Article

Facing the Challenge of Climate Change

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Abstract

Central Asia faces serious environmental challenges, many as a legacy of Soviet times. Many of these environmental issues involve the use and abuse of scarce water resources. The huge investments in irrigation infrastructure by Soviet planners resulted in a vast diversion of water flows from the two main rivers of the region—the Syr Darya and the Amu Darya—into arid areas to feed the rapid expansion of region-wide cotton production, and to supply the rapidly growing urban centers in Central Asia. Since water was treated as a free good, it was used wastefully and unsustainably. In addition, Central Asia has to deal with many environmental hot spots caused by industrial and mining activities initiated in Soviet times. Add to this the lack of effective treatment of industrial and residential waste water and solid wastes in the growing cities of the region, and it is clear that Central Asia faces a tremendous environmental challenge, which needs to be addressed both at a national and a regional level to ensure that by 2050 the vision of a livable and sustainable future for the region is assured. These environmental challenges, which are generally well known and understood, will further be aggravated by the likely global and regional impacts of climate change, which until recently have not been as well understood and sufficiently considered, let alone addressed. This article focuses only on the climate change impacts and possible ways for Central Asian countries to address them in the coming decades.

Keywords

Central Asia, climate change, water, environment

Introduction—The Environmental Challenges in Central Asia[1]

Central Asia faces serious environmental challenges, many as a legacy of Soviet times. Many of these environmental issues involve the use and abuse of scarce water resources. The huge investments in irrigation infrastructure by Soviet planners resulted in a vast diversion of water flows from the two main

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rivers of the region—the Syr Darya and the Amu Darya—into arid areas to feed the rapid expansion of region-wide cotton production, and to supply the rapidly growing urban centers in Central Asia. Since water was treated as a free good, it was used wastefully and unsustainably.

This became tragically obvious after Independence, as the Aral Sea—a major body of water until its untimely demise, a source of lively hoods from fishing, and a stabilizer of the regional climate—rapidly and irreversibly dried up, since the waters of the Syr Darya and of the Amu Darya, which fed the Sea, were largely diverted to upstream agricultural uses. Along with the disappearance of the Aral Sea, major portions of the surrounding agricultural areas and settlements suffered from prolonged misuse of irrigation waters, with heightened levels of salinity of soils, severe pollution of ground water, declining agricultural yields, and severe public health threats.

In addition, Central Asia has to deal with many environmental hot spots caused by industrial and mining activities initiated in Soviet times, including radioactive pollution of soil and water from uranium tailings; chemical pollution from major industrial plants, for example, the Tajikistani aluminum processing plant TALCO, previously known as TDAZ; and biological pathogens left behind on now defunct Soviet military research installations, for example, on Vozrozhdeniye, the former island in the now dry Aral Sea. Add to this the lack of effective treatment of industrial and residential waste water and solid wastes in the growing cities of the region, and it is clear that Central Asia faces a tremendous environmental challenge, which needs to be addressed both at a national and a regional level to ensure that by 2050 the vision of a livable and sustainable future for the region is assured.[2]

These environmental challenges, which are generally well known and understood, will further be aggravated by the likely global and regional impacts of climate change, which until recently have not been as well understood and sufficiently considered, let alone addressed. This paper focuses only on the climate change impacts and possible ways for Central Asian countries to address them in the coming decades.

Vision 2050

By 2050, all five Central Asian countries would have taken mitigation measures consistent with efforts of the global community to contain the rise of average temperature to 3°C or less by year 2100. These efforts will have:

1. Achieved zero net national carbon and other greenhouse gases (GHG) emissions above the levels reached by 2030;
2. Reduced energy intensity of gross national economic output to levels required to achieve the zero net carbon and other GHG emissions objective;
3. Increased the share of renewable energy sources (wind, solar, water, and nuclear) to 50 percent or more, in line with the targets adopted by the EU for 2030, and reduced burning of fossil fuels (coal, wood, and oil); and
4. Sharply reduced the carbon footprint of cities by creating smart cities and intelligent buildings, and having a much greater use of mass transit systems.

Equally important, each country would have taken adaptation measures necessary to minimize potential damage and economic losses from climate changes inevitable with the expected rise of average global temperature up to 3°C by 2100—more severe weather patterns (floods and droughts), melting of glaciers, rising sea levels, and higher temperatures that required changes in cropping patters and adoption of new agriculture technologies and seeds. Finally, all new infrastructure projects incorporated measures to minimize risks arising from climate change, while existing facilities were retrofitted to mitigate and manage such risks.

Global Climate Change—Why Should Emerging Market Economies Care?

After the failure of international negotiations in Copenhagen in 2009 to meet expectations, there was a relative lull in public and political interest in tackling climate change. Predictably, this state of affairs changed markedly in 2014. Climate change returned to the political agenda with the US–China deal in late 2014 and the anticipation of the December 2015 United Nations conference in Paris. The increased focus on climate change is significant for emerging market economies,[3] where there is a great deal at stake—substantial opportunities and significant risks. The renewed focus was driven by several factors of which five events were among the most important.

First, the bilateral climate deal between the US and China in November 2014 surprised many commentators and included commitments by both parties to reduce emissions that could create new opportunities for emerging market economies.

Second, the release of the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) concluded that it is now even more likely—95–100 percent likely—that humans are the predominant cause of climate change and that extremely severe outcomes cannot be ruled out, including in Central Asia and Latin America (Intergovernmental Panel on Climate Change, 2014). Critically, a core finding was that the emissions need to be reduced to net zero for stabilization of temperatures at any level.

Third, research and announcements from the IMF, the World Bank, and the Bank of England about the economic benefits of action on climate change and the risks to fossil fuel industries put the issue on the agenda of mainstream financial communities. Perhaps the three most striking findings are that the fossil fuel subsidies are now at a total of over $5 trillion when calculated on a post-tax basis,[4] the local air pollution is reducing economic output in China by around 10 percent, and that self-interested carbon prices for many key emerging market countries are already $30 or more.

Fourth, the United Nations "Climate Summit" in New York in September 2014 saw around 700,000 people demonstrating around the world to demand that world leaders take action, coupled with a range of corporate and sub-national commitments (Foderaro, 2014).

Fifth, two reports on the business and economics of climate change sought to reclaim issue for the center-right of politics in 2014. The *Risky Business* report in the United States, backed by a cross-party group including Henry Paulson, former US Secretary of the Treasury under President George W. Bush, identified climate risks to the US in very granular fashion, identifying likely impacts (floods, storm surges, crop risks, etc.) in each local community (Risky Business, 2015). The *New Climate Economy* report, chaired by the former center-right President Calderon of Mexico, concluded that action for a better climate was in any case required for better economic growth (The New Climate Economy, 2015).

Economic prosperity in a world with a changing climate and government policy will be generated by innovations in energy and agriculture and the intelligent deployment of infrastructure that preserves options in uncertain times. For instance, around $90 trillion will be invested globally in infrastructure over the next 15 years, around $60 trillion thereof in emerging markets, much of it catering to rapidly growing and urbanizing populations (Stern, 2014; The Global Commission on the Economy and Climate, 2014). This investment could promote compact, clean, and resource-efficient cities, with lower health care costs and a variety of wealth-generating interactions between inhabitants. In contrast, replicating tired old models of isolation in urban sprawl would be a lost opportunity for Central Asian economies that would damage prosperity, increase pollution and GHG emissions, and hence exacerbate climate risks.

Intelligent infrastructure and innovative, cheap clean technologies could create economic growth and new jobs. These opportunities clearly provide medium-term benefits and may also deliver short-term net gains, although the latter is more contentious in times when and places where clean technologies are not yet cheaper than unclean technologies. Nevertheless, the local benefits from reduced emissions and pollution are now unequivocal, creating substantial value for many emerging economies and they do not depend on bilateral or international agreements. As noted above, IMF research in 2014 concluded that the implementation of relatively high carbon prices is in the self-interest of many countries because of the direct local economic benefits to the implementing country (Coady, Parry, Sears, & Shang, 2015).

In general, a key idea of the last 2 years is that the enlightened self-interest by countries can take us quite some distance towards a stable climate and a prosperous future (Hepburn & Ward, 2011). There are many actions that may be taken by emerging market economies, individually and as a group, to promote higher economic growth and productivity while reducing climate risk. At present, instead, some countries are harming their own citizens by not addressing climate change seriously (Box 1).

There are very significant economic implications of climate change for the economies of Central Asia. This paper explores those implications in more detail in the following three sections. The next section provides an update on the science and the new knowledge about the risks created by changes to

Box 1. Should Emerging Market Economies Act on Climate Change, or Wait?[5]

Continued fossil fuel-driven growth could leave Earth around 4.9°C warmer in 2100 than in 1990 and sea levels 0.5 meters higher. This would have extremely damaging implications for G20 Emerging Markets (GEMs),[6] with economic damages possibly causing annual GDP to be 6.0 percent lower than it otherwise would be by 2100. The last time global temperatures were this high—the Eocene period, 35–55 million years ago—swampy forests covered much of the world and there were alligators near the North Pole.

Even with ambitious action[7] by the G20 Developed Economies (GDEs),[8] GEMs will still experience most of the damaging consequences of climate change. If GDEs reduce their emissions by 80 from the 1990 levels by 2050, temperature increases over 1990 levels might still be 4.4°C in 2100, because over the next decades the GEMs will contribute the lion's share of global emissions growth.

For GEMs to avoid the damaging consequences of climate change, they must take ambitious action alongside GDEs. GEMs are now responsible for roughly the same amount of emissions as the GDEs. China has replaced the United States as the world's largest emitter. Rapid economic growth to 2050 coupled with population growth implies GEMs will contribute most to future emissions. While GDEs have contributed the most to historic emissions, it is the GEMs that are expected to be responsible for much of the future warming of the planet. If GEMs restrain their emissions to 2005 levels by 2050, and reduce emissions from deforestation by 50 percent, temperature increases from 1990 levels may be limited to 2.7°C. This would avoid some of the worst impacts. Through action, GEMs can control their own destiny—and that of the planet.

A significant proportion of the benefits generated by GEM action are the result of China, India, and Brazil controlling their emissions. If these three GEMs alone were to take action, then temperature increases may be restricted to around 3.5°C above 1990 levels. This would reduce the damages experienced by these countries. China's losses are estimated at 2.2 percent of 2100 GDP, compared with 3.2 percent if no GEMs act, and India's losses at 4.2 percent of GDP, compared with 5.9 percent without any GEM action.

Regardless of whether some or all GEMs act, these temperature increases would still be likely to have serious consequences. Many scientists regard a 2°C increase as a maximum before the risks of dangerous climate

(Box 1 Continued)

(Box 1 Continued)

change become unacceptable. This position is recognized in the Copenhagen Accord. Limiting temperature increases to 2°C on pre-industrial levels would require more ambitious action by GEMs, GDEs, and also the rest of the world.

Given this, it is unsurprising that GEMs have already begun to take action. There has already been a rapid and pronounced acceleration in low-carbon innovation activity within the GEMs. China, for instance, is now one of the leading countries in the world in solar, wind and nuclear power, electric cars, and high-speed rail technologies. Brazil has launched a sophisticated real-time deforestation tracking mechanism and committed to reducing deforestation. India's eleventh five-year plan (2008–2012) includes measures aiming to increase energy efficiency by 20 percentage points by 2016–2017. South Korea and Mexico have put in place absolute emission targets, and it is likely that several GEMs will beat the US to the introduction of carbon pricing.

Current policies are not enough, however. Accelerated action could trigger a low-carbon race that the GEMs are well positioned to win. As well as reducing the climate damages GEMs may face, coordinated GEM action could prompt GDEs to ramp up their emission reductions, providing larger markets for GEM low-carbon products. For instance, a HSBC report predicted that if governments went beyond the commitments they made during the run up to Copenhagen 15 then, even by 2020, the low-carbon market would be worth $2.7 trillion; 30 percent larger than if governments simply kept to their Copenhagen 2015 commitments and 100 percent larger than in their worst-case scenario.

There are costs to the transition, but the costs only increase with delay. Fossil fuel intensive growth implies the construction of new, dirty capital stock which is likely to have to be scrapped early once the full cost of dirty production is accounted for. Early action will also speed up the rate of technical progress in low-carbon technologies. Both these factors mean that starting early can allow for a more gradual and planned, and hence less costly, transition. For instance, if GEMs started taking action in 2012 to bring emissions back to 2005 levels by 2050, then they would only have to achieve annual reductions in emissions of 0.4 percent per annum. If they wait until 2030 before starting to take action (a typical "delayed action" starting point), with the intention of reaching the same target by 2070, then average reductions of 1.5 percent per annum might be required. While historical experience shows that reductions of 0.5 percent per annum are achievable without significant economic consequences, reductions of more than 1.0 percent per annum have typically only been associated with prolonged economic recessions. All in all, research suggests that costs to emerging economies could be between 25 and 33 percent lower with early action.

Post transition, GEMs will have more secure energy supplies. Currently, six of the nine GEMs are reliant on imports for more than 20 percent of their total energy requirements. Fossil fuels provide a small number of countries with disproportionate economic and geopolitical power. In contrast, many low-carbon energy resources (solar, wind, hydro, nuclear, biomass, and geothermal) are more readily available in GEM countries.

GEMs will also be healthier and more efficient. Of the 10 cities with the worst air pollution in the world, nine are in GEM countries. Fossil fuel combustion is largely to blame for the adverse health consequences for the 50 million people who live in these cities; each year in China alone air pollution is thought to cause 270,0000 cases of chronic bronchitis and 400,000 hospital admissions for respiratory or cardiovascular disease. Air pollution problems are also due to cause an additional $6–10 billion per annum in crop yield losses in India and China by 2030. These problems are sufficiently great, and alleviating them so important, that one study has suggested that reducing emissions by 15 percent through a carbon price in China would be desirable on these grounds alone. Moreover, there is the possibility for GEMs to implement measures that both reduce emissions and generate efficiency savings of at least $100 billion per annum.

GEMs could seize the climate policy agenda, and open up these broader opportunities, with a coordinated, self-interested announcement to exploit the fear of "losing the low-carbon race" in the West. Such a strategy would likely thwart resistance within GDEs to action on climate change, which would be to the benefit of GEMs. Irrespective of GDE action, however, without early action by the GEMs, they themselves risk bearing the impacts of dangerous climate change.

the climate itself, including effects of water stress, extreme climate events, and heat stress. The following section focuses on impacts that are likely to occur in Central Asia and the section after that discusses some of the most pressing adaption challenges for Central Asian countries. As the US–China deal of 2014 shows, once the economic benefits of the transition are broadly recognized the policy response in major trading partners of emerging markets can be very rapid indeed. The paper concludes by putting these findings in the current political context and examines potential future directions, examining some specific policy opportunities for Central Asian economies. These include improving energy efficiency, avoiding stranded assets, exploiting gas for export in the short term and renewables in the long term, encouraging ambitious action by others, and accessing carbon finance. The core point is that many of these interventions do not involve any or much additional short-run cost—but they do require informed and enlightened policy making.

The Scientific Context

The three core findings of the AR5 of the IPCC, published in September 2014, are: (i) climate change exists and is man-made; (ii) the impacts of climate change are already observable in weather patterns and on human societies; and (iii) unless we reduce net emissions of GHG to zero, further global warming and continued change of our weather patterns will occur, severely affecting human and nature systems. Each of these is considered in turn.

The first major finding rests upon the following simple analysis. First, every year, human production and consumption leads to emissions of around 40 billion tons of GHG equivalent, such as carbon dioxide, methane, and nitrous oxide. Second, the atmospheric concentration of GHG has been rising along with these emissions, and is now higher than at any other point in time over the last 800,000 years. Third, the increase in GHG in the atmosphere is from human processes, because fossil carbon has a different proportion of carbon 14 isotope to natural carbon—and the human marker is observed in the atmosphere. Natural processes are thus not to blame for the increased GHGs in the atmosphere—humans are the cause. Fourth, precisely how much heat is trapped by GHGs is known—this can be measured in a laboratory and is beyond debate. An increase in GHGs is therefore expected to lead to warming. Fifth, warming since pre-industrial levels is indeed unequivocally observed and the changes in the atmosphere and oceans over the mid-twentieth century are unprecedented. For these reasons, it is now beyond doubt that changes in climate are occurring and humans are contributing to it. What is new in 2014 is the conclusion from the IPCC that it is extremely likely (specifically 95–100 percent likely) that humans are the predominant cause of the warming between 1951 and 2010. In comparison to the last report (AR4) in 2007, there is now unfortunately even greater evidence that human activities are the cause of global warming.

The second major finding from the IPCC is that this change in climate is already having worrying effects on the weather, with impacts on human and natural systems across the globe. These impacts vary strongly between regions. After the mid-twentieth century, many observed extreme weather events can now be linked to human influence on the climate. Examples include the increase in observed heat waves, and the observed reduction in cold temperature extremes, an increase in sea levels, and an increase in the number of heavy precipitation events. These events have already had significant influences on human and natural systems via the increasing number of strong storms, droughts, floods, and other events, for example, landslides after heavy rain. The magnitude of the impact of such events depends heavily on the exposure of these systems in the affected regions (people, assets, and infrastructure at risk) and also the vulnerability (resilience to external shocks) of these human and natural systems, but it is now statistically clear that climate change has increased the frequency of intense climate disasters (Thomas, Albert, & Hepburn, 2014).

The third key finding from the IPCC is that it is the cumulative emissions of GHGs over time that will determine the global mean warming by the late twenty-first century and beyond. Thus, unless net emissions are reduced to zero, the temperature will continue to rise. The current projections of emissions are not consistent with limiting global warming to below 1.5–2.0°C by 2050. While the pledges under the Cancun agreement are consistent with scenarios that give a “likely” chance (66–100 percent probability) of limiting global warming to below 3°C (in 2100), current projections of global carbon emissions pathway rather suggest an increase of 3.7–4.8°C (in 2100) if no new policies to mitigate climate change are implemented. This would increase the likelihood of “severe, pervasive, and irreversible impacts for people and ecosystems” as a result of the increased incidence of heat waves, more frequent and intense water stress (storms, floods, droughts, etc.), acidification of oceans, and increased sea levels (Intergovernmental Panel on Climate Change, 2014). Because impacts depend upon cumulative emissions, for example, the stock of GHG in the atmosphere, the world is already most likely in the position where it will need technologies to suck GHG out of the atmosphere to constrain temperature increases. Completely decarbonizing global economic systems and halting all GHG emissions is unlikely to be enough given projected emissions—negative emissions technologies will be required.

The IPCC, therefore, concludes that humans need to start preparing to adapt to climate changes, in addition to working as hard as possible to prevent the worst scenarios from emerging. With luck, the climate will not be as sensitive to increases in GHG as it currently appears, and the warming that results from GHG emissions will be at the lower end of the range of estimates. But rather than relying on luck, a prudent strategy involves innovating to reduce the cost of clean technologies, and sensibly applying (at the least) self-interested carbon prices to accelerate the inevitable transition to full decarbonization. It is plausible that enlightened self-interest and a strong focus on innovation could contain warming to 3°C or lower.

The physical impacts from climate change span all sectors and regions, and four notable IPCC AR5 conclusions (with high confidence) are that there will be:

1. Risk of severe ill-health and disrupted livelihoods resulting from storm surges, sea-level rise, and coastal flooding; inland flooding in some urban regions; and periods of extreme heat;
2. Systemic risks due to extreme weather events leading to breakdown of infrastructure networks and critical services;
3. Risk of food and water insecurity and loss of rural livelihoods and income, particularly for poorer populations; and
4. Risk of loss of ecosystems; biodiversity; and ecosystem goods, functions, and services.

The risks of catastrophes for Central Asian countries are very strongly affected by the scale of action by the G20 emerging markets (GEMs), led by Brazil, India, and China. Even if rich countries take seriously ambitious action, this is not enough—action in emerging markets is also required to avoid the worst risks (Hepburn & Ward, 2011; Ward et al., 2012). If action is not taken, and temperatures continue to rise, emerging markets will likely lose valuable human and physical assets.

Adverse Effects from Water Stress, for Example, Droughts

In a substantially hotter world, the models project significant changes to the global water cycle. While changes will not be uniform around the world, billions of people will experience either very much reduced or very much increased water supply compared to current conditions (Ward et al., 2006). For example, the flow of rivers from the Himalayas, which serve countries accounting for around half the world's current population, would likely be disrupted (Stern, 2007). The IPCC forecasts that high latitudes and the equatorial Pacific as well as many mid-latitude wet regions are likely to experience an increase in annual mean precipitation under the (Representative Concentration Pathways 8.5) RCP8.5 scenario, while many mid-latitude and subtropical dry regions will see a decrease of mean precipitation.

Furthermore, increased temperature; sediment, nutrient, and pollutant loadings from heavy rainfall; increased concentrations of pollutants during droughts; and the disruption of treatment facilities during floods will likely reduce raw water quality and pose risks to drinking water quality. Or—put differently—already wet regions with a lot of precipitation would likely see more rainfall but a deterioration of water quality, while many subtropical regions, which are already comparatively dry today, would see less rainfall and more drought. Extreme precipitation events over most mid-latitude landmasses and over wet tropical regions would become more intense and more frequent in the (Representative Concentration Pathways 8.5) RCP8.5 scenario.

The IPCC concludes,

> the fractions of the global population that will experience water scarcity and be affected by major river floods are projected to increase with the level of warming in the 21st century [because] climate change over the 21st century is projected to reduce renewable surface water and groundwater resources in most dry subtropical regions […], intensifying competition for water among sectors […]. (IPCC, 2014)

Extreme Events, Disease, and Conflict

Extreme Events and Sea Level Rise

The IPCC finds that "climate-change-related risks from extreme events, such as heat waves, heavy precipitation and coastal flooding, are already moderate […]" and that "… with 1°C additional warming, risks are high…" because "risks associated with some types of extreme events, e.g., extreme heat, increase progressively with further warming […]" (IPCC, 2014).

Conflict

Hsiang, Meng, and Cane (2011) examine the extent to which changes in global climate in the past have been responsible for "episodes of widespread violence and even the collapse of civilizations." While previous studies have only found that "random weather events might be correlated with conflict in some cases," Hsiang et al. (2011) directly associate planetary-scale climate changes with global patterns of civil conflict using data from 1950–2004. They find that the probability of new civil conflict doubles during El Niño years relative to La Niña years and hence that ENSO (El Niño/Southern Oscillation) may have had a role in 21 percent of all civil conflicts since 1950.

This finding is supported by the findings of the IPCC, which states in its recent AR5 that "climate change is projected to increase displacement of people […]" and that …" displacement risk increases when populations that lack the resources for planned migration experience higher exposure to extreme weather events, such as floods and droughts." Therefore, "climate change can indirectly increase risks of violent conflict by amplifying well-documented drivers of these conflicts, such as poverty and economic shocks" (IPCC, 2014).

Risk of Heat Stress, for Example, Crop Failure

It is virtually certain that more hot and less cold temperature extremes will be observed over most land areas on daily and seasonal timescales, as global mean surface temperature increases over the next decades until the end of this century. According to the IPCC, it is "very likely that […] heat waves will occur with a higher frequency and longer duration" while "occasional cold winter extremes will continue to occur" (IPCC, 2014).

Agriculture is one of the most sensitive economic sectors to climate change because agricultural production is heavily dependent on weather outcomes, especially heat and precipitation. Hence climate change has the potential to significantly alter the sector's productivity. Lobell, Schlenker, and Costa-Roberts (2011), for example, analyze climate trends and global crop production for the four most important crops since 1980 and find that that global maize and wheat yield declined by 3.8 and 5.5 percent, respectively, compared to a counterfactual without changes in climate. For soybeans and rice, winners of climate change, for example, by increased participation and beneficial change of temperatures, and losers largely balance out. In some countries analyzed, the decrease in crop yields due to climate change is large enough to offset a significant portion of the increase in average yields that arise from technology, carbon dioxide fertilization, and other factors (Lobell et al. 2011).

These findings largely accord with the findings of the IPCC, which states "all aspects of food security are potentially affected by climate change, including food production, access, use, and price stability" (IPCC, 2014). While the agriculture sector in some regions may even benefit from milder climate and increased precipitation for wheat, rice, and maize in tropical and temperate regions, for example, some parts of Kazakhstan, climate change without adaptation is projected to negatively impact global production.

Overall 10 percent of projections for the 2030–2049 period show yield gains of more than 10 percent, and about 10 percent of projections show yield losses of more than 25 percent (compared with the late twentieth century). A global temperature increase of 4°C or more, combined with increasing food demand, would hence pose large risks to food security, both globally and regionally.

The Effects of Climate Change in Central Asia

This section explores the impacts from physical changes to the climate (rather than policy and market transitions) in Central Asia. Climate changes and impacts are already underway. Indeed, temperatures in Central Asia have been rising now for several decade and field observations and measurements by scientists indicate that the impacts of this warming climate can already be observed in this region (IPCC, 2014). For the next decades, a further warming of the climate is foreseen and while some effects of global warming are positive—for example, a potential increase in crop yield in some parts of Kazakhstan, the overwhelming majority of effects of a changing climate have been found to have a negative impact on human societies.

Water supplies are a major area of vulnerability for Central Asia. The changing climate is likely to shift water cycles and to reduce the supply of fresh water for a growing population. This could affect countries in the region heavily over the next decades. Indeed, the conclusion of a recent report for the Asian Development Bank was that "river water must be seen partly as a non-renewable resource in Central Asia" (Punkari et al., 2014).

Approximately one-third of the water flowing in the rivers of Central Asia, especially the Syr Darya and the Amu Darya rivers, stems from mountain glaciers, which also provided melting water during the hot and dry summers. However, these glaciers are expected to retreat at an increasing pace (Figure 1). Indeed, water from melting glaciers is expected to fall significantly as glacial extent declines by about 50 percent by 2050.

The impacts are expected to vary at different months of the year. For instance, in 2050 in the months of January–May, discharges are expected to remain similar to today's, but major reductions will take place in the June—November discharges because of diminishing glaciers (Figures 2 and 3).

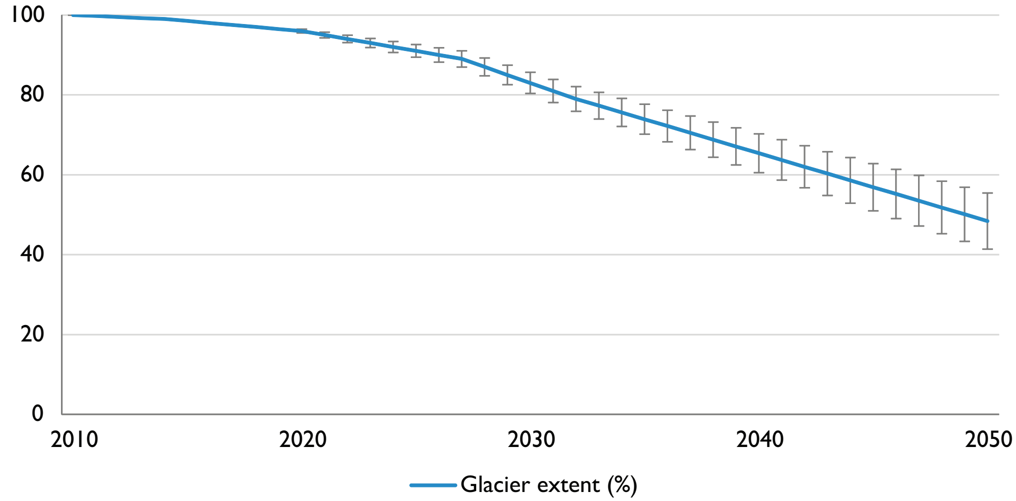

Figure 1. Central Asia's Glaciers Are Expected to Retreat at an Increasing Pace
Source: FCG International.

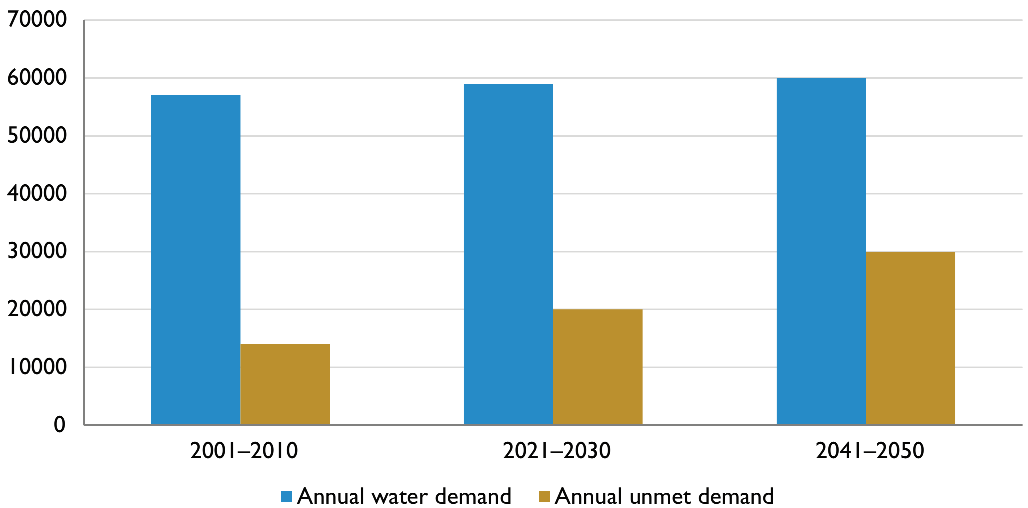

Figure 2. At the Same Time as the Supply of Water Falls, Demand for Water will Increase in the Amu Darya Basin
Source: FCG International.

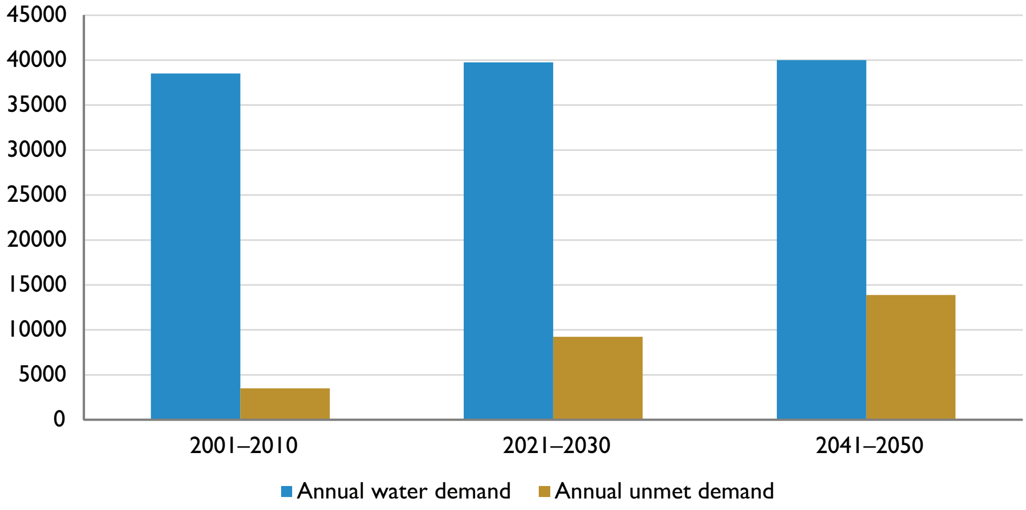

Figure 3. The Same Phenomenon is Occurring in the Syr Darya Basin, though to a Lesser Extent
Source: FCG International.

At the same time, as the supply of water falls, demand for water will increase because of the impacts of a hotter and drier climate on irrigated agriculture on the plains together with a steady population and economic growth. Punkari et al. (2014) expect that, by 2050, water demand will increase by 3–4 percent in the Syr Darya Basin and 4–5 percent in the Amu Darya Basin while supply will decrease over the same period of time, as shown in Figures 2 and 3.

These developments have led to unmet water demand in the past and are likely to lead to an increase of water shortages in the future, which will be a serious problem for the national economies, societies, and the environment. It might even "generate water management disputes and conflicts between people living in the mountains and on the plains" (Punkari et al., 2014).

While the decreased water supply and the diminishing glaciers may decrease flooding risks in some parts of the region, the retreating snow line in the mountains will expose permafrost areas to melting, which will decrease the stability of these hill slopes. Massive landslides and mudflows could thus result. Even today these disasters are the cause for much destruction of buildings, agriculture, and infrastructure—in the future, these events could happen more often and with worse effects.

Given the pressure on water, it is unsurprising that the agricultural sector in Central Asia is expected to be impacted by climate change. In addition to reduced water supply, likely problems include soil degradation and desertification.

Adapting to Climate Change

Given the emerging and future likely effects of climate change on Central Asian countries, strategies need to be adopted. The long-run extent of continued climate change will depend heavily on the success of mitigation effort all over the world. Central Asia has a strong interest in promoting emissions reductions globally, as further discussed below.

Appropriate adaptation to climate change will vary from country to country. The ADB concludes for Central Asia as a whole that "most existing strategies underestimate the problems caused by climate change and have presented incorrect conclusions" (Punkari et al., 2014). The core challenges are to expand future water supply, increase water productivity, and reduce future water demand.

Focusing then on water, the most cost-effective adaptation measures to address Central Asia's expected scarcity of up to 43 billion m^3 of water per year in 2050 are in the agricultural sector. These measures include improving agricultural practices, adopting deficit irrigation (the application of water below full crop requirements), increasing the reuse of water in agriculture, and reducing the area under irrigation. The ADB report finds that efficient adaptation measures will cost up to $1.7 billion per year in 2050 (net present value). All alternatives, including employing no adaptation measures at all, will come at higher cost for the economies in this area.

Climate Policy Opportunities

Central Asian countries have an important and self-interested role to play in the reduction of GHG emissions. There are seven key opportunities within Central Asia, some applicable in only a subset of countries:

First, increase energy efficiency. Central Asian countries have inherited energy systems with low efficiency from the former Soviet Union. Economies were "built around providing large volumes of low-priced energy to drive industrial and agricultural production, with only minor regard for economic value or energy efficiency" (Walters, 2015). In 2010, Central Asia had average energy intensity (megajoules per 2005 US$ GDP at PPP)[9] of 15.7, compared with a world average of 7.7 and a European average of just 5.0. Unfortunately, this legacy promotes wasteful consumption, leading to increased demand and decreased energy security with longer blackouts with resulting loss in economic output. Increasing efficiency would improve energy security and economic output. More generally, energy efficiency reduces the price of energy services, which has been shown to increase economic productivity and economic growth.

Second, improve water management. The most cost-effective adaptation measures to address Central Asia's expected scarcity are in the agricultural sector. These measures include improving agricultural practices, adopting deficit irrigation, increasing the reuse of water in agriculture, and reducing the area under irrigation.

Third, avoid wasting money on stranded fossil fuel assets. In the absence of climate policy, most energy assets being built today are likely to still be in operation in 2050. However, climate policy in the rest of the world may change that landscape. As other countries take stronger action to reduce emissions, potentially including trade measures, capital investment in dirtier fossil fuels (coal and oil) and related generation capacity is likely to come under pressure to be prematurely written off or written down. There are already signs of this in rich countries, where many coal plants have prematurely stopped operating in the US, and where Peabody Energy, the largest coal mining company in the country, has lost 80 percent of its market capitalization in recent years.

Fourth, develop gas for export. Other emerging markets, particularly China, are shifting from coal to gas for their power and heating sources, in part because gas is a much cleaner fuel, both in terms of local pollutants which damage economic output through harmful health effects, and in terms of global pollution as natural gas has approximately half the greenhouse emissions of coal. China plans to more than double the share of gas in the energy mix by 2020, making the country an extremely large consumer and indeed importer of gas. Central Asian countries, particularly Turkmenistan, could supply this gas for power and heating.

Table 1. The Kazakhstani Government Has Adopted a Number of Policies with the Goals of Adapting to Climate Change and Reducing Emissions (Table 1 and Table 2)

Adapting to Climate Change	Reducing Emissions
Kazakhstan has incorporated adaptation measures into its long-term ecological/economic plans.	Kazakhstan's stated national priority is to focus on low-carbon development following the models of Denmark and Norway.
Ministerial programs to combat desertification, secure and preserve potable water, and sustainably develop rural lands for agricultural use may be considered adaptation programming.	Much emphasis has been placed on modernizing the energy industry, maximizing efficiency, and diversifying the industry through incentivizing exploitation of renewable sources.
The Ministry of Environment is reported to be drafting a national strategic plan specific to adaptation (so far no drafts have been published).	Legislative action in this arena culminated in the launch of (Kazakhstan Emissions Trading Scheme) KAZ ETS, an emissions trading scheme (closely modeled after the European (Emissions Trading Scheme) ETS) for 178 companies in January 2013.
	After a 1-year pilot phase, the program entered its second 2-year phase (until 2020) in January 2014.

Source: Authors.

Table 2. The Tajikistani Government Has Adopted a Number of Policies with the Goals of Adapting to Climate Change and Reducing Emissions

Adapting to Climate Change	Reducing Emissions
There are few direct adaption measures in place.	Tajikistan's flagship policies for climate change mitigation are the National Action Plan (NAP) on Climate Change (adopted in 2003) and the National Action Plan (NAP) on Environmental protection (adopted in 2006).
The third national communication to the United Nations Framework Convention on Climate Change (UNFCCC) states that resilience to climate change is mainly being addressed by focusing on economic growth, welfare of the population, poverty reduction, diversification of economy, means of communication, and political stability.	Both plans are currently under revision and likely to be updated in 2015. The majority of legislation emphasizes modernizing the energy industry, maximizing efficiency and diversifying the industry through incentivizing exploitation of renewable sources (especially hydro power).
Long-term planning will likely focus on ensuring energy independence by reducing the vulnerability of hydro energy to extreme events and long-term consequences.	While Tajikistan's third national communication to the UNFCCC acknowledges the positive influences of policy instruments such as carbon energy taxes it is unclear to which extent this will be included in the revision of the NAPs.
The communication acknowledges that agriculture requires a careful adaptation strategy, given that it is more affected by the impact of extreme events and is more vulnerable to climate change (rainstorms, droughts, floods, continuous high and low temperatures, frosts, and locust and other pest outbreaks).	

Source: Authors.

Fifth, upgrade power grids and develop renewables for domestic use and export. With appropriate infrastructure, Central Asia could export significant renewable energy to China. In addition to exploiting the good solar and wind resources, hydropower in Tajikistan and the Kyrgyz Republic could become a very valuable energy storage asset, as more intermittent renewables are added to regional power grids, notwithstanding the considerable pressure in water availability from climate change.

Sixth, encourage emission reductions in other countries. This will reduce the severity of climate impacts (especially on water) in Central Asian countries. Central Asian countries, for instance, might take a lead from China and join in with its efforts. The important bilateral deal on climate between the US and China in late 2014 suggests that China may well become a key pacemaker for the region. The new Emissions Trading Scheme in Kazakhstan should be considered for adoption by other Central Asian countries.

And, seventh, tap rich country finance and support where possible to transition to a low-carbon economy. Rich countries recognize their self-interest in reducing global emissions to reduce the harmful impacts from climate change on their own economies. They have, therefore, developed various mechanisms to channel money to countries engaging constructively with reducing emissions in their economies.

These measures would assist in turning the threat of climate change into a positive stimulus to increase productivity and resilience in the agricultural and energy sectors in Central Asia. Careful climate policy decisions can help enhance prosperity in Central Asia for 2050.

Notes

1. The introduction draws on UNDP Regional Bureau for Europe (2005); the rest of this paper draws heavily upon material previously prepared for the Emerging Markets Forum.
2. According to the 2014 Environmental Performance Index, which rates and ranks 178 countries on nine performance indicators, Central Asian countries are ranked overall as follows: Kazakhstan (84), Turkmenistan (109), Uzbekistan (117), Kyrgyz Republic (175), and Tajikistan (154). For all five countries, water and biodiversity/habitat are ranked as the biggest challenges among the nine environmental areas rated (Yale Center for Environmental Law & Policy, 2015).
3. Different definitions for "emerging market economies" exist, most of them have in common that an emerging market is a country that has some characteristics of a developed market, but does not meet the standards of a fully developed market (e.g., GDP per capita and various others).
4. This calculation includes as a "subsidy" all of the unpriced externalities from fossil fuels, such as the damage to health and to the climate. The "post-tax" basis is so named because the subsidies are calculated compared to a world in which the optimal internalising taxes have been applied (Coady et al., 2015).
5. Adapted from Hepburn and Ward (2010).
6. Argentina, Brazil, China, India, Indonesia, South Korea, Mexico, South Africa, and Turkey.
7. Defined as an 80 percent reduction on 1990 levels by 2050 (and no change in land use change emissions), emissions constant thereafter.
8. Australia, Canada, European Union, France, Germany, Italy, Japan, Russia, Saudi Arabia, United Kingdom, United States.
9. More fully, this is primary energy intensity in energy used per unit of GDP, in mega joules per dollar of GDP measured in 2005 dollars at PPP. Higher numbers represent lower energy efficiency (Sustainable Energy for All, 2013).

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