Potential Security Implications of Environmental Change in Central Asia

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01 / 09 / 2010

Introduction

There exists a general consensus that future climate change has the potential to severely impact fragile regions on the planet, especially the semi-arid to arid zones [1]. If adaptation strategies are absent and institutions are not in place for mitigation, economies will suffer and intra- and interstate conflicts over the allocation of scarce resources will potentially ensue. These developments, together with growing population pressures, have the potential to increase social tensions and cause a dramatic deterioration of the security situation at watershed scales and beyond [2] (see Figure 1). Central Asia, in particular, is one of the regions vulnerable to environmental change.

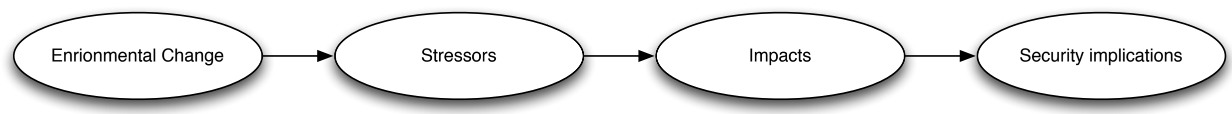

***Figure 1**: The impacts of environmental / climate change may lead to severe security implications if components of environmental change and impact pathways via stressors are not adequately understood and adaptation / mitigation strategies not in place*.

Central Asia is a landlocked region of some 4 million square kilometers with 80 million inhabitants, a mere 2 percent of Asia's population. Yet it sits astride $3 trillion of fossil fuels and remains a strategic crossroads at which the interests and influences of foreign lands meet.

The five Central Asian republics crucially depend on the availability of sufficient amounts of annual renewable freshwater for hydropower production in the upstream and for irrigated agriculture in the downstream. The degree of water's importance to the region is a simple matter of geography and climate. Central Asia is arid except for the mountainous regions of Kyrgyzstan and Tajikistan, where annual precipitation feeds the region's major rivers, the Amu and Syr Darya. It was these rivers, and the Aral Sea into which they drained, that drew in the Soviet Union in the 1920s. Central Asia's last foreign overlords, the Soviets produced 20,000 miles of canals, 45 dams, and 80 reservoirs, providing water for agriculture and industry. The system was centrally controlled from Moscow until 1991, after which a group of untested national governments was forced to manage what had been a unitary economic system untroubled by largely factitious borders.

After the fall of the Soviet Union, the newly established Central Asian republics enshrined the principle of resource sovereignty in their constitutions. Their legalistic claims had, of course, little to do with hydrological reality. In upstream Kyrgyzstan and Tajikistan, two nations with only a negligible share of fossil fuels, water provides the cheapest source of electricity. This is especially important in the winter months, when heating needs are the most urgent. In order to generate hydropower during those months, the Kyrgyz and Tajiks spend the warmer ones husbanding water in several large reservoirs.

But that is precisely when downstream Uzbekistan, Turkmenistan, and Kazakhstan have the most pressing need for irrigation water. This means that upstream and downstream demand patterns are diametrically opposed, and seasonal variations and the partitioning of infrastructure have led to a species of water diplomacy that follows deal-making with deal-breaking and uses rivers as collateral [3]. Thus, the water-energy-agriculture nexus in the region unfolds in a complex interaction of independent state and non-state actors with rival objectives for freshwater allocation in space and time.

Current Issues

National decision-makers have shown decreasing interest for proper trans-boundary resources management in recent years. For example, the barter agreement in place since 1998 regulating water and energy compensations between the upstream and downstream has all but collapsed after an unprecedented freshwater scarcity in 2008 that may be a harbinger of what the future holds for the region [4,5].

Neither the water and energy allocation and distribution among the various sectors and users nor the agricultural sector strategies including crop choice are guided by sound principles of efficient and sustainable resources management. On the contrary, up-and-coming Central Asian oligarchs try to gain substantial influence in the distribution of the monetary benefits of water and energy sales and belligerent talk about issues surrounding the nexus appears more and more on the agenda [6].

The hydropower and irrigation infrastructure that was built during Soviet times is rapidly aging which makes it ill-prepared to handle adverse impacts from future climate change. In many places, the monitoring network has fallen into disrepair and the coverage of data collected on key environmental variables has been greatly reduced in the region (personal communication: Dr. Yakovlev, Uzbek Hydromet Service, May 2008).

The ongoing construction of new large-scale infrastructure in Kyrgyzstan and Uzbekistan adds fuel to the increasing trans-boundary tensions. The downstream is especially concerned about the Kamabarata I & II (Kyrgyzstan) and Rogun (Tajikistan) dam projects due to the fear of lacking expertise in the proper management of these large-volume storage systems (see also Figure 2). These concerns are certainly warranted as the former Soviet hydraulic and agricultural engineering elite is gradually retiring and leaving behind a notable vacuum in proper expertise which Central Asian republics are ill-prepared to backfill.

Further, the negative effects of past, unsustainable resource use and management practices are increasingly being felt. This occurs at a time when population is expected to grow by 20 million people over the next 40 years, which corresponds to a 30 percent increase relative to today, Uzbekistan contributing with 50 percent and Tajikistan with 25 percent to the expected growth (Data source: World Population Database, United Nations). The agricultural production in the downstream countries especially is showing signs of widespread yield decreases. The losses of soil fertility are mainly due to widespread soil salinization [7]. The latter is a complex phenomenon of two controlling processes. First, it can be attributed to continuously rising shallow groundwater tables in irrigated low lands due to the lack of proper maintenance, repair and extension of the existing drainage systems including vertical drainage pumps. Second, the extent of soil salinization in the region is controlled by the diurnal freezing and thawing of top soil in the winter time [8].

In summary, it has to be acknowledged that renewable freshwater is the backbone of Central Asia and key to the future viability of the region's economies. Over the last few years, management has been replaced with *muddling through*, which leaves the region vulnerable to the largely unknown dynamics related to a changing climate in the future.

Potential Future Climate Change Impacts in Central Asia

Recent research shows that glaciers outside the Antarctic have reacted to small-scale natural climate fluctuations in an acutely sensitive way over the past 100,000 years. Anthropogenic climate change makes this past natural variability look small and there is near-unilateral consensus among experts that glaciers outside the Antarctic will entirely vanish in the 21st Century [9].

The time scales of land ice loss and the reduction in snow cover due to rising average temperatures in the mountain ranges of Tien Shan, Pamir and Hindukush have not yet been established despite the tremendous impacts in the downstream. Over the short to medium-term horizon, it is to be expected that increases in mean runoff will translate to increased water availability. For example, uniform melting of the estimated 150 km^3 of glacier volume in the catchment of the Syr Darya over the next 50 years would increase mean runoff in the downstream of Syr Darya from 400 m^3/s to 500 m^3/s, all else being equal. This additional water needs to be properly managed so as to reduce risks from flooding during peak runoff times. Additional flow will also increase the load of suspended solids in the river waters thus causing higher sedimentation rates and augmenting the threat of reservoir siltation [10] (see Figure 2).

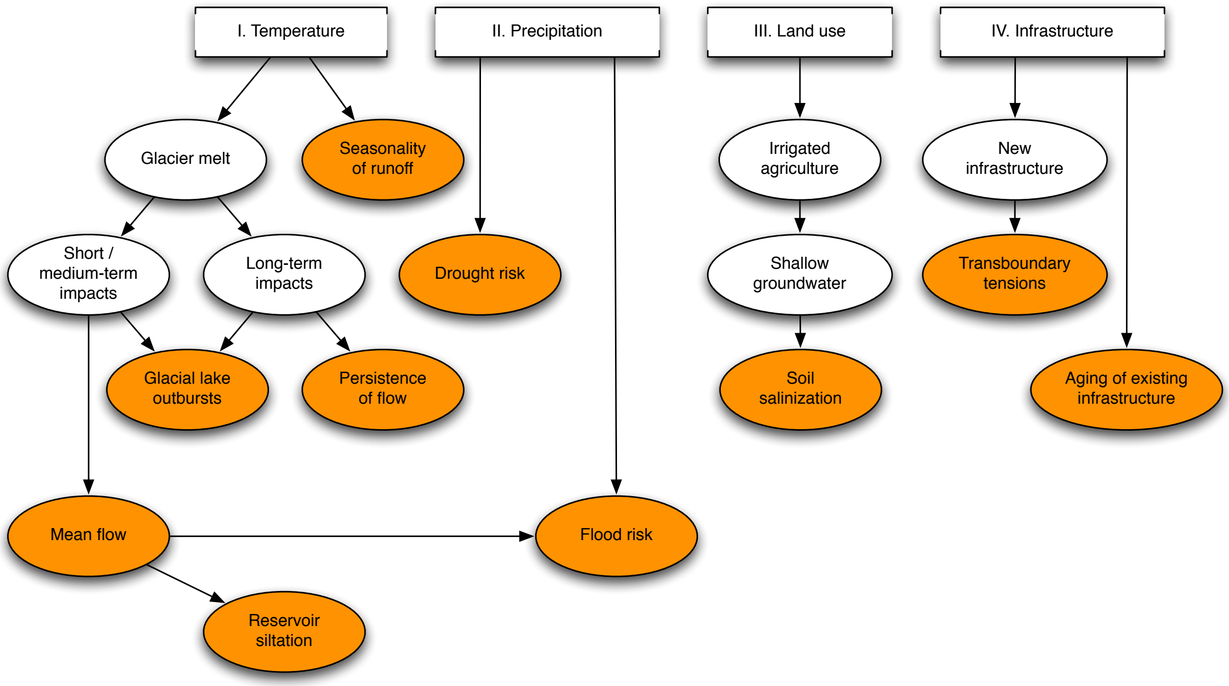

***Figure 2**: Depiction of the four main components of change with associated impacts (see also Figure 1). Stressors are highlighted in orange color.*

As natural water storage in glaciers vanishes over the long-term, a change in the seasonality of the runoff will occur with increases in winter runoff and pre-agricultural season runoff during late winter and early spring [11]. Besides, an increase in runoff, variability and decrease in the persistence of flows will likely be observed with significant impacts in the downstream during the summer irrigation period. Adequate measures such as the construction of supplemental man-made storage will have to be taken in order to address these changes.

The predicted warming in Central Asia could lead to an increase in the moisture holding capacity of the atmosphere, thus impacting precipitation and the hydrology of the two Daryas. However, there is inconclusive evidence as to the direction and magnitude of changes in precipitation in the region. Different isotope-based tree ring climate reconstructions are pointing to more humid conditions during past interglacial warm periods [12]. This could indicate a shift from a current climate of “Mediterranean character” to a wetter future with a corresponding intensification of the hydrological cycle in the region.

However, these predictions rely on extrapolation beyond historic climate ranges and hence are very uncertain. At the same time, a recent study of the climate change impacts on the discharge of the large Asian rivers that descend from the Tibetan plateau uses multi-model ensemble mean predictions from the common general circulation models to predict a reduction in the availability of annual renewable freshwater in Central Asia by 40 % in 2100 relative to today [13]. Models that show a trend towards drier conditions suggest that divergent moisture fluxes and changes in large-scale circulation patterns would explain such development.

Glacial lake outbursts in unstable geological environments due to retreating land ice may pose a severe and significant threat to downstream regions, to hydrological infrastructure and to settlements alike [14]. Similarly, increasing temperatures lead to a thawing of permafrost thus destabilizing critical mountain slopes. Landslides into natural or man-made reservoirs could potentially damage dams in a catastrophic way. This threat has most prominently been recognized in the case of Lake Sarez, Tajikistan. The lake was formed in 1911 after an earthquake triggered a massive landslide behind which 19 km^3 of water are nowadays stored.

Rising temperatures can impair agriculture in the downstream directly. An increase in heat wave frequency in the oases of Uzbekistan, Turkmenistan and Kazakhstan as well as an increase of night-time temperature will impact agricultural yields of temperature sensitive crops.

Addressing Environmental Change

From the above discussion, it should become clear that climate change dynamics in the region will be multifaceted and complex with the potential for cascading effects and intricate feedback loops. Key stressors have not been identified yet and impacts not yet quantified. This clearly translates into an increased risk of exposure in Central Asia.

What is urgently needed in the region is a new long-term trans-boundary water and energy resource-sharing agreement that is efficient, fair, and flexible. Two distinct management challenges exist at different time scales for adaptation to and mitigation of the impacts of environmental change in Central Asia. These are real-time resources management issues as well as long-term planning issues. Real-time management issues include identifying efficient reservoir release policies during shortage conditions and optimizing irrigation deliveries. Another problem is the inter-temporal management of reservoir storages under hydrologic uncertainty, using short- and medium range operational forecasts. Long-term planning issues must address the effect of climate change on water resources availability, the effect of intensified irrigation on agriculture and the increasing demands for electrical power, and the design of water management policies and institutions as well as the extension of hydropower infrastructure in order to develop a coherent risk management plan.

Quantitative models must be developed to allow the measurement of trade-offs stemming from the allocation of these resources while accounting for future economic and environmental uncertainties. Such trade-offs would allow the hydrocarbon-rich but water-poor republics to provide energy compensation in return for guaranteed water supplies. As part of this process, a supra-national institution should be established to explicitly deal with questions of natural resources allocation in the region, as well as to foster dialogue and mutual trust between the multiple stakeholders.

The international community should back this institution—both with money and expertise—as the consequences could not be direr. The implosion of national economies, precipitated by water failure, would witness the obliteration of all stabilizing social mechanisms and the onset of chaos, with all the accompanying brigandage and brutality it summons.

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