95412

Uzbekistan

CLIMATE CHANGE AND AGRICULTURE COUNTRY NOTE

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This Country Note for Moldova is part of a series of country briefs that summarize information relevant to climate change and agriculture for four pilot countries in the Europe and Central Asia (ECA) Region, with a particular focus on climate and crop projections, adaptation options, policy development and institutional involvement. The Note series has been developed to provide a baseline of knowledge on climate change and agriculture for the pilot countries participating in the **Regional Program on Reducing Vulnerability to Climate Change in ECA Agricultural Systems**. For Uzbekistan, this note was shared with the Government and other agricultural sector stakeholders and used as an engagement tool for the National Awareness Raising and Consultation Workshop on Reducing Vulnerability to Climate Change in Uzbekistan's Agricultural Systems, held in Tashkent in May 2010. Feedback and comments on the Note from this consultation process have been incorporated into this updated version in collaboration with the Uzbekistan Ministry of Agriculture and Water Resources (MAWR).

Climate Change Exposure and Risk for Uzbekistan

Agriculture is extremely important for rural livelihoods in Uzbekistan, with approximately 34% of the population employed in the sector and 23% of the country's GDP derived from agriculture.[7] As agriculture is a highly climate- sensitive sector, much of Uzbekistan's rural population is vulnerable to climate change. Historical data indicate that Uzbekistan is characterized by a highly variable climate that has already experienced an increase in mean temperature, extreme hot days and evapotranspiration (aridity). Climate projections for the future indicate that, on average, Uzbekistan will be exposed to:

- *A 1.9°C to 2.4°C increase in mean annual temperature by 2050, with regional differences, with the greatest warming projected to occur in winter and spring*
- *An increase of 15-18% in mean annual precipitation by 2050, with the greatest seasonal increase in summer*
- *A progressive worsening of projected water deficit at the Aral Sea basin level, as water demand increases and secured water withdrawals decline in both the Amu Darya and Syr Darya catchments*
- *Projected water deficit increases from 2km^3 in 2005 to 11-13km^3 in 2050*
- *A riskier agricultural production environment, as increasing temperatures result in greater crop evapotranspiration, offsetting projected increases in precipitation and resulting in a more arid production environment that is more reliant on already stressed and deficient water resources*
- *Increased exposure to new pests and diseases for agricultural crops and livestock due to changes in the temperature and precipitation regime*
- *An increased length of growing seasons, especially in northern areas, providing opportunities for new crops, increased productivity and changes to cropping patterns*

In this Note

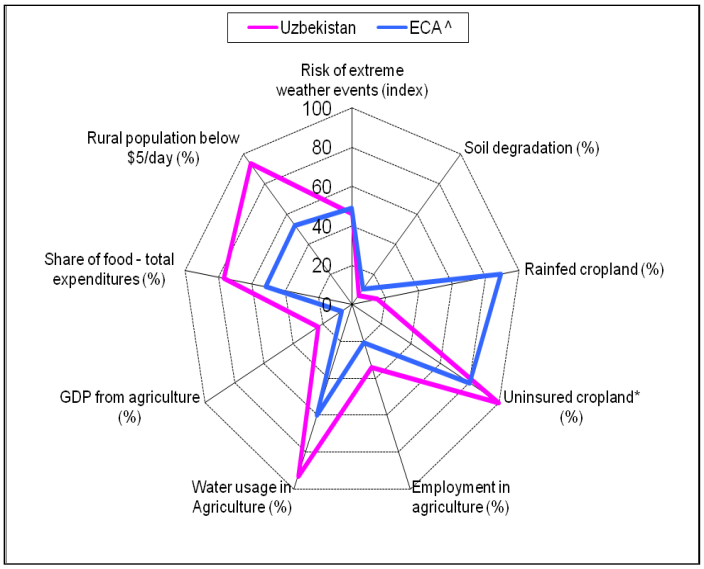
Uzbekistan at a Glance[7]

Population	*27,606,007*
Population below the poverty line	*26%*
GDP	*US $32.8 billion (2009)*
GDP Per Capita	*US $1,182 (2009)*
Share of Agriculture in GDP	*23%*

I. Introduction

The Europe and Central Asia (ECA) Region of the World Bank recently released a new report titled "*Managing Uncertainty: Adapting to Climate Change in Europe and Central Asia.*"[1] This report is a flagship document that raises awareness of the threats, challenges and opportunities that ECA countries and communities will face in adapting to climate change across a variety of economic sectors. This Country Note was developed as a basis for beginning work in Uzbekistan under a World Bank regional program designed to enhance the ability of ECA countries to integrate climate change adaptation into agricultural policies, programs and investments.[2] To support the Government of Uzbekistan in this effort, the Ministry of Agriculture and Water Resources (MAWR), the State Committee for Nature Protection of the Republic of Uzbekistan and the World Bank are working together to develop Uzbekistan's Response to Climate Change and Agriculture.

***Figure 1*: Uzbekistan Vulnerability Indicators**



Note: ^ECA statistics come from transitioning and developing economies in Eastern Europe and Central Asia, where available; employment in agriculture (% of total employment); rain-fed cropping (% of cropland); water usage in agriculture (% of total annual freshwater extraction); uninsured cropland (estimate); soil degradation (% of total land); risk of extreme weather events (additional 1:20 year events 2070-2100 vs. 1961-1990); share of food – % of total expenditures; GDP from Agriculture; Sources: World Development Indicators 2008; EarthTrends 2003, FAO AGL 2005; Baettig, M. et al., 2007.

Agriculture is of vital importance to Uzbekistan, in terms of employment, rural livelihoods, food security and self-sustainability and exports. However, because this sector is highly climate sensitive, the potential adverse risks of climate change (e.g. changes in temperatures, water resource availability and the frequency of extreme events) are likely to increase the vulnerability of poor and rural populations. This deterioration will place a further strain on institutions, food supply and rural growth in Uzbekistan. Furthermore, financial constraints and limited institutional capacity to respond to climatic hazards threaten future sustainable agricultural production and rural development in the country. However, the introduction of a proactive approach that focuses on taking advantage of potential opportunities while simultaneously minimizes risk to climate change via adaptation can help agriculture and rural livelihoods in Uzbekistan become more resilient, sustainable and competitive in the face of a changing climate.

Figure 1 displays nine climate change vulnerability indicators and compares Uzbekistan to the Europe and Central Asia (ECA) Region average for transition economies. Agriculture and rural livelihoods in Uzbekistan appear to be more vulnerable than the ECA average to climate change for the majority of indicators. The four categories where Uzbekistan appears substantially more vulnerable than other countries in the region are for the percentage of water usage in the agricultural sector, the percentage of the population employed in the agricultural sector, the percentage of the rural population living on less than $5 per day and the share of food as a percentage of total household expenditure.

II. Overview of Agriculture

After Uzbekistan gained independence in 1991, the country's agricultural systems underwent significant structural changes resulting in total agricultural output dropping 16% by 1996.[5] However, with the implementation of land distribution initiatives and the engagement of an increasing number of households in agriculture and crop diversification, output has since increased significantly and has surpassed output levels attained in 1991.[5] Structural changes to the type of land tenure available following the restructuring of large collective and state farms has resulted in the formation of private farms and the expansion of small household plots, which are now responsible for much of the growth in agricultural output over recent years, with strong productivity gains leading to increased household incomes.[5]

Acknowledgements:

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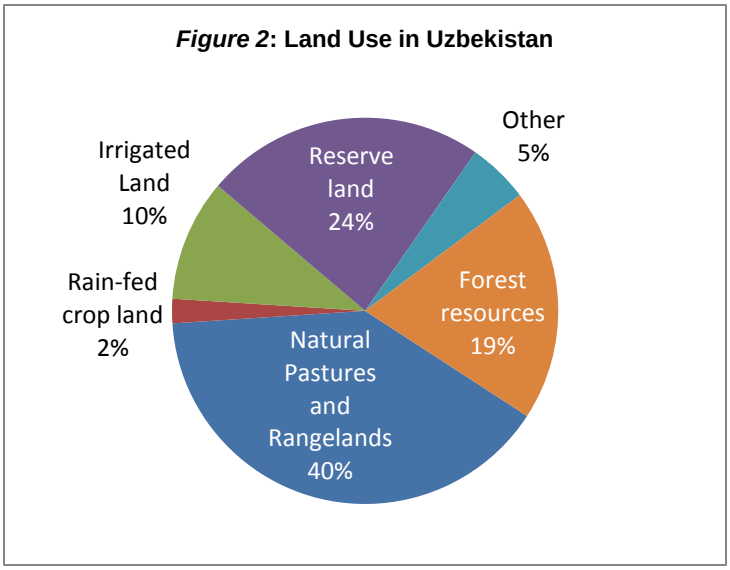
A large area of land is used for agriculture in Uzbekistan, with natural pastures occupying 40% of the country and rain-fed and irrigated cropland accounting for an additional 12% (see ***Figure 2***).[3] Due to the arid conditions of the country, more than 85% of Uzbekistan's cropland is irrigated. This irrigated cropland comprises approximately 10% of the land area of the country.[3]

By area, cotton and wheat are by far the two major crops grown in Uzbekistan. Smaller areas are occupied by fodder crops, grapes, apples, barley, tomatoes, potatoes and rice. Although the area occupied by fruit and nut trees is relatively small in comparison to wheat and cotton, the prevailing climatic conditions are suitable for the expansion of their production area.[4]

***Figure 2*: Land Use in Uzbekistan**



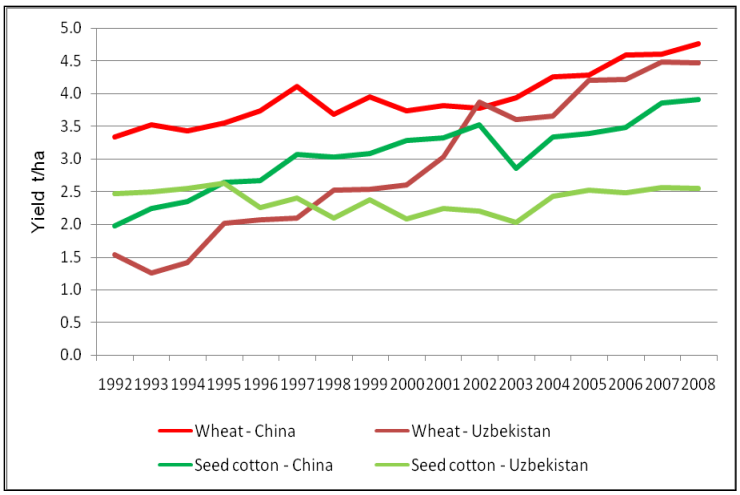
Source: Centre of Hydrometeorological Service, Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change, Tashkent, 2008

Projected changes in the agro-climate, such as increased temperatures and evapotranspiration, pose a serious risk to agricultural production, water availability and economic growth for rural livelihoods in Uzbekistan. Across the country there is significant variation in vulnerability to climate risks and associated adaptive capacity to climate change. This variation depends on a range of factors, including the current climatic exposure, financial capacity, social structures, institutional capacity, knowledge and education and access to infrastructure. Areas that are already under marginal rain-fed production will be at increasing risk, while communities in relatively high rainfall or irrigated areas have more adaptation options to buffer their production systems against projected climate change, providing that sufficient water remains available for irrigation. In some instances, there could also be potential opportunities to increase production as a result of climate change (e.g. an increasing length of the growing season) that could be taken advantage of if appropriate measures are put in place.

III. Agriculture and the Adaptation Deficit

Both the sensitivity of the agricultural sector to the climate and the high reliance of this sector on water resources for irrigation have important implications for Uzbekistan. Because a considerable number of the country's rural poor depends on the agricultural sector for their livelihood, rural communities are vulnerable to changes that may occur as a result of climate change.[5] Uzbekistan's relatively low productivity and adaptive capacity to the present climate, also known as the adaptation deficit, further exacerbate the inherent risks of climate change. This can best be illustrated by a comparison of cotton seed yields between Uzbekistan and China between 1992 and 2008, illustrated in ***Figure 3***. China, particularly its western region, is considered a similar production environment to Uzbekistan. Cotton seed yields have remained relatively stagnant in Uzbekistan, with mean yields between 1992 and 2008 increasing only marginally - from 2.5t/ha to 2.6t/ha - and comparative yields with China declining significantly, from 125.2% to just 65.5%.[6] Uzbekistan's adaptation deficit can also be illustrated through comparisons of wheat yields with China, although the comparison is much less stark. Wheat yields in Uzbekistan have greatly increased since the country gained independence, both in gross terms and in comparative terms with China. Between 1992 and 2008, mean

***Figure 3*: Mean Yields in Uzbekistan and China for Cotton Seed and Wheat from 1992-2008**



Source: Adapted from http://faostat.fao.org

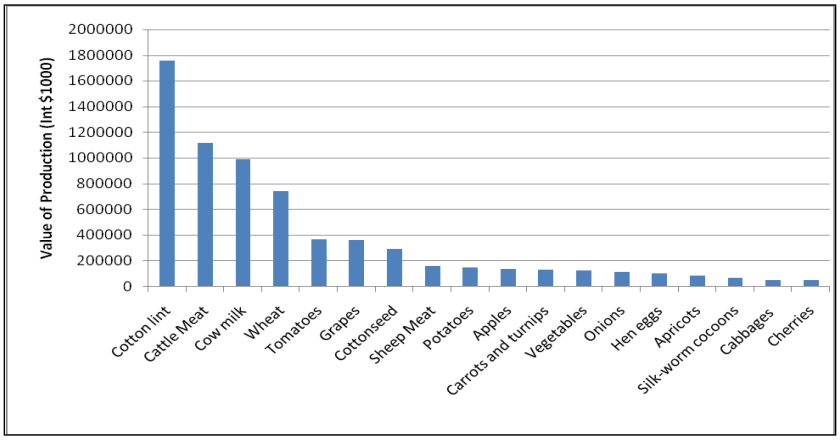
yields in Uzbekistan increased from 1.5t/ha in 1992 to 4.5t/ha in 2008 and comparative yields (as a percentage of mean yields in China) increased from 46.2% to 93.7% during this same period.[6] Despite these improvements, however, Uzbekistan nonetheless lags behind China and is still significantly below its agronomic potential, highlighting the existing adaptation deficit in Uzbekistan's agricultural systems.

The underperformance of both wheat and cotton seed yields in Uzbekistan can be attributed to a complex set of factors, including distortions and imperfections in agricultural output and input markets; poor quality public services in areas like agricultural education, extension, research, and market information systems; delays in farm restructuring and undeveloped agricultural land markets; lack of access to finance; deteriorating land quality; poor quality seed; sub-optimal farming system design; insufficient irrigation; and high vulnerability to natural hazards like droughts and heatwaves.[5,4] These factors, combined with the increased challenges posed by climate change, signify the importance of the actions that need to be taken now in order to address the adaptation deficit as part of any climate change adaptation strategy for Uzbekistan.

IV. Agriculture and the Economy

The economy of Uzbekistan has gone through a significant transition since achieving independence in 1991. Although GDP declined from 1991 until 2000, Uzbekistan experienced a strong average annual growth rate of 6.2% from 2000-07. [5] GDP reached US$ 32.8 billion in 2007 while GDP per capita was US$ 1,182.[7] Agriculture has traditionally been a strong and relatively stable contributor to Uzbekistan's economy. Between 2000 and 2007, the sector expanded at a robust average annual rate of 6.8%.[5] Despite this growth rate, however, the sector's share of GDP declined from 32% to 23% between 1995 and 2007, as other sectors of the economy, such as industry and services, grew at a faster pace.[5] Even with this decline, 40% of Uzbekistan's exports still come from the agricultural sector, highlighting the importance of agriculture to Uzbekistan's economy.[5] Cotton is the primary source of these exports, as Uzbekistan is the world's fifth largest producer of cotton and second largest exporter of this commodity (after the USA).[7]

***Figure 4*: Average Value of Agricultural Production by Commodity, 2005-07**



Source: Adapted from http://faostat.fao.org

At the commodity level, cotton lint, cattle meat, cow milk, wheat, tomatoes grapes, and cottonseed made the most significant contribution to the average value of agricultural production in Uzbekistan from 2005-07 (***Figure 4***). Approximately 60% of the value of agricultural production is derived from the annual and perennial crop sectors, while the livestock sector produces the remaining 40%.[5] Although field crops like cotton and wheat are grown extensively and occupy a large percentage of the cropping land (figure 4), other crops like tomatoes, grapes, potatoes and apples make a significant contribution to the value of agricultural production on a proportional basis, as they can garner higher price.[4]

Overall, the agricultural sector accounts for approximately 34% of total employment in Uzbekistan and more than 60% of the population lives in rural areas.[4] Of this population living in rural areas, 93% earn less than $5 per day and are highly vulnerable to any changes in agricultural income.[8] As a result, the national economy remains inherently vulnerability to climate related events that impact the agricultural sector.

V. Agriculture and the Environment

Agri-environmental management has implications for the resilience of Uzbekistan's agricultural sector to climate change. The most significant impacts Uzbekistan's agriculture has on the environment are associated with inefficient water use, soil salinization abandonment of irrigated lands due to salinity, pumping costs and poor water quality.[4] All of these issues adversely affect the natural resource base of the country and increase the vulnerability of agricultural systems and rural

livelihoods to external shocks like climate change. The continuing economic burdens which result from this degradation are immense, with the annual cost of salinity to Uzbekistan estimated at $1 billion per year.[4]

The problems of poor water resource management, inefficient water use, improper land use and soil salinization are inextricably linked to (and best symbolized by) the degraded state of the Aral Sea. At a basin level, improper water resource management of the two major sub-catchments of the Aral Sea – the Amu Darya and Syr Darya Rivers – across Central Asia has resulted in over allocation of water for consumption and insufficient water for environmental flows to the Aral Sea and its once productive deltas.[4] The arid soils of Uzbekistan are generally high in salt, which is leached and deposited into local groundwater systems through irrigation. Reuse of such water downstream for irrigation exacerbates the salinity problem. Additionally, rising groundwater results in salts returning to the root zone during winter, which then requires more water to be used to leach salinity before the next cropping season. This leaching process adds to salinity problems downstream and the cycle continues. The latest data available on land salinization indicates that 51% of Uzbekistan's irrigated land is salinized to some degree, with 4% strongly saline, 17% moderately saline and 30% slightly saline.[3]

Soil erosion is also a significant problem across vast areas of the country, primarily as a result of poor land management. About 50% of irrigated land, as well as large areas of rain-fed and pasture lands, are affected by wind erosion.[4] Natural processes of erosion, such as steep slopes, climate, land cover patterns and soil properties, combine with human factors, such as poor cultivation practices, overgrazing and salinization, to accelerate the overall rate of erosion in Uzbekistan and contribute to land degradation across the country.[3] Poor agricultural practices at the farm level - including improper crop rotations and poor fertility management - also combine with the impacts of soil erosion to further create significant soil degradation.[4] It should be highlighted that many of the environmental problems caused by agriculture can be addressed concurrently by bridging the adaptation deficit to both the current and projected future climate, thus underscoring the importance of integrating environmental considerations into the climate change agenda for the agricultural sector in Uzbekistan.

VI. The Climate Context

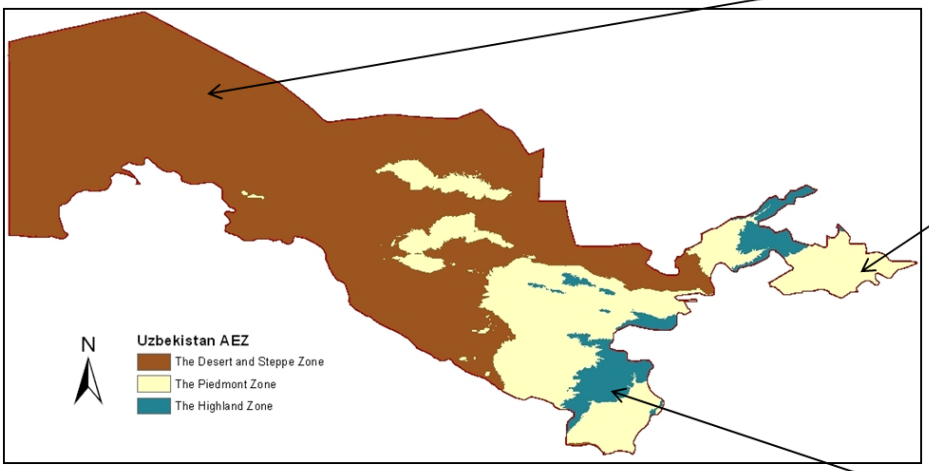
Climate Description and Historical Trends

Uzbekistan has an arid, continental climate that is characterized by cold winters, hot summers and limited precipitation in most parts of the country. Mean summer temperatures range from less than 22°C in the mountainous areas along the eastern border of the country to 28-30°C in central districts, with summer temperatures during extreme events exceeding 50°C.[3] Mean winter temperatures range from -9°C in northern districts of the country to 5-7°C in south-eastern districts. During severe winters, temperatures can drop below -35°C in many areas. On an annual basis, mean precipitation ranges from 80-200mm in the desert plains area and 600-800mm in the highland mountain areas in the east of the country. Precipitation falls predominately in winter and spring, with precipitation being extremely sparse in the summer.[3] Most of the country receives less than 100mm of precipitation during the summer months. From an agricultural perspective, the arid climate of Uzbekistan is highly challenging, as this sector in highly reliant on irrigation to overcome the country's natural water deficit. For rain-fed cropping and rangeland pastures, extended dry periods (especially in summer) combine with high temperatures and extremely variable annual precipitation to create a high risk production environment with limited productive potential in most years.

Analyzing climate trends from historic data is an important first step in identifying the current and potential future impacts of climate change on agriculture in Uzbekistan. Since 1938 all regions of Uzbekistan have experienced an increase in mean minimum and maximum temperatures for all seasons of the year, although the warming trend is less pronounced in the Tyan-Shan and Pamir-Alay mountain branches than in the rest of the country. While there is significant inter-annual variability, the general trends indicate that temperatures across Uzbekistan have increased on average by approximately 1.5°C and precipitation has declined by approximately 10mm. Alarmingly, the warming trends observed since 1951 in Uzbekistan have occurred at more than twice the global average for this time period.[9] Across the country, however, there have been some spatial differences in precipitation trends, with annual precipitation declining between 50-100mm in some central and eastern districts and moderately increasing in areas surrounding the Aral Sea.[10]

Uzbekistan can be divided into three climate types based on temperature, precipitation and elevation. These climate types can be further consolidated into three agro-ecological zones, as illustrated in ***Figure 5***. Each of these zones will be impacted by climate change differently, due to variations in their underlying biophysical, climate and agricultural production systems.

***Figure 5*: Agro-Ecological Zones of Uzbekistan**



Desert and Steppe Zone

Landscape: Lowlands and low plateaus in western areas with vast valleys in the central part of the zone

Elevation: 60 – 150m above sea level, with smaller areas in eastern districts with elevations greater than 400m

Temperature: Annual mean temperatures range from 10ºC in northern areas to 15ºC in central areas.

Precipitation: Most areas receive less than 200mm per year, although far western areas receive less than 100mm.

Agriculture Conditions: A harsh agricultural production environment with limited water availability. Crop production is only possible with irrigation, whilst the remaining rangeland area is used for livestock production. Sand deserts in the central parts of the zone are not suitable for agriculture, especially during summer due to extreme heat.

Piedmont Zone

Landscape: Undulating terrain intermixed with open plains

Elevation: 400–1000m above sea level

Temperature: Annual mean temperature ranges from 12ºC to 14ºC

Precipitation: Generally below 400mm per year with precipitation falling predominantly in winter and spring.

Agriculture Conditions: Diverse irrigated crop production is possible in relatively flat areas with good water supply, although there are some areas with rainfed crops (i.e. wheat). There are also extensive areas of pasture for livestock production, with the vegetation transitioning with increasing elevation from an arid type to grasses and scrubs. Gardens and plantations are also scattered throughout the zone.

Highland Zone

Landscape: Steep and mountainous interspersed with areas of highland plains. This includes the Tien-Shan and Gissar-Allay mountain ranges.

Elevation: Greater than 1,000m above sea level

Temperature: Annual mean temperature ranges from -5ºC to 5ºC

Precipitation: **Exceeds** 600mm per year, with a considerable part of winter precipitation falling as snow

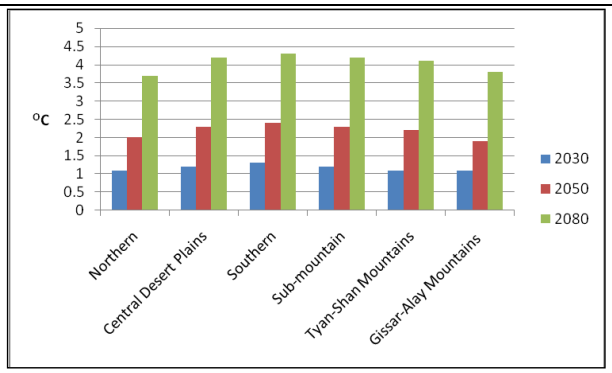
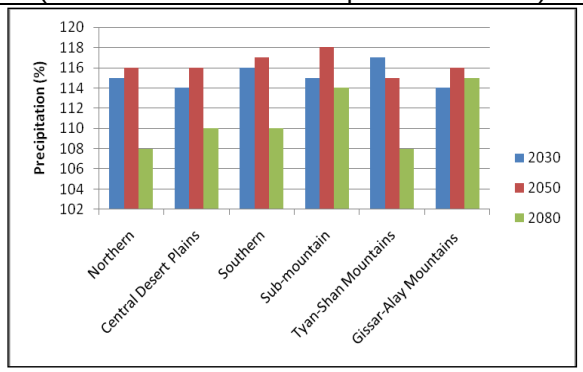
Agriculture Conditions: This zone is not suitable for crop production, but is utilized for summer grazing by livestock as well as for the growth of wild fruit bearing trees, and medicinal plants within extensive areas of forests.

Source: Adapted from Jarvis A., H.I. Reuter, A. Nelson, E. Guevara, 2008, Hole-filled seamless SRTM data V4, International Centre for Tropical Agriculture (CIAT), available from http://srtm.csi.cgiar.org; Centre of Hydrometeorological Service, Cabinet of Ministers, 2007. Climate Change and its Impact on Hydrometeorological Processes, Agro-Climatic and Water Resources of the Republic of Uzbekistan, Tashkent; http://www.fao.org/ag/AGP/AGPC/doc/counprof/Uzbekistan/uzbekistan.htm

Climate Projections

The Second National Communication of Uzbekistan outlines future climate projections for the country. The general trends using different emission scenarios are quite consistent and indicate that Uzbekistan will become hotter with increased precipitation over time. However, the precipitation increase is likely to be offset by greater plant evapotranspiration (due to higher temperatures) and will result in increased aridity, especially on the plains and in the foothills across the country.[3] Additionally, it is also projected that climate will become more variable, with an increased probability of extreme events like droughts, heatwaves and cold snaps.[3] The climate projection analysis was performed using six general circulation models (GCM's), a combination of four different emission scenarios and three time horizons, with the results being statistically downscaled for different regions of the country.

Figure 6: **Projected Change in Mean Annual Temperature and Precipitation to 2080**

Projected Change in Mean Annual Temperature	Projected Change in Mean Annual Preciptation (100 = Mean Annual Precipitation 1961-90)
	

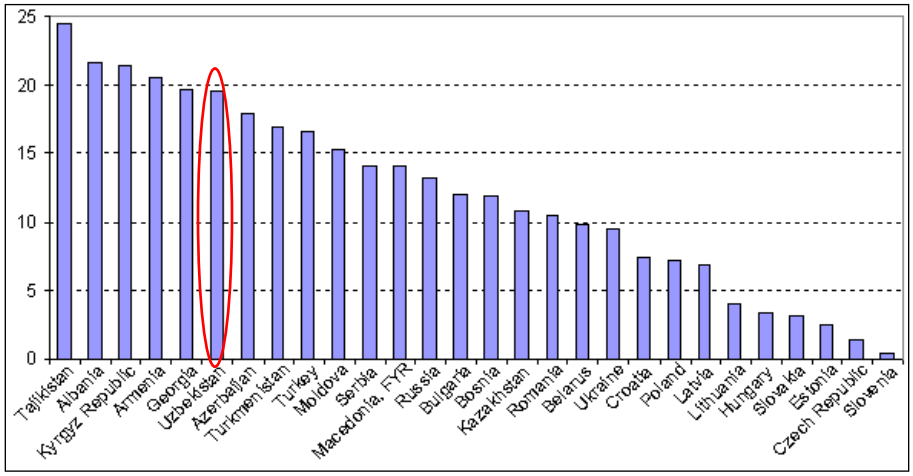
Source: Adapted from Centre of Hydrometeorological Service, Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change, Tashkent, 2008

Results of future climate projections for temperature and precipitation by geographic regions within Uzbekistan are presented in ***Figure 6***. Given the complex geography of Uzbekistan there will be a significant difference in the magnitude of changes in temperature and precipitation across the respective regions, with this trend intensifying over time. For 2050, mean temperature is projected to increase in a range from 1.9°C in the Gissar-Alay Mountains to 2.4°C in the Southern region. Mean precipitation is projected to increase in a tighter range across the regions, between 15%-18% above the mean rainfall for the 1961-90 period.[3]

On a seasonal basis, temperatures across Uzbekistan are projected to increase for all seasons, with the greatest increase projected for winter temperatures, which are expected to rise by 4.5°C by 2080.[3] For mean precipitation, seasonal projections for 2030 and 2050 indicate that all seasons will become wetter, although it should be noted that summer precipitation is increasing from a relatively small base. However, by 2080 mean summer precipitation is projected to decline by approximately 10%.[3]

The recent World Bank report "Managing Uncertainty: Adapting to Climate Change in Europe and Central Asia" developed a series of indices to assess the exposure, sensitivity and adaptive capacity of countries

Figure 7: **Climate Change Vulnerability Index, ECA Region**



Source: Adapting to Climate Change in Europe and Central Asia, Washington DC. The World Bank 2009

to climate change in the ECA Region. The vulnerability index displayed in ***Figure 7*** is a combination of the exposure, sensitivity and adaptive capacity indices. The vulnerability of Uzbekistan to climate change based on this index can be classified as high compared to most countries in the region. The main underlying drivers of vulnerability identified were particular social and productive structures, which enhance the sensitivity of Uzbekistan to climate change.

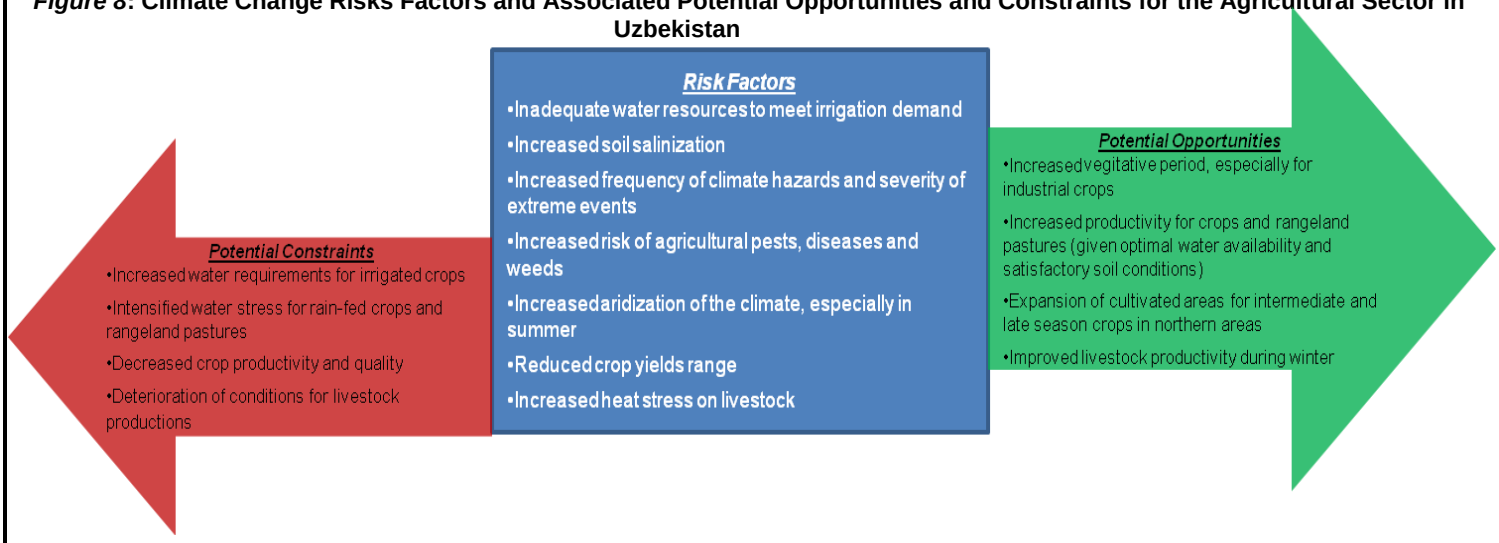
VII. Impacts of Climate Change on Agriculture and Water Resources

The downside risks for the agriculture sector in Uzbekistan outweigh any potential benefits that may result from climate change.[11] Unless investments and structural changes are implemented in the agricultural sector which address the country's relatively low productivity and associated adaptation deficit, even those particular crops and agro-ecological zones which could potentially benefit from climate change may suffer.[12]

Climate change projections and adverse agricultural implications outline the challenges for Uzbekistan. Although mean annual rainfall is projected to increase during the first half of the century, this change is not likely to improve water availability for agriculture. Instead, crop producers will be faced with greater irrigation requirements due to increased crop evapotranspiration as a result of increased temperatures, heatwaves and droughts[3]. Moreover, projected trends of declining water supply and increasing demand highlight the importance of improving water-use efficiency to limit the further expansion of water supply deficits.[3] An increase in mean annual air temperature over the last century has already resulted in a reduction of mountainous glaciation in Central Asia by as much as one-third.[3] As more than 90% of extracted freshwater is used for irrigation in Uzbekistan, the agricultural sector appears to be the most vulnerable sector in terms of future reductions in water allocation. Unless adaptation measures are adopted, this scenario could result in increased water scarcity for irrigation, declines in crop yield and quality and a more arid and risky production environment throughout the country.[3] Furthermore, changing climatic conditions may lead to problems associated with an array of agronomic issues, including changes in soil drainage patterns, damage to soil structure and exposure to new pests and diseases that challenge current plant and animal genetics and management.[11] On a positive note, the length of the growing period across Uzbekistan is projected to increase and the number of frost days is projected to reduce.[13]

This projected change in frost days will provide opportunities for crop distribution changes and longer-season varieties, especially for winter and late season crops in the northern districts of the country.[3] Despite this opportunity, overall climate change is projected to have a negative impact on Uzbekistan's agricultural sector, further illustrating the importance of developing and implementing adaptation options to increase the resilience of agricultural systems to climate change.[3] For the crop and livestock sectors of Uzbekistan, projected climate changes clearly highlight key risk factors and constraints, as well as potential opportunities for the future, as outlined in ***Figure 8***. If Uzbekistan is to address these risk factors, limit potential constraints and take advantage of potential opportunities it is clear that a strong focus on the development and adoption of adaptation measures is required to ensure that agricultural systems remain resilient as the climate changes.

***Figure 8*: Climate Change Risks Factors and Associated Potential Opportunities and Constraints for the Agricultural Sector in Uzbekistan**

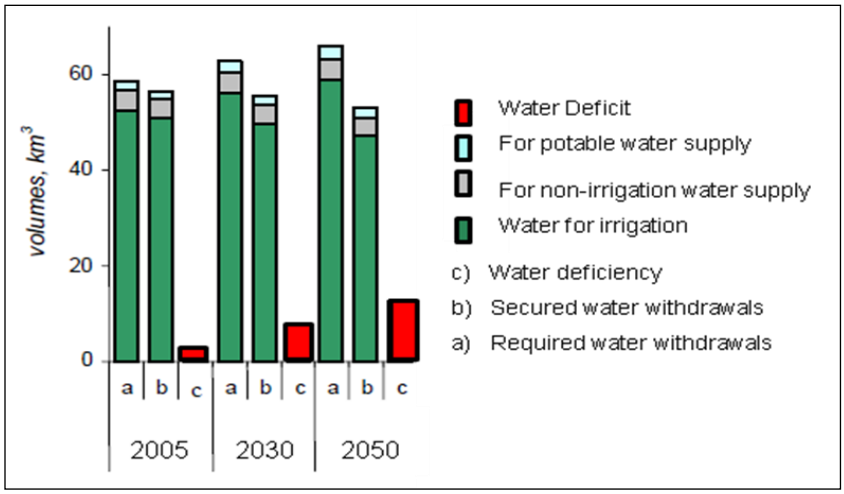


Source: Adapted from Centre of Hydrometeorological Service, Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change, Tashkent, 2008

Projected Water Resources Impacts

Local modeling for the projected impact of climate change on the water resources in Uzbekistan was undertaken in the Second National Communication. This modeling assesses the change in both supply and demand for water resources across the Amu Darya and Syr Darya river basins, with the results displayed in ***Figure 9***. Total required water withdrawals, including from the agricultural sector, clearly increase from 2005 to 2050. Water withdrawals are projected to increase from 59km^3 in 2005 to 62-63km^3 in 2030 and 65-66km^3 by 2050.[3] Unfortunately, on the supply side, secured water withdrawals are projected to decline from 57km^3 in 2005 to 55-56km^3 in 2030 and 52-54km^3 by 2050.[3] These conflicting water supply and demand trends highlight a considerable challenge for Uzbekistan, as projected climate change further exacerbates the already ongoing water deficit by over 500% - from 2km^3 in 2005 to 11-13km^3 in 2050.[3]

Figure 9: **Climate Change Vulnerability Index, ECA Region**



Source: Adapted from Centre of Hydrometeorological Service, Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change, Tashkent, 2008

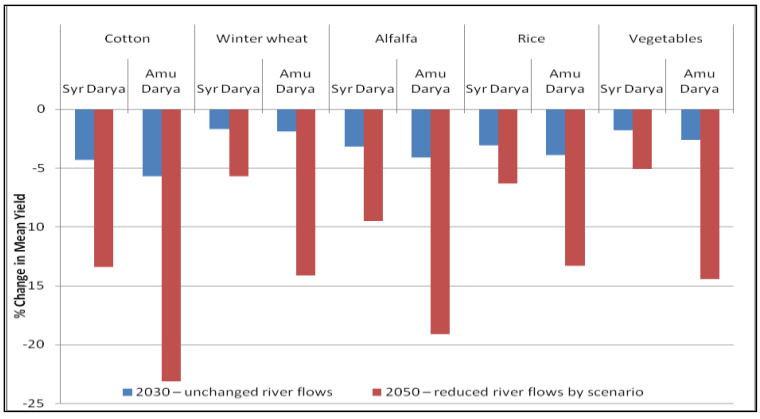
Presently, agriculture constitutes more than 90% of annual freshwater withdrawals in Uzbekistan. Since independence, however, deficiencies in water resources have gradually devastated irrigation-dependent crops in Uzbekistan, including cotton and winter wheat.[14] Moreover, as much as 20% of water used during irrigation is lost due to inefficiencies and structural deficiencies creating additional water deficits.[15] As a result, one of the most obvious and cost-effective ways to adapt to this looming challenge of water demand is by combining structural and non-structural initiatives regarding water resource management and use in the agricultural sector.

The current level of water use efficiency in the sector is poor and has resulted in reduced crop yields (via waterlogging), increased salinity and large-scale land degradation. However, there are numerous opportunities for water savings in Uzbekistan - from the delivery systems to the farm scale. Some good initial steps have already been taken by the government and international donor organizations to address these water related issues, through investments to improve infrastructure and changes to the water quota system. However, much more needs to be done to create additional improvements, while simultaneously adapting to the emerging challenges posed by climate change.

Projected Crop Yield Impacts

Local studies to project the impact of climate change on crop yields have been carried out over the last few years for Uzbekistan. However, many of these studies have failed to integrate climate change impacts on both irrigation water availability and crop productivity. Given the inherent arid nature of the climate in Uzbekistan and the fact that over 85% of cropland is irrigated, it is essential that future crop yield projections integrate both of these impacts. The most recent analysis presented in the Second National Communication of Uzbekistan does incorporate the interrelated impacts of climate change on water availability and irrigated crop yields and the results are displayed in ***Figure 10***. The projections

Figure 10**: Percentage Change in Projected Irrigated Crop Yields by River Basin and Associated Crops, Compared to the 1961-1990 Period**



Source: Adapted from Centre of Hydrometeorological Service, Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change, Tashkent, 2008

across both a high and medium-level emissions scenario indicate that mean yields for a variety of crops in both the Syr Darya and Amu Darya catchments will decline marginally, with unchanging river flows, in 2030 and decline moderately for most crops, with reduced river flows, (due to increased water demand and less runoff) in 2050.[3] For all crop yield projections, the yield decline is greater in the Amu Darya catchment across southern Uzbekistan than in the Syr Darya catchment. Because cotton is the most economically significant agricultural commodity for the nation, these mean yield projections are particularly worrisome, with cotton yield declines in 2050 ranging from 10.8% to 23.1%, depending on the location and emissions scenario. Even with unchanged river flows in 2030, yield declines are still projected for all crops, as higher rates of crop evapotranspiration are projected to further limit the ability of Uzbekistan to meet additional crop water demands. Furthermore, with increased frequency and severity of extremely hot days, especially during summer, many crops could suffer yield losses if such events occur during critical crop growth phases. Cotton is particularly vulnerable to such events, as its most vulnerable stage (fruit formation and accumulation) occurs across the high-risk summer months (June-August).

The adverse impact of climate change on agricultural productivity for a variety of crops exposes the need to develop agricultural systems that are resilient and highly adaptable to a hotter and more variable future. Significant improvements in water-use efficiency at the delivery and farm levels are also necessary to counteract the results of increased crop water demand and reduced river flows that will only intensify into the future. Furthermore, considerable work and investment will be required to take advantage of situations in areas wherein potential opportunities exist. These opportunities include an increased length of the growing season (which could lead to new crops in some areas), increased productivity, and changes to cropping patterns. Many such opportunities will require access to irrigation. It is therefore important that a strong focus be placed on adaptation so that adverse impacts can be minimized – and advantageous opportunities exploited – for the agricultural sector in Uzbekistan.

Uzbekistan is already facing many challenges in the agricultural sector which result from limited water availability. These challenges are only projected to increase with rising temperatures and less precipitation. The Second National Communication of Uzbekistan recognizes these challenges and identifies the need for adaptation strategies and measure which focus on changes in water consumption and water use. This document also recognizes a need for the reorganization of the agricultural sector in Uzbekistan to become a key strategy for adaptation. Recommended measures for this strategy include:

- *Large-scale introduction of water saving technologies in the industry, agriculture and utilities sectors*
- *Reform of the economy development strategy to include the efficient use of available water resources*
- *improvement of irrigation and drainage systems in order to reduce water consumption*
- *improve the level of mechanization and automation for water allocation in the river basins and irrigation regions*
- *shift to a non-waste system of the water resource use*
- *shift to a flexible planning system of the optimal volume of agricultural output*

Potential Impacts on the Livestock Sector

Changes in temperature, precipitation, climate aridity and climate variability will not only affect cropping conditions but also the livestock sector, in terms of animal health, nutrition, husbandry, and feed availability.[3] Increasing temperatures and the frequency and severity of extreme events will enhance the risk of heat stress in livestock. This may lead to a reduction in animal productivity and impacting reproductive cycles, especially during summer months.[3] Provided that pastures are maintained and not overgrazed or degraded via salinization, increased precipitation and warmer temperatures in winter can increase pasture productivity. Conversely, however, increased summer temperatures and the risk of drought will result in higher rates of plant evapotranspiration. This increased evapotranspiration will more than offset any increase in precipitation and, therefore, adversely affect

fodder production and pasture biomass.[3] This could lead to volatile feed prices, increased competition for grazing lands, and reduced autumn feed/fodder reserves.[3]

Although analyzing the impact of climate change on the livestock sector in a quantitative manner is still in its infancy, the Second National Communication of Uzbekistan outlines the direct and indirect effects of climate change on the livestock sector and an initial assessment of the change in thermal stress for locally adapted Astrakhan sheep was undertaken. Future climate projections indicate an increase in heat stress in May of 2-7% in 2050 and 5-11% by 2050.[3] Furthermore, projections indicate that heat stress in late summer – when thermal stress peaks for sheep – will increase by up to 16% by 2050.[3] This increased heat stress is likely to have even greater adverse impacts on productivity and reproductive cycles on non-local breeds, which are not as well adapted to local conditions as Astrakhan sheep.[3] Additionally, indirect effects of climate change on the livestock sector will result in a more challenging operating environment for producers. These indirect effects include reduced pasture production and fodder availability, possibly resulting in more volatile feed prices as well as an increased risk of exposure to new pests and diseases, as the biological range of such threats expands.[3]

VIII. Potential Adaptation Measures for the Agricultural Sector

A range of climate change adaptation options for sectors including crop production, livestock and irrigation are proposed by Uzbekistan's Second Communication and other documents (***Table 1***). A number of these adaptation options are technologies that are ready for implementation and are also proven to increase current productivity – a "win-win" situation. Unfortunately, many of these options and associated action plans have not been implemented because of a range of factors, including policy, economic, institutional, technological, educational, cultural, environmental and political barriers. In order to effectively prioritize adaptation options and focus investment within an action-planning framework, in-depth analysis of effectiveness, cost efficiency and feasibility of adaptation options is required. The importance of taking a proactive approach to adaptation in Uzbekistan is reinforced by the significant synergistic benefits for agriculture and rural livelihoods gained by such an approach.

***Table 1*: Adaption Options for Different Sectors in Uzbekistan**

Sector	Adaptation Option
General	Invest in research and extension services to enhance the capacity and delivery of information to the agricultural sector, with particular reference to climate change and the implementation of adaptation options.
	Improve the weather monitoring network and associated weather information systems, including the publication and distribution of agriculture-specific weather forecasts on a frequent basis (e.g. short-term and seasonal forecasts, the monitoring of drought, etc.)
	Invest in the monitoring and detection of new pests and diseases for the crop and livestock sectors through improvements in the sanitary and photosanitary regime.
Crop Production	Development of new genetic varieties of superior yielding crops with higher resilience to increased temperatures, droughts and saline soils, with the potential of increased production via carbon fertilization.
	Increase farming system water-use efficiency and reduce soil erosion via improved surface management techniques, including the adoption of minimum and zero tillage practices.
	Development and adoption of improved agronomy and risk management techniques to optimize farming system performance, including crop rotations
Irrigation and Water Resources	Implementation of an integrated catchment management plan that involves all concerned stakeholders.
	Optimization of land use and crop selection by matching crops and irrigation to suitable land types
	Reconstruction and maintenance of economically viable irrigation delivery and drainage infrastructure to improve system water use efficiency
	Introduction of new irrigation techniques and improvement of existing techniques to enhance water-use efficiency
	Development of water resource monitoring, including improvement of the water recording system and quality management
	Development of methodological base of assessment and forecast of the mountainous snow reserve and glaciation status
Livestock	The adoption of improved animal breeds and associated technologies to reduce heat and water stress, and increase resilience to projected climate conditions
	Increase the area of irrigated fodder crop production to improve feed value and year-round feed availability
	Improved pasture management by matching stocking rates to pasture production and integrating pasture improvement to increase feed value, especially on degraded lands

Source: Adapted from Centre of Hydrometeorological Service, Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change, Tashkent, 2008

With low levels of current productivity, a challenging arid climate, and an increasing water supply deficit for irrigation, the benefits of immediate action on adaptation are clear, especially for vulnerable rural communities. Potential gains from this action are further increased when considering the enhanced resilience these communities will achieve in the face of increased agricultural vulnerability under climate change. The focus, therefore, should be on reducing the adaptation deficit by increasing the efficiency, productivity, and adaptive capacity of the agricultural and water sectors to the present climate. Simultaneously, effective long-term adaptation options for a range of farming and livestock systems for each agro-ecological zone of the country should also be developed. Given the inherent uncertainties of climatic developments, these adaptation options should be evaluated robustly under a range of different future climate scenarios.

IX. Impacts of Agriculture on Greenhouse Gas Emissions

Globally, agriculture contributes 14% of total greenhouse gas emissions. When combined with land use change and forestry, this figure increases to 32.7% of total emissions, which is second only to the energy sector.[15] As of 2005, the agricultural sector accounted for approximately 12% of Uzbekistan's greenhouse gas (GHG) emissions (slightly below the global average), and was second to the energy sector, which produced the vast majority of the GHG emissions for the country (83%).[16] The land-use change & forestry sector has generally been a net emitter of GHG in Uzbekistan since 1990, primarily as a result of deforestation and land-use change. However, the most recent assessment in 2005 indicated that this sector has been a small net sink of GHG, largely due to a sharp decline in the use of swamp land for rice cultivation.[3] Overall, agriculture has an important role to play in the mitigation of greenhouse gas emissions, with many of the practices that have benefits for both productivity improvement and adaptation also having synergistic mitigation benefits (i.e. "win-win-win").

Agriculture and Land-Use Change

Agriculture accounts for 13.7% of methane emissions and 96.5% of nitrous oxide emissions from Uzbekistan.[16,1] The major source of methane emissions from the agricultural sector is enteric fermentation of livestock, with minor levels of emissions resulting from manure management, rice cultivation and burning of agricultural residues.[3] Methane emissions from enteric fermentation increased by 35% from 1990 to 2005, with the major driver being the expansion of livestock and sheep production in the country.[3] Nitrous oxide emissions from the agricultural sector are predominantly a result of the application of nitric fertilizers and associated soil fertility management, although poor land and manure management practices also contribute to these emissions.[3] Between 1990 and 2005 a distinct decline can be observed in nitrous oxide emissions from the agricultural sector, owing greatly to reduced fertilizer use on irrigated and rain-fed cropland.[3]

A range of measures are available for implementation in the agricultural sector in Uzbekistan that can help mitigate agricultural emissions. Some examples of potential mitigation measures which can have multiple benefits in terms of GHG reduction, climate resilience, and increased productivity include:

Crop Production Management[3]

- Improved fertilizer management strategies
- Restoration of degraded agricultural lands
- Improved water-use efficiency and irrigated land management to reduce water logging

[1] GHG emissions can be split into three primary constituents: carbon dioxide, methane, and nitrous oxide, with each constituent having a different heating potential. For example, methane and nitrous oxide have a 21 and 310 times greater heating potential then carbon dioxide, respectively.

Grazing Land and Livestock Management[3]

- Improvement of animal genetics to improve animal productivity
- Improvement in the quality of feed rations for livestock to enhance feed digestibility
- Improved pasture management incorporating feed budgeting
- Recovery of methane through improvements in livestock manure management, including installation of methane recovery and flaring systems at selected farms

X. The Policy Context

The Second National Communication of Uzbekistan, published in 2008, is the primary policy document that assesses the impact of climate change and outlines adaptation options to respond to projected future climate hazards. This document includes climate projections for Uzbekistan to 2100 and undertakes a preliminary vulnerability assessment of different sectors, including agriculture, water resources, and biodiversity and ecosystems. This assessment includes an analysis of climate change impacts, as well as broad recommendations on potential adaptation and mitigation options for each sector. Although the Second National Communication identifies adaptation options and defines action plans, limited economic analysis, evaluation, and prioritization of these potential adaptation options and action plans has been carried out.

National Plans, Strategies, Programs, and Analytical Studies

Uzbekistan does not currently have a focused climate change and adaptation policy document. The mainstreaming of climate change into the policy initiatives of the agricultural sector is still relatively new. This situation should be rectified in order to ensure that investments and decision-making for the agricultural sector, as well as rural development, are based on potential climate conditions and not historical conditions. Given the multi-sectoral nature of the issue, climate change has been addressed, to a minor extent, in various policy documents, including:

- **The *National Strategy of Sustainable Development,*** which outlines the social, economic and environmental policy goals for the sustainable development of Uzbekistan. This strategy covers a number of topics relevant to the agricultural sector and to rural livelihoods. Strategies to improve living standards across the country, address the environmental degradation of the Aral Sea, and enhance natural resource management via improved land and water management are included in this plan. At present, the vast majority of measures outlined in the strategy have not moved beyond the planning phase.[3] It is clear that climate change and adaptation should be mainstreamed into this strategy in order to achieve its objectives, especially in relation to the agricultural sector.

- ***The Water Saving and Rational Water Use in Irrigated Land Tenure Strategy,*** which highlights the priority needs for adaptation in the agricultural and water resources sectors. Many of the measures outlined in this strategy require significant investment and include improvements to irrigation and drainage infrastructure, as well as the introduction of more water efficient on-farm irrigation methods and technology, such as trickle irrigation and water scheduling equipment.

- **The Uzhydromet: Climate Change and its Impact on Hydrometeorological Processes, Agro-Climatic and Water Resources of the Republic of Uzbekistan, 2007,** which is the key background and supporting document that underpins the analytical foundation of the Second National Communication of Uzbekistan. This report includes an analysis of historical climate trends, future climate projections, current and projected future water resources, and future projected impacts on the agricultural sector as a result of climate change.

XI. The Institutional Context

Generally, the institutional arrangements in Uzbekistan with regard to climate change and adaptation have significant room for improvement, especially in terms of coordination, funding and effectiveness. Given the complexity and multi-disciplinary nature of climate change, a number of institutions are each focused on different aspects of this issue and its associated challenges. However, in order to address climate change and adaptation in an efficient and systematic way, there remains a need to create formal structures for coordination across relevant ministries that will ensure a better overview of creating and implementing climate change policy. Such a structure already exists for mitigation activities under the Interdepartmental

Council of the Cabinet of Ministers (CDM). However no such structure exists for overall climate change strategy and adaptation activities.[3]

The Cabinet of Ministers is the overarching executive body of the Government of Uzbekistan and is responsible for providing leadership and guidance on economic, social and cultural policy and strategy within the country.[17] A number of organizations are subordinate agencies under the Cabinet of Ministers, including the Center of Hydrometeorology (Uzhydromet), the State Grain Inspectorate and the Center of Certification of Cotton Fiber.[17] Uzhydromet is responsible for weather forecasting, agro-meteorological monitoring and forecasting, climate research and the operation and maintenance of weather stations across the country.[18] Additionally, this agency is also responsible for developing National Communications and undertaking various implementation functions under the UNFCCC, including public awareness and capacity building activities related to climate change.[18]

The Ministry of Agriculture and Water Resources (MAWR) is responsible for the formulation and promotion of policies and strategies related to the development of agriculture and water resources across Uzbekistan.[19] Given the level of rural poverty, MAWR plays an important role in improving rural livelihoods by increasing farm competitiveness and access to markets, while reducing barriers for private investment in the sector. MAWR is also responsible for matters relating to the protection of animals and plants from pests and diseases, the management and regulation of water resource availability and use and the design, construction and maintenance of water storage, delivery and drainage infrastructure (for irrigation).[19] The nation lacks a dedicated agriculture extension service, apart from area-specific activities under some donor funded projects, although MAWR does provide some limited, ad hoc training for farmers to improve productivity and sustainability. Agriculture research is well developed in Uzbekistan and primarily falls under the responsibility of MAWR, via a range of subordinate research institutes with specific mandate.[4] There are at least 14 such research institutes, covering the plant industry, fruit growing, viticulture and wine making, cotton breeding and seed production research, cotton growing, plant protection and several others.[20] In order for Uzbekistan to improve and develop the competitiveness and sustainability of its agricultural sector it is vital that the work done by these research institutes be closely linked with the situation on the ground and the requirements of farmers and that all results and practical measures be widely disseminated.

The State Committee for Nature Protection (SCNP) is the responsible authority for the protection of the environment and the use of natural resources within Uzbekistan. The SCNP leads the development and implementation of environmental protection policies, monitors environmental health, pollution and other harmful substances and promotes the adoption of clean technologies and waste recycling.[21] The SCNP is also responsible for reviewing programs, concepts and other relevant documents relating to the environment on the national and regional level.

XII. Ways Forward

This Country Note is just the First Step - Upcoming Activities in the Development of *Uzbekistan's Response to Climate Change and Agriculture*

National Awareness Raising and Consultation workshop, Tashkent, May 2010

The National Awareness Raising Consultation workshop on Reducing Vulnerability to Climate Change in Uzbekistan's Agricultural Systems was held in Tashkent in May 2010. During this conference a Climate Change and Agriculture Country Note was disseminated to, which generated a groundswell of support and interest for further analytical work in the country. Mr. Asatilla Salimov, Deputy Minister of Economy, and Mr. Yashin Khidirov, Deputy Minister of Agriculture and Water Resources, led this support and both expressed their appreciation for the Country Note. They also indicated that they could already observe the effects of climate change in Uzbekistan, which were impacting agriculture, via increased mean temperatures and extreme hot days – leading to an increasingly arid climate. These thoughts were also echoed by workshop participants and other stakeholders, including The State Committee for Nature Protection (SCNP), Uzhydromet and UZGIP. Additionally, both Deputy Ministers expressed strong commitment and interest in enhancing the Government's ability to mainstream climate adaptation into agricultural policies, programs and investments. The MAWR, in coordination with the State Committee for Nature Protection of the Republic of Uzbekistan, is the lead agency supporting and working jointly with the World Bank to develop *Uzbekistan's Response to Climate Change for Agriculture* in FY11.

Broadly, this response involves rigorous analysis and economic modeling to assess both the impacts of climate change and potential adaptation measures for a range of farming, livestock and production systems across three Agro-Ecological Zones (AEZ). Crops to be modeled and analyzed include cotton, wheat, tomatoes, potatoes, apples and alfalfa. Rangeland pastures used for livestock production will also be modeled. This analysis will be performed by expert staff from the Industrial Economics, Inc. (IEc) consulting firm, in close consultation with local experts across a range of organizations. Furthermore, IEc will deliver training and capacity building services to local experts and organize sub-national consultation meetings with farmers, policymakers and researchers to raise awareness of the risks and opportunities posed by climate change on the agricultural sector, while assisting with groundtruthing results and prioritizing adaptation measures at the AEZ level. This will result in the development of an Agriculture and Climate Change Impact Assessment & Menu of Adaptation Options that will highlight the physical, economic and social impacts of climate change on the agricultural sector and identify adaptation priorities for investments, capacity development and policy improvement. These options will be practical and operational, with a focus on "win-win-win" adaptation options that have benefits for adaptation, mitigation and the local economy.

This analysis will be disseminated at a high-level National Dissemination and Consensus Building Conference, to be jointly hosted by MAWR, the State Committee for Nature Protection of the Republic of Uzbekistan and the World Bank in 2011, to build consensus on priorities for action and focus on exploring ways to integrate adaptation recommendations into national policies, programs and investments. A Regional Knowledge Exchange Conference will follow, wherein experts from Uzbekistan can share their experiences and results and learn from experts in other participating countries in the Regional Program on Reducing Vulnerability to Climate Change in ECA Agricultural Systems. This forum will also explore opportunities for greater regional collaboration and assist with the establishment of regional communities of practitioners working on agriculture and climate change issues.

The Sustainable Development Department of the ECA Region at the World Bank is carrying out a regional, three-year program of analytical and advisory activities to better determine the potential impacts of climate change on the agricultural sector in four pilot countries, namely Albania, FYR Macedonia, Moldova and Uzbekistan. Through the Regional Program on Reducing Vulnerability to Climate Change in ECA Agricultural Systems, the World Bank is working with stakeholders to develop practical recommendations on actions these countries can take to increase the resiliency of their agricultural sectors in the face of climate phenomena. The overall objective of the program is to enhance the ability of ECA countries to mainstream climate adaptation into agricultural policies, programs and investments. This will be achieved by raising awareness of the threat, analyzing potential impacts and adaptation responses, and building capacity among country stakeholders with respect to climate change impact assessment and adaptation in the agricultural sector.

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