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Climate Risk Management in Central Asian agriculture: A situation analysis

by

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ABSTRACT. The region of Central Asia, and in particularly the agricultural sector, is extremely vulnerable to climate change risks. The countries have started to develop adaptation strategies and climate risk management strategies, most of them described in the National Communications on the United Nations Framework Convention on Climate Change. These and other efforts are presented and commented in this paper.

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1 Introduction

Climate change impacts a country in various ways with agriculture being "the most climate-sensitive of all economic sectors" (Stern, 2006, p 7), a statement that is true for labour- as well as capital-intensive agriculture. Especially in developing countries, where agriculture plays an enormous role for development and poverty reduction, climate change has to be considered in both, farming activities and policy making.

Based on their exposure, sensitivity and adaptive capacity, countries and their agricultural sectors show different vulnerabilities to climate change. In order to detect and to reduce this vulnerability, the climate change discussion has brought up the approach of climate risk management. This approach aims to better manage climate risks due to a clear process-orientation and the consideration of the various timescales of climate change.

The discussion paper has a closer look on climate risks and current climate change adaptation and risk management strategies in the countries of Central Asia. The region is significantly threatened by climate change, and due to the key role that agriculture plays in their economies, these countries face particular consequences for their development. It is possible to reduce the vulnerability of Central Asian agriculture and rural livelihoods to climate change. However, this requires firstly a more specific analysis in order to better understand climate change risks and their impact on economy and society, and secondly, to strengthen institutional frameworks and technical capacity to manage the risks.

The discussion paper contributes to the preparatory work of setting up a comprehensive climate risk management in Central Asia by providing an overview on the current situation of the region. First of all, chapter 2 compiles and explains the main key words in this context. Chapter 3 provides the information on Central Asia with regard to climate change and agriculture by evaluating relevant studies and reports and concludes with comments on the existing strategies. Key messages of this paper are summarized in chapter 4.

2 Theoretical background: key words and definitions

The link between poverty and climate change is recognized as a central issue for social and economic development (Stern, 2006, p 7). Research and development cooperation have been concentrating increasingly on the interrelation of climate and development. There exist multiple definitions of climate change related-concepts and issues; the central ones being presented here:

Risk is defined by the Intergovernmental Panel on Climate Change (IPCC) "as a combination of the likelihood of an outcome or event and some quantitative measure of the consequences of that outcome or event" (IPCC, 2004, p 5). "**Climate risk** denotes the result of the interaction of physically defined hazards with the properties of the exposed systems - i.e., their sensitivity or social vulnerability. … [Climate] risk equals the probability of climate hazard multiplied by a given system's vulnerability" (World Bank quoting UNDP).

The scientific community and policy makers speak of **vulnerability** in order to classify regions or population groups and to propose and allocate adaptation measures accordingly. Originating either from the biophysical or the socioeconomic approach, various frameworks have been developed (outcome or contextual vulnerability) making a conceptualization of vulnerability measures difficult. Furthermore the purpose of a vulnerability assessment should a priori clearly define the use of vulnerability indicators. Aggregated indices require normative choices in selecting and weighting information which determine the results of the ranking. This can influence decisions based on such indices, e.g. the allocation of funds for adaptation strategies. The development of vulnerability indices to climate change is therefore as much a political as a scientific task (Füssel, 2009, p 7).

According to the IPCC, vulnerability is defined as "the degree to which a system is susceptible to, and 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 change and variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC, 2007, p 883).

Vulnerability to climate change risks is identified by three main factors: the country's exposure, sensitivity, and adaptive capacity (World Bank, 2009, pp 2). These three sub-indices are explained as follows: First, exposure is determined by the type, magnitude, timing, and speed of climate events and variation to which a system is exposed to. Second, sensitivity depends on how stressed a system already is, e.g. the endowment with natural factors, public resources, or assets of the population. Both, exposure and sensitivity determine the potential impact on a system (without adaptation). Finally, the adaptive capacity of the system itself affects the vulnerability: how capable is a system to cope and adapt to risks. This factor is related to organizational skills, access to and ability to use information, and access to financing. All three sub-indices are estimated by a number of indicators.

The result of such a vulnerability measure can only be an approximation and is definitely influenced by normative specifications and weighting. But it is useful to comprehensively assess a country's vulnerability to climate change and to reveal underlying causes which might be exogenous or induced by the system itself (World Bank, 2009, pp 2). It provides a good overview about the situation and framework conditions of a country in general. However, for the assessment of climate change risks on a particular sector of the economy, the vulnerability analysis should be more focused on the characteristics of the very sector and the capacity of its stakeholders.

The concept of **climate change adaptation** refers to all measures undertaken to adjust to the changing climate and its impacts. The IPCC defines adaptation as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007, p 869).

A rather new approach in the climate discussion has become climate risk management. It originates from the conventional approach of risk management. **Risk management** is a structured tool for decision making, and there are three facets to its foundation: first, making choices on technological risk under conditions of uncertainty; second, referring to hazards and disaster management; and third; concerning social aspects of risk (May and Plummer, 2011). The International Organization for Standardization (ISO) has even developed principles, a framework and a process for risk management (ISO 31000:2009)[1] that ought to be applicable to any type of risk and to any organization in public or private sector. Risk assessment under ISO 31000 comprises the three steps of risk identification, risk analysis, and risk evaluation.

Climate Risk Management (CRM) is an "approach to climate-sensitive decision making that is increasingly seen as the way forward in dealing with climate variability and change and

[1] http://www.iso.org/iso/iso_catalogue/management_and_leadership_standards/risk_management.htm

seeks to promote sustainable development by reducing the vulnerability associated with climate risk. CRM involves proactive 'no regret' strategies aimed at maximizing positive and minimizing negative outcomes for communities and societies in climate-sensitive areas such as agriculture, food security, water resources and health. The 'no regrets' aspect of CRM means taking climate-related decisions or actions that make sense in development terms, whether or not a specific climate threat actually materializes in the future" (World Bank quoting IRI). Further methodological developments of CRM have brought up a new hybrid called "Adaptive Collaborative Risk Management (ACRM)". By strongly including participation, learning, and governance, ACRM builds upon approaches to community climate change adaptation, and innovatively addresses both technical and governance concerns in a single integrated process (May and Plummer, 2011).

Whereas the term "climate change adaptation" focuses more on the response to climate change beyond the existing variability of the climate, the approach of "climate risk management" considers historical, current, and future climate conditions across multiple timescales (i.e. seasonal, annual, decadal) and planning horizons (Hammill and Tanner, 2011). CRM is more a process-oriented approach including feedback mechanisms while adaptation focuses stronger on the expected outcome itself. Climate risk management (CRM) combines the systematic use of climate information, technology that reduces vulnerability, and policy that transfers risk (Hansen et al, 2007).

Hammill and Tanner (2011) provide a categorization of the various methodologies and tools of CRM that are used by organizations and development agencies. They have developed a CRM framework (see table 1). Within this CRM framework, **risk assessment** -as the analytical core of the CRM approach- **is the classical task of climate/environmental and development research**. Therefore research focusing on climate risk management incorporates mainly on three steps:

- Studying the nature of climate risk and related vulnerability of climate-affected sectors, people's livelihood, and environment (risk assessment)
- Analysing risk management options to minimize negative effects and maximize positive opportunities (risk analysis)
- Develop and evaluate strategies and activities to manage (and to adopt to) climate risks (options evaluation)

The other steps of the CRM framework, namely awareness raising, implementation, and monitoring (and their related activities) are often the duty of other stakeholders like development agencies or governments (although they can be accompanied by research measures).

CRM is an instrument to take climate into account of development issues, in particular related to sensitive sectors like water, agriculture, forestry, health but also private dominated sectors like tourism. If climate risks and risk management options are not included into "normal" development strategies and policy, those might fail or lead to a misuse of investments. For example, a public strategy on drinking water provision has to consider the sufficient availability of water at all. Or another example, tourism development like skiing or trekking in mountainous regions has to take into account climate induced disaster risks.

To conclude: Climate risk management (CRM) aims to better manage risks and reduce vulnerability or take advantage of opportunities caused by climate variability and change. Development and environmental research has the task to identify the climate risks and vulnerabilities and to develop and evaluate appropriate risk management options.

Table 1: Climate Risk Management Framework

Adaptation Tool Function	Step of CRM Approach	Description	Key Question
Communication	Awareness raising and engagement	Communicating and engaging with development actors with climate change issues in relation to their role and context.	How does climate change link with our work?
Screening	Pre -screening	A systematic examination of a development activity to select or eliminate it from further analysis, or to make a diagnosis. It tends to be relatively quicker to conduct and is broader in scope. As a very light touch process it is commonly referred to as pre-screening.	Is more assessment needed?
	Risk Screening		
Assessment	Risk Assessment (Identification)	A methodology to determine the nature and extent of risk by analyzing potential hazards (current and projected) and evaluating conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend.	What is the problem?
	Risk Analysis	A process that considers management options to minimise negative impacts and take advantage of opportunities in light of the identified current and future risks.	What are the options?
	Options Evaluation	Evaluating both the adequacy of current risk management strategies and potential new activities to manage additional risk or to take advantage of opportunities.	What is the course of action?
Implementation	Implementation	Putting selected options into action either as part of a broader suite of development activities (integration) or as discrete climate risk management / adaptation initiatives.	How to undertake the course of action?
Monitoring and Evaluation (M&E)	Monitoring and Evaluation	Tracking and assessing implemented activities or initiatives to see if they are delivering intended benefits.	What was achieved?

Source: Adopted to Hammill and Tanner, 2011.

3 Current situation: Climate change and climate risk management (CRM) in Central Asia

Based on the approach of CRM and the analytical core task of research that is assessment, the chapter is going i) to describe the extent of climate change in Central Asia and the vulnerability of the agricultural sector in particular (risk assessment; chapter 3.1, 3.2, 3.3); ii) to list risk management options and strategies proposed or already in place by the countries with regard to agriculture (risk analysis; chapter 3.4); and iii) to comment on these strategies (options evaluation; chapter 3.5). It is not an in-depth assessment per se but a concentrated summary of existing information and the current situation.

3.1 Climate variability and climate change in Central Asia

Climate is changing globally. According to IPCC Assessments, the global average surface temperature grew by about 0.6°C over the last century. This trend will continue ever to a larger extent if greenhouse gas emissions will not be reduced. The Fourth IPCC Assessment Report of IPCC estimates, climate change will lead to a rise in global mean temperatures of 1.4-5.8°C by 2100 (Scenario A1B) (IPCC, 2007).

Climatic trends in the region of Central Asia partly even exceed the global trend (see table 2). During the last century a warming of 1-3°C took place in the region. The warming has mainly been observed during autumn and winter season leading to a prolongation of the frost-free period. Also an increasing occurrence of heat waves was noticed in the plain territories of Central Asia. Although the development of precipitation does not show a definite trend, the climatic aridity in desert- and semi-desert areas was rising. There was an increasing irregularity of precipitation observed with more days of heavy precipitation events but not necessarily more annual rainfall.

The general trend of warming and irregular precipitation in Central Asia is going to continue in the future. Climate projection models in Central Asia perform poorly so far due to the extreme differences in topography. Nevertheless all models estimate a warming of the region which amounts to 2-3°C until 2050 and 4-6°C until 2100. The general annual warming and in particular the rise of the mean winter temperatures in the region will have a major impact on water resources especially on the glacier and snow pack development.

Table 2: Observed and forecasted climate trends in Central Asia

Coun-try	Observed climatic trends (in the 20th century)		Climate change scenarios (base period 1961-1990; projection till 2100)	
	Temperature	**Precipitation**	**Temperature**	**Precipitation**
Kazakhstan	- **increase** in **average annual temperature** by 0.31°C / decade - **highest warming in winter** (min temp increase 0.44°C / decade; max temp increase 0.14°C / decade) - reduction of number of cold days, increase in number of hot days - significant **increases** in the duration **of heat waves**, decreasing duration of cold waves	- **no definite trend** in annual and seasonal rainfall - **increasing climate aridity in the areas of deserts and semi-deserts** - **increasing total rainfall in northern parts** of Kazakhstan and in the Saryarka zone	- **increase in mean annual temperature** (+1,4°C up to 2030; +2,7°C to 2050; and +4,6 °C to 2085)	- **slight increase in the quantity of rainfalls** (by 2% to 2030, by 4% to 2050 and by 5% to 2085) - **mainly in winter** - possible but uncertain decrease in quantity of rain in summer until 2085

Coun-try	Observed climatic trends (in the 20th century)		Climate change scenarios (base period 1961-1990; projection till 2100)	
	Temperature	**Precipitation**	**Temperature**	**Precipitation**
Kyrgyzstan	- **increase in mean annual temperature** by 1,6°C - Maximal **warming in winter** (2,6°C), minimal warming in summer (1,2°C)	- **insignificant increase** of precipitation amount (6%), partly even more (20-30%) - Considerable **decrease** of amount **in high-mountain** region of Tien-Shan (41-47%)	- **increase in mean annual temperature** (4,6-6,2°C up to 2100) - warming especially in winter	- **insignificant changes** in annual precipitation but significant **fluctuations** - significant **precipitation reduction during summer**, and precipitation growth in winter
Tajikistan	- **slight increase** in **average annual temperature** in plain territories (0,1-0,2°C/ decade) - **highest warming in autumn-winter** (min temp increase 0,5-2,0°C /decade; max temp increase 0,5-1,0°C/decade) – with exception of high mountain regions - **increased duration of frost-free period** by 5-10 days (i.e. frost-free earlier in spring and later in autumn)	- **increased irregularity and intensity** of precipitation - **decreased number of days of precipitation** - **insignificant increase of annual amount** on areas up to 2500m (8% on average), and small reduction in mountainous regions (-3%)	- **increase in mean annual temperature** (0,1-0,2°C to 2030) - warming especially in winter	- **unclear trend**: decrease in Eastern Pamir, South lowlands; increase in Western Pamir
Turkmenis-tan			- **increase in mean annual temperature** (2-3°C until 6-7°C up to 2100)	- **expected decrease in precipitation**
Uzbekistan	- **increase** in **average annual temperature** - **highest warming in autumn-winter** (min temp increase 0.36°C/ decade; max temp increase 0.22°C/ decade) - significant reduction of low temperature - significant **increases** in the duration **of heat waves**, decreasing duration of cold waves	- **no definite trend** in annual and seasonal rainfall - **increased** number of **days** with **heavy precipitation** - climate **aridity** signifi-cantly increased during warm parts of a year **near the Aral Sea** - higher tendency for aridity in the plain and foothill territories than in mountain regions	- **significant increase in temperatures** (+ 1,1-1,7°C up to 2030, +1,9-2,5°C to 2050, +3,2-4,3°C to 2080) - warming especially in winter	- **probable increase in precipitation** (but not in winter) - probable increase of days with heavy precipitation

Source: National Communications (NC) under the UN Framework Convention on Climate Change (UNFCCC): Kazakhstan, 2nd NC, 2009; Kyrgyzstan, 1st NC, 2003 and 2nd NC, 2009; Uzbekistan, 2nd NC, 2009; Tajikistan, 2nd NC, 2008; Turkmenistan, 2nd NC, 2010.

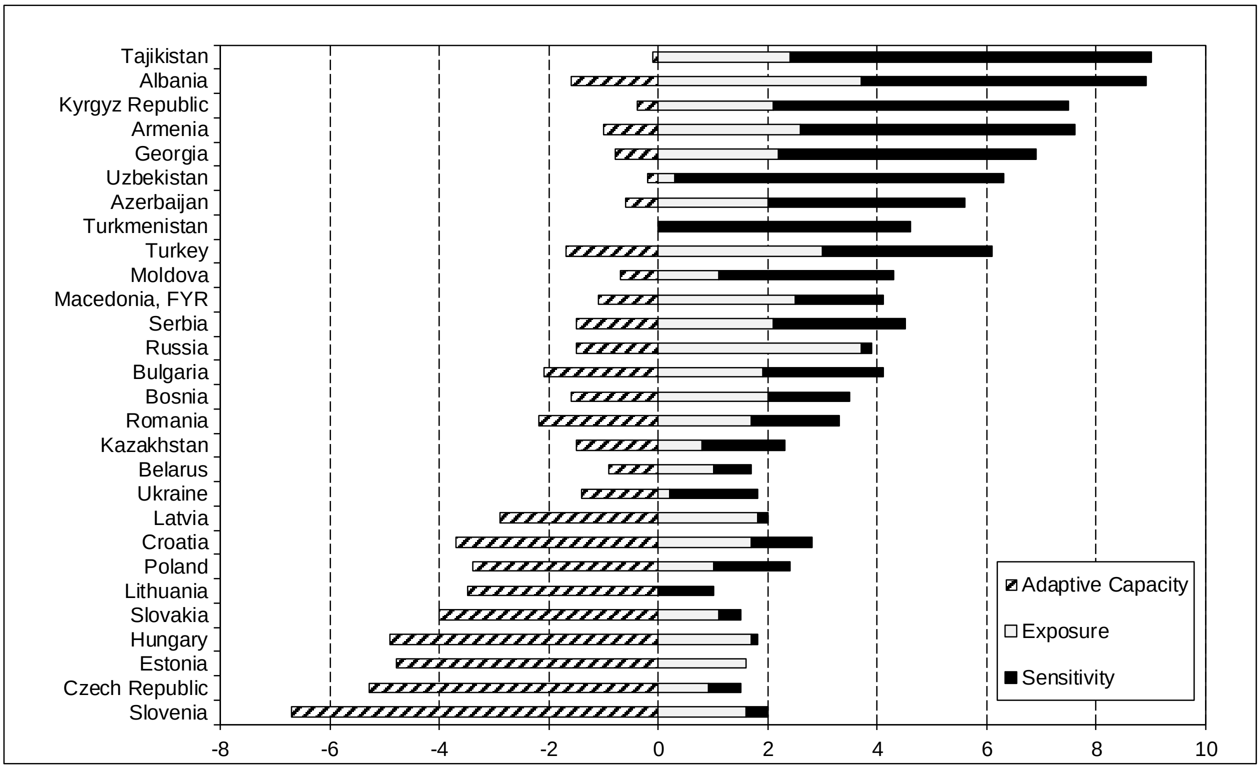
3.2 Overall vulnerability of Central Asian countries to climate change

Applying the vulnerability index of World Bank to the countries of Eastern Europe, Caucasus and Central Asia reveals a comparatively high aggregated vulnerability to climate change risks of the countries of Central Asia. Although the exposure to climate change is not very much higher in Central Asia compared to the other countries, the extreme vulnerability is caused by the high sensitivity and low adaptive capacity of Central Asian countries. Except Kazakhstan, whose economic situation is considerably better, the Central Asian countries are characterized by social, economic and public structures that make them very sensitive to climate change risks and poorly prepared for adaptation measures (Fay and Patel, 2008).

Taking a closer look on the underlying causes of this high vulnerability, it becomes obvious that the countries of Central Asia still suffer from the legacy of former Soviet Union with its central planning system and environmental mismanagement. The still poor state of infrastructure, a neglected environmental policy, and growing socioeconomic differences within the population define the sensitivity and adaptive capacity of Central Asia to climate change risks in the future – likely more than the exposure to the risks itself.

The most vulnerable sectors to climate change are water, agriculture, ecosystems, natural disasters, and human health. They have been assessed by various studies, in particular for the preparation of the National Communications on the United Nations Framework Convention on Climate Change (UNFCCC). Although these studies and their results are of uneven quality they present the most available (and official) information. The following chapter elaborates on it.

Graph 1: Index of vulnerability to climate change in Central Asia, Caucasus, and Eastern Europe



Source: Adopted to Fay and Patel, 2008.

3.3 Vulnerability of the agricultural sector of Central Asian countries to climate change

3.3.1 The role of agriculture in Central Asian economies

Agriculture is an important factor in the overall vulnerability of a country to climate change considering the share of agriculture in GDP and the share of population depending on agricultural production and living in rural areas. In the Central Asian countries agriculture is a key sector counting from 5% (Kazakhstan) to 29% (Kyrgyzstan) in GDP. It is a strategic sector providing the basis of food security as well as significant state revenues through the export of cotton (particularly in Tajikistan and Uzbekistan) and wheat (mainly in Kazakhstan). Furthermore, the agricultural sector absorbs a high percentage of labour force. From 42% of the total population in Kazakhstan up to 74% in Tajikistan live in rural areas and depend on agricultural production (World Development Indicators, 2010). The majority of them are poor: the rural poverty rate in Central Asia is estimated 94%, the rural extreme poverty rate 62% (Alam et al, 2005). Therefore the Central Asian countries face significant risks to their agricultural systems, food security, and rural livelihoods as a result of climate change.

3.3.2 The vulnerability of the agricultural sector

Both, the increase in temperature and the change in water availability (precipitation, river- and groundwater) due to climate change, are influencing the agricultural productivity of the region. However, the impact varies across the region: an increased frequency of heat stress, drought, and flooding will probably reduce crop yields and livestock productivity in many areas. Shorter, less harsh winters may result in potential productivity gains in other areas.

Global climate change impact models cover the region of Central Asia only to a certain extent or work on a higher aggregation level that does not reflect the diversity of agro-ecological zones sufficiently. Local assessments of the agronomic impact of climate change in Central Asia have been conducted in the frame of UNFCCC obligations or by certain research projects. Both assessments often focus on well-defined areas only and do not cover the countries completely. However, despite the usual problems and uncertainties of climate impact models, results for Central Asia give some clear indications (see table 3). Most of the region of Central Asia (Tajikistan, Kyrgyzstan, Uzbekistan) has been indicated as a potential net loser in agriculture of climate change, while Kazakhstan shows mixed or uncertain outcomes.

Table 3: The agronomic impact of climate change on Central Asian agriculture

Coun-try	Impact	Sources
Central Asia	*Unchanged or increased winter rainfall, decrease in rainfall and surface water in spring, summer, fall, with droughts* • Major stress on water resources for irrigation • decline in cereal yield from water shortage from spring to fall, and from thermal stress† • drought, desertification, soil erosion, salinization • widespread crop failures during droughts • increased suitability for drought-resistant tree crops. Note, greater water demand for rice production with higher temperatures † • yield impact 2080 without CO2 fertilization -9%, with CO2 fertilization +4,6% # *Hotter summer, milder winter* • Greater water demand for rice production with higher temperatures† • despite CO2 fertilization, increased heat and significant water shortage cause decline in cotton yields.† *Livestock* • Marginal grasslands at risk for aridization, desertification. Heat stress reduces milk production. †	† IPCC, 2007 # Cline, 2007
Kazakhstan	*More rainfall, surface water year-round in north, with very dry summers in south* • Despite CO2 fertilization, increased heat and water shortage cause decline in cotton, rice, fodder, vegetable and fruit crop production in irrigated south † • potential expansion of grazing land northwards and in formerly virgin marginal lands, that were later ploughed for wheat cultivation. Note, greater water demand for rice production with higher temperatures. † • yield impact 2080 without CO2 fertilization +11,4%, with CO2 fertilization +28,1% # *Much warmer throughout year, slightly more in summer* • Potential increase in cereal, legume and oil crop production in cooler, wetter north • increased fodder production • increased water demand of plants and drying of soils in warmer months because of higher temperatures, causing drought risk and water scarcity to persist or worsen. † • Earlier start and end of vegetation period for grain cultivation in the North * • Hotter summers might overweigh the CO2 fertilization effect leading to a decrease in grain productivity * *Livestock* • Initial warming good for livestock, provided sufficient water availability, but after first few degrees, increased heat stress and disease.† • Aeolian plain pasture productivity will increase in the spring season but lessen in Summer, Autumn and Winter seasons due to pasture digression. The productivity of the piedmont plain pastures will increase in the Summer and Autumn periods. *• leading to reduced winter pasturing, although with growing inter-annual variability * • the reduced pastures productivity and the earlier Summer sun burning *	† IPCC, 2007 * 2nd NC of Kazakhstan # Cline, 2007
Kyrgyzstan	*Agriculture* • until 2100 indefinite trend of agricultural productivity development: trend towards decreasing productivity of grain but increasing productivity of potato, vegetables and fruits * *Pastures* • until 2100 productivity tend to increase *	* 2nd NC of Kyrgyzstan

Table 3: The agronomic impact of climate change on Central Asian agriculture (continued)

Tajikistan	*Agriculture* • future risk due to increase of temperature and extreme weather events as droughts and flooding * *Pastures* • rising temperatures of 2-4°C in February and March can lead to 20% decrease in winter-spring pasture productivity; • in high mountain pastures, rising temperatures of 1.5-3°C can increase pasture productivity by 25-50% #	* 2nd NC of Tajikistan # 1st NC of Tajikistan
Turkmenistan	*Agriculture* • as critical air temperature may not exceed allowable value and probability of such an event is low, there might be no negative impact on agricultural productivity * *Pastures* • grassland productivity may decline to 10-15% *	* 2nd NC of Turk-menistan
Uzbekistan	*Agriculture* • until 2030, potential mean losses of yield do not exceed 2-5% all over Uzbekistan; • by 2050 the mean losses of yield due to climatic factors alone reach 11-13% for cotton and 5-7% for wheat in the Syrdarya River Basin; 13-23% for cotton and 10-14% for wheat in The Amudarya River Basin. • in some arid years yield losses in The Syrdarya River Basin may achieve 15-17% by 2050, and 17-28% in The Amudarya River Basin * *Pastures* • vegetation period will shift forward by 5-10 days; • by 2030-2050 pasture yield will not allow meeting the fodder needs of growing livestock population * *Livestock* • increasing thermal stress to livestock might lead to reduction of productivity if no adjustment of livestock management occurs *	* 2nd NC of Uzbekistan

Source: as indicated in the table (note: NC – National Communication).

Considering the weaknesses of agronomic impact models, the **analysis of the economic and socioeconomic impact** of climate change on agriculture is even more problematic. Economic effects of climate change on agriculture include direct yield impacts as well as subsequent effects on product and input markets. Generally several approaches exist for analyzing the economic impacts of climate change on agriculture, but each has its limitations and assumptions, making interpretations of climate change impacts very risky. In Central Asia, an economic analysis of climate change impact on the agricultural sector or estimations of costs and benefits of agricultural adaptation strategies are missing so far (Sutton, 2008, p 24).

A serious attempt to compute the future global food security situation under climate change (and economic and population growth) scenarios is undertaken by IFPRI.[2] The model forecasts for all regions that negative productivity effects of climate change will reduce food availability and human well-being by 2050. Climate change increases the number of malnourished children in 2050 (relative to perfect climate mitigation, optimistic development scenario) by about 10 percent globally and by over 11 percent for the low-income developing countries (including Central Asia with exception of Kazakhstan) (Nelson

[2] IFPRI's IMPACT model combines various sub-models (agriculture and policy, hydrology, crop) and explores scenarios that are based on the main drivers of population, GDP, climate scenarios, rainfed and irrigated exogenous productivity and area growth rates (by crop), and irrigation efficiency. Results are aggregated up to spatial units, called food production units, and are expressed by country development groups (Nelson et al, 2010).

et al, 2010, p 49). However, this type of modeling is still in its infancy and there is a need for further improvement.

3.4 CRM and adaptation strategies with regard to agriculture in Central Asia

CRM and adaptation encompasses activities and investments in multiple areas, and not only at the farm-level: measures can be technological, institutional, and policy-based. A broad list of technological adaptation measures with regard to agriculture exist, ranging e.g. from diversification in cropping, irrigation and soil cultivation techniques to changing land use patterns or improving the resilience of livestock and pasture systems. The Central Asian countries could benefit from extensive climate-change related research already carried out in other countries of similar latitudes. The challenge is less on developing appropriate technologies but more on institutional aspects facilitating CRM and adaptation. This includes the existence of comprehensive adaptation-oriented policies and functioning supporting institutions and framework conditions in Central Asia. Furthermore the "assessment and selection of adaptations should be guided by a process of prioritizing adaptation measure that explicitly incorporates and distinguishes among response time, duration of implementation, appropriateness for current versus future climate, win-win(-win)[3] or cost-benefit characteristics, and the vulnerability of those helped by the measure" (Sutton, 2008, p 43). It is the task of a functioning climate risk management to consider the variability of climate and to transfer it into appropriate technologies and planning policies.

3.4.1 Legislative and institutional context on climate change

All five Central Asian countries have a national legislative and institutional framework for further improvements in the area of climate change. All countries are active participants in the two main international treaties – the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.[4] In their National Communications under the UNFCCC the countries report on current assessments and progress on mitigation and adaptation strategies. So far, two National Communications have been submitted, further are in process. On adaptation, all of the countries are in the process of developing their National Adaptation Plans of Action (NAPAs) which should present climate change adaptation strategies more on an operational level; however there are none officially adopted at this moment. [5]

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3 "Win-win" adaptations are defined as those measures that would yield a positive rate of return, even without the additional potential benefit of avoiding climate-induced losses. "Win-win-win" advances the three goals of economic development, adaptation, and mitigation of greenhouse gas emissions (Sutton, 2008, p 31 and 35).

4 Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan have ratified the Kyoto Protocol, but as countries not listed in Annex B, they do not have mandatory quantitative commitments to reduce greenhouse gas (GHG) emissions and can only participate in projects under the Clean Development Mechanism (CDM). Kazakhstan has ratified the Kyoto protocol in 2009 and is an Annex I country. However, Kazakhstan is the only Annex I country which has no quantified commitments fixed in Annex B of the Kyoto Protocol but has voluntary declared commitments to reduce its GHGs emission.

5 Kazakhstan would develop its NAPA on a voluntary basis since being an Annex I country it is not obliged to do so. However, the progress on Kazakhstan's NAPA is currently stagnating (oral information by Yegor Volovik, UNDP Almaty, 27.12.2011). The other four countries of the region, non-Annex I countries (i.e. developing countries), are required by UNFCCC to adopt NAPAs and are in the active process of its development.

In addition, the countries have enacted various laws with more or less explicit regard to environmental protection and climate change. An overview on main laws and decrees can be found at CAREC (2011).

The coordination of climate change issues in the countries is mainly with the Ministries of Environmental Protection. For specific measures other Ministries become involved, as the Ministries of Energy, of Health, of Agriculture, and of Emergency. Climate change related research is conducted predominantly by the National Hydrometeorological Services (Hydromet). They are responsible for the implementation of the commitments under the UNFCCC, climate and weather observations and change assessments, conduction of the Greenhouse Gas Inventory, and partly also for vulnerability assessments and evaluation of adaptation measures.

3.4.2 Proposed and present adaptation measures in agriculture

The National Communications under the UNFCCC are the main and official summary of studies, activities, and strategies related to climate change in the various Central Asian countries.

The Regional Environmental Centre for Central Asia (CAREC) has summarized the proposed adaptation measures stated by the National Communications as priorities and has classified them by: 1) Prevention/improving resilience - prevent negative effects of climate change and enhance the adaptive capacity of the key vulnerable sectors (based on medium and long-term forecasts); 2) Preparation - reduce the negative effects of extreme events on vulnerable sectors (based on short-term climate forecasts); and 3) Response measures – alleviating the direct effects of extreme events (CAREC, 2011, p 32). The following table is a summary of the officially proposed adaptation measures in the area of water and agriculture in the countries of Central Asia.

Table 4: Proposed adaptation measures to climate change on water resources and agriculture in Central Asia

TYPE OF MEA-SURE	PREVENTION (refer to medium and long-term climatic effects)	PREPARATION (refer to short-term climatic effects, extreme events)	RESPONSE (direct response to extreme events)
POLITICS, INSTITUTIONS, GOVERNANCE	• development of agreements on transboundary water management and cooperation in water resources management (KZ, UZ); • improving management of surface runoff (KG); • establishment of IWRM at the national and transboundary levels (KZ); • harmonization of standards, on transboundary water level (KZ); • linking the policy of preservation and protection of ecosystems and agro-biodiversity policy with the climate change adaptation (KZ); • improvement of public and social programs for development of agriculture and rural areas; • grassland restoration management (KZ); • legal recognition of pasture users (KZ); • providing each individual farmer or rural community with several types of grazing land for seasonal use (KZ); • introduction of a regulated system of grazing animals (KZ);	• review of operating modes GPS (KZ); • prioritization of economic activity in accordance with water availability (KZ); • load regulation in terms of livestock grazing on pastures with different grazing seasons, reducing the load of livestock grazing on pasture near the settlements and heavily degraded pasture (KZ).	• organization of an effective veterinary and sanitary inspection, quarantine regulations and other measures to control livestock infectious diseases of (KZ); • providing conditions for fertilization, lambing, shearing animals, sanitary control, migration to summer pastures, as well as the storage of additional forage due to increasing instability of the climatic conditions (KZ).
TECHNOLOGY, METHODOLOGY, PRACTICE	• use of drains (KZ, TM); • introduction of modern, efficient water distribution systems to minimize losses (KG); • chemical and biological wastewater treatment (KZ); • creation of buffer zones near surface water sources (KZ); • prevention of soil erosion and introduction of soil conservation technologies to minimize the human impact (KZ); • improved land use to prevent land degradation, conservation of agricultural land with good parameters of humidity and soil fertility (KZ); • creation of zones for grazing cattle by a combination of natural grassland and areas especially planted with annual forage crops (KZ);	• diversification of crop production, including valuable crops (KZ); • replacing water-intensive crops with less water consuming crops (CA); • introduction of water saving technologies in irrigated agriculture (CA); • introduction of water saving technologies and water recycling systems in industrial enterprises and social facilities (KZ).	• revision of species of sheep in relation to climate change; • restoration of pasture system for sheep - wider use of mountain pastures; • improving topsoil for growing vegetation in degraded pastures, planting Haloxylon on arid and semiarid grasslands (KZ);

TECHNIQUE, INFRASTRUCTURE	• rehabilitation of irrigation systems to minimize water loss (CA); • improving the efficiency of on-farm and inter-farm canals (TJ); • construction of the ROW in artificial ponds (KG); • construction of reservoirs of long-term regulation (TM);	• use water-saving irrigation systems such as sprinklers, drip irrigation, etc.(CA); • providing emergency services with necessary equipment to ensure their immediate response (KZ); • dredging and reconstruction of berths and piers on navigable rivers (KZ);	• rehabilitation of wells and installation of pumps with independent power sources for grazing purpose (KZ);
ECONOMICS & FINANCE	• economic incentives for water users to make effective use of water (KG, TM);	• allocation of finance and infrastructure development as compensation for resettlement of people from unfavorable areas (KZ); • prioritization of economic activity in accordance with water availability (KZ).	• import of foodstuffs and industrial goods which production is domestically unprofitable due to lack of water resources (KZ).
SCIENCE, INFORMATION	• expanding the network of systematic observation and environmental monitoring (CA); • mandatory environmental impact assessments of new projects on water resources (KZ); • improve the timeliness and reliability of hydrological forecasts (KZ); • development of schemes of water resources (KZ); • the creation of observation posts for monitoring snow and ice in mountain areas in the upstream area of the Aral Sea basin (UZ); • selection and breeding of highly productive and drought-resistant crops (KZ, TM); • science-based agricultural development, its mechanization, irrigation chemicalisation (KZ); • development of new moisture saving agricultural technologies by modeling changes (shifts) in the distribution of precipitation (KZ);	• weather forecasting, climate modeling system and early warning (CA); • study of the level of adaptability of sheep and identification of stress-resistant sheep for each climate zone (KZ);	
EDUCATION, CAPACITY DEVELOPMENT	• capacity building to strengthen the institutional, technical and human resources (CA); • improvement of knowledge on timely adaptation to climate change and access to this knowledge for end-users (CA).	• farmer training to new and effective methods of agriculture (KZ); • raising awareness of farmers on the weather conditions through the media and the introduction of scientific approach in the management of livestock (KZ).	

Note: KZ - The Republic of Kazakhstan , UZ – The republic of Uzbekistan , KG - Kyrgyz Republic , TM - Turkmenistan , TJ - The republic of Tajikistan , CA - all countries of Central Asia

Source: CAREC, 2011, Annex table 1.1, pp 66.

To summarize, the **priority adaptation measures <u>proposed</u>** by the governments of the Central Asian countries in the field of water and agriculture – covering the levels of policy, technology, infrastructure, economics, science, and education – mainly refer to:

• water conservation and sustainable water use;

• combating land degradation;

• sustainable irrigated agriculture;

• sustainable use of rangelands and the diversification of grazing methods;

• increasing the productivity of crop and livestock production;

• preservation and maintenance of lake and river ecosystems (CAREC, 2011, p 36).

Looking at **<u>current</u> programmes and activities** on climate change adaptation and agriculture in Central Asia it becomes obvious that this sector is quickly developing – but mainly from the outside and not policy-induced. More and more international donors are launching initiatives. An overview of projects conducted during the last five years reveals that the majority of projects that have been implemented in the region so far will fall into the category of **preventive adaptation**, i.e. referring to long-term effects (CAREC, 2011, pp 37). Here most action has been attributed to indirect adaptation measures (implicitly) such as infrastructure improvements (e.g. irrigation systems), capacity building measures (e.g. environmental and poverty reduction legislation), and transboundary water related issues. More recently also explicit adaptation measures to climate change have been set up, mainly in from of building institutional and climate risk assessment and resilience capacity (e.g. project in Tajikistan by WB, EBRD, ADB started 2011[6]). With regard to **preparatory measures**, i.e. referring to short-term effects and extreme weather events, there are numerous activities dealing with the improvement of water use efficiency and agricultural crop diversification. Most of these activities are of demonstrative character as for example projects funded by the Global Environmental Facility Small Grants Programme (SGP GEF [7]).

In particular in the sector of agriculture and water, **multi-country initiatives** have been established that approach climate change in a direct or indirect way. For example, the Central Asian Countries Initiative for Land Management (CACILM [8], 2006-2014) is a partnership between the Central Asian countries and the international donor community (ADB, UNDP, GIZ) to combat land degradation, improve rural livelihoods, and adapt to climate change in five countries of the region. Through national and multi-country projects, the initiative promotes the multiplication of best practice examples on sustainable land management (mainly related to pasture, forest, and water management), provides capacity building measures, and facilitates legislative reforms like the Forest or Pasture Code. Another initiative, the Central Asian Multi-Country Programme on Climate Risk Management implemented by UNDP (CA-CRM [9], 2011-2013), seeks to strengthen climate-related disaster risk reduction and adaptive capacity by developing and conducting a comprehensive climate risk assessment in Central Asia, setting up a regional knowledge network, implementing capacity building measures, and conducting preparatory demonstration measures in the field of water management, reforestation, or drought management. An indirect linkage to

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6 http://go.worldbank.org/54E45GXBE0 ; http://pid.adb.org/pid/TaView.htm?projNo=45436&seqNo=01&typeCd=2

7 http://www.thegef.org/gef/sgp

8 http://www.adb.org/projects/cacilm/

9 UNDP has a specific and narrow understanding of climate risk management that is the interface between climate change adaptation and climate-related disaster risk reduction. http://www.climate-action.kz/uploads/files/CA_CRM_prodoc1.pdf

climate change can be found at various water initiatives: A well-known one is the International Fund for Saving the Aral Sea (IFAS [10], founded in 1993), an organization supported by the Central Asian governments that works for cooperation in the Aral Sea Basin in the field of water resources, environmental management, and socio-economic development. It has recently launched its third programme (Aral Sea Basin Program 3, ASBP-3, 2011-2015) that supports national and regional projects related to Integrated Water Resources Management, environmental protection, socio-economic development, and improving institutional and legal instruments.

3.5 Comments on CRM and adaptation strategies in agriculture in Central Asia

The issue of climate change has arrived in Central Asia's reality and is becoming more and more reflected in various policies and activities of the countries. The water and agricultural sector is the most vulnerable one and receives a lot of attention as the National Communications under the UNFCCC confirm. However, there are still gaps between what is needed, what has been proposed, and what has already been done in order to respond to climate change risks.

The National Communications reflect the actual needs of climate change adaptation in agriculture, namely the need for better scientific data on climate change dynamics and impact, institutional strengthening, integrated resource management, and improved infrastructure. Still, they do not demand a socio-economic assessment of current and potential climate change risks which can be taken as a sign of insufficient awareness on the severity of situation among the policy makers. Another limitation is the lack of practical implementation methods and concrete responsibilities for enforcing adaptation strategies. Especially no financial or economic tools are proposed for implementing adaptation measures (with some exception of Kyrgyzstan and Turkmenistan mentioning economic incentives for efficient water use) (CAREC, 2011, pp36). Furthermore, the proposed adaptation measures – although relevant – are isolated activities but not integrated into an inherent strategy or action plan for increasing the resilience of agriculture to climate change. The Ministries of Agriculture are not sufficiently involved in both, the analysis of current situation and the strategic planning of adaptation or risk management strategies.[11]

The high economic and political importance of the water and agricultural sector in Central Asia has led to an increasing number of (internationally funded) projects focusing implicitly or explicitly on climate change aspects. Among them are several valuable projects showing best practice examples or initiating a multi-country approach. Still, those projects exist segregated from each other. The lack of socio-economic impact assessments makes it difficult to analyse the effectiveness of such projects. As the "market of climate change projects" in the region likely enlarges in the future, there is a high need for i) profound baseline information on the economic value of the agricultural sectors and its potential gains and losses through climate change; and ii) a coordination of adaptation (as well as mitigation) projects according to a credible policy. Both tasks are in the responsibility of the respective countries, even if supported by international research and consultancy [12].

[10] http://www.ec-ifas.org/

[11] For example, the Ministry of Agriculture was neither directly nor indirectly involved in the compilation of the Second National Communication on UNFCCC of Kazakhstan.

[12] CAREC is planning to set up a website platform for all actors dealing with (development and research) projects on climate change in Central Asia (oral information by Atabek Umirbekov, CAREC, 22.12.2011).

Further barriers to effective climate risk management and adaptation strategies in Central Asia occur due to still insufficient technical capacity and information. Especially decision-makers seem to be not yet well informed about climate change impacts and the difference between mitigation and adaptation. There is still a lack of certain climate data (e.g. glacier melting rates) due to inadequate hydro-meteorological systems and monitoring stations. In addition, there is no functioning data and information exchange between the various state institutions, ministries, and non-governmental organizations. This is due to the fact that climate data is not yet recognized as an important factor of development planning. Although increasing amounts of climate data are being collected, they are not yet used for future adaptation scenarios (UNDP, 2010, p 11).

Among Central Asian policy-makers climate change is perceived as an environmental rather than a development problem. This results in contradictory objectives and policies. So far, the policy discussion on climate change is dominated by mitigation, while little attention is given to adaptation. There are several reasons for this including capacity and awareness gaps, but also the high cost of adaptation measures (competing with other development priorities), limited funding, lack of local experience with climate change modeling, and the use of diverging models and predictions, which are difficult to compare (CAREC, 2011, p 5).

Research plays a key role for the preparation of the region to climate change impacts. The technical analysis of the processes of climate change - which is mainly conducted by the Hydrometeorological Services - is more or less satisfactory, although the application of climate projections and impact scenarios is still insufficient. Considering the importance of the agricultural sector for the development of the countries and its vulnerability to climate change, more emphasis should be given to agricultural and agro-economic research. Here the list of research priorities is comprehensive, ranging from efforts in agronomy and animal husbandry, to sustainable land and water management technologies, and to economic incentives like water pricing, payments for environmental services and virtual water trade. A general drawback of agricultural research in Central Asia is the poor integration of national research institutions into the international scientific community as well as the insufficient communication and transfer of research results from research institutions to national authorities and finally to farmers and producers (Christmann et al, 2009, pp 62). [13] Through the work of international research institutions being present in Central Asia, international scientific exchange has significantly increased (see e.g.: the International Center for Agricultural Research in Dry Areas - ICARDA[14], the International Water Management Institute - IWMI[15], and the Scientific-Information Center of the Interstate Coordination Water Commission of Central Asia - SIC ICWC[16]). In addition there are various research activities carried out in cooperation with Western partners that focus on agriculture or water issues in Central Asia (e.g.: the Khorezm Project, 2000-2011, ZEF[17]; Livelihood strategies in

[13] One recent example for the insufficient transfer of research results into action is the wheat harvest 2011 in Kazakhstan: Although very high wheat yields have been forecasted already in May by the Kazakh Space Research Institute and have been communicated to the Ministry of Agriculture, no action have been taken to cope with the yield surplus which have led to high product losses on not harvested fields due to under-capacities of harvest and storage equipment (oral information by research assistants of the Kazakh Space Research Institute, 28.12.2011).

[14] http://www.icarda.org/cac/

[15] http://centralasia.iwmi.org/

[16] http://sic.icwc-aral.uz/index_e.htm

[17] http://www.khorezm.zef.de/

Kazakhstan and Kyrgyzstan, 2011-2013, Magdeburg University[18]; Risk management of the Zerafshan Watershed, 2008-2010, Hanover University[19]). However, current research activities refer to the aspect of climate risk management indirectly and not in a comprehensive way. The economic aspects of climate change impact on agriculture and livelihood of rural population are often missed out.[20] Agricultural/agro-economic research should also go beyond the common focus of farmers and take notice of landless people and female headed rural households as well as investigate off-farm employment opportunities (Christmann and Aw-Hassan, 2010, p 341).

4 Conclusion

Climate change impacts the development of every country, with agriculture being the most climate-sensitive economic sector. The level of exposure, sensitivity, and adaptive capacity of a country or economic sector defines its vulnerability to climate change risks. On the response side, climate change adaptation and climate risk management provide measures to cope with these risks and impacts. Climate change adaptation is an adjustment approach with a focus on the final outcome. Climate risk management (CRM) instead is a process-oriented approach including feedback mechanisms. It aims to better manage risks and reduce vulnerability (or take advantage of opportunities) caused by climate variability and change.

In Central Asia a general trend of warming and irregular precipitation can already be observed and is expected to be continued. Both, the increase in temperature and the change in water availability (precipitation, river- and groundwater) due to climate change are influencing the agricultural productivity of the region. Most of the countries (Tajikistan, Kyrgyzstan, Uzbekistan) have been indicated as a potential net loser in agriculture due to climate change, while Kazakhstan shows mixed or uncertain outcomes.

Irrespective of the exposure to climate change risks, the Central Asian countries show an extreme vulnerability to climate change that is caused by a high sensitivity and low adaptive capacity. The reasons for this lay in the still poor state of infrastructure, a neglected environmental policy, a rather weak economic situation (with exception of Kazakhstan), and growing socioeconomic differences, altogether making the countries poorly prepared for adaptation measures.

However, in the frame of international efforts the countries of Central Asia have joined the process of combating climate change. But political emphasis is given so far to mitigation of climate change rather than adaptation or risk management measures. Still, the evaluation of the National Communications under the UNFCCC and other reports allows following **conclusions on present and proposed adaptation and risk management measures for the agricultural (and water) sector in the Central Asian countries**:

- There is still a need for better scientific data on climate change dynamics and impact.

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18 http://www.volkswagenstiftung.de/foerderung/internationales/zwischen-europa-und-orient-mittelasienkaukasus-im-fokus-der-wissenschaft/bewilligungen-2011.html?L=0

19 https://www.warb.uni-hannover.de/e107_plugins/content/content.php?content.37

20 Agro-economic research is still busy with the legacy of transition and deals with aspects of productivity increase, competitiveness, and framework conditions for market economy. Climate change is not yet perceived as a priority for agro-economic research (oral information by Galischan Madiev, Director Institute Agrobusiness at Kazakh National Agricultural University, 21.12.2011).

- Socio-economic assessments of current and potential climate change risks are completely missing.
- Appropriate technologies (e.g. water management, soil conservation, productivity enhancements, etc.) are gradually being introduced and demonstrated in best practice examples. Still, these efforts are isolated activities.
- Institutional shortcomings are the most important bottleneck in facilitating climate risk management and adaptation measures, e.g. through adaptation-oriented policies and regulatory frameworks, functioning supporting institutions, and clearly defined responsibilities.

Research can support the process of setting-up climate risk management and adaptation measures considering the identified gaps above. Open research questions, to name only a few, include for example: climate observations, climate risk analysis on the natural and social environment, cost-benefit analysis of adaptation strategies, evaluation of human coping strategies, scenario building, and institution analysis of policy making. In order to contribute effectively to climate risk management, the new research should be linked to existing outcomes and should network with other research groups, practitioners and policy makers.

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