and second-largest feeder of the now divided Aral Sea – has been a central source of conflict between the four upriver and downriver republics in the independence era. Part of unlocking the impasse over regional water management lies in a re-appreciation of the Syr Darya as an object of enquiry, interaction and management. Through collaborations with local NGOs and communities who live by and get their livelihood from the river, the project hosted by the University of Tübingen aims at co-constructing and sharing knowledge between riparian communities. Through research, 'dialogic workshops', and an exhibition that travels along the Syr Darya, upriver and downriver residents get to meet, learn about each other's livelihoods, and connect mutual needs. One of the challenges is also to provide policymakers with sustained insight into river-based livelihoods affected by their decisions.

that costs and responsibilities are equally shared, could be put forward. Also, although there is little clarity on the future opportunities as part of the Belt and Road Initiative, it could well be a growing factor in economic integration in the region.

Private sector expansion: The role of the private sector in water and natural resources management is still very limited. The public sector retains exclusive decision authority in this field, but individual entrepreneurs can certainly act as pioneers and try out technical and risky innovations. Examples can be seen in many rural regions of Central Asia, but these do not necessarily mean that individual successes or failures always initiate social development. A good example is a company called Pamir Energy, which provides electricity in Gorno-Badakhshan at affordable prices (https://www.akfusa.org/our-work/pamir-energy/). In any case, supporting the private sector in certain enterprises might be useful in stimulating public action, engaging stakeholders, providing qualitative service, and developing innovations.

3.2 Opportunities in the Caucasus region

As a result of complex geopolitics, there is not yet a regional programme in place. Building on positive achievements in institutional DRR, however, a strategic engagement in climate change adaptation and integrated risk management is being developed for the region.

Keeping an eye open for small and evolving opportunities of transboundary cooperation: Regarding potential opportunities, the Enguri HPP, jointly operated by Georgia and Abkhazia and managed by the Russian company Inter-RAO, is a good practical example of how transboundary water can have a positive impact in a tense context. The dam on Georgian-controlled territory and the power generator on the Abkhazian side set up the potential for a win-win situation. Azerbaijan and Armenia might consider such an arrangement in the Nagorno-Karabakh area where the stalemate is far tenser and offers little potential for cooperation at present. Instead, opportunities at the national and local levels may be pursued with prospects of integration at later stages. This may apply, for example, to DRR data management and sharing practices and to the synchronisation of standards and protocols, and may entail bringing together experts from the South Caucasus region at expert meetings in Eastern European and Eurasian contexts.

Climate change can foster technological innovations: Opportunities may also revolve around the adaptation challenges increasingly arising from the local effects of climate change. Specifically, in Armenia, mild winters and the lack of precipitation affect the country's agriculture with local reservoirs left without sufficient water for irrigation during the summer. The Government is trying to improve the situation by promoting the use of drip irrigation by subsidising interest rates of loans for the introduction of drip irrigation systems. The Ministry of Agriculture plans to install drip irrigation systems on 1,600–1,700ha of land annually between 2018 and 2022.

4. Final thoughts

The pathways described above embrace several groups of solutions:

- Technical solutions implemented at local, national and transboundary levels, capitalising on innovations and ongoing modernisation processes for natural resources management including irrigation, water quality, groundwater, data management and information coordination, and climate adaptation
- Citizen- and awareness-based solutions that increase the understanding, participation, ownership and engagement of the general public, users and communities in the development and implementation of environmental projects
- Central measures and governance approaches that emphasise constructive political will and public accountability for developing policies, and for building robust institutions and investments for sustainable water and other natural resources

Combining these three groups of solutions is critical to the successful implementation of relevant projects, but to align the solutions with the different contexts, the solutions could be implemented over different time frames.

In both regions, the development community is investing significantly. Water resources projects occupy a major share in development portfolios, compared to the newer and broader climate resilience and specific disaster risk management projects. By nature, cross-sectoral, these latest approaches have proven to have less political sensitivity and are more propitious for developing multi-scale actions (e.g. improving livelihoods, community development projects, etc.). Pilots are seen as a convenient format for experimenting and trying new solutions. The prospects for replication, however, should be carefully studied throughout the project. Finally, modernisation processes do not imply reinventing the wheel and introducing totally foreign techniques: for instance, rural sectors of the population will respond most positively to the valuation and redefinition of existing practices.

Coordinating the actions of different members of the development community is always an issue, due to: (a) lack of common development vision among the organisations; (b) lack of coordination of programmes and projects; and (c) frequent contradictions between programmes and project goals and the interests of power holders and social elites. Experience has also demonstrated, however, that coordination platforms at various levels (central authorities, operational level) with an active engagement of the governments and other stakeholders can be helpful. The National Policy Dialogue project, implemented by the UNECE and supported by the EU Water initiative in the Central Asia and Caucasus regions, provide excellent examples of successful coordination.

Although the geopolitical environments remain challenging in the Central Asia and Caucasus regions, adjusting to climate change may bring opportunities to introduce improved models for modernising the water and DRR sectors. The multidimensional nature of these sectors will ensure that the positive effects of these interventions are multiplied and passed along to other related sectors (i.e. agriculture, forestry, energy, etc.). The final outcomes would be highly rewarding in terms of building the resilience of local communities and creating better economic prospects for livelihoods. The expansion of new technologies and the possibility of connecting with experiences and practices all over the globe add positive perspectives. The national, regional, and global levels consist of an interconnected value chain that is important to consider in the climate change context; thanks to modern communication means and networks, activities at all levels can impact and influence people to take initiatives, be inspired and create new solutions. Water resources management and DRR also engage a diversity of sectors, actors, and disciplines at all levels, and engineers, economists, lawyers, politicians, entrepreneurs, youth and communities need to be engaged and empowered to make a difference.

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Annex: Background Information Paper

Sustainable water management and disaster risk reduction under climate change: Concepts, approaches and methods

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At the 1992 Earth Summit in Rio de Janeiro, more than 159 countries signed the United Nations Framework Convention on Climate Change to stabilise greenhouse gas concentrations in the atmosphere.

In 1995, countries launched negotiations to strengthen the global **response to climate change**, and in 1997 adopted the Kyoto Protocol, which legally binds developed country Parties to emission reduction targets.

The central aims of the Paris Agreement, adopted in 2015, are to keep a global temperature rise this century well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C.

Nowadays **water** scarcity and an excess of water affect more than 40 per cent of people around the world, an alarming figure that is projected to increase with the rise of global temperatures. Although 2.1 billion people have gained access to improved water sanitation since 1990, dwindling supplies of safe drinking water are a major problem impacting every continent. The Sustainable Development Goals (SDGs), as successors of the Millennium Development Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The 17 Goals came into effect in 2016 and include new areas such as climate change, innovation and sustainable consumption, among other priorities. SDG 6 seeks to ensure the availability and sustainable management of water and sanitation for all.

Excess water can be a consequence of meteorological events such as storms, and can trigger flooding and disasters. To reduce the natural disaster risks, the concept of **disaster risk reduction** (DRR) has evolved into a widely adapted framework in recent decades.

The UN International Decade for Natural Disaster Reduction (1990–1999), the Yokohama Strategy and Plan of Action for a Safer World (1994) and the Hyogo Framework for Action 2005–2015 (Building the Resilience of Nations and Communities to Disasters) have contributed to a comprehensive understanding of hazards, vulnerability and risks, and to the development of a forward-looking strategy for managing risk.

The main priorities of the Sendai Framework for Disaster Risk Reduction 2015–2030 as the successor of the Hyogo Framework for Action 2005-2015 are risk assessment; risk governance; resilience building and preparedness; and preventing new and reducing existing risks. It is a non-binding framework for international cooperation for nations and national and international institutions.

The following sections provide basic background information on the relevant concepts and approaches applied by the Swiss Agency for Development and Cooperation and project partners to address the challenges of climate change, sustainable water management and disaster risk reduction.

1. Climate Change Adaptation and Mitigation

The Intergovernmental Panel on Climate Change **Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation** (**SREX**; http://www.ipcc.ch/report/srex/) addresses how to reduce and manage the risks of extreme events and disasters in a changing climate.

A changing climate leads to changes in the frequency, intensity, spatial extent and duration of extreme weather and climate events, and can result in unprecedented extremes. Such events affect vulnerability to future extreme events by modifying resilience, coping capacity and adaptive capacity. The cumulative effects of disasters can substantially affect livelihood options and resources as well as the capacity of societies and communities to prepare for future disasters.

There is evidence that some extremes have changed as a result of anthropogenic influences, including increases in atmospheric concentrations of greenhouse gases.

Trends and projections in extreme events:

- Since 1950, extraordinary hot days and heavy precipitation have become more common
- Climate models project more frequent hot days throughout the 21st century
- Climate models project there will be more heavy rain events throughout the 21st century

Trends in disaster losses:

- Economic disaster losses from weather- and climate-related disasters have increased, but with large spatial and inter-annual variability, and higher losses in developed countries
- Fatalities are higher in developing countries (from 1970–2008, over 95% occurred in developing countries)
- Increasing exposure of people and assets has been the major cause of changes in disaster losses

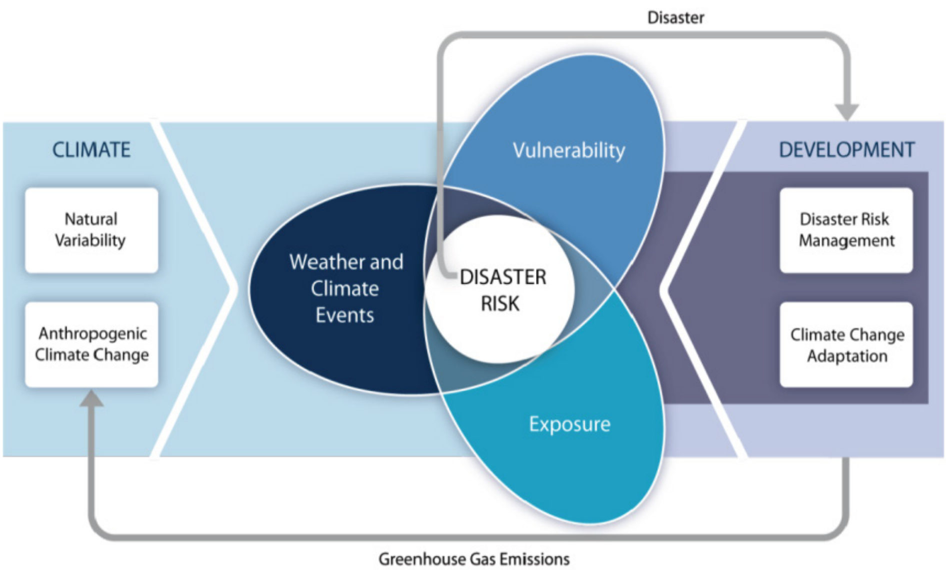

Figure 1: IPCC risk concept

- Increases in vulnerability, exposure, or severity and frequency of climate events increase disaster risk.
- Information on vulnerability, exposure, and changing climate can inform climate change adaptation and disaster risk management; an iterative process involving monitoring, research, evaluation, learning, and innovation can reduce disaster risk in the context of climate extremes; Figure 1 shows that disaster risk management and climate change adaptation can influence the degree to which extreme events translate into impacts and disasters. The importance of climate change, climate change scenarios and adaptation is also reflected in the Hyogo Framework for Action 2005–2015 and its successor, the Sendai Framework for Disaster Risk Reduction 2015–2030.

Adaptation and mitigation are fundamental responses to climate change. The idea that less mitigation means greater climatic change, and consequently requires more adaptation, is the basis for the urgency surrounding reductions in greenhouse gases. Climate mitigation and adaptation should not be seen as alternatives to each other, as they are not discrete activities but rather a combined set of actions in an overall strategy to reduce the worst impacts of climate change.

CC Adaptation:

Adaptation methods are those based on strategies that enable individuals or communities to cope with or adjust to the impacts of the climate locally. They include efficient environmental resource management practices such as the planting of early maturing crops, adoption of hardy varieties of crops and selective keeping of livestock in areas where rainfall has declined. They also include the use of technological products that enable the individual to function in the new conditions. Beyond a certain threshold, however, the possibilities for adaptation are also limited.

CC Mitigation:

Mitigation strategies are procedures or activities that help prevent or minimise the process of climate change. Mitigation strategies can be grouped into two categories: some represent mainly technological solutions; others involve changes in economic structure, societal organisation, or individual behaviour.

The International Panel on Climate Change (IPCC) defines mitigation as: "An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases." Strategies aimed at reducing GHG emission emphasise cutbacks in the burning of fossil fuel through improved energy-efficiency, use of clean energy sources, particularly solar, and discontinuation of gas flaring. Carbon sink enhancement generally involves forestry programmes that protect the forest and encourage afforestation in marginal areas including rangelands *[The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel; A. Nyong et al. 2007]*.

New innovations and technological progress have led to a paradigm shift regarding the economics of clean energy generation. Today, much lower costs and the move away from centralised to decentralised energy systems provide a unique opportunity to decarbonise economic growth, increase resilience, and exploit the co-benefits of climate-smart development. Together, these innovations and improvements contribute to the achievement of the Sustainable Development Goals of the 2030 Agenda for Sustainable Development. SDC's Global Programme Climate Change and Environment is well positioned to provide policy solutions and innovation to deliver on this transformational process *[SDC Global Programme on Climate Change]*.

Climate change is likely to further increase the exposure to risks related to the magnitude, frequency and spatial distribution of disasters (IPCC, 2014; SREX, 2015). It influences slow onset disasters such as environmental degradation and droughts as well as more rapid onset disasters such as debris flows and floods. Climate change will not only influence the availability of water but also other natural resources. As a consequence, SDC has developed the Climate, Environment and Disaster Risk Reduction Integration Guidance (CEDRIG) to systematically integrate climate, environment and disaster risk reduction into development cooperation and humanitarian aid in order to enhance the overall resilience of systems and communities.

2. Natural Resource Management (NRM)

A natural resource is an asset that we can obtain from our environment: water, soil, plants, wind, animals, minerals, the energy of the sun and many others. Natural resources are often seen in terms of economic value because so many of them are crucial in people's livelihoods. Natural resources typically share a number of key features, which often include exhaustibility, uneven distribution across countries, dominance within national economies and price volatility. A distinction is often made between renewable and non-renewable natural resources:

- A renewable natural resource can regrow, or its supplies can be replenished through natural processes. Some examples of renewable resource include plants, animals, or water. If the renewable resources in a particular area are overexploited for a long period of time, it is possible that they may become endangered or even disappear altogether.
- A non-renewable natural resource will not replenish itself. Examples include oil, coal, or minerals. The use of these resources should be carefully monitored and managed according to their availability.

The challenge of managing limited resources in a context of growing demand generates tension when human behaviours confront natural limits. Hence natural resources management is a field in which many disciplines meet.

Natural resource management involves efforts by different institutions to formulate and implement laws, policies and legislation to ensure viable use of natural resources. Natural resources are not only important as a source of food and other domestic products but also form the basis for social and cultural functions.

The implementation of a natural resource management plan typically involves the following steps *[USAID/CRS/MEAS. 2015. Managing natural resources: a smart skills manual]*: **a)** understanding the community context; getting familiar with the livelihood, socio-economic and policy context; **b)** identifying and engaging stakeholders; **c)** mapping natural resource challenges and opportunities – supporting stakeholders to identify and map their resources using participatory methods; **d)** developing a natural resources management plan to identify and implement interventions and achieve the desired objectives; **e)** managing natural resources projects – e.g. creation of demonstration plots, pilots or on-farm trials in order to identify the interventions that work best; and **f)** developing a monitoring and evaluation system to facilitate measuring the progress and assessing the impact of the activities.

A specific and often applied method of managing natural resources is Community Based Natural Resource Management (CBNRM), which can be defined as collective use and management of natural resources in rural areas by a group of people with a self-defined, distinct identity, using communally owned facilities. The focus of CBNRM is not merely wise management of natural resources. Equally important is the need for community development, local self-government and the creation of local institutions for managing common property resources *[Community-Based Natural Resource Management, C. Fabricius, Rhodes University, South Africa]*.

3. Integrated Water Resource Management (IWRM)

IWRM has emerged over the past decades as a globally recognised guiding concept for managing water resources. It is promoted by all major organisations dealing with water and is increasingly shaping national legislation and regional cooperation arrangements. In 2015, the United Nations explicitly adopted the global implementation of IWRM as Sustainable Development Goal 6.5.

The Global Water Partnership, a global champion of IWRM, defines it as "a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment."

The basis of IWRM is that the many different uses of finite water resources are interdependent. High irrigation demands and polluted drainage flows from agriculture mean less freshwater for drinking or industrial use; contaminated municipal and industrial wastewater pollutes rivers and threatens ecosystems; if water has to be left in a river to protect fisheries and ecosystems, less can be diverted to grow crops; etc.

IWRM is a cross-sectoral policy approach, designed to replace the traditional, fragmented sectoral water resources management approach that has led to poor services and unsustainable resource use. IWRM is based on the understanding that water resources are an integral component of the ecosystem, a natural resource, and a social and economic good. The Human Rights to Water and Sanitation are complementary concepts emphasising the government's responsibility to fulfilling the access to sufficient, safe and affordable water for all people.

Management of water resources in natural units (river basins and watersheds, groundwater bodies) rather than in administrative units, as well as cross-sectoral integration, coordination or cooperation are key approaches in IWRM addressing the natural interdependencies in water resources management. In practice, this may be done through dedicated institutions and tools (e.g. river basin organisations responsible for river basin planning), but may also be done through extensive cooperation between the relevant administrative levels (e.g. federal states like Switzerland rarely have dedicated institutions on river basin level but rather implement IRWM through adequate cooperation among the federal agencies). For large river basins covering several countries, IWRM principles call for transboundary cooperation.

IWRM also requires participation of all water users in the process of defining priorities and resource allocation; in practice, this participation is often implemented through coordination and participation mechanisms such as river basin councils or committees.

IWRM is not a blueprint approach: it requires an individual, tailored application for each national or local context. In Switzerland, for example, the application of IWRM is quite diverse, reflecting the complex institutional landscape of the federal system. The Swiss Federal Office for the Environment provides guidance for the implementation of IWRM under the heading, "watershed management".

The European Union's Water Framework Directive (WFD) is the world's most complete and ambitious legal framework on water resources management; it reflects most but not all elements of IWRM. As it is designed for the situation and needs of EU countries, it is not necessarily suitable as a blueprint for other regions, but the EU-WFD is frequently used as a guiding concept in water sector reforms in countries in the EU neighbourhood, including in Southern Caucasus. In Central Asia, several countries are also undertaking water sector reforms based on the IWRM principles (more details on this appear in Thematic Input Paper 2).

4. Disaster Risk Reduction: Natural hazards, vulnerability, disaster risks and resilience

Every day, populations face a wide variety of risks arising from geopolitical, economic and natural hazards, all of them being influenced by climate change. Disaster risk reduction (DRR) deals with the effects of natural hazards that often threaten human life, health, livelihoods and safety. Moreover, they can heavily impact the environment, put communities at further risk, displace populations and destroy development achievements. Reducing disaster risks is not just necessary in order to save lives and livelihoods, but also to contribute to poverty alleviation, to sustainable development and to building resilience *[SDC Guidelines on DRR; April 2018]*.

With the Hyogo Framework for Action 2005–2015 and with the Sendai Framework for Disaster Risk Reduction 2015–2030 as its successor, the focus shifted towards mainstreaming and building resilience. The concept of DRR used today was developed with particular emphasis on proactive measures (prevention, preparedness and resilience) aimed at preventing new and reducing existing risks as opposed to being reactive to disasters.

The United Nations International Strategy for Disaster Reduction (UNISDR) terminology promotes a common understanding and common usage of disaster risk reduction concepts and assists the disaster risk reduction efforts of authorities, practitioners and the public. The following terms are defined according to the UNISDR terminology *[https://www.unisdr.org/we/inform/terminology]*.

Hazard: A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.

Exposure: The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.

Vulnerability: The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

Capacity: The combination of all the strengths, attributes and resources available within an organisation, community or society to manage and reduce disaster risks and strengthen resilience.

Disaster Risk: The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time determined probabilistically as a function of hazard, exposure, vulnerability and capacity.

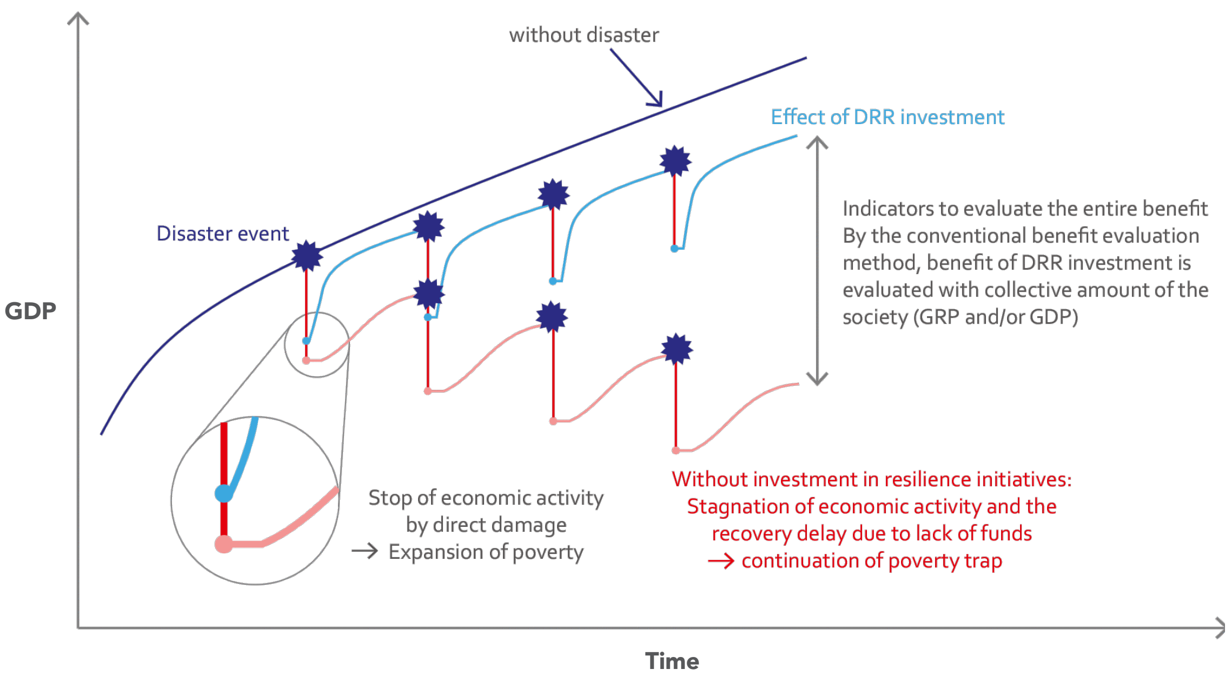

Figure 2: Resilience aims to ensure that shocks, stresses and hazardous events do not lead to a long-term downturn in development progress and economic growth. Investment in DRR for resilience is also priority No. 3 of the SFDRR 2015–2030.

Disaster Risk Reduction: Disaster risk reduction is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development. *Disaster risk reduction is the policy objective of disaster risk management, and its goals and objectives are defined in disaster risk reduction strategies and plans.*

Resilience: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.

5. Integrated Risk Management (IRM)

SDC strongly advocates for integrated (disaster) risk management (IRM). IRM refers to an overall risk assessment process and its components (risk identification, risk analysis and risk evaluation) as well as risk treatment (prevention, preparedness, response, recovery). Natural disasters are the manifestation of risks resulting from the combination of an exposure to hazard, the conditions of vulnerability and insufficient capacity or measures to reduce or cope with the potential negative consequences. Even if disasters cannot be completely avoided, their root causes can be addressed, and their impacts mitigated. The goal is sustainable development and human welfare that is not compromised by natural hazards.

Interventions to reduce risks should be based on the risk concept: all risks and the corresponding hazards – including the impact of climate change on the magnitude or frequency of hazards – vulnerabilities and coping capacities are assessed and evaluated ('know your risks'). An in-depth assessment of all prevailing risks and their complex interconnectedness provides the basis on which to decide which risks to address *[SDC Guidelines on DRR; April 2018]*.

The approach of **IRM** addresses the guiding question how to handle DRR in a systematic manner (see Figure 3):

Assess: What can happen? Identification and assessment of hazards, exposure, vulnerability and coping capacity (qualitative vs. quantitative assessments).

Evaluate: What is allowed to happen? What do we accept and where do we want to reduce the risks? How much safety at what price? (Drawing lines between 'acceptable', 'tolerable' and 'intolerable' risk is one of the most controversial tasks in the risk governance process.)

Manage: What has to be done? Plan for risk reduction measures: prevention, mitigation, preparedness; use cost-benefit analysis.

Measure: What is the effect of DRR? Establish a monitoring and evaluation system to demonstrate the effectiveness of DRR.

Figure 3: Integrated risk management

The Sendai Framework for Disaster Risk Reduction 2015–2030 (SFDRR) with the overall goal to "prevent new and reduce existing disaster risk… and thus strengthen resilience" defines four priorities for actions: **1)** understanding disaster risk, **2)** strengthening disaster risk governance to manage disaster risk, **3)** investing in disaster risk reduction for resilience, and **4)** enhancing disaster preparedness for effective responses and to "Build Back Better" in recovery, rehabilitation and reconstruction. The relevance of climate change regarding natural disaster risks is mentioned several times.

The SFDRR focuses on risk assessment, risk governance, resilience building and preparedness. The SFDRR is mainly a tool for nations, national and international institutions and for international cooperation. The SFDRR is a bit less developed for work at the local or project level; adapted risk management frameworks are also necessary to address the issue of evaluation (especially on the project level).

The risk staircase, as a risk management model, illustrates the set of possible measures to reduce and prevent risks. Based on a risk analysis, the total risk is consecutively reduced by prevention or mitigation and preparedness measures and transferred or shared. The residual risk of disaster has to be borne *[SDC Guidelines on DRR; April 2018]*. The risk staircase also reflects the four priorities for action of the SFDRR 2015–2030 (see red numbers in Figure 4 and the four SFDRR priorities above).

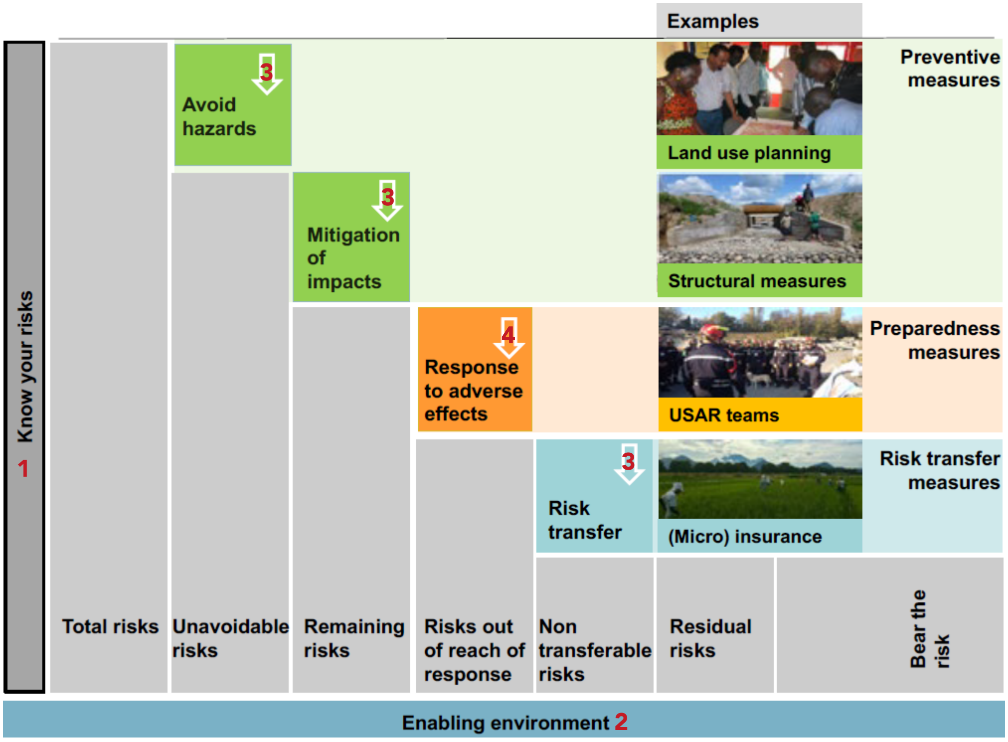

Figure 4: Risk Staircase

6. Integrated Watershed Management (IWSM)

Integrated Watershed Management (IWSM) can be viewed as part of a Disaster Risk Management approach. But it also provides a framework for integrating natural resource management with community livelihoods in a sustainable way. IWSM addresses the issues of degradation of natural resources, soil erosion, landslides, floods, frequent droughts and desertification, low agricultural productivity, poor water quantity and quality and poor access to land. The approach also considers the relevance of climate change and climate change adaptation.

As a consequence, it shares a common perspective with the NRM/IWRM approach. But with the aim to improve livelihoods (resilience building), the IWSM approach has an important additional scope.

IWSM includes improvement of governance, especially in land and water management, to improve livelihoods, to optimise productivity and sociocultural benefits, and to sustain the resource base and ecological functions or services. It is important to adapt technical solutions to the socio-economic and cultural conditions of the resource users. Impacts of upstream use on downstream use and the different interests of neighbouring land users in the upper and lower parts of a watershed must be taken into account. A balance of costs and benefits must be ensured.

The following table describes exemplarily the key topics of effectively integrated watershed management *[Wolfgramm B., IWSM policy brief No2. University of Bern, CDE, 2015]*.

Watershed management is the integrated use of land, vegetation and water in a geographically discrete catchment or drainage area for the benefit of its residents, with the objective of maintaining the hydrological services that the watershed provides and of reducing or avoiding negative downstream or groundwater impacts (adapted from World Bank 2008).

Co-management describes "partnership arrangements in which government, the community of local resource users, external agents (NGOs, academic and research institutions), and other resource stakeholders share the responsibility and authority for decision making over the management of a natural resource; it covers various partnership arrangements and degrees of power sharing and integration of local (informal, traditional, customary) and centralised government management systems" (Pomeroy in Meinzen-Dick, Knox, Di Gregorio, 2000)

Land governance concerns the rules, processes and structures through which decisions are made about access to land and its use, the manner in which the decisions are implemented and enforced, and the way that competing interests in land are managed. (FAO, UN-HABITAT 2009)

Tenure systems define and regulate how people, communities and others gain access to natural resources, whether through formal law or informal arrangements. The rules of tenure determine who can use which resources, for how long, and under what conditions. They may be based on written policies and laws, as well as on unwritten customs and practices. (FAO 2012)

Best practices (acquired e.g. in the IWSM-project in Muminabad, funded by SDC and implemented by Caritas) on how to achieve co-management of the natural resources and inclusive land governance at the watershed level, recommend the involvement of all stakeholders through establishment of steering committees (discussing matters of strategic importance regarding project steering and ownership), civil society committees (discussing matters of interest at the local level) or pasture user unions (planning and thereby improving the use of pasture land).

The establishment of such committees and unions allows evidence-based decision making, e.g. with the support of watershed action plans that describe the state of the watershed and define activities in thematic fields such as:

- Pasture management (to improve pasture land and organise users)
- Conservation agriculture (to improve soil fertility and increase the availability of fodder)
- Agroforestry (to improve tree coverage and provide livelihood opportunities)
- Energy efficiency (to reduce wood consumption and improve health conditions)
- Mitigation infrastructure (to improve protection)

7. Useful links

Natural Resource Management

http://www.ucentralasia.org/Resources/Item/1148
http://www.sanudurabilitas.ch/uploads/downloads/5/Understanding_Natural_Resource_Management_2015.pdf

Integrated Water Resource Management

http://www.un.org/waterforlifedecade/iwrm.shtml
http://www.unece.org/index.php?id=35306
https://www.gwp.org/
https://www.eda.admin.ch/deza/en/home/themes-sdc/water/water-food.html
https://www.shareweb.ch/site/Water/Documents/Water%202015_EN.pdf
https://www.bafu.admin.ch/bafu/de/home/themen/wasser/publikationen-studien/publikationen-wasser/einzugsgebiets-management-anleitung.htm
http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

Integrated Watershed Management

http://www.cde.unibe.ch/research/projects/watershed_management_and_disaster_risk_reduction/index_eng.html
https://www.caritas.ch/fileadmin/user_upload/Caritas_Schweiz/data/site/was-wir-tun/engagement-weltweit/country-programme/tadschikistan/2014_IWSM_Experiences.pdf
https://link.springer.com/content/pdf/10.1007%2Fs11676-016-0293-3.pdf
https://www.wocat.net/en/
http://www.icimod.org/?q=310

DRR and IRM

https://www.shareweb.ch/site/DRR
http://www.planat.ch/en/home/
http://www.babs.admin.ch/en/home.html
http://drm.cenn.org/index.php/en/
https://www.preventionweb.net
https://www.unisdr.org
www.gfdrr.org

Climate Change Mitigation and Adaptation

https://www.eda.admin.ch/deza/en/home/themes-sdc/climate-change.html
https://www.shareweb.ch/site/Climate-Change-and-Environment/Pages/%C2%B0.aspx
https://www.cedrig.org/
http://www.ipcc.ch/
https://unfccc.int/process
https://public.wmo.int/en
https://www.greenclimate.fund/home
https://www.munichre.com/topics-online/en/2017/topics-geo/resilience-overcoming-natural-disasters