CLIMATE VULNERABILITY, INFRASTRUCTURE, FINANCE AND GOVERNANCE IN CAREC REGION

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The Central Asia Regional Economic Cooperation (CAREC) Institute is an intergovernmental organization dedicated to promoting economic cooperation in Central Asia and along the Silk Road through knowledge generation and sharing. The Institute is headquartered in Urumqi, Xinjiang Uygur Autonomous Region, the People's Republic of China (PRC) since 2015.

The CAREC Institute is jointly shared, owned, and governed by eleven member countries: Afghanistan, Azerbaijan, the PRC, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. It is a knowledge support arm of the CAREC region.

The Institute acts as a knowledge connector among the five CAREC themes – economic and financial stability; trade, tourism, and economic corridors; infrastructure and economic connectivity; agriculture and water; human development – to ensure coherence in design and implementation of policies, programs, and projects to promote regional economic cooperation and integration.

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CONTENT

List of Abbreviations

A&M	*Adaptation and Mitigation*
ADB	*Asian Development Bank*
FAO	*Food and Agriculture Organization*
GDP	*Gross Domestic Product*
GHG	*Greenhouse gas*
IEA	*International Energy Agency*
INDC	*Intended Nationally Determined Contribution*
IPCC	*Intergovernmental Panel on Climate Change*
NC	*National Communication*
NDC	*Nationally Determined Contributions*
SDG	*Sustainable Development Goal*
UN	*United Nations*
UNESCO	*United Nations Educational, Scientific and Cultural Organization*
UNFCCC	*United Nations Framework Convention on Climate Change*
VNR	*Voluntary National Review*
WB	*World Bank*
WRI	*World Resources Institute*
WWAP	*World Water Assessment Programme*

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EXECUTIVE SUMMARY

In the coming decades, water, energy, and food demands are projected to increase across all countries of CAREC (Central Asia Regional Economic Cooperation) due to the rapid growth of populations and economies. Management of the access and use of natural resources in adequate quantity and quality are of strategic importance for sustainable development. Political economies, except China, are still heavily dependent on extracting natural resources instead using productivity and efficiency enhancements. Moreover, decades-old projections about climate change impacts will likely come true much sooner than anticipated.

This report is part of the scope of the CAREC Institute's project "Climate Insurance, Infrastructure and Governance in CAREC Region", which is implemented by the team of experts and aims to provide overview of the current realities of climate change in eleven countries through prism of water, energy, and food nexus, economic and financial aspects, and governance.

All countries of the CAREC region are signatories of global climate agreements such as the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21), known as the Paris Agreement, the Agenda 2030 on Sustainable Development and Sendai Framework for Disaster Risk Reduction for reducing risk and building resilience. Certainly, the countries of the region are at different stages of development and facing heterogeneous climate change impacts. In this context, all countries identify suitable adaptation and mitigation (A&M) strategies at national levels, yet with different levels of implementation progress. A&M measures encompass natural, engineering, social and institutional options. Most importantly, the central dilemma is what sectors are to be prioritized for financing at national levels. The next logical question is how national programs can contribute to the regional adaptation agenda.

According to the recent global reports and national communications on climate change, irrigation and agriculture are two interrelated sectors being the most vulnerable under the projected climate change impacts, especially related to temporal and spatial changes in precipitation patterns and intensities, air temperature regimes and so water availability. While a diverse mix of agricultural crops is grown in countries, three agricultural crops (wheat, rice and cotton) are of importance for food security and export revenues. For instance, lands under those three crops are allocated as 10% in Georgia and 81% in Turkmenistan. Hence, water footprint assessments of these selected strategic crops indicate that countries also allocate water needed for production from 0.3% in Georgia, and 32% in Pakistan to 46% in Uzbekistan of the total available renewable water resources. Therefore, some nations should strategically re-think their domestic water and land resources allocation for cropping structure and entire agricultural value chains.

Due to the predicted changes in drought frequency and intensity highlighted in drought index across the region, the most affected countries will be Kazakhstan, Azerbaijan, Georgia and Mongolia. Despite the expected increase in precipitation over the northern parts of Kazakhstan, the grain yields will be adversely affected by increases in evaporation rates and temperatures which will result in decrease of grain yields and wheat yields by 14-45% by 2050 in Kazakhstan and Mongolia respectively. This will likely impact food security to Central Asia, as Kazakhstan is a major supplier of wheat and flour products. Likewise, the yields of non-grain crops in Caucasus, are expected to decrease by 3–28% by the 2040s under the moderate climate change scenario.

Availability of water resources are preconditions in the production of energy and changes thereof will impact mitigation options. An examination of electricity use structure shows that that two sectors such as residential and industry & construction, on average consume approximately 37% and 36% of the total electricity consumption respectively across countries. Decision making should, therefore, be considered as priority focusing on designing energy efficiency programs and financial incentives as A&M measures for sector specific needs. Governments recognize that increased use of renewable energy will reduce the economy's carbon intensity, yet material evidence indicates now it constitutes a very small fraction in electricity generation across countries. Since 1990, all countries have substantially decreased their CO2 emissions, yet still show higher emission against a global average emission. The analysis indicates that the energy sector is the major emitter of greenhouse gases (GHG), following with agriculture and industry.

Not all intended and implemented adaptation strategies could be considered as sustainable options either at national or regional levels. Implementation of adaptation options should not be harmful for the environment of countries in the long run. Currently loans provided to the agricultural sector is relatively low compared to its importance in Gross Domestic Product (GDP) of CAREC countries. Agricultural insurance linked to loans may help to offset some of the risks and become an additional mechanism for improving access of farmers to credits and thus increasing their resilience to shocks.

Diagnostics show that intersectoral coordination mechanisms vis-à-vis the mentioned two global commitments of the countries is a pivotal driver of the climate change adaptation agenda. Intersectoral coordination and coherence of policies allow to avoid potential overlaps and minimize the risk that one sector progresses at the expense of another. Further analysis is needed for examining capability gaps of specialized governance structures focusing on effectiveness and coordination at national levels. Most importantly, international cooperative platforms are to be evaluated for regional contexts too.

The report clearly indicates that the availability of water resources, safe operation of water-related infrastructure and delivery of services with balanced agricultural cropping systems are prerequisites for resiliency of countries. The water sectors of four countries (Pakistan, Tajikistan, Turkmenistan and Uzbekistan) of the CAREC region show high levels of vulnerability, yet still practice inefficient water management especially in the agriculture sector.

The CAREC program is a partnership of 11 countries and development partners for collectively promoting sustainable economic growth and shared prosperity in the region. Economic and financial stability; trade, tourism, and economic corridors; infrastructure and economic connectivity; agriculture and water; human development are strategic themes under the CAREC program. CAREC 2030 is a strategic framework document for moving forward balanced national development strategies through regional cooperation projects. CAREC 2030 is closely linked with global development agendas such as the Paris Agreement and Agenda 2030. Climate change is integral part of the CAREC 2030, therefore, it needs to consider the implications of the two international development goals and the expectations from member countries in supporting to achieve these goals. Besides project investments, CAREC 2030 promotes policy dialogue among various stakeholders and delivers knowledge. The CAREC Institute (CI) promulgates knowledge solutions on various sectorial and cross-cutting aspects.

The report is divided into five chapters. Chapter one provides an overview of the changing climate and weather patterns in the region and analysis of the most climate vulnerable sectors, geographic areas. Chapter two examines three important sectors of water-agriculture-energy as part of resources and policy nexus approach, reflecting on water and energy efficiency, footprint and greenhouse emissions. Economics and financing of climate change adaptation is reviewed in chapter three, which describes existing financial instruments for A&M measures. Chapter four discusses governance, legal policies, national institutions and linkages between Nationally Determined

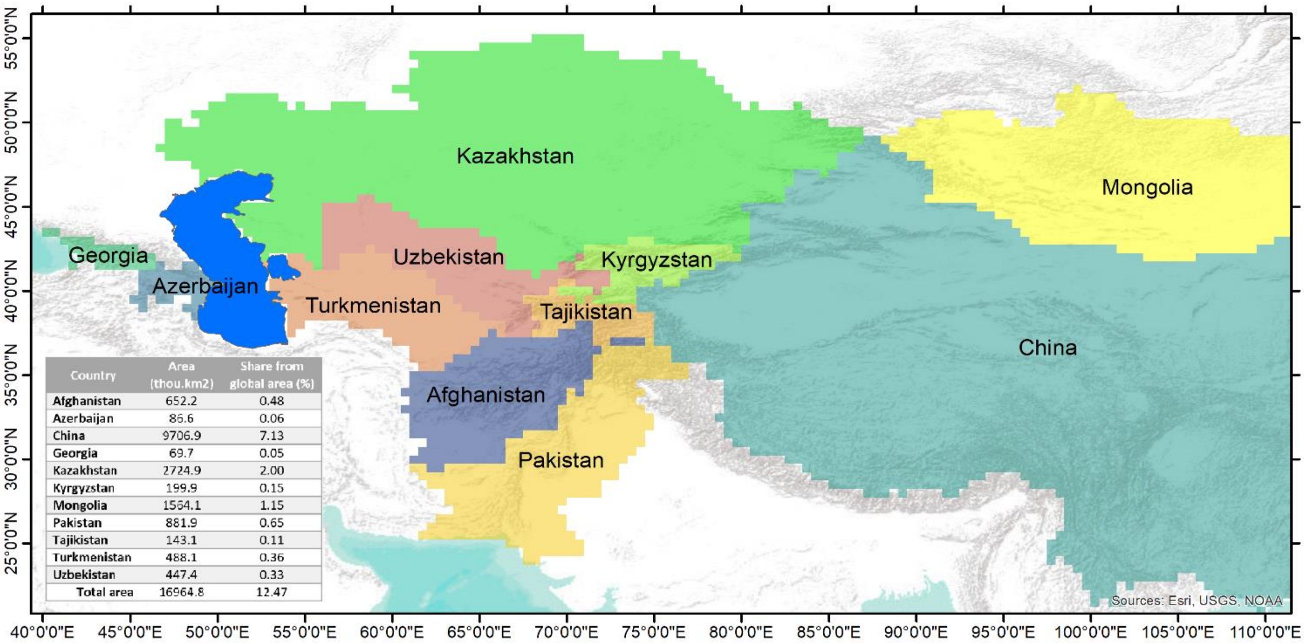
Contributions (NDC)s and Sustainable Development Goals (SDG)s for climate change A&M efforts. Lastly, chapter five provides results of water sector vulnerability indexes of each country estimated by methodological approach which was developed in the scope of this project.

INTRODUCTION

It is reported that CAREC countries collectively emit on average one third of the total global greenhouse gas emissions (Figure 1). About 775 million people (45%) of the total population resides in rural areas in CAREC countries and their livelihoods directly or indirectly depend on agriculture related businesses (ADB 2017a). On average, agriculture contributes to 14% of the gross domestic product (GDP) and employs over 34% of the labor force (CAREC Institute 2019). Due to climatic conditions, irrigated agriculture is practiced for agricultural production in all countries of the region. On the other hand, irrigation produces crop yields that are 2-4 times greater than is possible with rainfed farming (FAO 2019). Indeed, globally irrigated agriculture currently provides 40% of the world's food from approximately 20% of all agricultural land (WRI 2019).

It is projected that by 2040 Afghanistan, Azerbaijan, Kazakhstan, Kyrgyzstan, Pakistan, Turkmenistan and Uzbekistan will be experiencing "extremely high" levels of water stress among other top 33 countries across the globe (WRI 2019). Irrigation accounts for approximately 80% of the total current water withdrawals in the CAREC region. However, new sources of water are increasingly expensive to develop, seasonal and geographic variations in water availability is the most common bottleneck for countries. In addition, degradation of water quality translates directly into risks, impacting human health, limiting food production, reducing ecosystem functionality and hindering economic growth (WB 2019a).

Climate change will affect the rural and urban populations differently. Poverty, migration and food insecurity are most prevalent in rural areas. For example, the vulnerability of rural population to climate-related risks is higher than urban population because of existing constraints on available financial resources, access to employment options, and a fragile physical infrastructure.



Country	Area (thou.km2)	Share from global area (%)
Afghanistan	652.2	0.48
Azerbaijan	86.6	0.06
China	9706.9	7.13
Georgia	69.7	0.05
Kazakhstan	2724.9	2.00
Kyrgyzstan	199.9	0.15
Mongolia	1564.1	1.15
Pakistan	881.9	0.65
Tajikistan	143.1	0.11
Turkmenistan	488.1	0.36
Uzbekistan	447.4	0.33
Total area	16964.8	12.47

Figure 1: Area of CAREC countries and their share from global area (Adapted from UN 2019)

Water and energy are interlinked in various ways, approximately 90% of global power generation is water intensive related for such as hydropower generation and cooling thermal plants. Energy is required for the pumping and distribution of water (including for irrigation), drinking water supply, wastewater treatment and water desalination; and the energy sector also requires water to cool thermal power plants, generate hydropower and grow biofuels (WWAP 2014).

Temperature changes and heat extremes are projected to increase in summer months than in cold periods (ADB 2017a). The increase in air temperature will increase biological water requirements of agricultural crops on average by 5–10% in Uzbekistan (Third NC of Uzbekistan 2016). As a result, more water is needed for irrigated agriculture and increased evapotranspiration rates elsewhere. In many parts of the world, the peak electricity demand is being observed during summer months for conditioning instead of winter months for heating, i.e., there is a seasonal shift. As a result, hydropower operational regimes are to be operated in different modes against design parameters.

Climate models project a general upward trend in annual precipitation over most Asian land areas, especially in areas located above 2,500 m a.s.l. toward the 21st century (ADB 2017a). By contrast, in some subregions, annual mean precipitation is projected to decline over this period. Drylands/lowlands are already vulnerable as a result of limited rainfall, therefore, there will be enhanced risks of desertification (WWAP 2020). For example, in Central Asia a decrease in precipitation is predicted in summer and fall, while a modest increase or no change in precipitation is expected in the winter months (Rakhmatullaev and Abdullaev 2014).

Scientific observations and state-of-the-art climate models show an increase in the frequency and intensity of rainfall events in many parts of the world (WWAP 2020). Extreme precipitation events are pre-conditions for mudflows, flash floods, landslides, and accelerated rates of erosion and sedimentation, each of which will pose a danger to normal operation of hydraulic installations (World Bank 2009; WWAP 2014; WRI 2019). For example, a 10% increase in extreme precipitation can trigger a two-fold rate of sedimentation to water bodies from erosion, mudflows and landslides (Third NC of Tajikistan 2014). In the CAREC region, water reservoirs store and accumulate about 33% of water resources for irrigation, hydropower and drinking water supply; thus, sedimentation might cause negative impact for intended service provisions (Rakhmatullaev et al 2014).

Snow cover, glaciers and ice caps – the main water sources of the major rivers of the region – are projected to shrink. Glaciers recession may melt more rapidly due to the warming, which may reduce river flow significantly and negatively impact long-term water availability in some countries (World Bank, 2009). At first, the shrinking of glaciers will supply surpluses for the river runoff, but in the future, a reduced glacier volume will eventually result in a decrease in summer runoff, at the peak of vegetation period (WWAP 2020). On the other hand, an increase in precipitation occurring as rain and less water stored as ice in the headwaters also increases flood risk downstream. According to WWAP (2019), about 90% of all-natural disasters are water-related, causing human casualties and financial damages in different parts of the world.

Vulnerability to coastal sea-level rise (coastal flooding) is particularly worrisome for China and Pakistan given that a share of their population and urban centers are located in low-lying coastlines (ADB 2017a). Sea-level rise and coastal flooding will increase salinity intrusion and inundations that will be risky for rice and wheat production, especially for deltaic zones (UNDDR 2019). For example, yield reduction might be minimal when plants submerge for a few days, however, if plants are submerged for more than 15 days – total yield loss will be observed (ADB 2017a).

Climate change affects agricultural production as well. Liu et al (2016) indicate there will be a yield reduction in wheat production in China approximately 3%. Without accounting for changes in irrigation water availability, wheat yields in Central Asia might increase by 12% (ranging 4%–27%) across all periods and scenarios mostly due to higher winter and spring temperatures, less frost damage (Sommer et al 2013).

CHAPTER 1. OBSERVED CLIMATIC CHANGE, FUTURE PROJECTIONS AND CHALLENGES TO WATER RESOURCES AND AGRICULTURE

1.1. Major climatic trends in the past and their intermediate impacts

Climate change is characterized by long-term changes in the climate variables, and the average temperature and precipitation patterns in particular. Overall, an increase in annual mean temperatures over the last century has been observed in all CAREC countries, with some countries in the region reporting the warming rates exceeding the global mean. The scale of annual growth in temperature during the second half of the twentieth century varies among the countries, while some parts of the CAREC region experienced moderate increases, some other locations such as south Afghanistan and south Mongolia experienced tremendous increases in annual temperature means by up to 2.4^{0}C and 2.2^{0}C respectively (NC 2017a, NC 2018).

Figure 2 below shows spatial patterns of the mean annual temperature increases across the region since the first decade of 1900s to present days. Accordingly, the highest increases in temperature values from the 1900s to 2000s had been observed in the north-western part of the Central Asian plains, south of Afghanistan and Pakistan, eastern stretches of the Tian-Shan and Pamir Mountains, and north west of Mongolia.

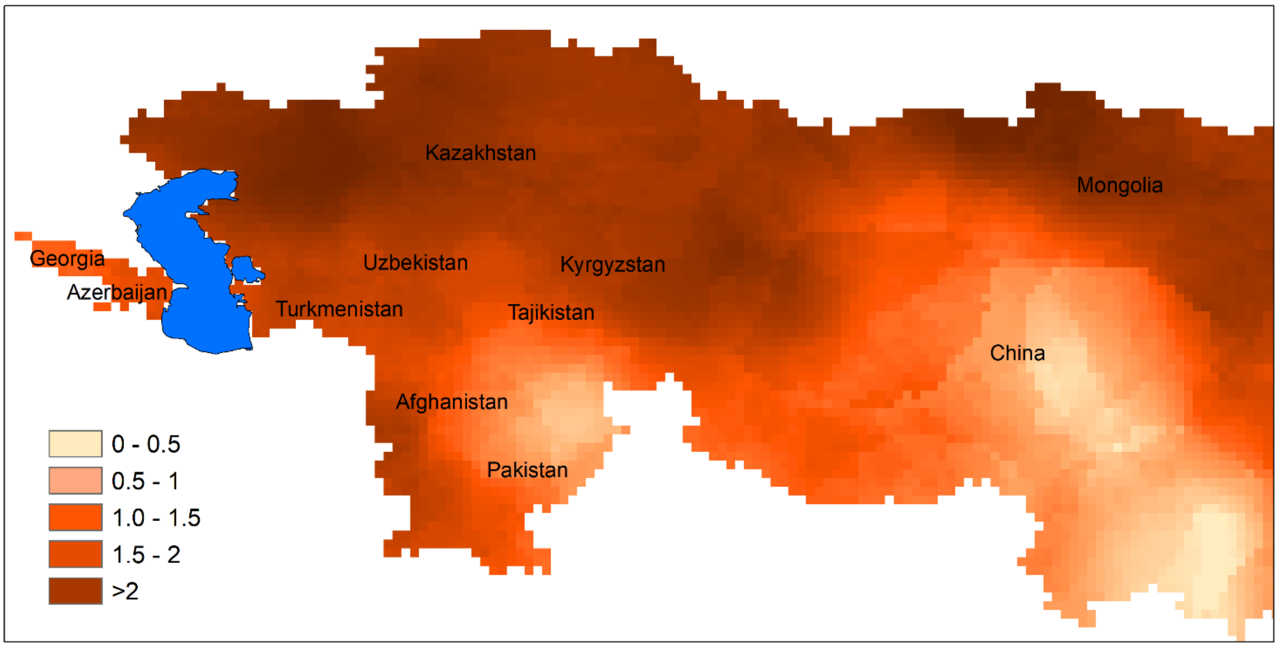


Figure 2. Change in mean annual temperatures (C) across the CAREC countries by 2000-2020 with respect to 1900-1920 averages (Source: based on C4RU TS 4.0 data, from Harris et al 2020)

In contrast to the increase in average temperatures, the average annual precipitations (aggregated on a country level) in the CAREC region do not show a common trend. There is, however, a noticeable change in the spatial and temporal dimensions of the precipitation patterns in the countries. Figure 3 provides an overview of how mean annual precipitation had been changing in the CAREC countries over the past century.

One of the main common trends in annual composition of the precipitation over CAREC countries is the increasing rain and snowfall in winter seasons, which are leveled out by decreased precipitation in the summer season. The magnitude of this seasonal shift is significant in some locations. Mongolia, for example, witnessed more than 40% increase in winter precipitation, leveled by decrease in the spring and summer precipitation (NC 2018a), and seasonal trends of comparable scales were also observed in southeast Afghanistan (NC 2017a). Furthermore, almost all countries confirmed changes in spatial variations of the precipitation.

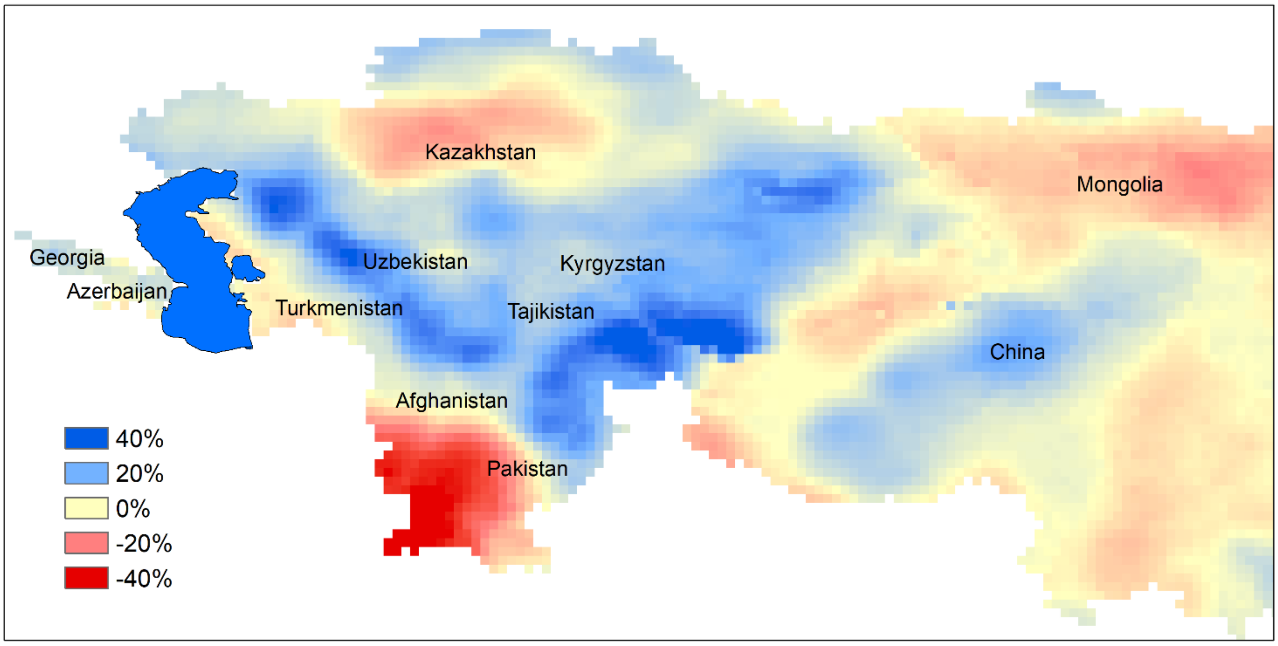


Figure 3. Change in mean annual precipitation across the CAREC countries by 2000-2020 with respect to 1900-1920 averages (Source: based on CRU TS 4.0 data, from Harris et al 2020)

The changing average temperature and precipitation patterns have ignited a growing impact on climate volatility in the CAREC countries, with drastic effects on key spheres, such as disaster management, water resources and agriculture. Almost all countries in the region reported an increasing frequency of the adverse hydro-meteorological events of a wide spectrum (all NCs). Increase in temperatures, coupled with changing seasonal and spatial patterns in precipitation, caused more frequent and severe droughts in the region, especially in the Central Asian plains (Spinoni et al 2019). On the contrary, during the last twenty years Mongolia has been challenged with increasing frequency of devastating *dzud*[1] events, conditioned by drier summers and excessive snowfall in winters (NC 2018). The Caucasus countries have reported a dramatic increase in the frequency of floods, mudflows and avalanches since the 1980s (NC 2015a, NC 2015b, NC 2016a).

[1] Livestock starvation due to lack of grass under severe winter conditions in Mongolia.

Figure 4 below depicts the dynamics of major climate hazards in the region.

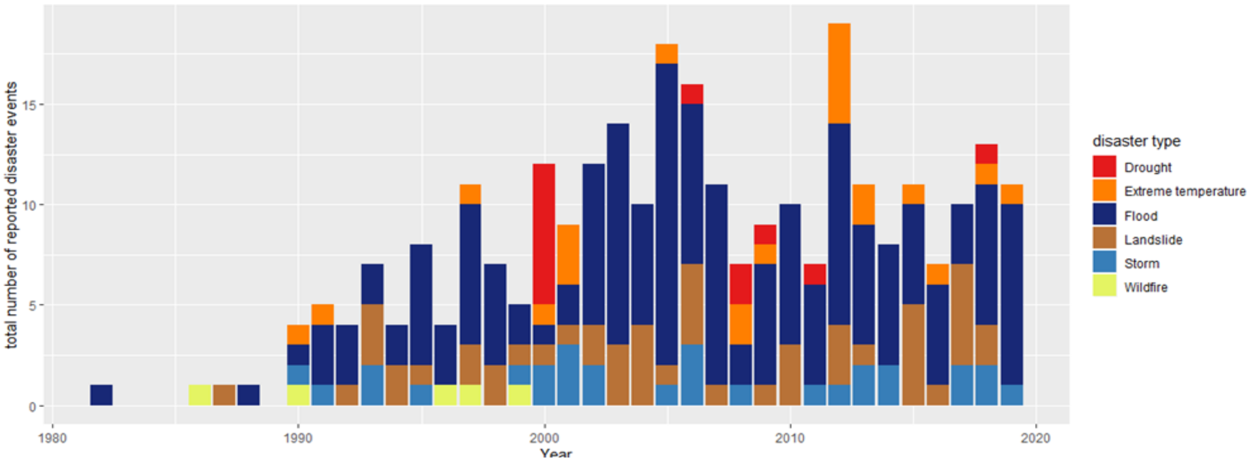


Figure 4: Occurrence of extreme events in the CAREC region from 1980s to 2019 (Source: based on EM-DAT 2019 data)

The rising temperatures along with changing precipitation variability have had a drastic impact on the mountain glaciers in the region. Records over the glacial monitoring in the Caucasus and Central Asia reveal that the glaciers had been decreasing during the past century, and the rate of melting had increased since the end of the century (NC 2015ab, 2016a, Hoelzle et al 2017). Respective assessments suggest that the glaciers in the Tian-Shan Mountains have already lost around third of their mass (see Figure 5), whereas in the Caucasus Mountains glacial loss became even more extreme and constituted up to 50%. Further rise in temperature will have substantial impact on Central Asia's water supply. The glacial loss is an alerting signal for water availability in endorheic transboundary river basins shared by Afghanistan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, since the glacial melt contributes to the major part of the rivers` runoff during the summer time (Hock et al 2019).

1.2. Climate projections under medium and high emissions scenarios

Upon medium to high climate change scenarios (corresponding to IPCC`s RCP4.5 and RCP8.5) the further growth in annual temperatures over the most of the region will be likely in between 2.5^{0}C and 4^{0}C respectively (IPCC 2013, Didovets 2020, Hattermann et al 2020, NC 2017a, NC2017b, NC 2018a,b,c). These increases will be more noticeable in Mongolia and the southern plains of Central Asia, whilst having lesser magnitudes at higher altitudes of the Caucasus mountains. Projections also suggest greater seasonal variability of annual temperature increases across different parts of the region, e.g. with highest monthly increases projected for the summer season in Azerbaijan, compared to higher rates of future temperature growth in winters in Kazakhstan.

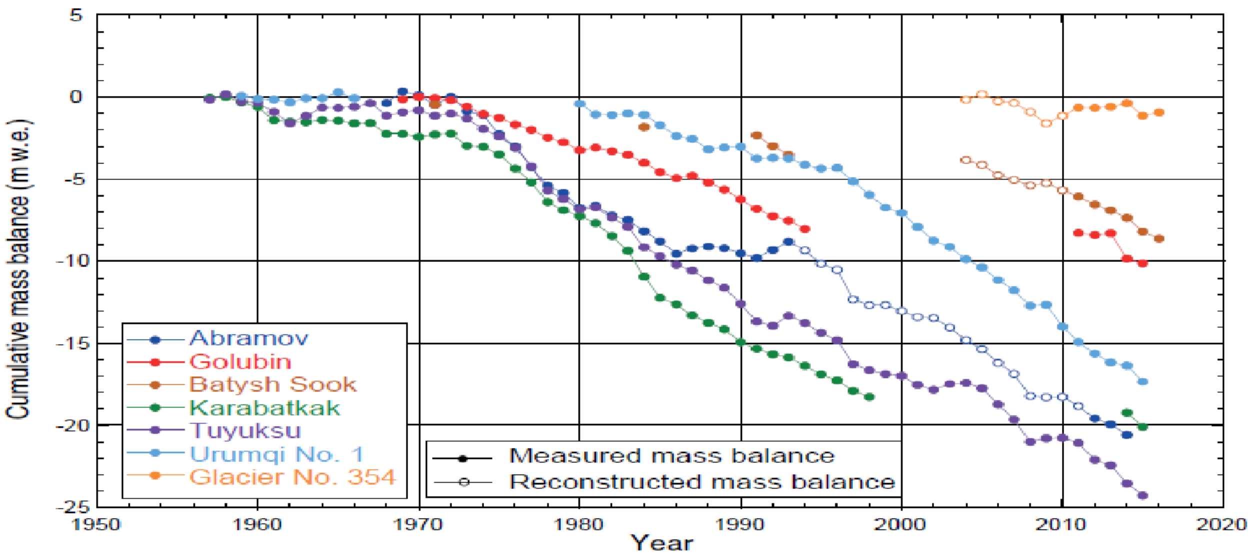


Figure 5: Dynamics of cumulative mass balance of some glaciers in Central Asia (Source: Hoelzle et al 2017)

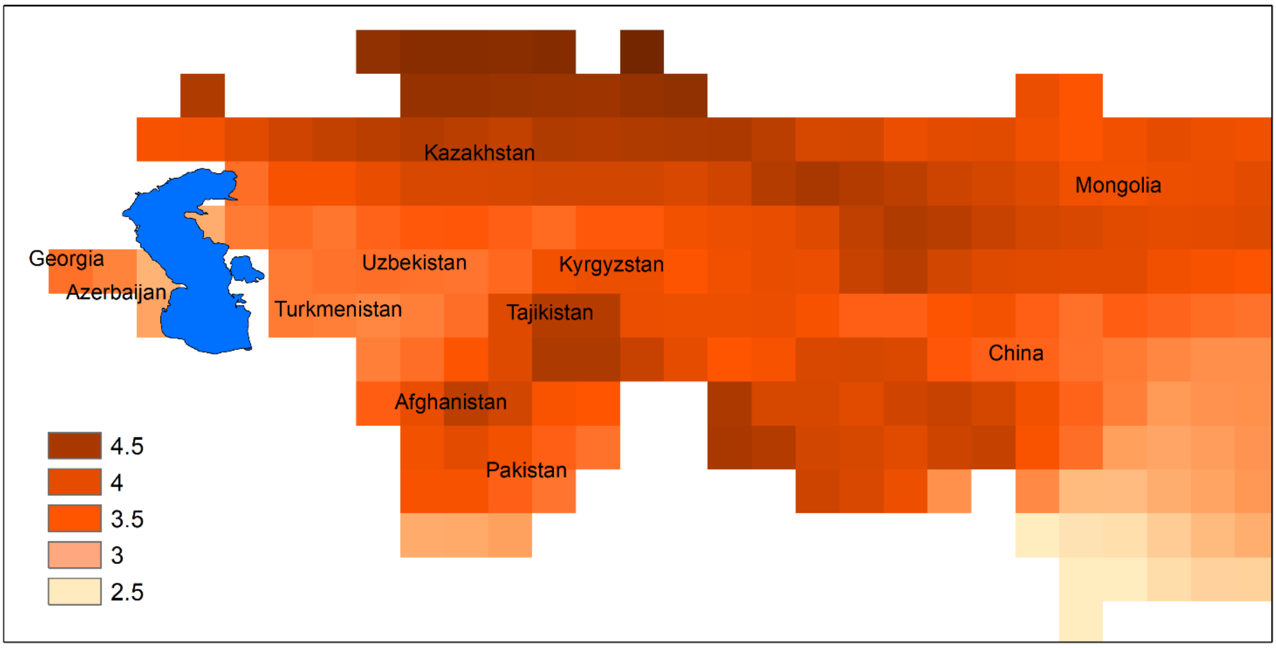


Figure 6. Projected Change in surface temperature in CAREC countries for 2060-2079 under the RCP8.5 scenario (compared to 1986-2005) (Source: based on CMIP5 Atlas subset ensemble of projections, IPCC 2013)

With regard to precipitation, the projections imply a slight increase in annual precipitation in the north-eastern parts of the region with expected decrease in the south-western parts (Figure 6). There is however a seasonal and spatial variability of changes in the projected precipitation across the countries in the region. In larger parts of Afghanistan and Azerbaijan the spring and early summer precipitation will likely decrease, whereas precipitation during autumn and wintertime will show a slight increase (NC 2016a, NC 2017a). In Mongolia winter snowfall will show a tendency to grow, whilst summer precipitation will not significantly change (NC 2018a).

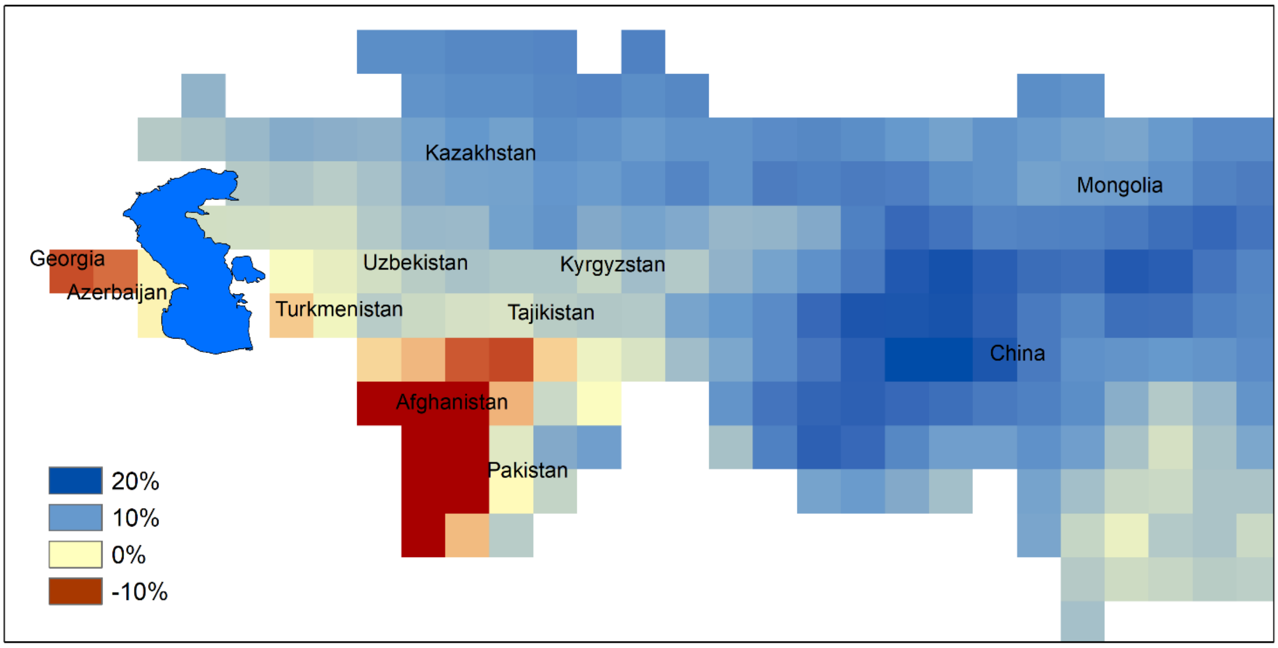


Figure 7. Projected Change in Precipitation across the CAREC countries for 2060-2079 under the RCP8.5 scenario (Compared to 1986-2005) (Source: based on CMIP5 Atlas subset ensemble of projections, IPCC 2013)

1.3. Projected climate change impacts on water resources

Further temperature increases in the region where most rivers are fed by snow and glacier melt will likely cause significant changes in volume and seasonal patterns of rivers` run-off. The expected changes in precipitation will contribute to alteration in the runoff of rivers in the region. Long term projections suggest that rivers in the southern part of Central Asia will likely observe reduction in annual runoff (NC 2016c), and upon the high impact emissions scenario the decrease in annual discharge of the region's largest rivers may constitute up to 25-30% (Punkari et al 2014). Some basins in the region may see a slight increase in annual discharge by the mid-century which will be linked to more intense glacial melt under the increasing temperatures, though under the same projections the discharge would eventually decrease by the end of the century after substantive loss of glaciers mass (NC 2017b, Hock et al 2019, Lobanova et al 2020). Climate change may thus significantly alter availability of water resources in the CAREC region. The Figure 8 shows spatial variability in changes of water supply across the region.

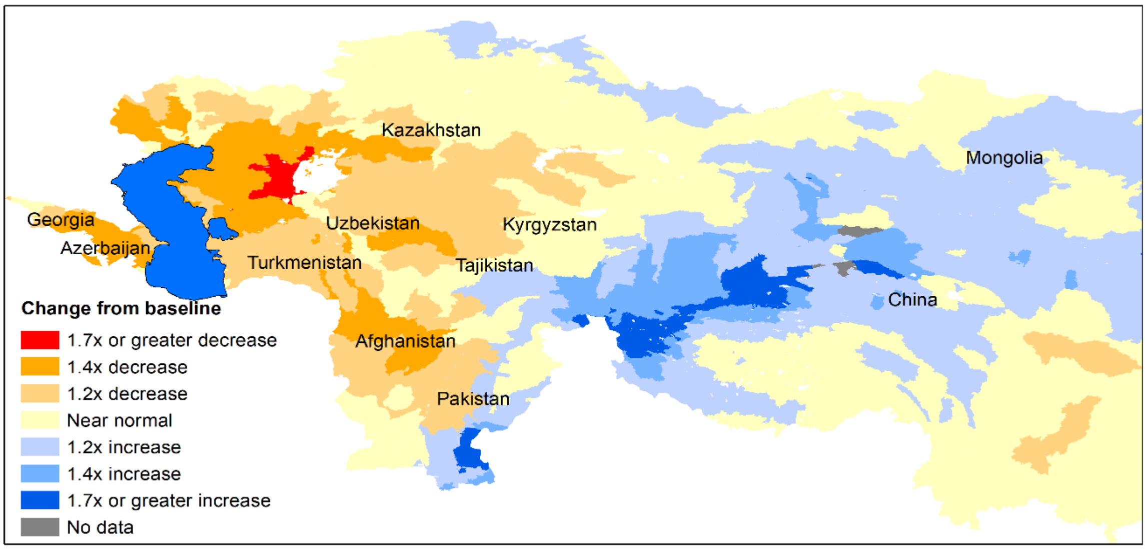
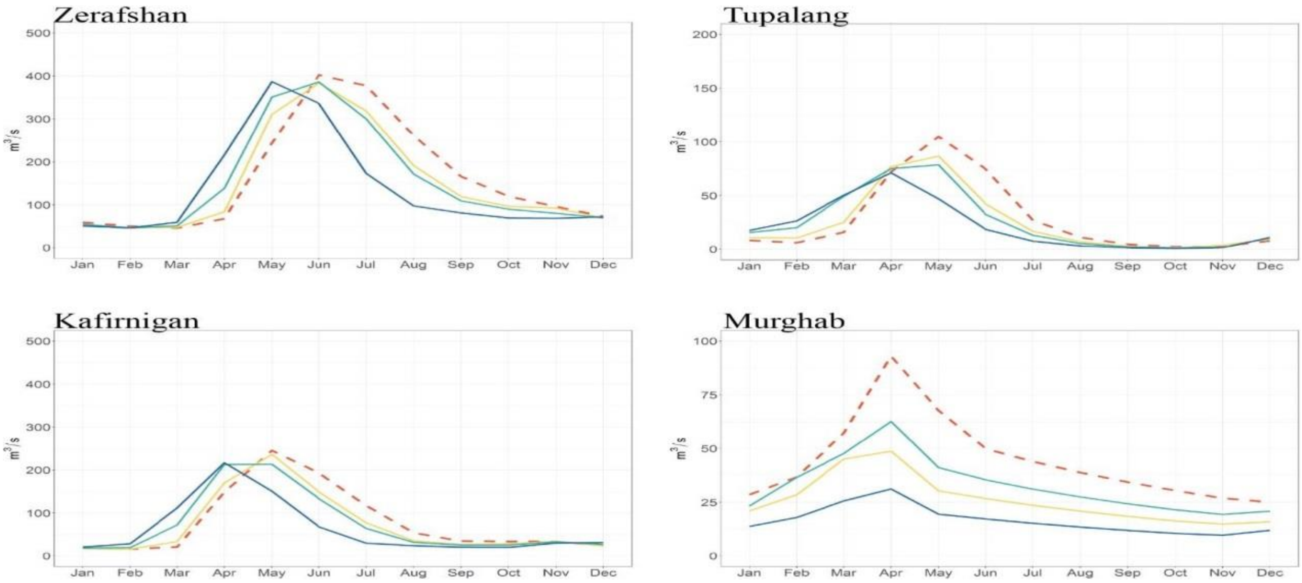


Figure 8: Projected changes in water supply by 2040 under RCP 8.5 scenario (adapted from WRI Aqueduct 3.0: https://www.wri.org/aqueduct)

Furthermore, respective assessments indicate that most rivers in the region will see seasonal shifts, with peak discharges shifting earlier by one month on average (Didovets et al 2020, Hattermann 2020, Lobanova et al 2020) as shown in Figure 9.

The shifts in seasonal monthly discharges may increase the probability of early spring floods, which already occur at higher frequency and magnitude in mountainous regions of the Caucasus and Central Asian countries (Ahouissoussi et al 2014, NC 2014, NC 2016b). The increased rate of floods in the northern and eastern plains of Kazakhstan will likely intensify further in the future (NC 2017b). On the contrary, reduced runoff during the summer months coupled with higher evapotranspiration rates will reduce availability of water for irrigated agriculture. This issue will especially touch upon endorheic basins in the southern plains of Central Asia, in Turkmenistan, Uzbekistan and south of Kazakhstan in particular.

These expected climate impacts, and decreased runoff in particular, will exacerbate the water scarcity already observable in the southern part of the CAREC region, and may intensify the intra-sectoral competition over water resources in and among the Central Asian states even further (Figure 10). Magnified by increased water withdrawals provoked by such factors as growth of population, increasing higher irrigation water requirements, the water supply-demand imbalances will likely prevail across larger part of the region putting most of the CAREC states in the list of high and extremely high-water stress countries in the world (WRI 2019).



red dash line - reference period (1990-2015), **yellow** - 2030, **green** – 2050, **blue** – 2080

Figure 9: Projected seasonal shifts in monthly discharges of selected Central Asian rivers under RCP 8.5 scenario (Source: Didovets et al 2019)

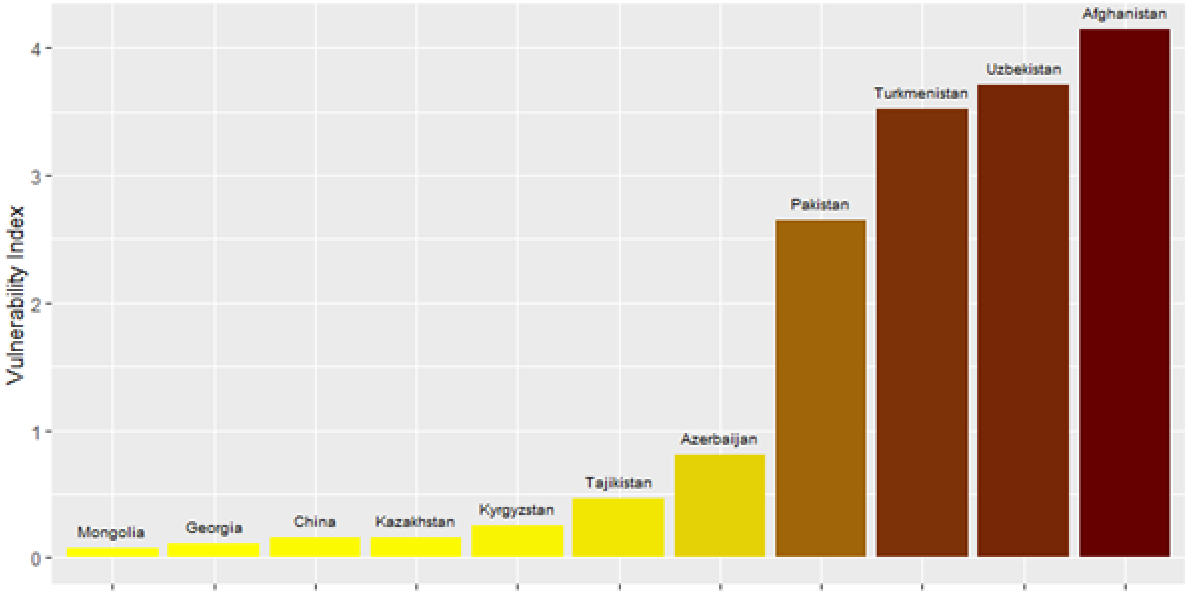


Figure 10: Comparative vulnerability of the CAREC region countries to expected change in water availability by 2040 under RCP 4.5 scenario (Source: Authors estimations based on the CAREC climate vulnerability index methodology, see Chapter 5 for details)

1.4. Projected climate impacts on the agricultural sector

1.4.1. Crop production

The rising average temperatures under climate change will extend the duration of warm seasons. On the one hand, this will prolong the vegetation season and offer opportunities for earlier planting as well as for harvesting crops at relatively later dates. This will be coupled with an increase in a number of hot days with temperatures of over 40^0C, which will likely emerge more evidently in the south-west of Afghanistan, and literally in the whole territory of Turkmenistan and Uzbekistan (see Figure 11).

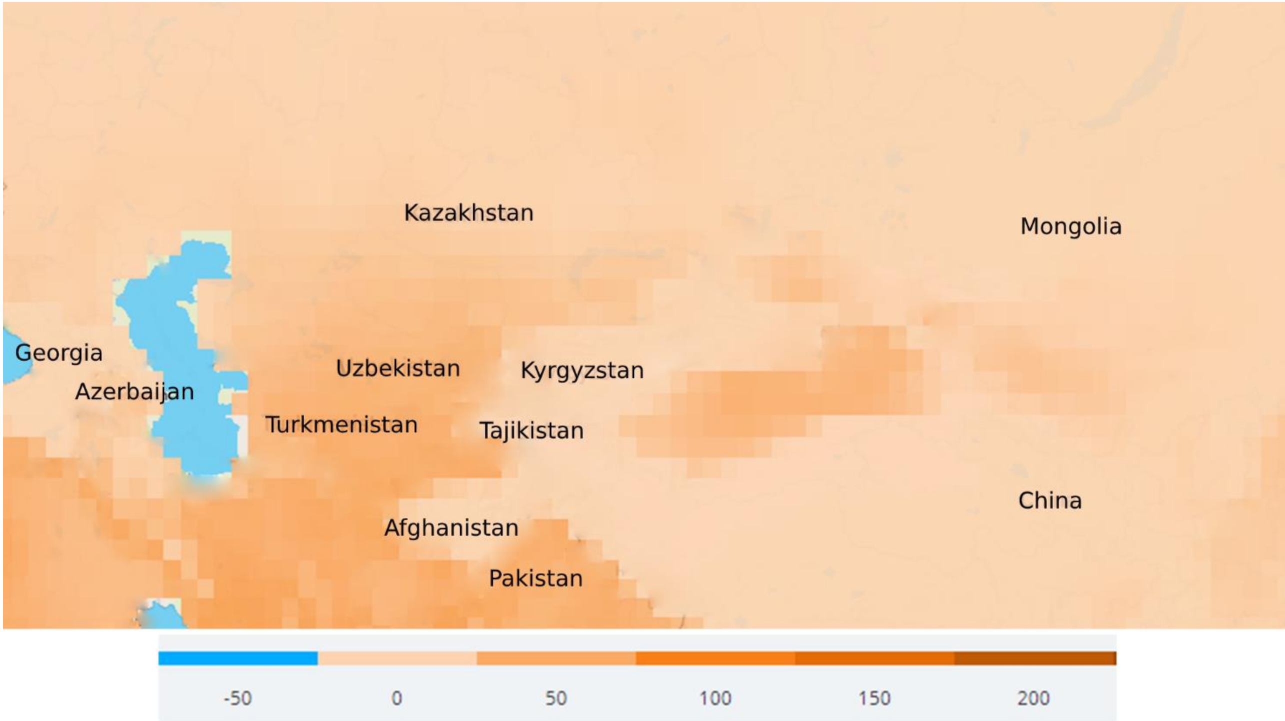


Figure 11: Projected change in number of hot days (t>40C) per year across the CAREC countries by 2060-2079 with respect to 1986-2005, under the RCP8.5 scenario (Source: based on CCKP-CMIP5 ensemble, CCKP 2019)

In general, the scale of projected changes in temperatures will likely outweigh the projected change in precipitation variability across the region. As a result, the larger parts of CAREC may expect drought conditions. Other projections (CCKP 2019) imply that drought frequency will likely also rise in the southern and central parts of Mongolia. The Figure 12 projects change in drought index[2] across the region under the RCP8.5 scenario.

As the rainfed agriculture is most common to the northern parts of the region, the most affected countries are Kazakhstan, Georgia and Mongolia. Despite the expected increase in precipitation over the northern parts of Kazakhstan, the grain yields will be adversely affected by increases in evaporation rates and temperatures surpassing conditions favorable for the crop production. According to the medium to extreme projections, wheat growing sector in Kazakhstan may thus see a decrease in grain yields by 14-45% by 2050 (NC 2017b, Sommer et al 2013). This would have a major implication for the agricultural sector of the country which is among the main wheat producers and exporters in Eurasia. Expected decrease in wheat yields in Mongolia fall in the

[2] Mean of the Standardized Precipitation Evapotranspiration Index (SPEI) for a 12-month period

same range as in Kazakhstan (NC 2018a). The yields of non-grain crops in Caucasus, which are predominant in local agriculture, are expected to decrease by 3–28% by the 2040s under the moderate climate scenario (Ahouissoussi et al 2014).

Climate change will not only reduce water availability in the region, as explained earlier, but simultaneously increase crop water demand due to higher evapotranspiration rates. This may have serious implications for arid and semiarid parts of the region where crop production is dominated by irrigated farming (Lobanova et al 2020). For example, Sutton et al. (2013) project significant fall in yields in major crops in Uzbekistan under reduced water availability for irrigated agriculture. It would be intuitive to extrapolate the same projections for larger parts of Turkmenistan, which shares similar agro-climatic zones with Uzbekistan and also relies on irrigation for crop production.

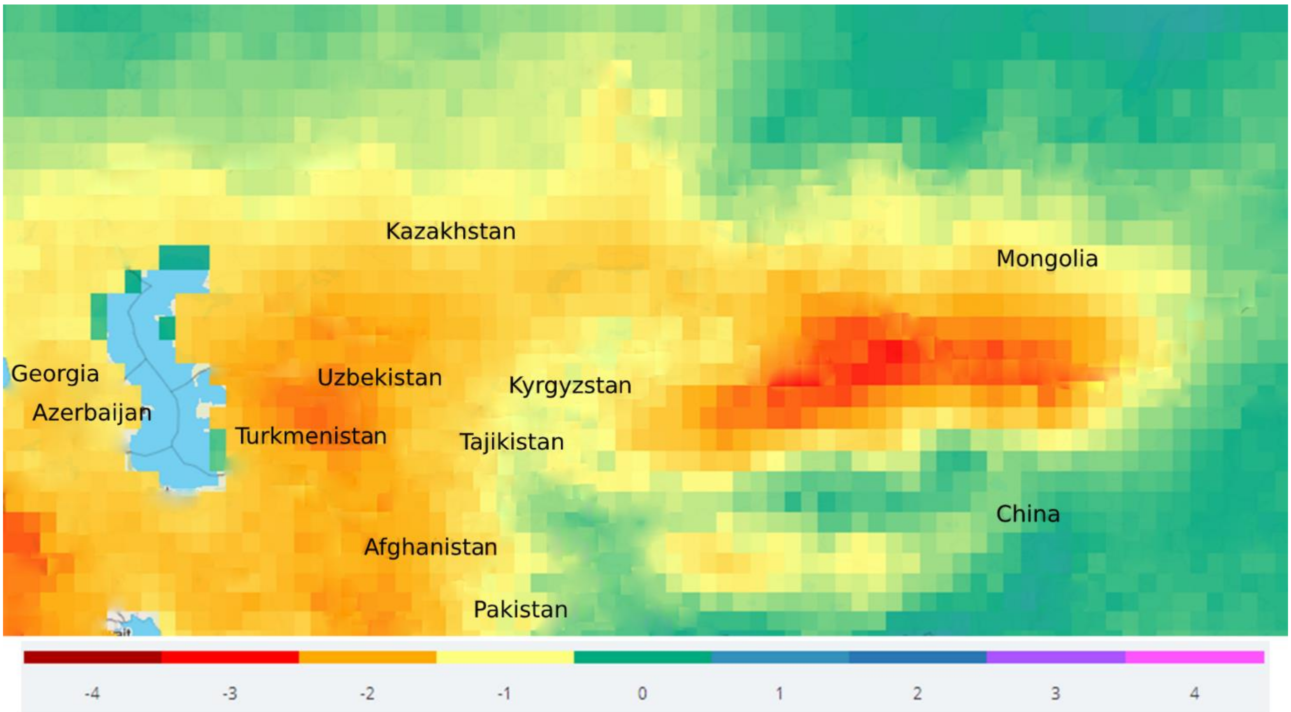


Figure 12: Projected Change in Mean Drought Index across the CAREC countries by 2060-2079 with respect to 1986-2005, under the RCP8.5 scenario (Source: based on CCKP-CMIP5 ensemble, CCKP 2019)

1.4.2. Livestock farming

The growing temperatures may have a favorable impact on cultivating livestock fodder crops, and respective projections suggest that upon sufficient moisture conditions yields of Alfa-Alfa crops may increase in the steep and piedmont regions of Central Asia (Sutton et al. 2014). Nevertheless, most projections expect that pasture productivity in Mongolia, Kazakhstan and Kyrgyzstan will likely decline due to decline in summer precipitation coupled with increase in seasonal temperatures (NC 2016b, NC 2017b and NC 2018a)

For Mongolia the climate projections suggest that the intensity of droughts followed by harsh winters, the sequence that determine *dzud* events, is expected to increase. This may increase the livestock losses by about 50% by the middle of the century in comparison to losses observed in the past (NC 2018a). Though having a large extent in the agriculture sector, livestock farming in

Kazakhstan is however less vulnerable to extreme weather events due to presence of stall-based livestock management practices in the country.

1.5. Conclusion

The global warming is pronounced in the CAREC countries, many parts of which exhibited much higher rates of temperature growth compared to the global averages over the past hundred years. Climate change had also altered seasonal and spatial patterns in precipitation in the region, which is more evident in the mountainous areas. The changing average temperature and precipitation patterns have ignited a growing impact on climate volatility in the CAREC countries, with drastic effects on key spheres, such as disaster management, water resources and agriculture. Almost all countries in the region reported an increasing frequency of the adverse hydro-meteorological events of a wide spectrum. It is projected that magnitude of future rise of temperature and shifts in the precipitation patterns will likely exceed the scale of the observed historical changes.

Climate change may significantly alter availability of water resources in the CAREC region. Expected further climatic changes will cause significant changes in annual volume and seasonal patterns of rivers` run-off. Since discharge in most of the rivers is predominantly shaped by snow and glacial melt, all basins in the region will observe earlier peaks in streamflow which will be followed by reduced runoff in subsequent months. Furthermore, some largest basins in the semi-arid and arid parts of the region will see reduction in annual runoff, and under extreme climate scenarios the scale of these reductions would be dramatic. These expected climate impacts, and decreased runoff in particular, will exacerbate the water scarcity already observable in the southern part of the CAREC region, and may intensify the intra-sectoral competition over water resources in and among the Central Asian states even further.

Most types of the agricultural activities in the region will be at the frontline of expected climate impacts. On one side, the rising temperatures will extend the warm season offering opportunities for prolonged vegetation season. On the other side, the projected growth in temperatures will likely increase frequency and extend periods of extremely hot days within vegetation season. Coupled with changing precipitation patterns, this will lead to higher incidence of drought conditions for rainfed agriculture over the larger part of CAREC region. Because of reduced streamflow and higher demand for irrigation water, the water stress will likely intensify and prevail across arid and semi-arid parts of the region. The fodder base for livestock farming in the northern part of the CAREC, will be adversely affected by higher incidence of unfavorable meteorological conditions.

CHAPTER 2: CLIMATE CHANGE AND WATER-ENERGY-AGRICULTURE NEXUS

The energy-water-agriculture linkage is central to shared prosperity and socio-economic development. Associated with both policy and resource nexus, these resources are tightly interconnected. In coming decades, water, energy and food demands are projected to increase across all CAREC countries due to the growth of populations and economies, changing lifestyles and consumption patterns. The political economies of countries are still based on increasing resource abstraction instead of its reorientation toward productivity gains and enhancing efficiencies. On the other hand, climate change is a growing threat to all countries of the region (Rasul 2014, Rasul and Sharma 2016, Scott et al 2015, Nepal et al 2019).

2.1. Water resources and irrigation

The fundamental question is rather not only about physical water availability per se, but importantly about economic water scarcity, where access to water is not limited as a result of the amount of existent water resources themselves, but by degraded conditions of physical infrastructure and poor institutional operations to collect, transport, irrigate and treat water for human purposes. Most importantly the water services are malfunctional. Nevertheless, water resources are not evenly distributed in space and time across the country. The present data shows that already Turkmenistan and Uzbekistan are using more water against existing physical water availability (Figure 13).

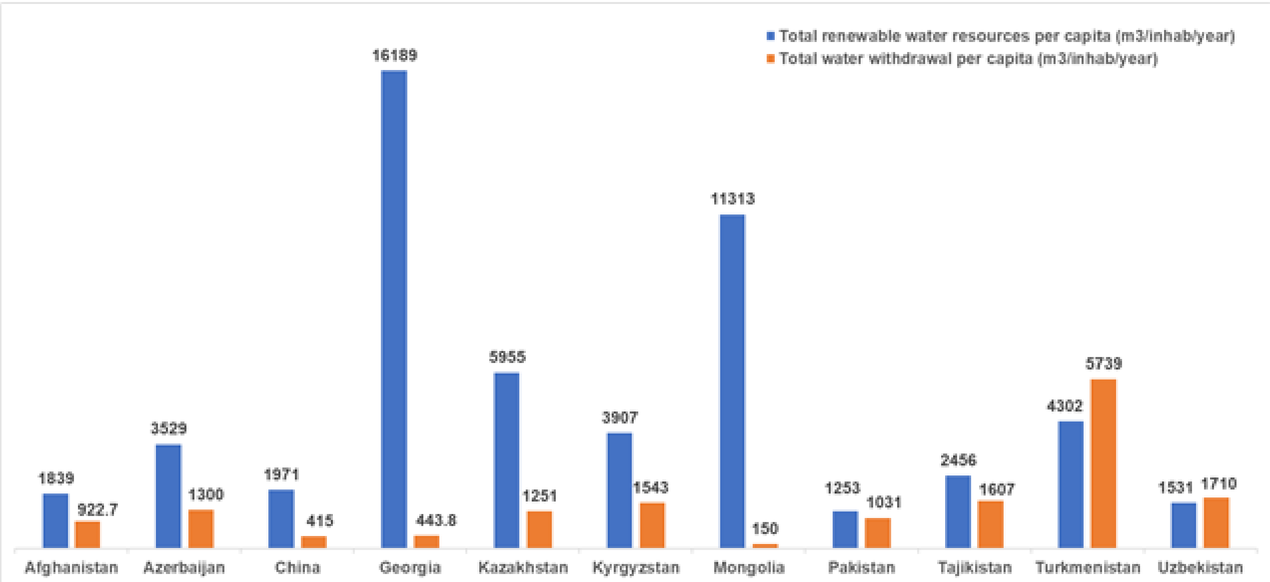


Figure 13: Availability and withdrawal of water resources per capita, 2014 in CAREC countries (FAO AQUASTAT Database 2019)

The total irrigated lands are estimated to be around 104 million ha in the CAREC countries, with China and Pakistan accounting for 69 and 19 million hectares respectively (Table 1). Yet, interestingly, about 15 million ha of land equipped for irrigation are reportedly not actually being irrigated due to various technical and financial reasons (FAO 2019). The reasons for such a gap can be linked to underinvestment of irrigation schemes, disrepair of hydraulic infrastructure, depletion of groundwater resources, and most importantly degradation of soil quality. This information should be re-examined in more detail for potential reclamation efforts.

Table 1: Characteristics of total irrigation lands across CAREC countries, share on electric powered and irrigated lands from groundwater sources (FAO AQUASTAT 2019)

Country	**Total area equipped for irrigation ('000 ha)**	**Actual irrigation ('000 ha)**	**Total powered irrigated area ('000ha)**	**Share of electric powered irrigated lands (%)**	**Area equipped for irrigation by groundwater ('000ha)**	**Share of area irrigated from groundwater (%)**
Afghanistan	3,208	2,165	32	1	577	18
Azerbaijan	1,446	1,386	479	33	97	7
China	69,863	58,449	36,066	57	19,369	31
Georgia	433	274	95	22	0	0
Kazakhstan	2,066	1,265	41	2	2	0.1
Kyrgyzstan	1,023	1,021	51	5	7	1
Mongolia	84	63	0.8	1	36	42
Pakistan	19,270	18,210	6,359	33	4,130	21
Tajikistan	742	674	296	40	33	4
Turkmenistan	1,991	1,991	318	16	9	0.5
Uzbekistan	4,199	3,700	1,133	27	274	6
Total	**104,325**	**89,198**	**44,872**		**24,534**	

Note: Zero means no data

The total electric powered irrigated area is about 44 million ha which constitutes approximately 43% of the total irrigated lands. In addition, approximately 24% of irrigated lands (i.e., 24 million ha) are irrigated from groundwater resources. Annually, billions of cubic meters of water is being lifted, conveyed and transported through a complex infrastructure system of pumping stations, water intake structures, boreholes and vertical drainage systems from surface and groundwater sources due to prevailing topographical and hydrogeological environments.

In fact, the share of electricity used in the irrigation sector varies from a country to country. For example, Azerbaijan, China, Georgia, Pakistan, Tajikistan and Uzbekistan irrigate more than 20% of their lands with electric pumped schemes. Afghanistan, China, Mongolia and Pakistan utilize groundwater sources for practicing irrigated agriculture. Governments allocate considerable financial resources from their national budgets for electrically powered irrigation. Thus, energy efficiency programs will be an integral part of mitigation measures.

For example, the irrigation sector consumes about 20% out of the total electricity use in Uzbekistan. Half of those electrical lift infrastructures are operated in Uzbekistan with 43 large, 1400 medium and 30 000 small sized pumping stations (Rakhmatullaev and Abdullaev 2014). Annually, about USD 425 million is spent on the operation of pump-lifted systems in Uzbekistan alone (cost per kWh = USD 0.047 in Uzbekistan 450 UZS/kWh (http://www.uzbekenergo.uz/ru/activities/tariffs-electric-power/).

Climate change may hamper the operation of the existing electrically operated water systems due to the lower water levels in waterways and irrigation canals, especially during vegetation periods. This may increase demand for electricity use. Irrigated agriculture may become expensive activity.

CAREC countries have plenty of water relative to their populations but have a very low economic return on water compared with other parts of the world (Figure 14).

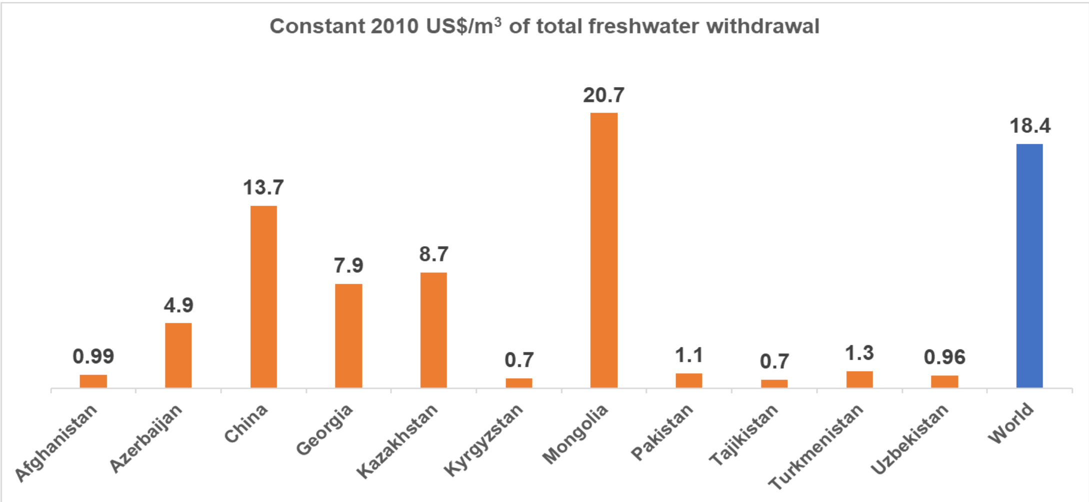


Figure 14: Water productivity across CAREC countries, 2014 (World Bank Data 2019)

Water productivity is calculated as GDP in constant prices divided by annual total water withdrawal. Due to the different economic structure of each country, these indicators should be used carefully, considering a country's specific sectoral activities and natural resource endowments. It is still evident that the majority of countries need to increase water productivity, especially in agriculture.

2.2. Agriculture

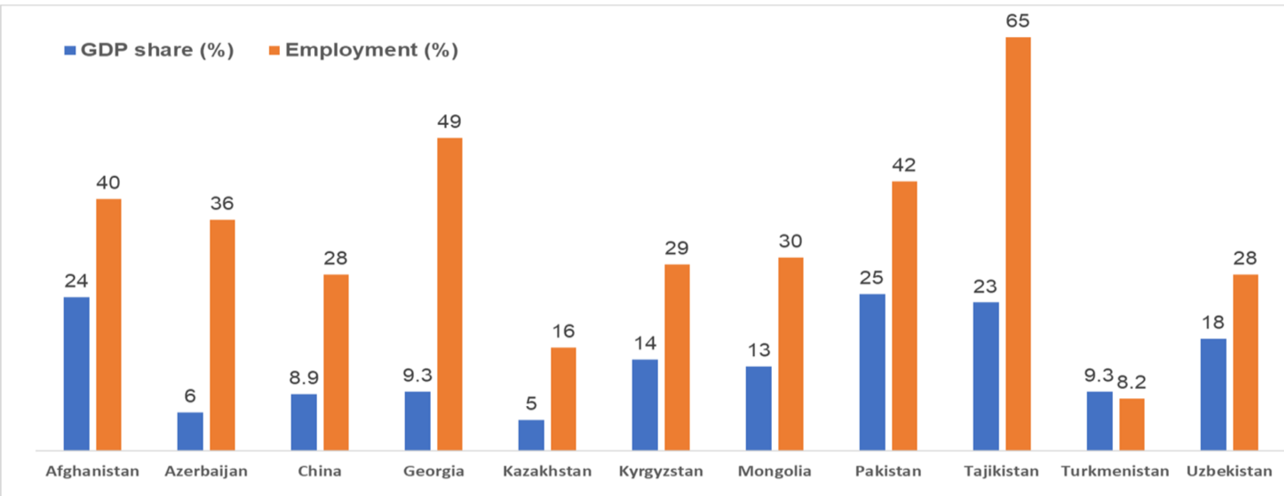


Figure 15: Share of Agriculture in GDP and labor force in agriculture, forestry and fishing in 2016 (ADB 2017a)

Jobs in the agricultural sector are highly water-dependent. Agriculture is still a vital sector of economy across all countries providing livelihoods for millions of inhabitants (Figure 15). Experts claim that even the higher proportion of rural people are employed in agriculture through informal arrangements.

Over a period of 25 years, the material evidence shows that arable land (hectares per capita) for all countries has substantially decreased (Table 2). In particular, Afghanistan, Georgia, Mongolia, Pakistan, Tajikistan and Uzbekistan should pay a due attention to the facts. With projections in population growth the situation will be even more alarming taking into account the degradation of soil quality. The only promising aspect might be increasing land productivity. In order to address these challenges, the breakthroughs in water and land productivities and diversification of agricultural production are required.

Table 2: Dynamics of arable land (hectares per capita) in CAREC countries, 2016 (World Bank Data 2019)

Country	**1992**	**2016**	**Change (decrease)**
Afghanistan	0.546	0.218	150%
Azerbaijan	0.231	0.205	13%
China	0.105	0.09	17%
Georgia	0.163	0.09	81%
Kazakhstan	2132	1652	29%
Kyrgyzstan	0.292	0.212	38%
Mongolia	0.607	0.186	226%
Pakistan	0.263	0.152	73%
Tajikistan	0.156	0.08	95%
Turkmenistan	0.381	0.343	11%
Uzbekistan	0.209	0.14	49%
World	**0.232**	**0.192**	**21%**

Aggregate mean figures do not reflect the full story on availability of arable lands. The most pressing factor is a spatial distribution and quality of arable lands within a country's geographic regions and communities.

National statistics show that tremendous enhancements have been reported on agricultural value added per worker across countries (Figure 16). Yet half of the countries still lag behind average global estimates. In developing countries, a large share of agricultural output is either not exchanged, as it is consumed within the household, or not exchanged for money. Agriculture comprises value added from forestry, hunting, and fishing as well as cultivation of crops and livestock production.

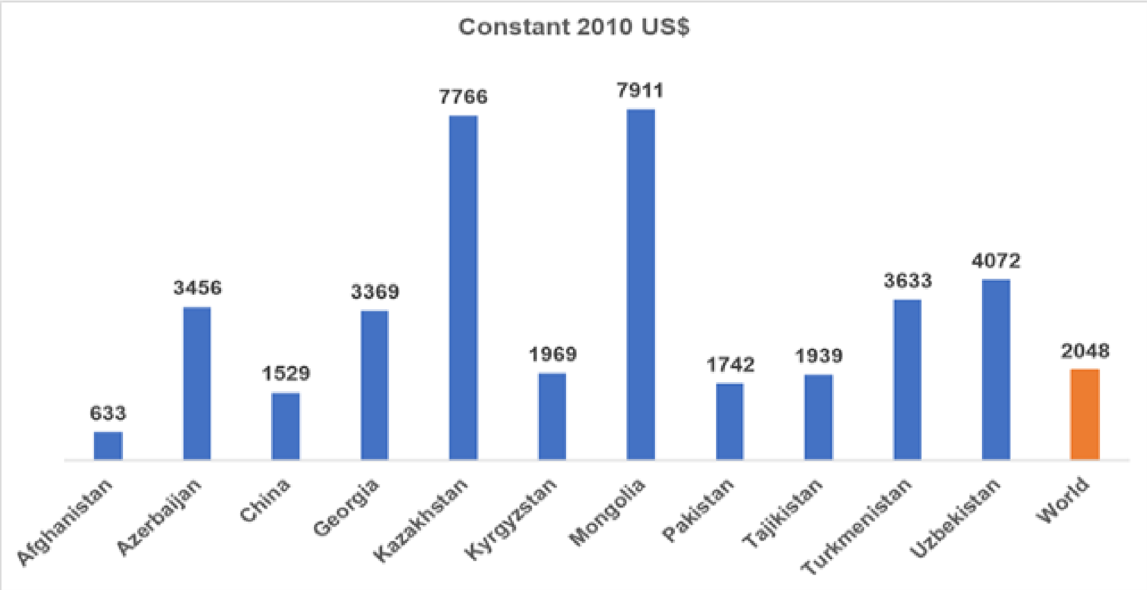


Figure 16: Agriculture value added per worker, 2016 (World Bank Data 2019)

2.3. Water footprint assessment of strategic agricultural crops

The water footprint of a product is the volume of freshwater consumed to produce the product, measured at the place where the product was actually produced (Aldaya et al 2010, Mekonnen and Hoekstra 2010). Water footprint assessment of agricultural crops could inform production and trade decisions, most suited to local environmental conditions under the projected climate change impacts, especially related to changes in precipitation patterns and water availability. A country can strategically treat its domestic water resources by importing water-intensive products instead of producing them domestically.

The green water footprint measures the volume of rainwater consumed during the growing period of the crop; the blue water footprint measures the volume of surface and groundwater consumed. The wheat, rice and cotton are important agricultural crops in the region in terms of export revenues and food security. On global scale, wheat and rice have the largest blue water footprints, together accounting for 45% of the global blue water footprint (Mekonnen and Hoekstra 2014). About 53% of the global cotton field is irrigated, producing 73% of the global cotton production. The largest share of the blue water footprint is observed in arid and semi-arid regions. Regions with a large blue water proportion are located, for example, in Central Asia, Pakistan and northeast China.

While a diverse mix of crops is grown in countries, three agricultural crops (wheat, rice and cotton) are dominantly sown in countries. Only Georgia (10%), Kyrgyzstan (22%) and Afghanistan (28%) allocate agricultural lands under the three crops, the rest use about 40%. The highest share of lands under those crops is reported by Turkmenistan – 81%; Tajikistan – 67%; Mongolia – 64%; Uzbekistan – 62%.

Wheat acts as a leading food grain in the diets of people, with rice being the second staple food crop across countries of the region. As a matter of fact, wheat and rice provide 38% of human daily calorie requirements (FAO 2019). In addition, wheat is also used as a feed source for livestock and poultry sectors., on average 26% of the total agricultural lands are allocated under wheat (i.e., ca. 51 million ha) in the region ranging from 10% in Georgia to 64% in Mongolia (Figure 17).

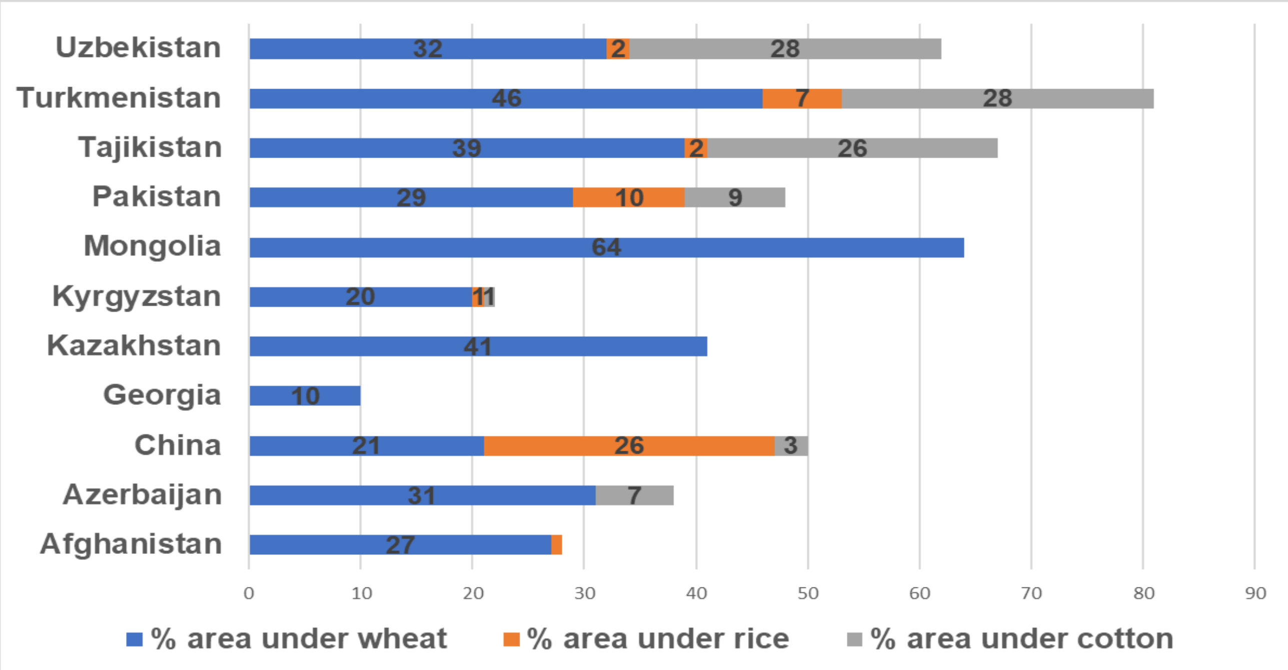


Figure 17: Share of lands under wheat, rice and cotton to the total arable lands across CAREC countries (FAOSTAT 2019)

China, Pakistan and Kazakhstan are top global wheat producers and grow wheat on about 45 million ha of their lands. The total wheat production in the CAREC region is estimated to be ca. 191 million tonnes of which 176 million tonnes are only produced by China, Pakistan and Kazakhstan. Winter and spring wheat varieties are cultivated throughout the region both in rainfed and irrigated areas. The average global total water footprint for wheat is estimated to be 1620 m^3/ton (Mekonnen and Hoekstra 2014). The total volume of 309 billion m^3 of water is needed to grow wheat in the region. For wheat, the water footprint per ton in irrigated and rain-fed agriculture are very similar at the global scale.

Rice is another important staple food, China and Pakistan are two dominant producers in the region with 34 million ha of lands cultivated under rice. The total production of rice is reported to be 227 million tons in the region. The average global total water footprint for rice is about 1486 m^3/ton (Mekonnen and Hoekstra 2014), i.e., the total volume of 337 billion m^3 of water is needed for cultivating rice.

Cotton has grown over 8.4 million ha of irrigated lands with China, Pakistan, Turkmenistan and Uzbekistan among top producers in the world. The total cotton production is estimated as 8.9 million tons. The average global total water footprint for cotton is about 3589 m^3/ton (Mekonnen and Hoekstra 2010). The total volume of 32 billion m^3 of freshwater is needed to grow cotton in the region.

The total renewable water resources of countries are estimated to be 3512.5 billion m^3/year. The total volume of water needed for production of wheat, rice and cotton is estimated to be approximately 765 billion m^3, i.e., 21% of water out of the total renewable water resources in the region. Uzbekistan, Pakistan, Kazakhstan, Turkmenistan and China use considerable amounts of water resources for production of wheat, rice and cotton (Figure 18). Uzbekistan and Pakistan should re-think their allocation of strategic crops towards diversification either less water intensive crops or dry resistant crop varieties under potential climate induced changes.

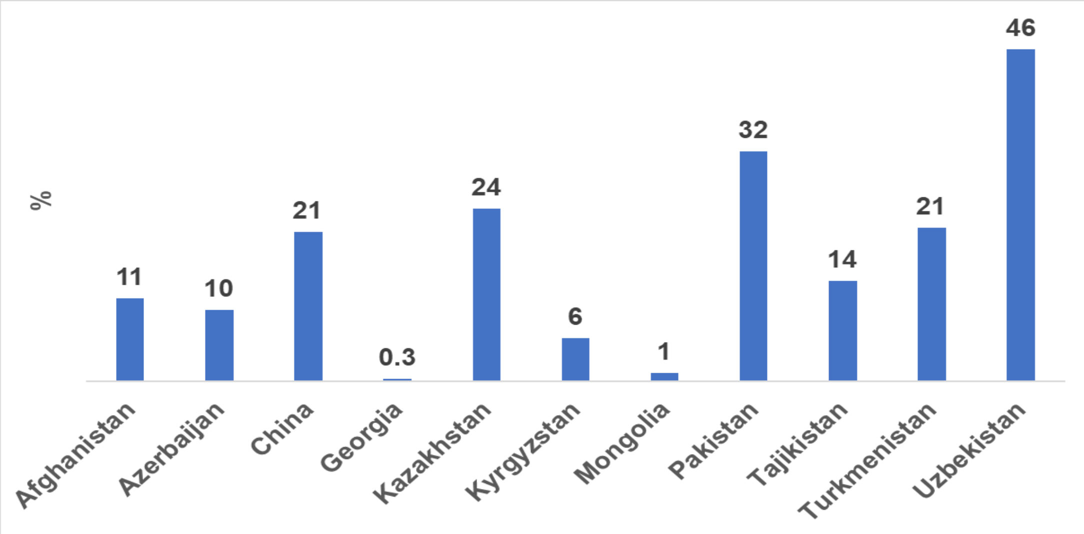


Figure 18: Share of water resources used for wheat, rice and cotton production across countries of region (Authors' estimates based on FAO 2018, Aldaya et al 2010, Mekonnen et al 2010)

Countries across the region differ in their strategies for ensuring food security. For example, Turkmenistan and Uzbekistan emphasize food self-sufficiency, while others pursue a more liberal trade regime and activist agricultural development policies as the path to food security.

The government of Uzbekistan has been persistently working on transforming its cotton- and wheat-growing zones with low yields (about 400,000 ha under several national programs, from 2016-2021) into horticultural production areas. Horticultural crops offer better export potential, tend to have a less water-intensive production, and generate higher value-added margins, i.e., gross margins per hectare are up to five times higher than cotton and wheat.

2.4. Energy

Whereas energy is required mainly for the provision of water services, water resources are required in the production of energy. As a country's or region's energy mix evolves, be it from fossil fuels to renewables, the implications for water and its supporting ecosystem services also change. It is important to look at the structure of electricity use by different sectors of the economy. This helps to provide weighted decisions for any country in the process of selecting mitigation and adaptation measures. It is evident that two sectors such as residential and industry & construction, on average consume about 37% and 36% of the total electricity respectively across countries (Figure 19).

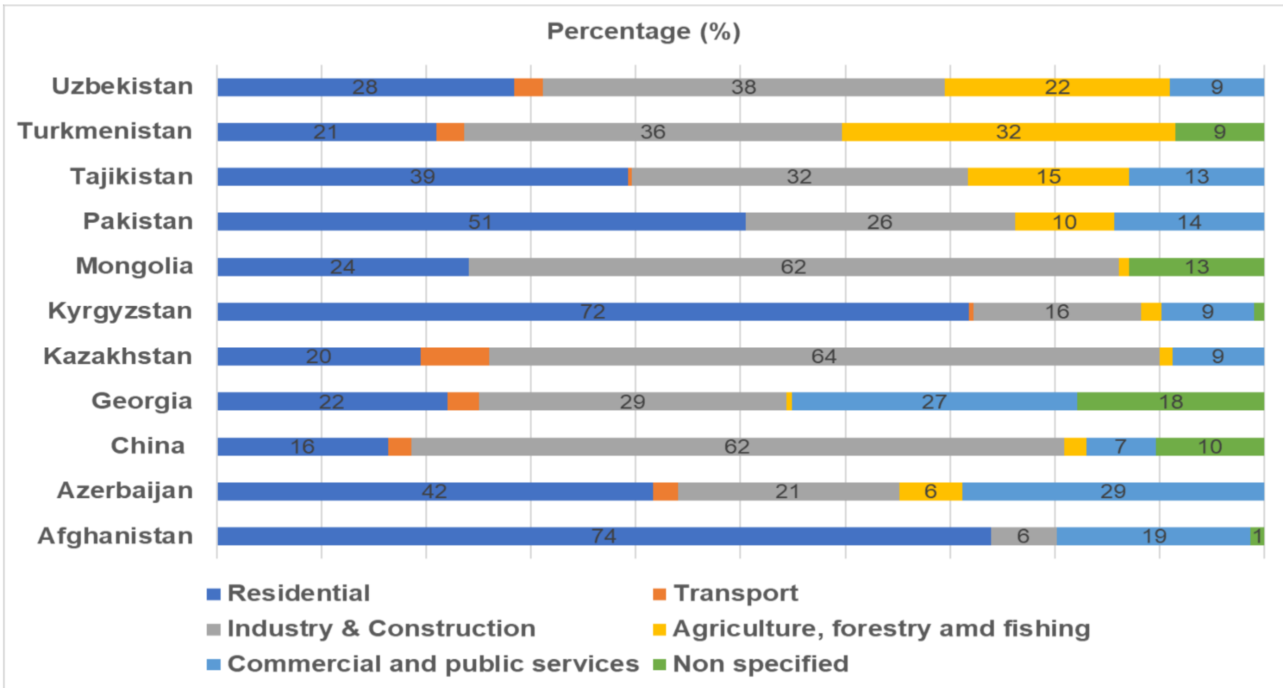


Figure 19: Electricity final consumption by sector in 2017 (IEA 2019) / For Afghanistan data are derived from presentation DA Afghanistan Breshna Sherkat 2011)

For example, Afghanistan, Kyrgyzstan and Pakistan governments should consider a priority to focus on designing energy efficiency programs for the residential sector as it consumes more than 50% of total electricity, whereas the industry & construction sector of China, Mongolia and Kazakhstan use more than 60%. Commercial and public services are an integral part of the economy which use about another 12% of total electricity.

Ironically, the effects of climate change on water availability may force countries to increase their dependence on coal and oil further increasing their carbon emissions. For example, energy shortages from low dam reservoir levels have already intermittently forced the use of coal-fired energy. Governments come under pressure to rebalance fossil fuel subsidies with support for cleaner energy sources in light of their Paris commitments.

Economies are still heavily dependent on fossil sources of electricity generation including coal, oil, and natural gas, contributing to the greenhouse gas effect (Figure 20). Hydropower generates more than 80% of electricity in Afghanistan, Georgia, Kyrgyzstan and Tajikistan. Natural gas generates more than 80% of electricity in Azerbaijan, Turkmenistan and Uzbekistan. Coal is the primary source of electricity generation in China, Kazakhstan and Mongolia. Approximately 60% of the region's electricity generation originates from coal, oil and natural gas fossil fuel sources. This characteristic of the region's energy sector explains the high share of global emissions of GHG in general, and of carbon dioxide in particular.

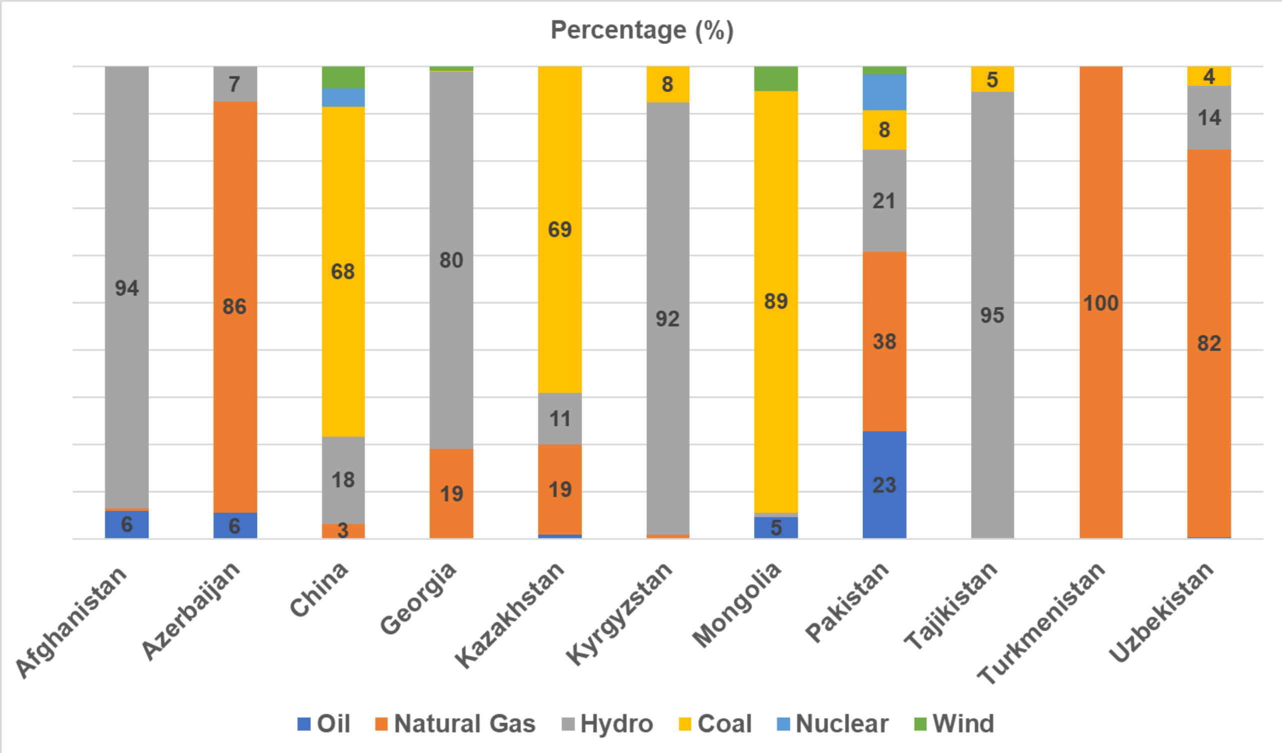


Figure 20: Electricity generation by source (IEA Data 2019)

The governments recognize that increased use of renewable energy will reduce the economy's carbon intensity and strengthen energy security by diversifying its energy mix through increased investments in renewable energy sources. At present, enabling the environment is in nascent conditions for full implementation of good intentions. Yet it is unfortunate that solar, wind, biofuels and geothermal (modern renewables) constitute a very small fraction in electricity generation across countries. Only China and Mongolia report to use modern renewables as 4% and 3% in electricity generation. This means that governments declare green economy and resource-efficient economic models as their strategic development milestones in absence of any practical proof of such a paradigm shift.

Energy intensity level of primary energy is the ratio between energy supply and gross domestic product measured at purchasing power parity. Energy intensity is an indication of how much energy is used to produce one unit of economic output (Figure 21). Central Asian countries remain among the least energy efficient and most carbon-intensive economies in the world. The root cause is old and inefficient energy infrastructure and industry machinery and equipment assets inherited from the former Soviet Union.

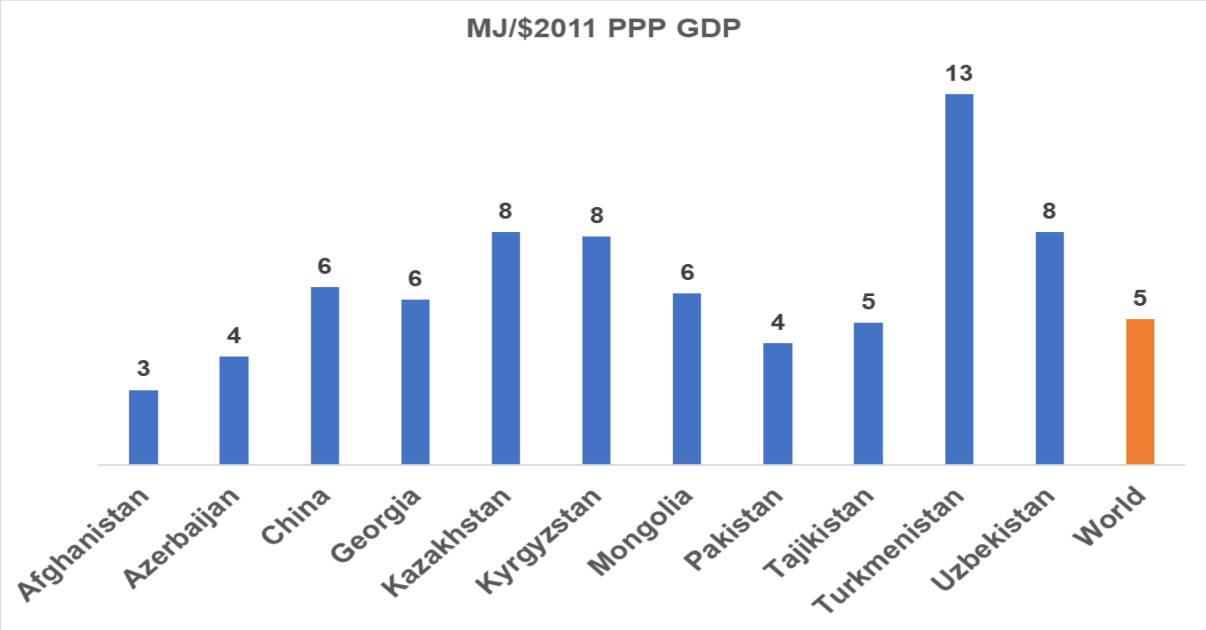


Figure 21: Energy intensity per unit of GDP, 2016 (IEA Data 2019)

2.5. GHG emissions

The structure of GHG emissions varies considerably among countries (Figure 22). Energy sector is the major emitter of GHG gases, followed by agriculture and industry. For example, 64% of overall GHG emissions was contributed from agriculture in Afghanistan (NC of Afghanistan 2017).

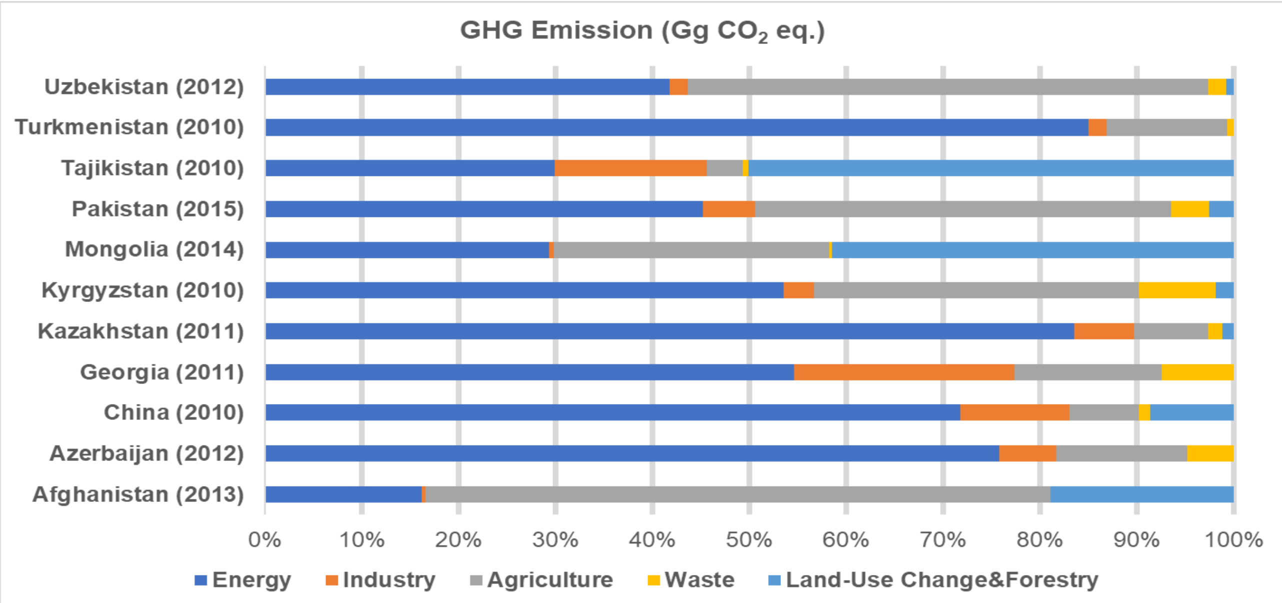


Figure 22: Greenhouse gas emissions by sectors across countries (National Communications to Climate Change)

Since 1990, all countries have substantially decreased their CO_2 emissions, except China, yet still show higher emission against global mean (Table 3). The main factor for decrease in emissions for the former Soviet Union republics is the collapse of their industrial capacities. Yet, the majority of countries still show high indication of CO_2 emissions. Collectively, CAREC countries emit about 30% of global greenhouse emissions, China contributes about 27% of that emission.

Table 3: Annual Greenhouse Gas Emissions (Carbon Dioxide) by CAREC countries and their share from global emissions (Source: Boden et al (2017), UNFCCC (2018), BP (2018))

	2015		**2016**		**2017**	
Country	**Territorial emissions in $MtCO_2$**	**Share from global emission (%)**	**Territorial emissions in $MtCO_2$**	**Share from global emission (%)**	**Territorial emissions in $MtCO_2$**	**Share from global emission (%)**
Afghanistan	10.1	0.03	12.3	0.03	13.0	0.04
Azerbaijan	40.2	0.11	39.7	0.11	38.2	0.11
China	9716.5	27.40	9704.5	27.20	9838.8	27.21
Georgia	9.5	0.03	9.8	0.03	11.0	0.03
Kazakhstan	263.5	0.74	278.4	0.78	292.6	0.81
Kyrgyzstan	9.9	0.03	9.9	0.03	10.4	0.03
Mongolia	20.4	0.06	28.7	0.08	30.4	0.08
Pakistan	172.1	0.49	187.4	0.53	198.8	0.55
Tajikistan	5.5	0.02	5.6	0.02	5.7	0.02
Turkmenistan	75.4	0.21	76.6	0.21	72.7	0.20
Uzbekistan	110.7	0.31	97.9	0.27	99.0	0.27
Total / share from global emissions (%)	10433.80	29.43	10450.80	29.29	10610.60	29.35

2.6. Conclusion

Agriculture is still an important sector for employment and economy for all countries. It is evident that with increasing population growth, per capita available arable land and water resources will be decreasing across all countries, except Georgia and Mongolia. Land degradation will impact quality of lands. In addition, desertification might be accelerated, and drier areas will demand more supplemental irrigation systems. It is obvious that electricity demand will increase too.

Governments should re-think on climate smart irrigation and agriculture systems such as drought resilient crops and solar powered irrigation pumps. Water productivities are still behind of global average and should be improved. For the production of wheat, rice and cotton, inappropriate share of lands and water are used. This can be observed mostly in Pakistan, Tajikistan, Turkmenistan and Uzbekistan. Vegetables, fruits and nuts are alternative crops for consideration instead of cotton and wheat.

Energy production balance clearly indicate that, more than 70% of it is powered from conventional sources. Solar and wind renewables are only operational on industrial level practiced in China, Mongolia and Kazakhstan. Most of the countries are rich with sunny days, yet solar photovoltaic production is still at nascent conditions. Greenhouse emissions are coming mainly from energy and agriculture sectors and its emissions per GDP are higher than global average.

CHAPTER 3. ECONOMIC AND FINANCIAL ASSESSMENT OF CLIMATE CHANGE IMPACT

This chapter explores the economic costs and financial aspects of climate change and potential options for adaptation. A greater emphasis is given to the agricultural sector which is one of the main sectors directly dependent on changing climate patterns.

Existing studies document A&M options as well as national commitments of countries from a technical perspective. Existing literature well defines which measure could be taken, however economic and financial potential on how to afford those technological changes are not yet discussed. A&M measures require enormous investments into financing technological changes. Moreover, motivation of involved stakeholders who are supposed to implement those mitigation and adaptation measures are not yet well documented. In the current literature, the role of financial instruments in creating a conducive environment for adoption of A&M measures were rarely in focus.

3.1. Assessment of economic losses due to climate change, economic costs of both adaptation and mitigation

3.1.1. Losses without adaptation

Changes in precipitation (Figure 7), water supply (Figure 8) and increased temperature (Figure 11) bring considerable economic losses in many economies of CAREC countries, especially in the agricultural sector. Therefore, estimation of costs is a very important aspect in order to prioritize investment strategies in the future. However, estimation of costs associated with climate change is a complex procedure which requires usage of climate, physical and economic models (ADB 2013b).

One of the important challenges in the estimation procedure is to differentiate if the occurred weather event is happening due to climate change or natural phenomena. Therefore, losses associated with weather extremes need to be estimated with and without climate change scenario. Difference between those estimations provides the economic loss associated with climate change. Several studies have emerged during recent years but availability of economic and financial impact is still limited in agriculture. For example, climate change may reduce GDP in Central Asia by 1.9%, in China 1,3% according to Zhai and Zhuang (2009). At farm level, the cost of climate change is associated with crop yield losses, livestock productivity as well as damages to farm and household assets associated with weather extremes (e.g. floods).

Bobojonov and Aw-Hassan (2014) estimate income changes under different climate change scenarios and identify that up to 57,5% decline in farm income could be estimated in some arid regions of Central Asia. Bobojonov et al. (2016) discuss that impact of climate change in irrigated farming systems is also location specific depending on the location of the farm in the irrigation system. Furthermore, economic cost of climate change could be also estimated according to the type of risks.

For example, ADB (2013a, b) estimates economic costs associated with reduced water flow is equal to USD 1.2 billion for Afghanistan, USD 103 million for Kyrgyzstan, and Tajikistan may have USD 177 million annually in 2100. Costs associated with natural disasters may sum up to USD 50 million for Afghanistan, USD 23 to 60 million for Kyrgyzstan and USD 280 million for Tajikistan in 2100 (ADB 2013b).

Several countries have already estimated the full cost of climate change including all sectors of economy. For example, Kyrgyzstan obtained overall losses without adaptation USD 1230.8 million in 2005 and USD 70 million from this amount belongs to agriculture and USD 718 million to water sector mainly due to unfavorable weather conditions (Government of the Kyrgyz Republic 2016). In Turkmenistan crop losses without adaptation for the years 2016-2030 is estimated as USD 20.5 billion (Government of Turkmenistan 2015).

3.1.2. Adaptation options

Table 4: Summary of key adaptation measure according to INDCs (Adapted from INDCs)

Country	**Adaptation measure**
Afghanistan	Increase irrigated land to 3.14 million ha; climate friendly irrigation; regeneration of 232,050 ha for forestry and 5.35 million ha for rangelands
Azerbaijan	Improved pasture and land management; plant new tree, windbreaks
China	Heat- resistant and drought-resistant crops; biological nitrogen fixation, green pest and disease; water conservation facilities; water-saving irrigation; restore grassland from grazing land; prevent grassland degradation; plant shelter belts; voluntary tree planting; construction of forestry infrastructure; Increase the forested area by 40 million hectares
Georgia	Innovative irrigation management and water application techniques, anti-erosion measures
Kazakhstan	Reconstruction and modernization of irrigation and collector networks; efficient irrigation techniques; crop rotation; increased soil fertility
Kyrgyzstan	Production specialization; cultivation of drought-resistant and salt-tolerant crops; phytomeliorative actions; improved pasture management, improvement of the agricultural infrastructure
Mongolia	Reduce bare fallow to 30%; crop rotation; expand irrigated cropland by 2- 2.5 times; zero-tillage technology; sustainable pasture management; soil protection; effective forest management
Pakistan	Green manure; better manure storage; organic fertilizer; genetically modified crops; Improved irrigation and water management; no-till technique; plantation of multipurpose and fast-growing tree species
Tajikistan	Green infrastructure in agriculture and irrigation systems
Turkmenistan	Drainage water collection and use after desalinization
Uzbekistan	Diversification of food crops; increasing crop resistance to droughts, pests and diseases; reconstruction and modernization of irrigation and drainage infrastructure; afforestation of the dried Aral Sea bottom; Restoration of forests; conservation of indigenous plant species

All countries consider a very large range of adaptation measures. In most of the intended nationally determined contributions (INDC)s and nationally determined contributions (NDCs) overarching objectives such as reducing the vulnerability, increasing adaptive capacity and improving resilience are included. Further aims and objectives relevant to the agricultural sector are increasing land use productivity, increased water use efficiency and reducing rural poverty. Adaptation of technologies with higher water use efficiency is required in Central Asia due to expectation of reduced water availability in the future (ADB 2014). In all countries the establishment of early warning systems for climate related extreme events is considered an important adaptation measure. More country specific adaptation measures are provided in Table 4.

Implementation of no-till technologies, crop diversification, effective irrigation systems, machinery upgrade, improved insurance mechanisms, improved grazing systems are mentioned as suitable adaptation strategies in the III-VI National Communication of the Republic of Kazakhstan to the UN Framework Convention on Climate Change (UNFCCC) from 2013. Adoption of conservation agriculture is already observed in Kazakhstan and China with high rates and potential for further increase is expected to be high. Furthermore, all countries consider the introduction of drought and heat resistant crop varieties to cope with increasing temperature.

3.1.3. Costs of adaptation

Annual cost of adaptation is estimated to range from USD 9 billion to 160 billion a year worldwide depending on the estimates of the World Bank, the United Nations Framework Convention on Climate Change, Oxfam and Global Environment Facility funds (UNESCO 2019). In agricultural production adaptation costs could be estimated according to the investment costs. For example, adoption of drip irrigation could range between USD 2300-3500 per hectare (FAO 2012). There are also some simpler methods of drip irrigation available. For example, IDE and Helvetas (2016) report about the potential of gravity-based drip irrigation for fruits with costs of USD 700-1200 per hectare. Costs of adoption of conservation agriculture in conditions of Kazakhstan are reported to be USD 250-300 per hectare mainly due to the need for investing in new machinery (World Bank 2013b).

In order to estimate the costs of adoption of technical adaptation measures in agriculture, expenses of a single adaptation measure and expected coverage under these technologies need to be estimated. For example, costs of adaptation are around USD $1.94 billion for Kyrgyzstan (Government of the Kyrgyz Republic 2016). In order to estimate costs of adaptation for other countries, expected hectares of each adaptation measure (e.g. Table 4) need to be obtained and multiplied with investment costs of each technology. There are also policies and socio-economic measures which can be considered as adaptation measure and costs associated with those measures could be approximated by amount of budget spent on those measures. However, there are still some costs can remain associated with structural changes which are difficult to measure directly.

3.1.4. Mitigation options

Table 5: Mitigation options (Adapted from INDCs' and National Communication from various years)

Country	**Mitigation options**
Afghanistan	Biomass recovery measures for energy; reduction in fuel used, or cleaner fuel technologies; optimal timing of fertilizer application
Azerbaijan	Methane gas from manure
China	reutilization of forestry and animal wastes; zero growth of fertilizer and pesticide use; methane and nitrous oxide emissions control
Georgia	increased forest area; expand protected area; carbon monitoring in forest areas
Mongolia	sustainable grassland management; forest protections; zero-tillage and crop rotation

Pakistan	Green manure; biogas and organic fertilizer; genetically modified crops; no-till farming
Tajikistan	Sustainable forest management, afforestation and reforestation
Uzbekistan	Conservation and restoration of forest resources; combating desertification

Agriculture is also one of the sectors which contribute to greenhouse gas emissions as discussed in Section 2.5 of the previous chapter. Therefore, reduction of emissions in agriculture is an important task to meet the climate goals. Therefore, a wide range of mitigation options also indicated as suitable options in national commitments and communications. Overall, all countries indicate improved crop management and irrigation mechanisms as potential options for mitigation which are often considered also as adaptation strategies. Furthermore, reducing nitrous oxide release from soils is also a widely mentioned aspect in many countries.

In the national commitments of Kazakhstan, Kyrgyzstan and Turkmenistan no specific action on mitigation is provided in the agricultural sector. However, some of the adaptation measures such as adoption of zero tillage and improved pasture management could be also considered as mitigation strategies at the same time. In the case of Uzbekistan, the largest attention is paid to afforestation of the dried Ara Sea bottom. ADB (2018) provides the review of a wide range of mitigation pilot projects for China. One of the interesting pilot projects combining several sectors is the Minan community's "Green Kitchen House" project where the city kitchen waste is used to produce compost and delivered to the population for free.

3.2. Financial tools to support mitigation and adaptation to climate change

3.2.1. Financing adaptation and mitigation

Several A&M options are identified in INDC and NDC and most of the defined measures have a technical character. Almost all the A&M activities require reliable economic and financial systems to finance implementation activities. In fact, there are several A&M options in agriculture, especially in crop production, which have positive or neutral return from switching to low carbon technologies. For example, switching to zero tillage technologies could be considered a promising adaptation as well as mitigation option for many countries of CAREC.

Reduced need for mechanization from the other side may contribute to increased energy efficiency. Improved soil productivity via residue accumulation and soil water capacity may help farmers to cope with negative consequences of rainfall deficit. There is a large number of studies investigating economic gains from conservation agriculture. However, enormous efforts are required in extension of activities at the regional and country levels. Furthermore, initial investment for purchase of machinery is also needed at farm level. Thus, financial resources are required to implement technical measures.

There are several options available to finance A&M activities - national and international sources is one of them. At the same time, they could be mobilized from public or private funds. In 2018 multilateral development banks consisting of the African Development Bank (AfDB), the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the Inter-American Development Bank Group (IDBG) and the World Bank Group (WBG) and the Islamic Development Bank (IsDB) committed USD 43,1 billion for climate financing in 2018 in developing and emerging economies (EBRD 2019). From these sources USD 12,9 billion is spent on adaptation and USD 30,2 billion spent to mitigation activities (EBRD 2019). Overall, 8% of mitigation finance is used for measures in the agriculture, forestry and land use sectors. In the adaptation finance, 18% is allocated to water and wastewater systems, 17% for crop and food production and 13% to other agricultural and ecological fields.

In most of the Central Asia countries financing activities are dependent on international funds and agencies, except the efforts of Kazakhstan, Turkmenistan and Uzbekistan (for limited activities). Kazakhstan is providing considerable support towards green economy and clean energy measures (OSCE 2017). Similarly, Uzbekistan is making large efforts to attract investment in the Clean Development Mechanism of the Kyoto Protocol. National Stabilization Fund and a State Development Fund in Turkmenistan provide loans for technological modernization and manage external shocks (UNECE 2013).

3.2.2. Financial instruments for adaptation and mitigation

Another type of A&M option is financial instruments. Agricultural credits could be considered as an important financial mechanism to increase adaptation potential of agricultural producers and rural population. Because adoption of more efficient, ecologically friendly technologies require certain investment and small-scale producers may not have required capital to purchase it. Therefore, availability and access to credits enable technology adoption thus making rural producers more resilient.

The table below shows the total credit provided to agriculture, forest and fishery in several countries of CAREC. The table also provides a share of credit provided to in total volume of credits to agriculture. The table shows that the share of credit provided to agriculture is relatively low when compared to the share of agriculture in GDP. One of the main challenges of low credit share in agriculture is the high interest rates of banks that make it unaffordable to many small-scale farms. Another problem is the high production risks and collateral required by banks. Many agricultural producers may not have assets to be used as collateral. Under these conditions, agricultural insurance may be used as collateral to obtain credits.

Table 6: Credit to agriculture, forestry and fishery in 2017 (Adapted from ADB 2019, FAOSTAT 2018, WB 2019a)

Country	**Credit to AFF, USD, current prices**	**AFF share of Total Credit to the economy**	**Share agriculture in GDP**	**Interest rate %**
Afghanistan	601,80	0,01	24,8	14,8
Azerbaijan	492,20	0,04	5,7	17,4
Georgia	38,26	0,02	8,0	11,1
Kazakhstan	2132,55	0,05	4,6	-
Kyrgyzstan	312,85	0,20	13,1	19,5
Pakistan	2937,99	0,08	23,9	8,5
Tajikisan	97,36	0,12	20,9	29,6

Additional to credits provided by national banks and microcredit agencies is that international organizations also provide loans for activities related to A&M. For example, the Green Climate Fund (GCF) has several loan programs to promote low carbon projects.

Agricultural insurance could be considered as one of the important tools to improve risk management options. Only limited countries have functioning agricultural insurance markets in the CAREC region. In fact, China, Kazakhstan, Mongolia, Pakistan and Uzbekistan have functioning agricultural insurance markets. One of the challenges in establishing functional insurance markets is the low-income generation in smallholder farming systems and low willingness to pay for insurance. Therefore, agricultural insurance is subsidized in many countries in the world (Mahul and Stutley 2010).

Agricultural insurance in China and Kazakhstan is subsidized as well. China provides about 80% subsidy towards insurance premiums (e.g. price of insurance). Similarly, Kazakhstan also subsidizes 50% of the losses of insurance companies associated with crop losses. Crop insurance in Uzbekistan is not subsidized but functions in combination with subsidized state credits to cotton and wheat production. Existing insurance markets have several challenges which limits the adaptation potentials. Lacking trust between insurance companies and farmers is one of the major challenges. Insurance companies suspect that farmers manipulate losses and claim payments also in conditions when crop loss occurs outside insured risks.

On the other hand, farmers show their mistrust to insurance farmers and indicate that they do not obtain claims also under conditions when insured risks occur. Furthermore, evaluation of losses by farm visit makes the product price very expensive. These challenges might be a main issue why agricultural insurance is not provided as adaptation potential in INDCs. Only Kazakhstan indicated options to improve its crop insurance mechanism in its INDC and is currently discussing development of insurance services intensively (OSCE 2017).

The recent development in the agricultural insurance market discusses the promising future for index-based insurance products. Advantage of index insurance is that the payments are not based on visits but rather on index highly correlated with yields. Data from climate stations (e.g. temperature, precipitation) and remote sensing data (soil moisture, NDVI) could be used as indexes to base insurance payments. These indexes are outside of the control of insurance companies and farmers therefore bring more transparency to the evaluation procedure. Furthermore, re-insurance companies are more willing to re-insurance national insurance companies when losses estimation processes are based on globally available data. Mongolia has the largest implementation of index-based insurance in the livestock sector (see section 3 for further info). Currently, index insurance is tested in pilot stages in China, Kazakhstan and Uzbekistan (KlimALEZ 2019). Further research needs to be conducted in order to investigate demand for such products and possible options for out-scaling.

Catastrophic risk coverage programs are another form of financial support aimed at supporting vulnerable stakeholders from extreme climate events. These are often programs providing payments to agricultural producers and rural population after extreme events such as floods and droughts. Producers usually participate with payment of small fees in these programs and are usually subsidized by states.

Subsidies could be considered as an important instrument to motivate farmers to adopt low carbon production methods or adaptation measures. In most of the cases, availability of budget for investing adaptation measures is low. Therefore, subsidies may provide some support in reducing the initial investment costs and make technologies more affordable. For example, the government of Kazakhstan is providing subsidies towards purchase of agricultural machinery to use for conservation agriculture (FAO 2013) (the next sub-section for more detailed info). Government of Uzbekistan (with PQ-4087 order of the president of Uzbekistan from 27.12.2018) has also announced a subsidy of 8 million soums (about USD 800) for purchase of drip irrigation for cotton production under state procurement.

Carbon market is one of the main mechanisms particularly in the energy sector which attracts investments from the private sector to invest into clean energy programs. Application of carbon market principle in agriculture is not yet wisely developed. This is mainly explained by relative low carbon saving in agricultural activities and low income earning from carbon projects in agriculture.

Energy and carbon taxation is another financial instrument that could be considered as an option in adoption of low emission technologies.

3.3. Best practices from CAREC region on climate financing

Currently, almost all countries indicate the need for adoption of A&M measures. However, in many countries, implementation strategies, policy frameworks and financing mechanisms to make A&M strategies attractive need to be developed further. The best practices discussed in this sub-section mainly provide examples where successful policy, legal and financial environments are well developed to support dissemination and wide scale adoption of A&M strategies.

3.3.1. Index-based livestock insurance in Mongolia

Index insurance for livestock could be one of the best examples from Mongolia to cope with negative consequences of climate change. Index based livestock insurance (IBLI) is almost only successfully commercialized not only in transition economies but also one of the few out scaled programs among developing countries. IBLI has been developed since 2001 with the support of the World Bank to protect herders from weather risks, especially harsh winters and dzud. Piloting activities started in 2006 in three provinces of Mongolia and stepwise scaled up to national levels till 2012. In 2014 all activities were transferred to private insurance companies and re-insurance companies based on public-private ownership. Insurance payments are based on district level livestock mortality rates. Insured headers receive indemnity payments when district level mortality drops beyond the predefined trigger (Bobojonov 2017).

In order to make the product price affordable, Mongolian government subsidizes the program. The state subsidizes the insurance premiums associated with extreme losses. Losses below 30% are insured under market-based conditions. Re-insurance of risks also implemented from collected premiums. Re-insurance of losses above 30% is fully covered by the state subsidies. In some extreme risky regions, extreme losses are defined at 20% level. Thus, in these regions the state subsidies the re-insurance premiums associated with losses are above 20% (Bobojonov 2017). Headers can select which livestock they want to insure and the percentage of the total value of the livestock.

For example, they can insure between 1-100% of the value of the livestock and on average 30% of the livestock value is insured (IBLI PIU 2012). In the 2015 season, about 5.1% of 51,98 million livestock in Mongolia was insured where the share of small ruminants was very high in insured livestock head (AgRe 2015). In 2015, there were 180 agents working in 1101 branches belonging to different insurance companies in 21 provinces of Mongolia (AgRe 2015). Participation of headers in the IBLI is voluntary and based on their interests on risk management. Another motivation aspect additional to risk management and premium subsidy from the state is that the insured headers could get a 2% reduction in interest rate when they obtain credits. Since 2017, banks have also started acting as brokers with certain brokerage fees and percentage of insured headers even increased since then.

3.3.2. Adoption of conservation agriculture for mitigation and adaptation in Kazakhstan

Conservation agriculture is one of the promising mechanisms to serve for both A&M purposes. Reduced energy use and carbon storage in agriculture makes the technology one of the attractive mitigation measures in the agricultural sector. Improved soil properties enable better soil water storage and higher yields, especially in the drought years. Kazakhstan could be considered as an example country where adaptation of conservation agriculture is happening with high speeds. Area under conservation agriculture has increased from 1,3 million hectare in 2008/2009 cropping season to 2,5 million hectares in 2015/2016 cropping season (Kassam et al 2018). Increased revenues due to reduced machinery costs and increased revenues could be one of the driving factors to adoption. Yield increase from adoption of conservation agriculture is estimated to be 14-41% in the regions (FAO 2013). However, large investments are also required associated with adoption due to changing machinery which is reported to be 250-300 USD (World Bank 2013b).

Government of Kazakhstan has created several incentive mechanisms to motivate farmers to invest in conservation technologies. One of the support forms is the provision of higher subsidies for machinery for conservation agriculture (FAO 2013). Although the amount of direct subsidy provided is not very high, combination of subsidy with benefits of adoption could provide incentives for adoption (Kienzler et al 2012). Therefore, without providing a conducive financial environment, the adoption rates may not have been such high.

3.4. Conclusion

Changing climatic conditions bring considerable economic losses in many economies of CAREC countries, especially in the agricultural sector. Estimating economic costs of climate change is a very important aspect in order to prioritize investment strategies in the future. Furthermore, suitable mitigation and adaptation mechanisms need to be identified to reduce environmental externalities and reduce the vulnerability of population, especially in rural areas.

Adaptation of technologies with higher water use efficiency, establishment of early warning systems for climate related extreme events, implementation of no-till technologies and crop diversification are considered as most important issues in the CAREC countries. Afforestation, improved crop management and irrigation mechanisms are considered suitable mitigation mechanisms in many CAREC countries.

Financial tools and mechanisms play an important role to accelerate adoption process and reduce climate vulnerability. There are several mechanisms such as credit, insurance, subsidies, carbon market and taxation could be showed as suitable financial mechanisms. However, there are fields yet underdeveloped in CAREC countries, except few exceptional situations. These few cases could be showed as case studies as an example to successful implementation and the role of financial mechanisms to boost adoption of mitigation and adaptation technologies. This report provides two case studies as best practices: dissemination of conservation agriculture in Kazakhstan and adoption of index-based insurance for livestock production in Mongolia.

CHAPTER 4: CLIMATE CHANGE GOVERNANCE

Governance is a process through which state and non-state actors interact to design and implement policies within a given number of formal and informal rules (World Bank 2017). It involves a set of policy, rules, norms, systems, institutions, mechanisms, and its successful enforcement is subject to effective interaction of various stakeholders involved in design and implementation. The World Economic Forum (2018) claims the failure of national governance as one of the top ten risks of highest concern globally for doing business. This attaches another importance to governance.

Hence, this chapter provides an understanding of governance and its interlink with climate change issues by giving a critical overview of national policy activities of CAREC member countries vis-à-vis the Paris Agreement and the Agenda 2030. By applying insights from engagement of CAREC countries with these global frameworks, the chapter explores climate change governance examining the synergies between NDCs and SDGs. Alongside aligning activities with global commitments of governments, national structures need also to exchange information, knowledge and experiences with each other, which is often limited in government systems, particularly, in developing countries. This is a bottleneck to explore for improving efforts in national boundaries and for crafting regional strategies on the subject.

4.1. **Climate change and governance**

Climate governance is often portrayed as a concept developed on global level and executed on national boundaries that collectively contribute to reaching global climate ambitions. Global policies are formulated through multilateral agreements that allow countries to align actions for common goal by providing pathways for implementing policies in a country-driven executing process. The adoption of the Paris Agreement in 2015 increased the reliance on national governments and suggested a hybrid form of governance by promoting polycentric, multi-field and collective decision-making (Ostrom 2009; Hoffmann 2011; Bulkeley et al. 2014; Boasson 2015; Hale 2016; Dorsch and Flachsland, 2017). The participation of a multitude of actors in decision-making beyond national governments and across a variety of sectors offers a holistic and inclusive climate action arguing in favour of both vertical and horizontal governance structures.

It is difficult to disagree with the notion that the blend of top-down and bottom-up approaches to combating climate change is the right way forward as they promote harmonization in activities while enhancing public participation. Yet it is difficult when it comes to coordination of large- and small-scale efforts (Farber D. 2011). Successful implementation of ambitious agreements therefore to a large part depends on how national stakeholders can interact effectively and coherently in the polycentric context. The role of both vertical and horizontal coordination and coherence of the governance architecture with a variety of stakeholders has since ever become crucial in tackling this and many other sustainability challenges. As Ostrom (2009) posits rightly, a polycentric approach to climate change has a significant role to play in successfully tackling risks and challenges associated with it.

An effective climate governance structure of a country is critical to identifying and assessing the potential risks and impacts of climate change and devising appropriate strategies to overcome them. The climate issue has globally become a national security challenge affecting many countries as its impact expanded over all sectors of economies (FAO 2018). Negative impacts on agriculture, health and environment far outweigh the other challenges they are facing. Effective measures against climate change can be developed through streamlined cooperation among different agencies of governments and other interested groups based on a participatory approach, and the effectiveness of their joint work. The urgency and volume of the matter is posing challenges for current political and institutional systems of countries in terms of coherence and coordination, including those of the CAREC region.

Climate change governance, herewith, has become a denotation of sustainable governance in general that directly affects economic growth, GDP, employment, and etc. Implications of increasing climate change related issues are actively slotting neatly into each sector of economies across both the CAREC region and the rest of the world. Under these circumstances, the consolidation of climate actions towards sustainable development goals has evolved into a precondition in reaching both climate and sustainability targets of countries.

4.2. **Global frameworks**

Signed in 2015, the Paris Agreement on Climate Change and the Agenda 2030 of Sustainable Development, call for governments and their national plans to combat climate change. In addition, countries adopted the Sendai Framework in 2015 to address a broader scope of hazards and risks to prevent and mitigate shocks caused by natural and man-made hazards (UNDRR 2019). In making the logical connection between reducing risk and building resilience, the Sendai Framework provides a connecting tissue for the 2030 Agenda and the Paris Agreement. The alignment between the latter two is critical to avoid duplication and increase impact of efforts by optimizing resource use, technical capacity, and sharing expertise and information (UNDP, 2017). Formulated transformative agenda in policy priorities, the analysis of these two helps to understand overlaps and reveal gaps in policy coherence in the countries.

The Paris Agreement generated sufficient political will and sense of urgency in tackling climate issues. As part of this process, CAREC countries also have expressed their commitments. Except Kyrgyzstan, all CAREC member countries have ratified the Agreement and INDCs have been submitted by each CAREC member country. Ratification of the agreement means the conversion of the submitted INDC to the first Nationally Determined Contribution (NDC) within the Paris Agreement which will determine the post-2020 period climate action on national level to meet the agreement targets. The first NDC will be valid until 2025 which is a year to submit the second NDC.

Historically, as true actors of global governance, countries’ commitment, and their actions through legislative, executive and judiciary governance bodies play a critical role in the realization of any multilateral agreement. The Paris Agreement has once more confirmed this notion while increasing reliance on national governments and their capabilities in meeting targets.

Table 7: Status of climate agreements in the CAREC region (Source: www.unfccc.int)

Country	**UNFCCC**	**Kyoto Protocol**	**Paris Agreement**	**Submission date of National Communication**	**Submission date of INDC**
Afghanistan	Jun 1992 (signed) Sep 2002 (ratified)	Mar 2013 (ratified)	Apr 2016 (signed) Feb 2017 (ratified)	NC1- Mar 2013 NC2- May 2017	Oct 2015
Azerbaijan	Jun 1992 (signed) May 1995 (ratified)	Sep 2000 (ratified)	Apr 2016 (signed) Jan 2017 (ratified)	NC1- May 2000 NC2- Jun 2011 NC3- May 2016	Sep 2015
China	Jun 1992 (signed) Jan 1993 (ratified)	May 1998 (signed) Aug 2002 (ratified)	Apr 2016 (signed) Sep 2016 (ratified)	NC1- Dec 2004 NC2- Nov 2012 NC3- Jun 2019	Jun 2015
Georgia	Jul 1994 (ratified)	Jun 1999 (ratified)	Apr 2016 (signed) May 2017 (ratified)	NC1- Aug 1999 NC2- Oct 2009 NC3- Feb 2016	Sep 2015
Kazakhstan	Jun 1992 (signed) May 1995 (ratified)	Mar 1999 (signed) Jun 2009 (ratified)	Aug 2016 (signed) Dec 2016 (ratified)	NC1- Nov 1998 NC2- Jun 2009	Sep 2015
Kyrgyzstan	May 2000 (ratified)	May 2003 (ratified)	Sep 2016 (signed)	NC1-Mar 2003 NC2-Dec 2008 NC3-Jan 2017	Sep 2015
Mongolia	Jun 1992 (signed) Sep 1993 (ratified)	Dec 1999 (ratified)	Apr 2016 (signed) Sep 2016 (ratified)	NC1- Nov 2001 NC2- Dec 2010 NC3- Dec 2018	Sep 2015
Pakistan	Jun 1992 (signed) Jun 1994 (ratified)	Jan 2005 (ratified)	Apr 2016 (signed) Nov 2016 (ratified)	NC1- Nov 2003 NC2- Aug 2019	Nov 2016
Tajikistan	Jan 1998 (ratified)	Dec 2008 (ratified)	Apr 2016 (signed) Mar 2017 (ratified)	NC1- Oct 2002 NC2- Dec 2008 NC3- Dec 2014	Sep 2015
Turkmenistan	Jun 1995 (ratified)	Sep 1998 (signed)	Sep 2016 (signed) Oct 2016 (ratified)	NC1- Nov 2000 NC2- Nov 2010 NC3- Jan 2016	Sep 2015

Country	**UNFCCC**	**Kyoto Protocol**	**Paris Agreement**	**Submission date of National Communication**	**Submission date of INDC**
		Jan 1999 (ratified)			
Uzbekistan	20 Jun 1993 (ratified)	Nov 1998 (signed) Oct 1999 (ratified)	Apr 2017 (signed) Nov 2018 (ratified)	NC1- Oct 1999 NC2- Dec 2008 NC3- Feb 2017	Apr 2017

The ratification of multilateral treaties demonstrates commitment of the countries, yet the degree to which the intended activities are well implemented depends on coherent and diligent actions of the involved stakeholders. By looking at the submission dates of National Communication (NC) reports to the UNFCCC, a tendency of falling behind the deadlines can be observed. According to the regulations of the UNFCCC, as Non-Annex I parties, all CAREC countries are expected to submit their first reports within three years after the ratification and the next ones every four years.

Table 7 displays delay in this process for all countries of the region in submitting both the first and next ones. This is another indicator, particularly, of efficiency and effectiveness of responsible government structures. This can be explained by limited financial possibilities or other constraints. But this can bear even more costs in the long-term. As the availability and exchange of information is a key instrument in making clear analysis of climate issues, the timely submission of informative materials becomes imperative. This, in its turn, can streamline the flow of financial and knowledge support in addressing the challenge in the best way.

The scale of governance effectiveness is manifested also in the submission of Voluntary National Reports (VNRs) on the implementation of SDGs for assessing the countries' achievements in fulfilling global commitments. VNRs on SDGs are voluntary and a state-led process which facilitates the sharing of experiences, including successes, challenges and lessons learned in implementing the 2030 Agenda. Among CAREC countries, only Azerbaijan already submitted two reviews, while others only the first ones. Kyrgyzstan and Uzbekistan are expected to submit first review reports in 2020.

Table 8: VNR submission years (Adapted from https://sustainabledevelopment.un.org/)

Country	Submitted years	Country	Submitted years
Afghanistan	2017	Mongolia	2019
Azerbaijan	2017; 2019	Pakistan	2019
China	2016; 2021 (planned)	Tajikistan	2017
Georgia	2016; 2020 (planned)	Turkmenistan	2019
Kazakhstan	2019	Uzbekistan	2020 (planned)
Kyrgyzstan	2020 (planned)		

Another aspect that needs consideration in this process is the designated focal points for the relevant treaties. Three dimensions of focal points depicted in table 9 are key structures to take the climate agenda forward in national contexts. UNFCCC focal points are usually responsible for the relationship of respective governments with the convention and translation of commitments into implementation phase. GCF NDAs maintain the workflow regarding financing A&M activities and focal points for High-level Political Forum on Sustainable Development (HLPF) on SDGs take responsibility for coordinating the work on SDGs in national contexts. These stakeholders are a bridge between the frameworks and governments, yet it is difficult to judge the effectiveness of the stakeholders involved on the ground. Through enhanced coordination, institutions can build on their different strengths, authorities and expertise to engage the government and other stakeholders more effectively (WRI 2018).

For instance, UNFCCC focal points and GCF NDAs for Kyrgyzstan and Uzbekistan are two different agencies. This leaves a space for miscoordination as work requires constant data exchange and assessment of indicators and made progress. Regarding SDGs implementation in countries, coordination will be even more of a need as they particularly require intra-governmental coordination on a larger scale. The question of whether SDG implementation groups in countries include UNFCCC and GCF national stakeholders for discussing at least SDGs 1, 2, 3, 7 and 13 remains open. These groups are differently formed and named in many of CAREC member countries.

Table 9. National Focal Points to UNFCCC, GCF, and High-Level Focal Point on SDGs (Source: www.unfccc.int, www.greenclimate.fund & www.susinabledevelopment.un.org

Country	National Focal Points to UNFCCC (agency)	National Designated Authority / Focal Point – GCF	Focal Point for High-Level Political Forum on SDG
Afghanistan	Ministry of Foreign Affairs	National Environmental Protection Agency	Ministry of Economy
Azerbaijan	Ministry of Ecology and Natural Resources	Ministry of Ecology and Natural Resources	National Coordination Council on Sustainable Development
China	Ministry of Foreign Affairs, Ministry of Ecology and Environment	Ministry of Finance & Ministry of Ecology and Environment	National Development and Reform Commission
Georgia	Ministry of Environmental Protection and Agriculture	Ministry of Environmental Protection and Agriculture	SDGs National Council Secretariat Administration of the Government
Kazakhstan	Ministry of Ecology, Geology and Natural Resources, Ministry of Energy	Ministry of Ecology, Geology & Natural Resources	Ministry for National Economy, Economic Research Institute
Kyrgyzstan	The State Agency on Environment Protection and Forestry	Ministry of Economy	State Agency on Environment Protection and Forestry
Mongolia	Ministry of Environment and Tourism	Ministry of Environment and Tourism	National Development Agency

Country	National Focal Points to UNFCCC (agency)	National Designated Authority / Focal Point – GCF	Focal Point for High-Level Political Forum on SDG
Pakistan	Ministry of Climate Change	Ministry of Climate Change	Ministry of Environment, Ministry of Foreign Affairs
Tajikistan	Agency for Hydrometeorology of the Committee of Environmental Protection	Committee of Environmental Protection	Ministry of Economic Development and Trade
Turkmenistan	Ministry of Agriculture and Environment Protection	Ministry of Agriculture and Environmental Protection	Minister of Nature and Environmental Protection
Uzbekistan	Centre of Hydrometeorological Service at the Ministry of Emergency Situations (UZHYDROMET)	Ministry of Investments and Foreign Trade	Mission of Uzbekistan to the UN

Of note, this is not a full architecture of government entities engaged in climate issues in the countries, but only those institutional mechanisms involved in communicating with international institutions and transferring commitments to national level implementation. To get the real picture and analyze the efficiency of policy development and implementation in national contexts, further institutional mapping will be necessary including those actors at the very local level represented by the private sector, civil society and local governments with access to and participation in decision-making.

4.3. NDC – SDG connections

The Paris Climate Agreement established objectives to tackle challenges associated with climate change and its implications while keeping the global temperature rise below 2 degrees Celsius. This, along with the Sustainable Development Agenda 2030, paved a pathway for a sustainable future until 2030 and beyond. In the implementation of sustainable development goals and NDCs, governance has a tremendous role. The analyses of the synergetic implementation courses of these two frameworks on the national level, to which CAREC countries bounded, can help to identify policy gaps and entry points for improving climate governance in the region.

It is necessary to look at how the implementation of the Paris Agreement is aligned with the 2030 Agenda for better understanding of policy coherence and efficiency in national contexts. Otherwise, it may pose a risk of making progress in one sector at the expense of another as the Agenda 2030 covers wide economic, social and environmental sectors. Coherent policies are subject to the availability and functionality of governance mechanisms that countries deploy in implementing the targets.

The juxtaposition of NDCs and SDGs explores the question whether the two multilateral agreements promote synergies (tables 10, 11 and 12). The data on NDC-SDG connections taken from the joint project website of the German Development Institute (DIE) and Stockholm Environment Institute (SEI) help to analyze the degree to which climate actions announced in NDCs reinforce SDGs implementation while providing ways for coherent policy framing in national contexts that can potentially bring coordination to the regional level as well. This can also outline some understanding on how political institutions and processes must be shaped in order to ensure coherent implementation of policies while minimizing trade-offs on the national level. Despite the fact that the data derived from analyzing only texts of NDCs of the countries, they can be instrumental in shaping climate related policies. Yet, ultimately, they provide also ideas for launching and strengthening collaboration that can be mainstreamed into regional scale operations.

Country	**Total Number of climate activities formulated in INDCs relevant to SDGs**
Afghanistan	74
Azerbaijan	25
China	94
Georgia	28
Kazakhstan	7
Kyrgyzstan	2
Mongolia	43
Pakistan	51
Tajikistan	24
Turkmenistan	9
Uzbekistan	n/a

The tables reveal that the activities highlighted in NDCs mostly encompass the SDGs 2, 6, 7, 8, 9, 11, 13, 15 and 17. The topic coverage spans from agriculture, water, energy, and climate action to economic growth, industry, infrastructure and partnerships. However, individual performance of each country differs from one another. The provided data also demonstrate that Central Asian countries have loosely connected NDCs with SDGs implementation, while Afghanistan, China, Mongolia and Pakistan are relatively performing better in combining these two global responsibilities in respective national contexts.

Table 11: NDC-SDG connections (a) (Source: adapted from https://klimalog.die-gdi.de/ndc-sdg/country/Average)

Countries	**SDG 1**	**SDG2**	**SDG3**	**SDG4**	**SDG5**	**SDG6**	**SDG7**	**SDG8**	**SDG9**
Afghanistan	1	13	0	3	0	10	11	3	7
Azerbaijan	0	0	0	1	0	1	11	0	1
China	1	5	2	2	0	4	16	5	20
Georgia	0	3	1	0	5	1	0	1	4

Countries	SDG 1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9
Kazakhstan	0	0	0	0	0	0	1	2	1
Kyrgyzstan	0	0	0	0	0	0	0	1	0
Mongolia	0	10	0	0	0	3	6	2	4
Pakistan	0	15	0	0	0	6	15	1	2
Tajikistan	0	1	1	1	1	3	1	2	4
Turkmenistan	0	0	0	0	0	1	1	2	0
Uzbekistan	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	1	47	4	7	1	29	62	19	43

Table 12: NDC-SDG connections (b) (Adapted from: https://klimalog.die-gdi.de/ndc-sdg/country/Average)

Countries	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16	SDG17
Afghanistan	0	0	6	9	0	9	0	2
Azerbaijan	0	7	0	3	0	1	0	0
China	0	23	3	2	1	7	0	3
Georgia	1	2	0	1	1	7	0	5
Kazakhstan	0	1	1	0	0	1	0	0
Kyrgyzstan	0	0	0	0	0	0	0	1
Mongolia	0	8	1	1	0	6	0	2
Pakistan	0	6	0	1	0	3	0	2
Tajikistan	0	1	0	2	0	4	0	3
Turkmenistan	0	0	0	2	0	1	0	2
Uzbekistan	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	0	48	11	21	2	39	0	20

The tables also show that agriculture (SDG 2) – one of the thematic focuses of this report – is well synergized with climate activities in Afghanistan, Mongolia and Pakistan. Seen through the prism of given data in the table, the situation in Kazakhstan, Kyrgyzstan, and Turkmenistan in this respect could look far better as agriculture is one of the most important drivers of their economies. Likewise, China also needs improvement in this sector.

SDG 7 – affordable and clean energy hits the top across all countries of the region with 62 climate activities cumulatively while also showing relatively higher positions in individual case vis-à-vis other SDGs. It shows that energy is a key sector for the economies of the region. Interesting comparison and analysis can be made by looking at table 13 which also shows that most of the adopted laws and regulations are in the energy sector. Following SDG 7, SDGs 11 – sustainable cities and communities, 2 – zero hunger, 9 – industry, innovation and infrastructure and 15 – life on land are top scorers in coherence with total climate activities in the amount of 48, 47, 43 and 39 respectively. Meanwhile, SDG 13 – climate action scored only 21 across the region.

SDG 6, which seeks to ensure the availability and sustainable management of water and sanitation for all, is far less aligned with climate activities across the whole region, yet, as was mentioned in previous chapters, it is the most vulnerable sector to climate change. Similarly, SDG 3 – good health and well-being is almost totally ignored, yet it is one of the most important goals.

These gaps underscore potential entry points for CAREC governments with respect to policy improvement and reinforcing the implementation of the two global agendas in national contexts. This would allow to reveal untapped potential for policy alignment while enhancing the impact of activities and resource effectiveness in the region. Yet, a high number of activities in NDCs is not necessarily an indicator of good policy coherence as they might undermine other potential factors affecting climate governance. For example, this does not show the capacity of governments to effectively implement them.

4.4. Climate change policy context

All eleven countries of the CAREC region have differing policies depending on the capacity and priority of the governments, size, financial capability, geographic and environmental particularities of each. Country response to climate change is shaped also by the country's location in the global economy, their relative material capacity and general status as a developed or developing country (Christoff P. et al. 2011). In order to analyze how the policies regarding climate change are effectively aligned, table 13 below presents the overview of strategic policies, laws and framework documents have been issued in each CAREC country since the UNFCCC launched in 1992.

Table 13: Number of climate change laws of CAREC countries since 1992 (Adapted from http://www.lse.ac.uk/GranthamInstitute/climate-change-laws-of-the-world/)

Countries	**Climate Change Laws**
Afghanistan	1. National Comprehensive Agriculture Development Priority Program 2016 – 2020 (Afghanistan / 2016 / Executive) 2. National Renewable Energy Policy (Afghanistan / 2015 / Executive) 3. National Biodiversity Strategy and Action Plan (Afghanistan / 2014 / Executive) 4. Rural Renewable Energy Policy (RREP) (Afghanistan / 2013 / Executive) 5. Law on Disaster Response, Management, and Preparedness (Afghanistan / 2012 / Legislative) 6. Strategic National Action Plan for Disaster Risk Reduction (SNAP) 7. The National Environmental Action Plan (NEAP) (Afghanistan / 2009 / Executive) 8. Energy Sector Strategy 1387-1391 (2007/8-2012/3) (Afghanistan / 2008 / Executive) 9. National Forestry Management Policy (NFMP) (Afghanistan / 2007 / Executive)
Azerbaijan	1. State Programme for the Socioeconomic Development of the Regions of Azerbaijan for the period 2014-2018 (Azerbaijan / 2014 / Executive)

Countries	**Climate Change Laws**
	2. National Forest Program (Azerbaijan / 2013 / Executive) 3. State Program on Poverty Reduction and Sustainable Development in the Republic of Azerbaijan for 2008-2015 (Azerbaijan / 2008 / Executive) 4. National Program on Environmentally Sustainable Socio-economic Development for 2003-2010 (Azerbaijan / 2003 / Executive)
China	1. 13th Five-Year Plan (China / 2016 / Executive / Mitigation Framework) 2. Law on the Prevention and Control of Atmospheric Pollution (China / 2015 / Legislative) 3. Energy Development Strategy Action Plan (2014-2020) (China / 2014 / Executive) 4. National Plan for Tackling Climate Change 2014-2020 (China / 2014 / Executive) 5. The National Strategy for Climate Change Adaptation (China / 2013 / Executive / Adaptation Framework) 6. 12th Five-Year Plan for the Development of National Economy and Society (2011-2015) (China / 2011 / Executive) 7. Energy Conservation Law (China / 2007 / Legislative) 8. Renewable Energy Act (Legislative) (China / 2006 / Legislative)
Georgia	1. Rural Development Strategy 2017-2020 (Georgia / 2016 / Executive) 2. Strategy for Agricultural Development in Georgia 2015-2020 (Georgia / 2015 / Executive)
Kazakhstan	1. Law on the transition to green economy (Kazakhstan / 2016 / Legislative) 2. Law on the Use of Nuclear Energy (Kazakhstan / 2016 / Legislative) 3. Law on Energy Saving (Kazakhstan / 2011 / Legislative) 4. Law about Support of Use of Renewable Sources of Energy No. 165-4 (Kazakhstan / 2009 / Legislative) 5. The Ecological Code of the Republic of Kazakhstan, No. 212 of 2007and Amendment to said legislation on 3 December 2011 (Kazakhstan / 2007 / Legislative) 6. The Concept of Transition of the Republic of Kazakhstan to Sustainable Development for the Period 2007-2024, Presidential Decree No 216 of 2006 (Kazakhstan / 2006 / Executive) 7. Law on Power Industry, No 588-II (Kazakhstan / 2004 / Legislative) 8. Government Decree No 857, on wind energy development (Kazakhstan / 2003 / Executive) 9. Civil Defense Law (Kazakhstan / 1997 / Legislative) 10. Law providing for management of natural and technological disasters (Kazakhstan / 1996 / Legislative) 11. Law providing for legal conditions of disaster management (Kazakhstan / 1993 / Legislative)
Kyrgyzstan	1. Climate Change Adaptation Programme and Action Plan for 2015-2017 for the Forest and Biodiversity Sector (Kyrgyzstan / 2015 / Executive) 2. Priorities for Adaptation to Climate Change in the Kyrgyz Republic till 2017 (updated to 2020) (Kyrgyzstan / 2015 / Executive) 3. National Sustainable Development Strategy for the Kyrgyz Republic (Kyrgyzstan / 2013 / Executive) 4. Law no. 137 “On the energy efficiency of buildings” (Kyrgyzstan / 2011 / Legislative) 5. Law No. 283 “On renewable sources of energy” (Kyrgyzstan / 2008 / Legislative) 6. Law no 71/2007 about state regulation and policy in the field of emission and absorption of greenhouse gases (Kyrgyzstan / 2007 / Legislative)

Countries	Climate Change Laws
	7. Law no. 88 “On energy saving” (Kyrgyzstan / 1998 / Legislative)
Mongolia	1. Action Programme for the Government of Mongolia 2016-2020 (Mongolia / 2016 / Executive) 2. Sustainable Development Vision 2030 (Mongolia / 2016 / Executive) 3. Green Development Policy (GDP) (Mongolia / 2014 / Executive) 4. Law on Air Quality (Mongolia / 2012 / Legislative) 5. Law on Soil Protection and Prevention of Desertification (Mongolia / 2012 / Legislative) 6. The Forest Law (Mongolia / 2012 / Legislative) 7. National Action Programme on Climate Change (NAPCC) (Mongolia / 2011 / Executive / Mitigation and adaptation Framework) 8. Renewable Energy Law (Mongolia / 2007 / Legislative) 9. National Renewable Energy Programme (2005-2020) (Mongolia / 2005 / Executive) 10. Law on Disaster Prevention, 2003 (Mongolia / 2003 / Legislative) 11. National Action Program to Promote Quality and Environmental Management Systems (Mongolia / 2002 / Executive) 12. The Energy Law (Mongolia / 2001 / Legislative)
Pakistan	1. Pakistan Climate Change Act, 2017 (Pakistan / 2017 / Legislative / Mitigation and adaptation Framework) 2. National Energy Efficiency and Conservation Act 2016 (Pakistan / 2016 / Legislative) 3. Pakistan 2025: One Nation, One Vision (Pakistan / 2014 / Executive) 4. Global Change Impact Studies Centre Act, 2013 (Pakistan / 2013 / Legislative) 5. National Power Policy (Pakistan / 2013 / Executive) 6. National Climate Change Policy (Pakistan / 2012 / Executive / Mitigation and adaptation Framework) 7. Alternative Energy Development Board Act (Pakistan / 2010 / Legislative) 8. National Forest Policy (Pakistan / 2010 / Executive) 9. National Sustainable Development Strategy (NSDS): Pakistan’s pathway to a sustainable and resilient future (Pakistan / 2010 / Executive) 10. The National Disaster Management Act 2010 (Pakistan / 2010 / Legislative) 11. The Pakistan Council of Renewable Technologies Act (Pakistan / 2010 / Legislative)
Tajikistan	1. Law No.587 on Promoting the Use of Renewable Energy (Renewable Energy Law) (Tajikistan / 2010 / Legislative) 2. Government Order No.73 on the Long-term Programme for Building Hydropower Plants for 2009-2020 (Tajikistan / 2009 / Executive) 3. Governmental Order No.189 on the Committee on Environmental Protection (Tajikistan / 2008 / Executive) 4. Governmental Order No.41 on the Complex Programme for the Widespread Use of Renewable Energy Sources (Tajikistan / 2007 / Executive) 5. National Action Plan for Climate Change Mitigation (Tajikistan / 2003 / Executive / Mitigation and adaptation Framework) 6. Law No.29 on Energy Saving (Tajikistan / 2002 / Legislative) 7. Law No.228 on Protection of the Atmospheric Air (Law on Air Protection) (Tajikistan / 1996 / Legislative)
Turkmenistan	1. National Strategy on Climate Change (Turkmenistan / 2012 / Executive / Mitigation and adaptation Framework)

Countries	Climate Change Laws
Uzbekistan	1. Decree no DP-2343 on the Program of measures to reduce energy consumption, implement energy-saving technologies in the fields of economy and social sphere for 2015-2019 (Uzbekistan / 2015 / Executive) 2. Decree no UP-4512 About measures for further development of alternative energy sources (Uzbekistan / 2013 / Executive) 3. Resolution of the Cabinet of Ministers No. 142 Action Plan of the Republic of Uzbekistan for Environmental Protection for the years 2013-2017 (Uzbekistan / 2013 / Executive) 4. Resolution of the Cabinet of Ministers No. 245 validating the Regulation on use of electric and thermal energy (Uzbekistan / 2009 / Executive) 5. Resolution of the Cabinet of Ministers No. 183 validating the Regulation on the State Hydrometeorological Service and Cabinet Decision no 606 (Uzbekistan / 2004 / Executive) 6. Law on the Rational Use of Energy; and the Parliamentary Decree regarding the procedure of enforcing the Law on the Rational Use of Energy (Uzbekistan / 1997 / Legislative)

Accordingly, all countries of the region are developing and implementing significant strategies, policy instruments and legal frameworks. This demonstrates that the climate issue is considered an important policy priority for the countries of the region. Yet, the question of their effectiveness in implementing those laws remains open. Garcia-Sanchez et al. (2013) argue that effectiveness is clearly linked to a country's economic and social growth, and that public organizations and their personnel perform their work well in accordance with overall social well-being. Basically, they argue that effectiveness of public administration is heavily affected by organization environment, political and internal characteristics.

The table shows insights into national governments' priorities with respect to climate policy. Key policy development on climate started in all countries of the region mainly from the early 2000s. It can be concluded that the mainstream policy making in the region is on the energy sector. As the previous section also highlighted, SDG 7 – affordable and clean energy is way ahead of the other SDGs when it comes to coherence in implementing the Paris Agreement and the Agenda 2030. Energy efficiency and renewable energy policies prevail over all other sectors.

4.5. **Conclusion**

Climate governance is not only about how effectively various government structures work together and produce sound laws and policies, but also how effectively they interact with global, regional development and financial stakeholders as well. This reflection could also provide more objective and evidence-driven assessment of governance in the region as this would allow assessment of how allocated financial resources through various funds, including the Green Climate Fund, are directed rationally in tackling climate challenges. Consequently, this may bring opportunities to countries and the CAREC region as a whole for further scaling up efforts to tackle climate change challenges by mobilizing yet untapped funds, expertise and technologies.

Lack of coordination or limited inter-agency cooperation in government structure may heavily downplay the practical application of laws and response policies. It is therefore largely important to analyze and understand how policy coordination patterns are well aligned in reinforcing manner. The given NDC-SDG connections provided assessment of policy coherence in the CAREC region that can serve as prospective entry points for changing or improving governance in the countries, also vis-à-vis legislation. As seen in previous chapters, the interaction of climate policy cuts across many other sectors, including water, energy, food and etc. Though, this only top-down part of policy making. To have the most comprehensive policy mechanism at hand, there should be clear interaction in both vertical and horizontal dimensions of governance. Ultimately, what is significantly needed is a broader understanding of the ways to involve the private sector, local farmers and populations in the areas in decision-making process of national climate policies. This in turn can provide comprehensiveness of policies developed.

CHAPTER 5: CAREC CLIMATE VULNERABILITY INDEX

5.1. Conceptual basis

There is no universally applicable methodological framework, nor is there a universal set of indicators to measure the adaptation progress (IPCC 2014, Leiter and Pringle 2018). Several initiatives, guidelines and frameworks have been launched at the national and global level (Christiansen et al 2018). The main constraints are absence of adequate baseline information, complexity of processes and project-specific outcomes. Instead, selection of both methodology and used indicators vary from case to case depending on the purpose of assessment (FAO 2017).

IPCC (2014) outlines three main uses of metrics and corresponding approaches:

- measuring adaptation needs, with a focus on vulnerability assessment;
- tracking the progress of adaptive actions;
- measuring the effectiveness of adaptation, which encompasses monitoring and evaluation.

The application of the latter two approaches is hampered by several constraints that refer to the absence of clear quantitative adaptation targets among the countries. Furthermore, the diversity of climatic zones, variability of endowed natural resources and associated main economic activities determine the multidimensional set of climate threats faced by CAREC region countries.

It is widely known, measuring the degree of country vulnerability, usually means metrics for identifying and prioritizing adaptation needs. The IPCC Third and Fourth Assessment Report defines vulnerability as “The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity” (IPCC 2001 and 2007).

Accordingly, the vulnerability is presented as a function:

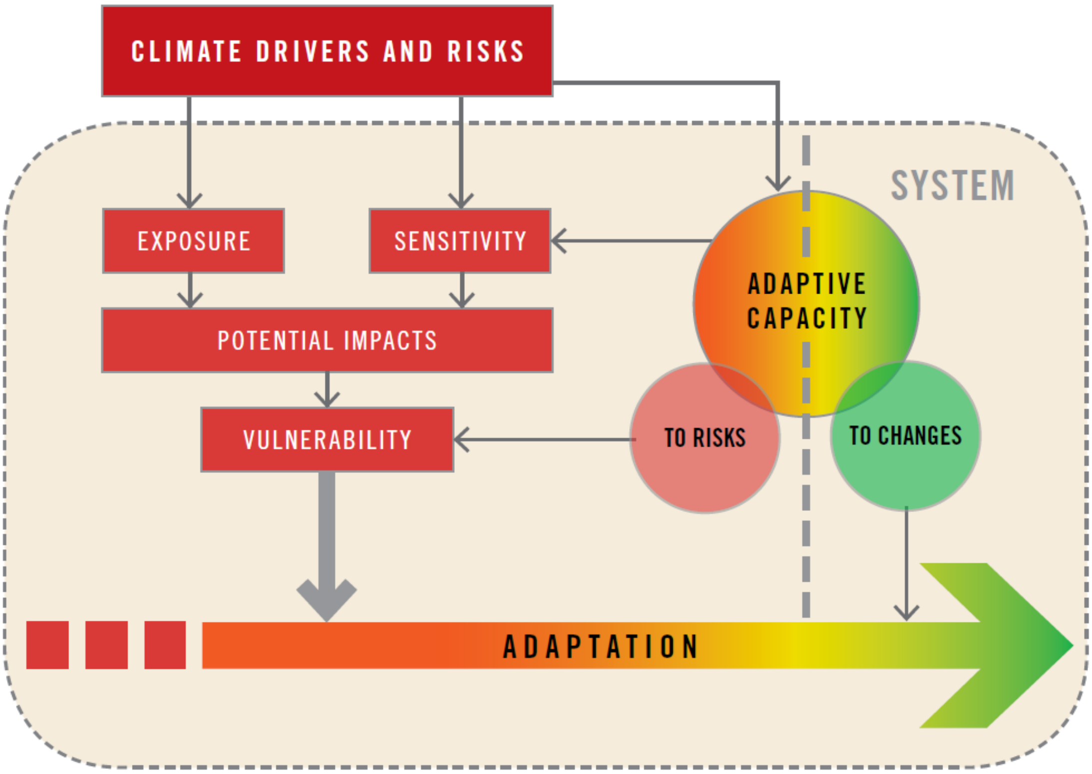
Vulnerability = f (Exposure, Sensitivity, Adaptive Capacity) where:

- Exposure - “The nature and degree to which a system is exposed to significant climatic variations.”
- Sensitivity - “the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise).”;

- Adaptive Capacity - "The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences."

The theoretical and conceptual basis is based on works by Fritzsche et al (2014) and Füssel and Klein (2006). Füssel and Klein (2006) describe a broader-scale vulnerability assessment framework which is regarded by them as the initial step ("first-generation") for the evaluation of climate impacts, assessment of the relative importance of climatic and non-climatic factors, and consideration of potential adaptation. Accordingly, both the sensitivity and exposure, which are also affected by a wide range of non-climatic factors, constitute the potential impact of climate change (Figure 23).

Figure 23. Relationship between vulnerability as function of Exposure, Sensitivity, Adaptive Capacity (Source: based on FAO 2017 and Fritzsche et al 2014)



It is proposed to estimate sectoral vulnerability indices across CAREC countries by juxtaposing a set of the selected indicators reflecting the Potential Impacts and Adaptive Capacity of the underlying system.

This paper outlines a methodological approach for CAREC Climate Vulnerability Index with a focus on the water sector at the national level. This Index provides a clear interrelationship between exposure, sensitivity, and adaptive capacity and selected seven subcategories of indicators reflecting on natural resources, infrastructure capacity, socioeconomics and institutions. Generally, indicators are quantitative, and data retrieved from databases related to international development.

The methodology provides step-by-step procedures including a scoring procedure with ascribing weights and normalization from 0 to 1, converted from raw quantitative data. The scoring system matches the three levels of vulnerability: high, moderate and low. In a next phase, agriculture and energy sectors should be included for elaboration of the Vulnerability Index.

5.2. Index Indicators

Table 14 presents the most important indicators to assess the adaptation potential and vulnerability of the water sector, and that address water availability issues associated with climate change. Selection of these indicators are implemented based on intensive literature review and expert judgement.

Table 14: Set of indicators for assessment of water sector vulnerability index

WATER SECTOR ASSESSMENT		
Potential Impact		
Exposure	**Sensitivity**	**Adaptive Capacity**
E: Projected decrease in availability of water resources under RCP 4.5	**S1:** Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as % of total renewable water resources per FAO) **S2:** Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices) **S3:** Water dependency ratio	**AC1**: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal) **AC2:** Institutional and Human capacity – Government Effectiveness **AC3:** Economic Capacity – GNI per capita (current)

*Exposure sub-indicator***:**

E: Projected decrease in availability of water resources by 2040 under RCP 4.5

This indicator measures future availability of annual renewable water resources in the country and largely consists of forecasts on changes in the annual discharge of river basins.

Data source: CMIP5 projections derived from Aqueduct 3.0, based on Luck et al (2015**) -**
https://github.com/wri/aqueduct30_data_download/blob/master/metadata.md

Sensitivity sub-indicators:

S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)

The proportion of total water resources used is the total volume of groundwater and surface water withdrawn from their sources for human use (in the agricultural, domestic/municipal and industrial sectors), expressed as a percentage of the total actual renewable water resources. It was the Millennium Development Goal (MDG) Indicator 7.5, from which the Sustainable Development Goal (SDG) indicator 6.4.2 is derived.

Measurement units: billion m3/billion m3 (%)

Data source: FAO AQUASTAT –
http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en

S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 US$)

Water footprint under this review stands for economic water productivity calculated as the amount of water used to produce goods and services in the CAREC region countries. This indicator serves as a proxy of dependence of the national economy on water resources. On the other hand, the indicator can be viewed as an estimate of water use efficiency on a national scale, which also allows tracking performance of the countries in strengthening their resilience to water scarcity in the future.

Measurement units: billion m3/US$

Data source: FAO AQUASTAT
http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en

S3: Water dependency ratio

Water dependency indicator expresses the share of total renewable water resources originating outside the country. The rationale behind inclusion of this indicator is in the fact that a substantial share of available renewable water resources in larger parts of the CAREC region are of transboundary nature.

Measurement units: billion m3/billion m3 (%)

Data source: FAO AQUASTAT
http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en

Adaptive Capacity sub-indicators

AC1: Infrastructure Capacity

Under this category the indicators include 1.) "***Water storage capacity***" which describes the total capacity of a country's water reservoirs in relation to the total annual freshwater withdrawal.

Measurement units: km3/km3

Data source: FAO AQUASTAT
http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en

AC2: Institutional and human capacity

Government effectiveness

Government effectiveness reflects abilities of the states to provide quality public services, maintain quality civil service, to design and implement sound policies, and the credibility of the government's commitment to such policies.

Data source: The Global Economy.com
https://www.theglobaleconomy.com/

AC3: Economic capacity

There is a universal consensus that developing countries are more vulnerable to negative climate change impacts compared to developed countries, and that vulnerability is linked with the level of economic prosperity of a country. GNI per capita (Atlas method in current US$) is chosen as an indicator measuring the state of the development.

Data source: WB country key indicator database
https://data.worldbank.org/indicator/NY.GDP.PCAP.KD

5.3. Calculating Approach to Water Sector Assessment

Step 1: Calculation of each sub-indicator**.**

Step 2: Setting the score for each sub-indicator according to the "Normalization" process. Indices for each sub-indicator range from ∈ {0….1} or {-1….1}. The ranges of scores per each indicator were established based on objective criteria where possible, and on expert judgement (Table 15). Accordingly, given numeric values have been normalized and sub-indicator scores have been established.

Table 15: Normalization of indicators for assessment of water sector vulnerability index

Projected decrease in availability of water resources by 2040 under RCP 4.5 scenario	default value									
Withdrawal to availability ratio	default value									
Water consumption per GDP (cubic meters/GDP in constant 2010 US$)	100 and less	200	300	400	500	600	700	800	900	1000 and more
	0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1**
Water dependency ratio	default value									
Water storage index (ratio of storage capacity to total annual withdrawal)	default value									
	-1.5 and less	*-1.5 to -0.9*	*-0.9 to -0.4*	*-0.4 to -0.1*	*-0.1 to 0.1*	*0.1 to 0.4*	*0.4 to 0.9*	*0.9 to 1.5*	*1.5 to 2*	*2 to 2.5*
Government effectiveness	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1**
GNI per capita (lowest and highest thresholds are derived from WB classification of low income and high income countries respectively)	Low income (less than 1025$)	1025-2500	2500-4000	4000-5500	5500-7000	7000-8500	8500-9000	9000-10500	10500-12000	High income (> 12,375$)
	0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1**

Step 3: Calculating weighted arithmetic average score per each component (**Exposure, Sensitivity, Adaptive Capacity**). The weights were assigned based on the expert judgement on degree of influence of each sub-indicator, e.g. *"Water withdrawal ratio" has more influence on Sensitivity than "Water dependency" so its contribution to the overall score for Sensitivity should be higher.*

Table 16. Weights assigned to the indicators for assessment of water sector vulnerability index

EXPOSURE	***weight assigned to the subindicator***
Projected decrease in availability of water resources by 2040 under RCP 4.5	*1*
SENSITIVITY	
Water withdrawal to availability ratio (Freshwater withdrawal as % of total renewable water resources (%))	*0.5*
Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 US$)	*0.30*
Water dependency ratio	*0.2*
ADAPTIVE CAPACITY	
Infrastructure capacity	
Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	*0.20*
Institutional and human capacity	
Government effectiveness	*0.4*
Economic capacity	
GNI per capita (current)	*0.4*

Step 4: Vulnerability Index is a function of Potential Impacts (a combination of Exposure and Sensitivity) and Adaptive Capacity, and is calculated as:

VI= (Exposure*Sensitivity) / (Adaptive Capacity)

5.4. Results and Discussion

Table 18 depicts water sector vulnerability index scores for CAREC countries. It is clear that all countries will have consequences on availability of water resources due to climate change. These challenges are however varying in degree of intensity across the countries, and the four countries, namely Afghanistan, Pakistan, Turkmenistan and Uzbekistan will most likely observe the harshest impacts.

Table 17: Estimated Water sector Vulnerability index for CAREC countries, and resulted scores per each component (Exposure, Sensitivity, Adaptive Capacity)

Country	Scores			
	Exposure	Sensitivity	Adaptive capacity	Index
Afghanistan	1,20	0,48	0,14	4,14
Azerbaijan	1,40	0,40	0,70	0,80
China	1,00	0,14	0,88	0,16
Georgia	1,40	0,06	0,81	0,11
Kazakhstan	1,00	0,21	1,31	0,16
Kyrgyzstan	1,00	0,22	0,87	0,25
Mongolia	0,83	0,04	0,39	0,08
Pakistan	1,00	0,72	0,27	2,65

Country	Scores			
	Exposure	**Sensitivity**	**Adaptive capacity**	**Index**
Tajikistan	1,00	0,31	0,67	0,47
Turkmenistan	1,20	0,90	0,31	3,52
Uzbekistan	1,20	0,87	0,28	3,71

high risk moderate risk low risk

Exposure indicator does not change with time, whilst the Sensitivity and Adaptive capacity may change with time. For example, implementation of water saving technologies on mass scale will improve water use efficiency, and thus diminish the sensitivity to water availability. For water dependency, effective transboundary agreements, data sharing and river basin organizations are preconditions.

Multiple studies show that improved governance is a precondition for better development outcomes such as economic growth, public and foreign direct investment, physical and social infrastructure management (Hughes et al. 2012, Garcia-Sanchez 2013, Han et al. 2014, Chen et al. 2015, Marin-Ferrer et al. 2017). With regard to adaptation efforts, the earlier study (Brooks et al. 2005) emphasizes the importance of governance indicators in translating vulnerabilities of the developing countries on national scale.

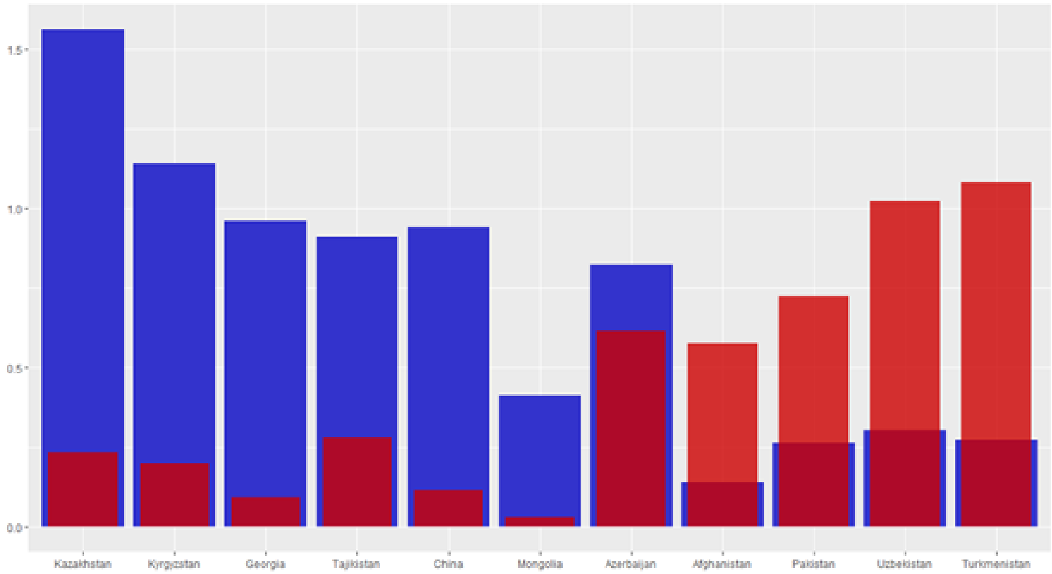


Figure 24: Potential impacts (red) on water resource availability and adaptive capacity (blue) of the CAREC region countries to climate impacts on water availability (Source: authors estimations)

Thus, it is necessary to re-think their agricultural production models, water allocation, and crop diversification with drought resistant varieties (Figure 24). For example, Turkmenistan and Uzbekistan should strategically reconsider diversification of cropping, from cotton to horticulture and fodder. In addition, for water-related infrastructure, there is a need to reassess the safety and sustainability for the optimization of their services. Overall operational efficiency declines as any structure approaches its design life. It is necessary to consider groundwater, drainage and reclaimed water resources in future planning. Five countries of the CAREC region are more water dependent from transboundary rivers. Thus, international water management cooperation is another important arena to improve its water security.

Natural hydrological systems are at the upfront of climate change impacts, because they are directly affected by variability of climatic factors (precipitation and temperature), that also determine dynamics of such important components as snowpacks and glaciers over a time. Climate change may significantly impact water resources in the region (CAREC 2019) and prospective challenges include reduction of rivers run-off in the medium to long term, shift in seasonal patterns of river run-off that eventually may lead to excessive discharge in the springs and reduced water availability in summer to autumn periods (PIK 2017). Thus, the higher the ratio of water consumption per unit of GDP, the more susceptible is the economy to future changes in water availability (Figure 25).

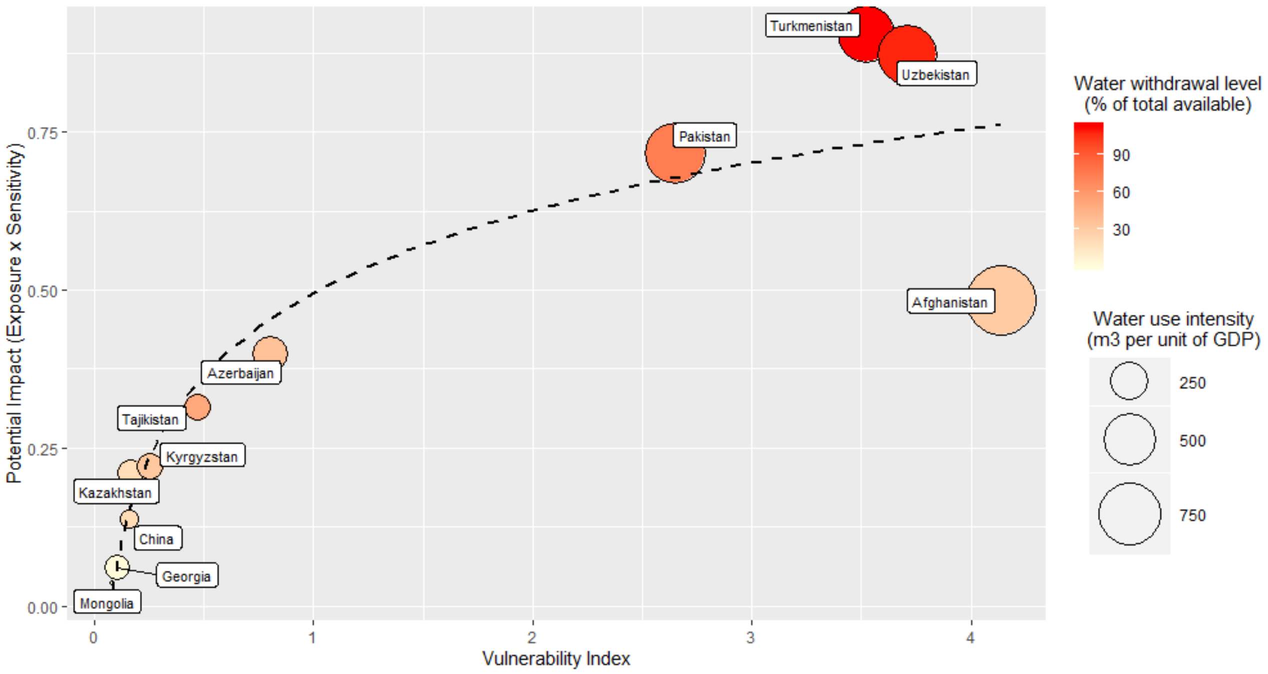


Figure 25: Relationship of the estimated vulnerability of the CAREC region countries to climate induced water stress with baseline water intensity

CONCLUSION

The mainstreaming of climate change adaptation programs requires concerted efforts via inter-sectorial coordination mechanisms both on national and regional levels. Comprehensive review of national communication reports and scientific research reports on climate change indicates that several geographic sub-regions could be particularly prone to population movements/displacements. Governments can use this information for making informed decisions in priority for financing and designing national programs. Interlinkages of water-energy-food should be reviewed on a systematic basis. For example, limited water availability interrupts electricity generation, at the same time, limitations on energy availability might constrain the delivery of water services.

High economic costs are unavoidable if adaptation measures are not implemented. First, large investment costs are required to make adaptation measures disseminate into large areas. Second, some of the adaptation measures require careful implementation not to danger sustainability in the long run. For example, in many countries increasing irrigated lands is considered as an important adaptation measure, whereas it may bring considerable problems to the environment in the long-term. Third, the time horizon of countrywide dissemination of adoption measures need to be realistically assessed. Usually, several years and decades are needed until adoption covers large areas.

The role of finance in A&M context is an important aspect of determining speed and spatial coverage of dissemination. For example, the provision of credits and monetary incentives. Agricultural insurance and catastrophic risk coverage programs are tools to increase coping strategy of agricultural producers. However, the importance of such instruments is not yet explicitly discussed in national circles up to date. Another challenge in current national intentions is the lack of systemic assessment of implementation strategy of A&M measures dissemination.

Besides the pursuit of new technical solutions, new policy and economic frameworks need to be designed to promote cooperation and integrated planning among sectors. Integrated planning and cross-sector cooperation will leverage possible synergies for decreasing costs, assessing tradeoffs, demand-side interventions, and decentralized services for ensuring sustainability of infrastructure and sectors. Increased access to finance through insurance can be instrumental for implementing adaptation policies. Setting up inter-sectoral coordination institutions and structures will be of foremost importance. In this regard, the implementation of climate change adaptation measures requires comprehensive analysis of stakeholders, their roles and perceptions.

The developed vulnerability index for the water sector clearly indicates that four countries of the CAREC region, namely Afghanistan, Pakistan, Turkmenistan and Uzbekistan, will likely experience significant risks associated with climate change impacts unless their existing agricultural cropping systems, agricultural diversification programs, value chains, adaptation of water and land conservations technologies are revisited.

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ANNEX: COUNTRY PROFILES

AFGHANISTAN

INDICATORS	Value	Indicator score	Componen t score
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	1,20	1,20	**1,20**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)	31.04%	0,31	**0,48**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	967,60	0,90	
S3: Water dependency ratio	28.72%	0,29	
ADAPTIVE CAPACITY			
AC1: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	0,10	0,10	**0,14**
AC2: Institutional and Human capacity – Government Effectiveness	-1.46	0,2	
AC3: Economic Capacity – GNI per capita (current), Atlas Method	564	0,1	
Vulnerability index			**4,14**

AZERBAIJAN

INDICATORS	Value	Indicator score	Component score
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	1,40	1,40	**1,40**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)	36.85%	0,37	**0,40**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	222,82	0,2	
S3: Water dependency ratio	76.6%	0,77	
ADAPTIVE CAPACITY			

AC1: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	1,68	1,68	**0,70**
AC2: Institutional and Human capacity – Government Effectiveness	-0.1	0,5	
AC3: Economic Capacity – GNI per capita (current), Atlas method	4050	0,4	
Vulnerability index			**0,7**

CHINA

INDICATORS	**Value**	**Indicator score**	**Componen t score**
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	1,00	1,00	**1,00**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)	20.92%	0,21	**0,14**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	52,00	0,1	
S3: Water dependency ratio	0.96%	0,0096	
ADAPTIVE CAPACITY			
AC1: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	1,40	1,40	**0,88**
AC2: Institutional and Human capacity – Government Effectiveness	0.48	0,7	
AC3: Economic Capacity – GNI per capita (current), Atlas method	9460	0,8	
Vulnerability index			**0,16**

GEORGIA

INDICATORS	**Value**	**Indicator score**	**Component score**
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	1,40	1,40	**1,40**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)	2.879%	0,03	**0,06**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	103,49	0,1	
S3: Water dependency ratio	8.211%	0,082	
ADAPTIVE CAPACITY			
AC1: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	1,87	1,87	**0,81**
AC2: Institutional and Human capacity – Government Effectiveness	0.61	0,7	
AC3: Economic Capacity – GNI per capita (current), Atlas method	4440	0,4	
Vulnerability index			**0,11**

KAZAKHSTAN

INDICATORS	**Value**	**Indicator score**	**Component score**
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	1,00	1,00	**1,00**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)	19.77%	0,2	**0,21**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	111,58	0,1	

S3: Water dependency ratio	40.46%	0,41	
ADAPTIVE CAPACITY			
AC1: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	3,51	3,57	**1,31**
AC2: Institutional and Human capacity – Government Effectiveness	0.2	0,6	
AC3: Economic Capacity – GNI per capita (current), Atlas method	8070	0,9	
Vulnerability index			**0,16**

KYRGYZSTAN

INDICATORS	Value	Indicator score	Component score
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	1,00	1,00	**1,00**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as % of total renewable water resources (%) per FAO)	32.63%	0,33	**0,22**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	116,60	0,1	
S3: Water dependency ratio	1.128%	0,13	
ADAPTIVE CAPACITY			
AC1: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	2,94	2,94	**0,87**
AC2: Institutional and Human capacity – Government Effectiveness	-0.061	0,5	
AC3: Economic Capacity – GNI per capita (current), Atlas method	1220	0,2	
Vulnerability index			**0,25**

MONGOLIA

INDICATORS	Value	Indicator score	Component score
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	0,83	0,83	**0,83**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)	1%	0,01	**0,04**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	3,46	0,1	
S3: Water dependency ratio	0.1%	0,01	
ADAPTIVE CAPACITY			
AC1: Infrastructure Capacity **-** Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	0,54	0,54	**0,39**
AC2: Institutional and Human capacity – Government Effectiveness	-0.23	0,4	
AC3: Economic Capacity – GNI per capita (current), Atlas method	3660	0,3	
Vulnerability index			**0,08**

PAKISTAN

INDICATORS	Value	Indicator score	Component score
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	1,00	1,00	**1,00**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)	74.35%	0,7	**0,72**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	721,87	0,7	

S3: Water dependency ratio	77.71%	0,78	
ADAPTIVE CAPACITY			
AC1: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	0,15	0,15	**0,27**
AC2: Institutional and Human capacity – Government Effectiveness	-0.63	0,4	
AC3: Economic Capacity – GNI per capita (current), Atlas method	1590	0,2	
Vulnerability index			**2,65**

TAJIKISTAN

INDICATORS	Value	Indicator score	Component score
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	1,00	1,00	**1,00**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)	51.07%	0,5	**0,31**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	117,67	0,1	
S3: Water dependency ratio	17.34%	0,17	
ADAPTIVE CAPACITY			
AC1: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	2,57	2,57	**0,67**
AC2: Institutional and Human capacity – Government Effectiveness	-1.1	0,2	
AC3: Economic Capacity – GNI per capita (current), Atlas method	1010	0,2	
Vulnerability index			**0,47**

TURKMENISTAN

INDICATORS	Value	Indicator score	Component score
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	1,20	1,20	**1,20**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)	112.5%	1	**0,90**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	624,62	0,7	
S3: Water dependency ratio	97%	0,97	
ADAPTIVE CAPACITY			
AC1: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	0,14	0,14	**0,31**
AC2: Institutional and Human capacity – Government Effectiveness	-1.04	0,2	
AC3: Economic Capacity – GNI per capita (current), Atlas method	6740	0,5	
Vulnerability index			**3,52**

UZBEKISTAN

INDICATORS	Value	Indicator score	Component score
EXPOSURE			
E: Projected decrease in availability of water resources under RCP 4.5	1,20	1,2	**1,2**
SENSITIVITY			
S1: Water withdrawal to availability ratio (MDG 7.5. Freshwater withdrawal as of total renewable water resources (%) per FAO)	108.1%	1	**0,87**
S2: Water consumption per GDP (total freshwater withdrawal/GDP in constant 2010 prices)	699,65	0,7	

S3: Water dependency ratio	80.7%	0,81	
ADAPTIVE CAPACITY			
AC1: Infrastructure Capacity - Water storage index (ratio of dam storage capacity to total annual freshwater withdrawal)	0,41	0,41	**0,28**
AC2: Institutional and Human capacity – Government Effectiveness	-0.55	0,3	
AC3: Economic Capacity – GNI per capita (current), Atlas method	2020	0,2	
Vulnerability index			**3,71**

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