Strengthening Agricultural Resilience against Droughts in Uzbekistan: From Crisis Management to Drought Risk Mitigation

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Executive Summary

Over the last two decades, Uzbekistan has faced several occurrences of **extreme hydrological droughts**, with crop yield losses of 50 percent to 75 percent in the worst-affected areas. These droughts also had substantial negative impacts on people's livelihoods and food security. Drought impacts are modulated by vulnerability and resilience to droughts, which are affected by actions taken to mitigate drought risks. **Drought risk mitigation** includes a variety of risk management activities carried out before droughts actually occur. However, often responses to previous droughts emphasized ex post crisis management approaches rather than proactive and more economically efficient drought risk mitigation strategies. If proactive drought risk management is socially optimal compared with reactive crisis management, then the question is: **what are the barriers and opportunities for the transition from crisis management to drought risk management in Uzbekistan?**

This case study seeks to provide responses to this question by reviewing past drought impacts and evaluating policy, institutional, and technological options to strengthen resilience against droughts. The study hypothesized that, for their successful uptake, drought risk management actions should have substantial co-benefits and positive social returns even without droughts. The results showed that improved access to extension, access to credit, and diversified cropping portfolios were strongly linked with farmer drought coping and drought risk mitigation actions.

Stakeholder analyses pointed out that major consensus-based drought risk mitigation policy actions in Uzbekistan were improving water use efficiencies through cleaning and good maintenance of irrigation and drainage networks, developing drought-resistant cultivars, adopting water-saving irrigation technologies, and improving market access for farmers—including access to drought risk insurance. Stakeholder responses indicate widespread understanding and agreement about the necessity of drought risk mitigation activities; however, what seem lacking are stronger inter-agency linkages and coordination, and the national-level strategy framework guiding these drought risk mitigation and preparedness activities.

Background

Uzbekistan is located in arid and semi-arid areas vulnerable to frequent droughts (Gupta et al. 2009). Because of its high aridity, agricultural production is possible only through supplemental irrigation in most of the country (Chub 2007). The major sources of irrigation water are the glacier-fed Amudarya and Syrdarya rivers, which have high inter-annual flow variability (Dukhovny, Sorokin, and Stulina 2008; Sorg et al. 2012). During minor drought years, this variability could be compensated by the vast network of 55 water reservoirs in the country; however, during major and protracted droughts, the current reservoir total capacity of about 20 cubic kilometers is not sufficient. Furthermore, the needs for irrigation water are growing rapidly (Cai, McKinney, and Rosegrant 2003). Increasingly, the imbalance between the availability of water and growing water demands is exacerbating the impacts of even previously mild drought years. As a result, over the last decade, Uzbekistan has faced several occurrences of extreme hydrological droughts, with crop yield losses of 50 percent to 75 percent in the worst-affected areas (FAO 2017). These droughts have also had substantial negative impacts on people's livelihoods and food security. During the drought in 2000–01, it was reported that cereal production declined by 10 percent, cotton production by 17 percent, and rice production by 60 percent, resulting in about US$130 million of losses (World Bank 2006). The biggest losses occurred in the downstream areas in Uzbekistan, where about 600,000 people were in need of food aid to the value of US$19 million (World Bank 2006; FAO 2017). In this context, Mirzabaev and Tsegai (2013) also found that a 30 percent reduction

in irrigation water availability could increase wheat prices by about US$400 per metric ton in the country over the price per metric ton in normal hydrological years.

The extent of drought costs and impacts is modulated by vulnerability and resilience to droughts, which are affected by actions to mitigate drought risks. Drought risk mitigation includes a variety of risk management activities carried out before droughts. However, a usual course of action in Uzbekistan in the past had been responding to droughts through costlier ex post crisis management, rather than proactive and economically more efficient drought risk mitigation, which is currently being increasingly promoted. In this regard, climate change is expected to increase the frequency and severity of droughts in Uzbekistan (Sorg et al. 2012), making crisis management approaches even less affordable. If proactive drought risk management is socially optimal compared with reactive crisis management, then the question is: what are the barriers and opportunities for the transition from crisis management to drought risk management in Uzbekistan?

This case study seeks to provide responses to this question by reviewing past drought impacts and evaluating policy, institutional, and technological response options against droughts. We hypothesize that, for their successful uptake, drought risk management actions and investments should have substantial co-benefits and have positive social returns even without droughts. Hence they can be widely promoted as low- or no-regret policy strategies for sustainable development and building resilience to a variety of environmental, economic, and social shocks.

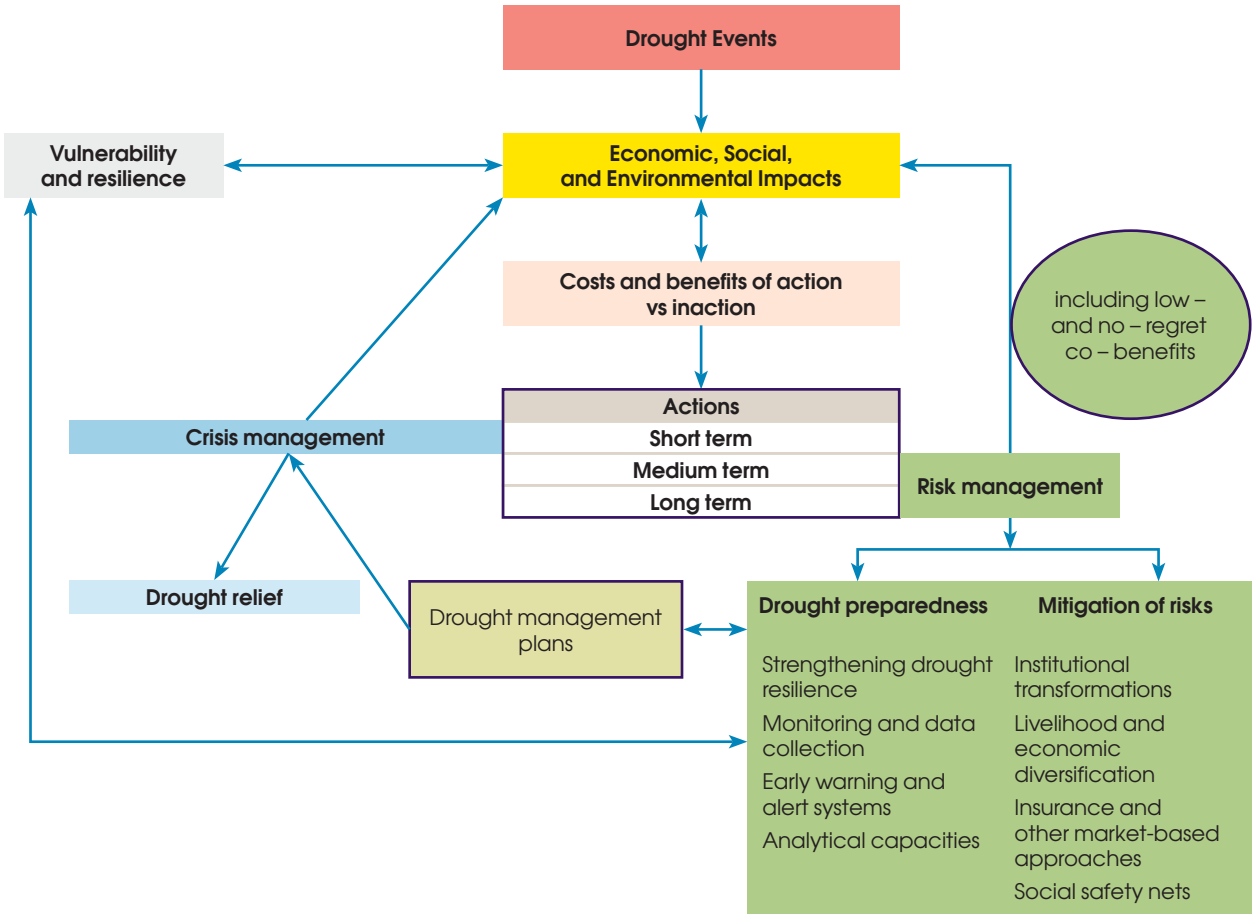
Conceptual Framework

Drought is a natural hazard, so its occurrence can be assessed by attaching probabilities depending on local biophysical and climatic conditions (Wilhite 2000). However, drought impacts are shaped by the socioeconomic context of the affected areas. This includes their vulnerability and resilience to droughts—that is, their level of drought preparedness. Vulnerability and resilience to droughts are affected by actions to mitigate drought risks and increase drought preparedness. Drought preparedness involves actions undertaken before droughts occur in order to improve operational and institutional responses to them (Kampragou et al. 2011). On the other hand, drought risk mitigation actions include a variety of risk management activities carried out before the droughts occur in order to minimize their impacts on people, economy, and environment (Figure 1).

In the past, a usual course of action taken in Uzbekistan was to respond to the impacts of droughts once they had occurred through crisis management, rather than proactively improving resilience against drought impacts through the use of appropriate risk management strategies (FAO 2017). In fact, information on the costs and benefits of mitigation actions is lacking, so governments may often be reluctant to make costly investments in drought risk mitigation (Ding, Hayes, and Widhalm 2011).

Moreover, under various uncertainties and with a shortage of empirical evidence of the higher efficiency of drought risk mitigation actions, it may be economically rational to respond to droughts only after shocks (Zilberman et al. 2011). Economic theory shows that, under conditions of uncertainty, actors will delay irreversible investments until their net benefits exceed a positive critical value (McDonald and Siegel 1986). Zilberman et al. (2011) indicate that major changes in institutions and technological adoptions are likely to happen ex post as a response to droughts. For example, the drought of 1987–1991 in California led to the wider adoption of water conservation technologies (sprinkler irrigation), fallowing land, and lining canals to reduce water loss, as well as the introduction of water trading—even though these measures had been recommended for a long

Figure 1: The Conceptual Framework of the Review



Source: Based on WMO and GWP 2017.

time before the occurrence of the drought (Zilberman et al. 2011).

Although ex post actions seem to happen more often, there are also economic reasons for ex ante actions. Drought is a business risk and agricultural producers will try to avoid its costs. They thus have incentives to undertake mitigation actions, but obstacles in Uzbekistan remain in the form of lack of knowledge about drought occurrences (early warning systems) and their impacts (extension and advisory services), and lack of funds (access to credit) (FAO 2017).

Indeed, numerous studies from around the world show that households in many drought-affected areas, as a normal part of their livelihood behavior, continuously apply risk management strategies. However, at the household level, such risk management strategies are often applied in response to past drought shocks. However, such strategies could be made more efficient and forward-looking with the input of available scientific data on climate, droughts, and drought risk mitigation measures, supported by ex ante government policies. Birthal et al. (2015) indicate that, although agricultural households carry out coping actions after droughts—actions that could serve as risk management strategies by reducing their vulnerability to future droughts—they may rarely be able to fully recover the loss of their productive assets due to the impact of past droughts. In fact, drought relief in many developing countries, including Uzbekistan, is not as comprehensive as it might be in some high-income countries, so that affected households are often left to their own devices.

Methodology and Data

Based on the above background and conceptual underpinnings, the case study methodology seeks to work across scales, covering various stakeholders—from farmers to responsible public agencies and institutions. For this purpose, we first conducted a review of the current state of drought-related literature and policies in Uzbekistan and assessed the potential of various alternative technologies as well as institutional and policy options for drought risk management in the country.

Second, using statistical exploratory approaches, we analyzed a nationally representative agricultural household survey from Uzbekistan for major responses that farmers undertook against droughts, their self-assessments of drought impacts, and barriers they faced and opportunities they had for strengthening their resilience against droughts (see Annex 1 for the questionnaire used).[1] Because farmers are the major stakeholders affected by droughts, their views and opinions about the opportunities and barriers for drought risk mitigation would represent a cornerstone of any activities to support drought risk mitigation in Uzbekistan.

Finally, we conducted expert interviews and held discussions with selected stakeholders from Uzbekistan's Ministry of Agriculture and Water Resources, the Tashkent Agrarian University, the Uzbekistan Hydro-Meteorological Service, farmers, farmer associations, national agricultural banks, insurance companies, local administrations, research institutes, agricultural universities, and international partner organizations and other organizations, soliciting their feedback and ideas on the current status quo and their insights and conclusions about drought risk mitigation strategies and approaches in Uzbekistan.

Results and Discussion

The results of the interviews with farmers show that absolute majority of farmers (94 percent) had experienced drought shocks during the previous five years. There were no significant differences in terms of drought experiences across different categories of farmers (lower-, middle-, and higher-asset farmers). However, there were significant differences in the actions they took in response to droughts: 60 percent of higher-asset farmers undertook drought response and drought risk mitigation actions, but only 21 percent and 30 percent of lower- and middle-asset agricultural producers, respectively, carried out such drought coping actions (Table 1).

Most farmers (70 percent) reported that they had experienced drought only once during the previous five years. Sixteen percent had experienced drought twice, 5 percent three times, and about 1 percent of farmers seem to have experienced drought almost every year during the previous five years.

Counterintuitively, more frequent experiences of drought were reported not in the downstream areas (Karakalpakstan), but in midstream (Kashkadarya) and upstream (Andijan, Tashkent) provinces in Uzbekistan. In most of the previous literature and development activities, the focus areas for drought coping interventions were mostly in downstream areas in Uzbekistan. Arguably, during large-scale droughts, those downstream areas are affected the worst. However, it seems that—at least in terms of farmers' perceptions of water availability—drought conditions are experienced more frequently in the upstream, more heavily populated areas of Uzbekistan.

This finding calls for a wider focus in drought mitigation policies and for targeting not only extreme cases

[1] The farmer interviews were conducted by the International Center for Agricultural Research in the Dry Areas (ICARDA) (Mirzabaev 2013) in 2010–11 across all major agro-ecological zones in Uzbekistan. The sample size was 400 farmers. The survey contains detailed information on farmer characteristics, agricultural production data, non-farm income and employment, experience of drought shocks and measures that farmers undertook to cope with drought impacts, the barriers for coping measures against drought impacts, farmers´ self-assessments of drought impacts, access to extension, and other variables.

Table 1: Drought Experiences and Farmer Coping Actions

Farmer categories by income	Experienced drought shock		Took action	
	No (%)	Yes (%)	No (%)	Yes (%)
All farmers	6	94	63	36
Lower-asset farmers (*N* = 150)	9	91	79	21
Middle-asset farmers (*N* = 101)	6	94	70	30
Higher-asset farmers (*N* = 131)	2	98	40	60

Note: Asset categories correspond to lower, middle and higher terciles of assets value (including house, car, other durables, and jewelry). In their monetary values, these represent for lower-asset farmers: US$0 to 10,000; for medium-asset farmers: US$10,001–30,000; for higher-asset farmers: US$30,001–90,000.

of drought but also milder cases. In terms of their economic impacts, milder droughts in highly productive and heavily populated areas might be actually more significant than more severe droughts in less productive and less populated downstream areas. Addressing this issue also requires focusing drought risk mitigation activities not only on hydrological droughts, but also on economic droughts (seen in the growing imbalance between supply and demand of water).

The most frequently used drought risk mitigation actions among all types of agricultural producers were changing crop varieties and crop types (19 percent) and changing planting dates (8 percent); fewer agricultural producers applied water conserving and sustainable land management (SLM) practices, reduced the area of cultivated land, or carried out other drought risk mitigation activities such as shifting from crop production to livestock rearing (Table 2). These categories of drought responses are also the ones that are common in other arid drought-prone areas around the world (WMO and GWP 2017). Uzbekistan, in this regard, could learn from the experiences of these other drought-affected countries in establishing drought preparedness and drought risk mitigation plans.

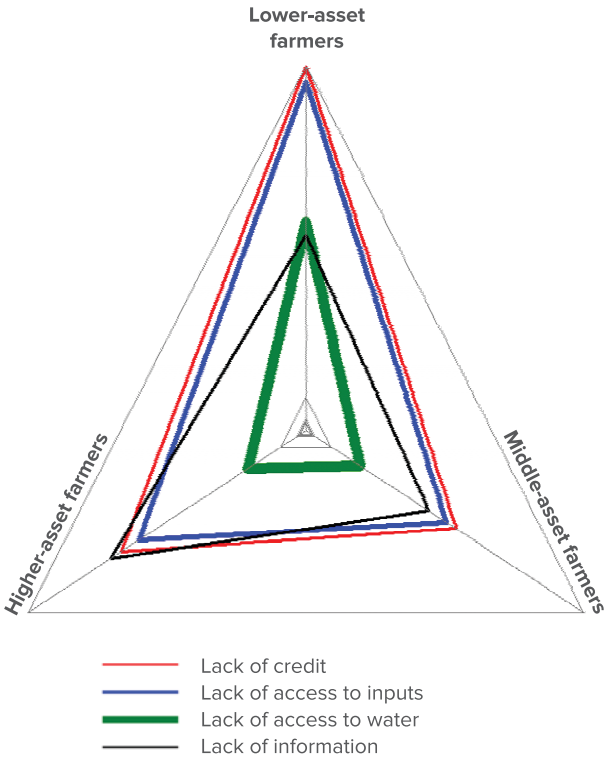
Among the barriers to taking drought coping actions, lack of access to credit and inputs came out as the major impediment, especially for lower-asset agricultural producers (Figure 2).

The fact that most farmers used their own savings to fund the needed coping activities also points to a lack of access to credit and lack of drought insurance, which could be major areas for developing drought risk mitigation strategies in Uzbekistan. Access to information (extension) and knowledge about SLM and water conserving agronomic practices was also found to be highly positively associated with under-

Table 2: Type of Drought Responses by Farmer Asset Category

Type of action in response to droughts	Share (% of total)	Share (% of lower-asset farmers)	Share (% of middle-asset farmers)	Share (% of higher-asset farmers)
No action	63	79	70	40
Planted different crop or crop variety	19	14	15	31
Changed planting dates	8	3	10	15
Applied water/land conserving practices	5	1	2	4
Others (e.g., shifted to livestock)	4	2	2	7
Reduced cropped land	2	1	1	3

Figure 2: Major Barriers to Drought Coping Actions, by Farmer Asset Category



Source: Based on Mirzabaev 2013.

taking drought coping and mitigation activities (Figure 3). Similarly, those farmers with more diversified cropping portfolios were found more likely to undertake drought coping and mitigation actions (Figure 4).

All in all, the analysis of interviews with agricultural producers showed that drought is one of the major environmental hazards affecting their productive activities. However, only about one-third of agricultural producers carried out drought coping and mitigation activities. Major factors that could strengthen and improve drought resilience were found to include better access to extension and knowledge about SLM and water-conserving agronomic practices, improved opportunities for crop diversification, and improved access to credit. It was also found that households did not use any drought insurance options—hence their development and wider use could be a major contribution to improved drought resilience in Uzbekistan. Unlike the accepted convention that the downstream areas are those most affected by droughts, the findings indicate that upstream and midstream areas are not less affected. Considering their relatively higher productivity and more dense populations, improving drought preparedness and resilience in these upstream and midstream areas could have considerable economic benefits.

These findings are in line with broad drought impact and mitigation literature from around the world. Experiences from other countries also show that, for example, better access to agricultural extension facilitated the adoption of drought risk mitigation practices among agricultural households in Bangladesh (Alam 2015). Similarly, Kusunose and Lybbert (2014) found that access to credit plays a major role in coping with droughts among farmers in Morocco. Holden and

Figure 3: Knowledge of SLM Practices and the Likelihood of Drought Risk Mitigation

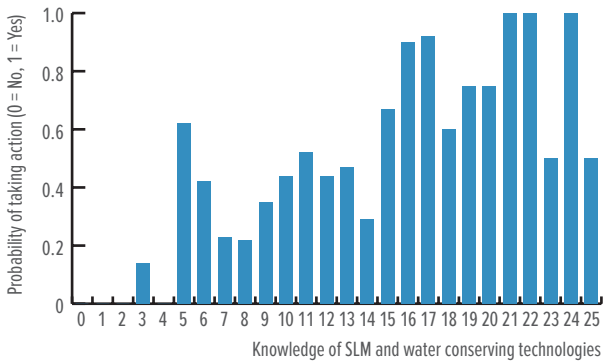
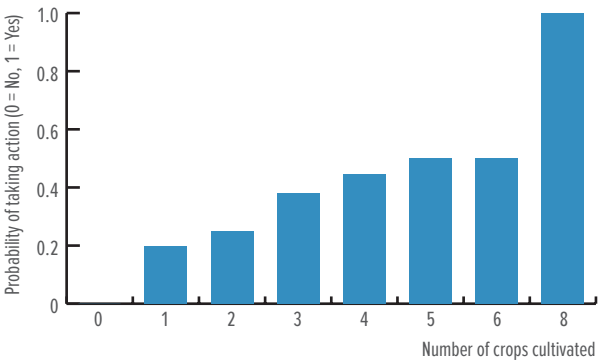


Figure 4: Crop Diversification and Drought Actions



Note: SLM = sustainable land management..

Shiferaw (2004) found that higher access to credit helps farming households in Ethiopia to better cope with drought impacts by helping them avoid divesting their productive assets. In other countries as well, land use change and the modification of cropping patterns were frequently used to build resilience against droughts (Lei et al. 2014: China; Deressa et al. 2009: Ethiopia; Huntjens, Pahl-Wostl, and Grin 2010: Europe; Willaume, Rollin, and Casagrande 2014: France). Another frequently used drought risk mitigation strategy consisted of diversifying livelihood sources to non-farm activities (Sun and Yang 2012: China; Kochar 1999: India; Kinsey, Burger, and Gunning 1998: Zimbabwe), and divesting livestock assets (Kinsey, Burger, and Gunning 1998; Reardon and Taylor 1996: Burkina Faso). The World Meteorological Organization (WMO) and Global Water Partnership (GWP) (2014) indicated that among the key characteristics of drought-resilient households in Kenya and Uganda were a strong asset base and diversified risk management options, which were primarily the result of their higher education levels, enabling them to have more knowledge about coping actions against various hazards and also providing them with more income-generating opportunities. These similarities in drought responses and drought risk mitigation activities in Uzbekistan and other countries around the world may provide highly useful opportunities for studying and learning from the lessons of global experiences from drought risk mitigation policies while strengthening drought risk mitigation strategies in Uzbekistan.

Stakeholder Groups

The analysis of stakeholder groups focused on farmers, farmer associations, water user associations, rural advisory services, national agricultural banks and insurance companies, local administrations, the Ministry of Agriculture and Water Resources, the Ministry of Emergency Situations, Uzhydromet (the hydro-meteorological service), research institutes, agricultural universities, and international partner organizations.

The interviews included a discussion of linkages and collaborative activities in this network of organizations (Figure 5), including discussion of their current roles as well as expectations of future contributions for drought risk mitigation activities in Uzbekistan.

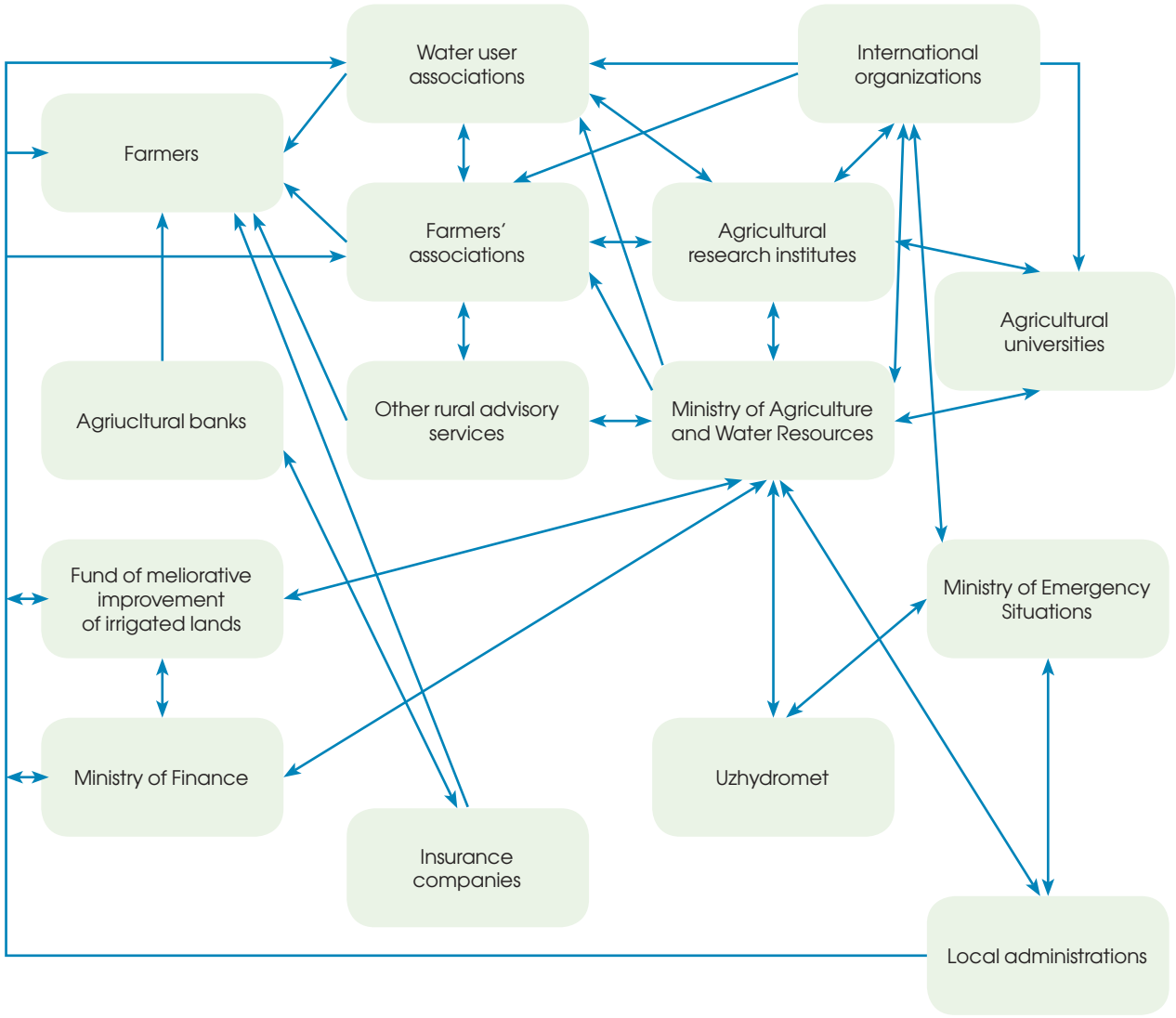
Government Stakeholders

The Ministry of Agriculture and Water Resources and Uzhydromet were mentioned as major organizations with institutional roles in mitigating drought risks and providing early warning and forecasts on droughts. In this regard, Uzhydromet operates the National Center for Drought Monitoring, the major function of which is to provide early warning and propose measures to alleviate the impacts of droughts under a changing climate. At the same time, several respondents highlighted the need for Uzhydromet to improve its work not only on monitoring and forecasting droughts, but also on the timely provision of drought-related information to other relevant organizations, specifically to local administrations, as well as to farmers through mass media. Currently such communication is deemed relatively slow and goes through complicated administrative channels. Moreover, it was suggested that the Ministry of Agriculture and Water Resources should take into account these forecasts while planning agricultural activities; it should also inform relevant organizations so they can take necessary actions to mitigate drought or develop drought risk mitigation strategies in coordination with local authorities.

Research Institutes

Although representatives of several research institutes interviewed indicated that they are making significant efforts to breed new drought-resistant crop varieties, the links between these research institutes and farmers, seed companies, and rural advisory services appear to be quite weak or even nonexistent. Many of the improved drought-resistant varieties are recommended to the government (through the Ministry of

Figure 5: Schematic Map of Stakeholder Interactions on Drought Risk Mitigation and Preparedness



Agriculture and Water Resources); it is then expected that the government should spread these varieties to farmers. Alternative approaches of working directly with seed companies and farmers are rarely practiced.

Associations and Advisory Services

Farmer associations, rural advisory services, and water user associations were considered to be highly important for providing farmers with knowledge of drought risk mitigation activities such as new drought-resistant crop varieties, modified agronomic practices, and the application of SLM and water-saving irrigation practices. However, despite their ongoing efforts, the use of SLM and water-conserving irrigation practices remains low. Few if any studies identify the reasons behind such low adoption. Research institutes and universities could play a bigger role by conducting such studies and providing insights on what needs to be done to improve technology uptake.

The Ministry of Emergency Situations

The role of the Ministry of Emergency Situations directly relates to drought crisis management. During the severe drought of 2000–01, the Ministry of

Emergency Situations played a vital role in providing the affected populations with access to potable water and emergency food aid. Although it does not engage directly in ex ante drought risk mitigation activities, it seems a combination of drought crisis preparedness actions involving the Ministry of Emergency Situations with drought risk mitigation activities led by other stakeholders would provide synergies that are not available when isolating drought crisis preparedness from drought risk mitigation.

Insurance Companies

Currently, insurance companies are playing an increasing role in providing drought insurance to farmers. However, only 30 percent of crops were reported to be covered by any insurance. Since the insurance is indemnity-based, it requires lengthy verification procedures for triggering the payments. Moreover, to qualify for payments farmers need to have strictly followed the agronomic recommendations set out by the Ministry of Agriculture and Water Resources for each region and crop, which leaves room for arbitrary interpretations and lack of transparency. Alternative index-based approaches could provide new opportunities by not only reducing transaction costs (resulting in lower insurance fees), but also with more transparent ways of triggering payments. However, establishing a well-functioning index-based insurance system would require much closer cooperation and exchange between Uzhydromet, research institutes, and insurance companies than is currently practiced. Furthermore, opening up the insurance market to new entrants and increased privatization of state-owned insurers could also provide some boost to the demand-driven and customer-oriented approaches in the work of insurance companies.

Stakeholder Coordination

The major conclusion of the stakeholder analysis is that numerous organizations are contributing vital elements of drought risk mitigation strategies in Uzbekistan, but what is lacking is effective institutional coordination of these different actors and their roles. In this regard, the development of a national drought risk mitigation and preparedness strategy could be a vital step for improving the coordination between stakeholders. Moreover, establishing a permanent, even if relatively small, unit that will coordinate these drought risk mitigation and preparedness activities under the Agro-Industrial Sector of the Cabinet of Ministers (in contrast to a previously used mechanism of ad hoc commissions to coordinate drought crisis response actions) could provide an important step for the transition from drought crisis management to drought risk mitigation approaches in Uzbekistan.

Stakeholder Analysis and Policy Actions for Drought Risk Mitigation

This section turns to institutional and stakeholder analysis. The interviews with various stakeholders also suggested a number of policy actions capable of contributing to drought risk mitigation in Uzbekistan. In contrast to expectations, broad similarities and complementarities were seen in the types of drought risk mitigation strategies proposed by the interviewed stakeholders, rather than contradictions or mutually excluding options.

As noted earlier, crop diversification—including a wider use of drought-tolerant crops and crop cultivars—was mentioned by farmers as the major drought risk mitigation strategy that they undertake. During the interviews, all institutional stakeholders further emphasized the role of crop diversification, as well as crop variety diversification—that is, they all emphasized breeding and disseminating new drought-resistant cultivars. In fact, crop diversification—as a response not only to droughts but also to the growing problems of land degradation and for

improving agricultural profits—has been increasingly promoted by the government as well. Presidential Decree No. 2460, from December 29, 2015, sets out a longer-term strategy to diversify and intensify crop production in the country whereby, between 2016 and 2020, about 170,000 hectares of cotton fields and about 50,000 hectares of wheat fields will be reallocated to other crops such as fruits, vegetables, oilseeds, forage crops, and legumes.

Reallocating land may not be sufficient by itself, however. To introduce more drought-tolerant forage crops such as barley, rye, maize, sorghum, and Sudan grass, domestic seed supply chains need to be developed. Moreover, current breeding programs mostly concentrate on developing new drought-resistant varieties of wheat and cotton. More efforts are needed to develop drought-resistant varieties of other crops, which will increasingly occupy larger arable areas in Uzbekistan.

Improving water use efficiency in agriculture was mentioned as another key priority area for drought risk mitigation by almost all interviewed stakeholders. There are several suggested approaches to do this.

First, cleaning and good maintenance of irrigation and drainage networks was cited as key for improving water conveyance efficiency and reducing water losses. In this regard, it was highlighted that the Fund for Improvement of Irrigated Lands under the Ministry of Finance has been channeling significant investments and efforts for cleaning drainage and irrigation systems in Uzbekistan, especially for the larger irrigation and drainage canals. At the same time, more needs to be done to improve the maintenance of local, smaller irrigation and drainage networks, which fall under the responsibility of local water user associations.

At the farm level, adopting water-conserving irrigation techniques could contribute to water saving and a higher productivity of water. For example, the Government of Uzbekistan has been investing in the expansion of drip irrigation by providing access to soft credit to farmers. However, proper water management is not easy in the irrigated conditions of Uzbekistan. The complex management requirements depend on geographical location, topography, fragile geomorphology, and farm size, as well as aspects of local water distribution. There is a need for “precision irrigation” based on a more accurate estimation of the real water needs of each crop. In this context, some stakeholders emphasized that there is also a need to improve the work of water user associations not only for improved efficiency, but also for equity of water distribution.

For higher impact, crop diversification and improving water use efficiency could also be combined. In 2007, the Government of Uzbekistan decided to increase production and improve water use efficiency by increasing intensive orchards areas—that is, orchards with a very high planting density. The area of intensive orchards has been steadily growing in the last 10 years and is currently estimated to be 43,000 hectares; all intensive orchards are using only the drip irrigation system. Bobojonov et al. (2013) reported that introducing crops that demand less water with a higher water productivity (meaning higher profits per cubic meter of water used) than wheat, cotton, and rice will become especially attractive in the downstream and tail end areas of the irrigation systems. Even though crops such as mung bean, maize, and sorghum currently have relatively low profits, nevertheless they may become suitable alternatives where the availability of irrigation water is not high enough to allow for the planting of high-water-demanding crops.

The responses of various stakeholders also pointed out the need to improve the extension and rural advisory services on SLM (for example, conservation agriculture practices and the expanded application of improved land leveling, such as the currently growing use of laser-guided land leveling) and water-conserving irrigation methods. This coincides

with the findings from farmer interviews, where lack of access to extension was also found to be a major deterrent to undertaking drought risk mitigation activities. One respondent also highlighted the importance of developing drought insurance, providing opportunities for off-farm employment, and employment diversification.

Three insurance companies provide drought insurance coverage in Uzbekistan: these are Uzagrosugurta, Agroinvest, and Halq sugurta. Murodullaev, Bobojonov, and Mustafaqulov (2014) note, however, that only 30 percent of crops in Uzbekistan were covered by insurance, including not only drought but such other events as wildlife crop damage, strong wind, and hail. In many cases, this insurance has high transaction costs because each event against which a claim is made would need to be verified on the ground; moreover, the insured farmers are required to follow the agro-technical norms set out by the Ministry of Agriculture and Water Resources for each crop (which are not always easy and may not make economic sense to a farmer) in order to qualify for drought payments. To spread coverage by reducing transaction costs, there is a need to expand opportunities and technical basis for index-based insurance options.

Among the specific measures suggested by a number of respondents was to increase the number of water reservoirs. In our opinion, however, this may not provide a viable solution because presently there are 55 reservoirs with a capacity of 20 cubic kilometers in total (more than a third of the water used annually in Uzbekistan's agriculture) that are already able, to a large extent, to accumulate any excess water during high water years to release during drier years. Adding more reservoirs may lead to greater evaporation, leading to more water loss. The main reason for the severity of the impact of droughts is not the lack of reservoirs that can mitigate these impacts, but seems to be a widening gap between available supplies of water and growing water use. Hence supply-side measures—such as minimizing water losses in the drainage and irrigation canals—are vitally important. At the same time, success in improving the resilience against droughts would largely depend on demand-side actions targeting ways to improve water use efficiencies and reduce overall water use in agriculture.

The interviews emphasized that current activities of monitoring and forecasting droughts would need to be significantly strengthened by investing in more granular and frequent weather and hydrological data collection and improved hydro-economic modeling of drought impacts. However, the crucial aspect stressed by several respondents was the provision of open access to such early warning signals, as well as to the climate and weather data. There are important opportunities for research institutes and universities to contribute by modeling the effects of drought on crop production and water availability, for which having open access to data is also essential.

Several respondents emphasized the need to boost the coordination of drought policies and programs, including linking information on monitoring, forecasts, and early warnings with long-term drought resilience strategies in agriculture. In this regard, the National Center for Drought Monitoring under Uzbekistan's hydro-meteorological service (Uzhydromet) could play a more active role in collaboration with the Ministry of Agriculture and Water Resources and its local administrative branches.

Finally, respondents also highlighted the need to develop a national strategy for drought risk mitigation and preparedness, which could provide the basis for such well-defined inter-agency collaborations. The national drought risk mitigation and preparedness strategy would need to include improved information about the impacts of past droughts (direct and indirect, immediate and longer term), including impacts not only on agricultural productivity but also economy-wide effects on incomes, poverty, and food security. Respondents suggested that such a national strategy should

also systematize the available knowledge concerning drought adaptation strategies (including technologies and approaches in agriculture and natural resources management) as well as strategies that support producer and farming communities via risk management (insurance).

Conclusions and Policy Implications

The findings of this case study show that improved access to extension and credit along with diversified cropping portfolios were highly related to farmer drought coping and drought risk mitigation actions. Stakeholder analyses pointed out that major consensus-based drought risk mitigation policy actions in Uzbekistan could improve water use efficiencies by cleaning and good maintenance of irrigation and drainage networks, developing drought-resistant cultivars, adopting water-saving irrigation technologies, and improving market access for farmers—including access to drought risk insurance. See Box 1 for a summary of recommended options.

Stakeholder responses indicate widespread understanding and agreement about the necessity of drought risk mitigation activities, but what seems to be lacking is stronger inter-agency links and coordination, and the national-level strategy framework guiding these drought risk mitigation and preparedness activities.

In this regard, further research is also needed across the agro-climatic zones to address the effects of various types of water management and irrigation regimes and to breed new drought-tolerant crop varieties under different crop rotations. There is also a lack of studies that identify the reasons behind low adoption of SLM and water-conserving practices and suggest ways to improve such technology adoptions. There are significant knowledge gaps on drought impacts and related quantitative cost-benefit analyses of reactive versus proactive actions for drought risk mitigation. When there is a lack of information on the costs and benefits of drought risk mitigation actions, the Uzbekistan government would naturally be reluctant to make costlier investments in drought risk mitigation activities.

The key recommendation coming from the stakeholder interviews was to develop a national drought risk mitigation and preparedness strategy. This strategy needs to be based on the latest research findings on the impacts of droughts, including impacts not only on agricultural productivity but also economy-wide effects on incomes, poverty, and food security. Such a national strategy is also expected to systematize the available knowledge on drought adaptation strategies and set the framework for inter-agency coordination of drought risk mitigation and preparedness activities.

Box 1: Summary of Recommended Drought Risk Mitigation Options

- ✓ Diversify crops
- ✓ Breed drought-resistant crop varieties and produce their seed, including for the diversification crops
- ✓ Improve water use efficiency in agriculture
- ✓ Improve extension and rural advisory services
- ✓ Expand drought insurance products, specifically index-based drought insurance approaches
- ✓ Improve monitoring and forecasting of droughts (data collection, hydro-economic modeling, and open access to data)
- ✓ Strengthen the coordination of drought response and risk mitigation activities
- ✓ Develop a national strategy for drought risk mitigation and preparedness

Teaching Assignment (Extended Classroom Game-Oriented Version)

The Government of Uzbekistan is organizing a national discussion for identifying major drought risk mitigation policies/actions and, based on this discussion, is developing a national strategy for drought risk mitigation. For this purpose, representatives from some of the various stakeholder groups were invited to participate in the discussion, including (1) farmers, (2) meteorological service, (3) the Ministry of Agriculture and Water Resources, (4) research institutes and universities, and (5) agricultural service providers (extension, banks, and insurance companies). The students are divided into these five categories of stakeholders. After a careful reading of the case study and of the recommended literature sources, each stakeholder group should identify:

1. What contributions can the stakeholder group make to promote drought resilience in the country?

2. Which barriers and problems does the group face in implementing its activities for drought risk mitigation?

3. What kind of input/support from each other stakeholder would the group need?

In the second round of discussions, each stakeholder group will make a presentation that includes whether or not it can provide the inputs and support requested by other stakeholders for drought risk mitigation activities, and what it may additionally need in return from other stakeholders. The stakeholder groups are allowed to evaluate and criticize each other's suggestions in case they do not seem to make sense from their perspectives. The discussion could be continued—ideally until consensus emerges among various stakeholder groups.

The purpose of the assignment is for students to better understand the interactions between various stakeholder groups, opportunities for collaboration, and existing barriers and problems with drought risk mitigation. The discussion facilitator should, from the beginning, make clear that the government is willing to invest sufficient funding to carry out these proposals, so that the students' creative thinking and proposed solutions are not limited or always reduced to funding availability, but instead are liberated for generating novel and out-of-the-box ideas.

Teaching Assignment (Brief Homework-Oriented Version)

The Government of Uzbekistan is organizing a national discussion for identifying major drought risk mitigation policies/actions and, based on this discussion, is developing a national strategy for drought risk mitigation. Based on your reading of the case study and other recommended materials, please answer the questions below from the perspectives of each of the following stakeholder groups: (1) farmers, (2) meteorological services, (3) the Ministry of Agriculture and Water Resources, (4) research institutes and universities, and (5) agricultural service providers (extension, banks, and insurance companies):

1. What contributions can the stakeholder group make to promote drought resilience in the country?

2. Which barriers and problems does the group face in implementing its activities for drought risk mitigation?

3. What kind of input/support from each other stakeholder would the group need?

References

Alam, K. 2015. "Farmers' Adaptation to Water Scarcity in Drought-Prone Environments: A Case Study of Rajshahi District, Bangladesh." *Agricultural Water Management* 148: 196–206.

Birthal, P. S., D. S. Negi, M. T. Khan, and S. Agarwal. 2015. "Is Indian Agriculture Becoming Resilient to Droughts? Evidence from Rice Production Systems." *Food Policy* 56: 1–12.

Bobojonov, I., J. P. Lamers, M. Bekchanov, N. Djanibekov, J. Franz-Vasdeki, J. Ruzimov, and C. Martius. 2013. "Options and Constraints for Crop Diversification: A Case Study in Sustainable Agriculture in Uzbekistan." *Agroecology and Sustainable Food Systems* 37 (7): 788–811.

Cai, X., D. C. McKinney, and M. W. Rosegrant. 2003. "Sustainability Analysis for Irrigation Water Management in the Aral Sea Region." *Agricultural Systems* 76 (3): 1043–66.

Chub, V. 2007. *Climate Change and Its Impact on Hydro-Meteorological Processes, Agro-Climatic and Water Resources of the Republic of Uzbekistan*. Tashkent, Uzbekistan: Uzhydromet.

Deressa, T. T., R. M. Hassan, C. Ringler, T. Alemu, and M. Yesuf. 2009. "Determinants of Farmers' Choice of Adaptation Methods to Climate Change in the Nile Basin of Ethiopia." *Global Environmental Change* 19 (2): 248–55.

Ding, Y., M. J. Hayes, and M. Widhalm. 2011. "Measuring Economic Impacts of Drought: A Review and Discussion." *Disaster Prevention and Management: An International Journal* 20 (4): 434–46. (Recommended: A good reference for approaches used for assessing the economic impacts of droughts.)

Dukhovny, V. A., A. G. Sorokin, and G. V. Stulina. 2008. *Should We Think about Adaptation to Climate Change in Central Asia? Adaptation to Climate Change: Regional Challenges in Light of World Experiences.* Tashkent, Uzbekistan: Scientific Information Center of the Interstate Commission for Water Coordination (SIC ICWC).

FAO (Food and Agriculture Organization of the United Nations). 2017. *Drought Characteristics and Management in Central Asia and Turkey.* FAO Waters Report 44 Rome, Italy: FAO. (Recommended: This report provides the most recent detailed coverage of drought characteristics and drought management activities and strategies in Uzbekistan and, more broadly, in Central Asia.)

Gupta, R., K. Kienzler, A. Mirzabaev, C. Martius, E. de Pauw, K. Shideed, T. Oweis, R. Thomas, M. Qadir, K. Sayre, C. Carli, A. Saparov, M. Bekenov, S. Sanginov, M. Nepesov, and R. Ikramov. 2009. "Research Prospectus: A Vision for Sustainable Land Management Research in Central Asia." ICARDA Central Asia and Caucasus Program. Sustainable Agriculture in Central Asia and the Caucasus Series No. 1. Tashkent, Uzbekistan: CGIAR-PFU.

Holden, S. and B. Shiferaw. 2004. "Land Degradation, Drought and Food Security in a Less Favoured Area in the Ethiopian Highlands: A Bio Economic Model with Market Imperfections." *Agricultural Economics* 30 (1): 31–49.

Huntjens, P., C. Pahl-Wostl, and J. Grin. 2010. "Climate Change Adaptation in European River Basins." *Regional Environmental Change* 10 (4): 263–84.

Kampragou, E., S. Apostolaki, E. Manoli, J. Froebrich, and D. Assimacopoulos. 2011. "Towards the Harmonization of Water-Related Policies for Managing Drought Risks across the EU." *Environmental Science & Policy* 14 (7): 815–24.

Kinsey, B., K. Burger, and J. W. Gunning. 1998. "Coping with Drought in Zimbabwe: Survey Evidence on Responses of Rural Households to Risk." *World Development* 26 (1): 89–110.

Kochar, A. 1999. "Smoothing Consumption by Smoothing Income: Hours-of-Work Responses to Idiosyncratic Agricultural Shocks in Rural India." *Review of Economics and Statistics* 81 (1): 50–61.

Kusunose, Y. and T. J. Lybbert. 2014. "Coping with Drought by Adjusting Land Tenancy Contracts: A Model and Evidence from Rural Morocco." *World Development* 61: 114–26.

Lei, Y., Y. Yue, Y. Yin, and Z. Sheng. 2014. "How Adjustments in Land Use Patterns Contribute to Drought Risk Adaptation in a Changing Climate: A Case Study in China." *Land Use Policy* 36: 577–84.

McDonald, R. and D. Siegel. 1986. "The Value of Waiting to Invest." *Quarterly Journal of Economics* 101: 707–28.

Mirzabaev, A. 2013. "Climate Volatility and Change in Central Asia: Economic Impacts and

Adaptation." Bonn University Dissertation. URN: urn:nbn:de:hbz:5n-32382

Mirzabaev, A., and D. Tsegai. 2013. "Effects of Weather Shocks on Agricultural Commodity Prices in Central Asia." ZEF Discussion Paper 140769. Bonn, Germany

Murodullaev, N., I. Bobojonov, and S. Mustafaqulov. 2014. "Current State and Future Prospects of Crop Insurance in Uzbekistan." Paper prepared for presentation at the Regional Economic Cooperation in Central Asia: Agricultural Production and Trade (ReCCA) conference, Halle (Saale), Germany.

Reardon, T. and J. E. Taylor. 1996. "Agroclimatic Shock, Income Inequality, and Poverty: Evidence from Burkina Faso." *World Development* 24 (5): 901–14.

Sorg, A., T. Bolch, M. Stoffel, O. Solomina, and M. Beniston. 2012. "Climate Change Impacts on Glaciers and Runoff in Tien Shan (Central Asia)." *Nature Climate Change* 2 (10): 725.

Sun, C. and S. Yang. 2012. "Persistent Severe Drought in Southern China during Winter–Spring 2011: LargeScale Circulation Patterns and Possible Impacting Factors." *Journal of Geophysical Research: Atmospheres* 117 (D10).

Wilhite, D. A. 2000. *Drought: A Global Assessment*. Natural Hazards and Disasters Series, Vol. 1. New York: Routledge. (Recommended: Wilhite (2000) remains a key global reference on the basics of droughts, definitions, terms, concepts, and a summary of the global research on drought impacts and drought risk mitigation activities.)

Willaume, M., A. Rollin, and M. Casagrande. 2014. "Farmers in Southwestern France Think that Their Arable Cropping Systems Are Already Adapted to Face Climate Change." *Regional Environmental Change* 14 (1): 333–45.

WMO and GWP (World Meteorological Organization and Global Water Partnership). 2014. *National Drought Management Policy Guidelines: A Template for Action* (D.A. Wilhite, author). Integrated Drought Management Programme (IDMP) Tools and Guidelines Series 1. WMO, Geneva and Stockholm: WMO and GWP.

———. 2017. "Benefits of Action and Costs of Inaction: Drought Mitigation and Preparedness – A Literature Review (N. Gerber and A. Mirzabaev, authors). Integrated Drought Management Programme (IDMP) Working Paper 1. WMO and GWP, Geneva and Stockholm. (Recommended: Gerber and Mirzabaev provide a detailed review of the literature on drought impacts, drought risk mitigation, and preparedness strategies at the global level, and can serve as an informative background paper for a better understating of broader drought-related issues.)

World Bank. 2006. *World Drought Management and Mitigation Assessment for Central Asia and the Caucasus. Phase two: Country Drought Management and Mitigation Profile and Strategy*. Tashkent, Uzbekistan: World Bank. (Recommended: Many of this report's major insights and recommendations on drought risk mitigation and preparedness activities in Uzbekistan still remain highly relevant.)

Zilberman, D., A. Dinar, N. MacDougall, M. Khanna, C. Brown, and F. Castillo. 2011. "Individual and Institutional Responses to the Drought: The Case of California Agriculture." *Journal of Contemporary Water Research and Education* 121 (1): 3. (Recommended: A highly recommended classic case providing a good theoretical and empirical discussion of drought impacts and drought risk mitigation actions.)

Additional Readings

Booker, J. F., A. M. Michelsen, and F. A. Ward. 2005. "Economic Impact of Alternative Policy Responses to Prolonged and Severe Drought in the Rio Grande Basin." *Water Resources Research* 41 (2).

Pulwarty, R. S. and M. V. Sivakumar. 2014. "Information Systems in a Changing Climate: Early Warnings and Drought Risk Management." *Weather and Climate Extremes* 3: 14–21.

Taylor T, A. Markandya, P. Droogers, and A. Rugumayo. 2015. *Economic Assessment of the Impacts of Climate Change in Uganda. National Level Assessment: Water Sector Report*. Kampala, Uganda: Climate Change Department, Ministry of Water and Environment, Uganda, Climate & Development Knowledge Network (CDKN).

Annex 1

Questionnaire
Introductory Remarks

This questionnaire is about identifying the key aspects of improving drought resilience in the agricultural sector in Uzbekistan and the role different organizations play in this process. We would like to especially focus on ideas for future measures that can help manage drought risks in advance before the occurrence of droughts, rather than only as crisis management after their occurrence. All data and information gathered for this study will be summarized for analysis and contribute to the preparation of a report on improving drought resilience in Uzbekistan. We thank you very much for your suggestions and inputs.

1) Name of the respondent

2) Position, organization

3) Please state how your organization is related to dealing with drought impacts:

   a) not at all b) somewhat
   c) closely d) very closely

4) What are the specific areas of addressing droughts that your organization is engaged in?

5) In your view, which organizations play a key role on addressing the impacts of droughts in Uzbekistan? Please list.

6) In your view, which organizations should play a bigger role in addressing the impacts of droughts? Please also say what actions these organizations should undertake.

7) Which are the key organizations that you work together in addressing drought impacts? Please rank by importance.

8) International practice shows that preparing in advance to deal with future droughts is often much cheaper than addressing the impacts of droughts.

   a) agree b) disagree

9) What are the actions and measures that are, in your opinion, necessary to strengthen such future drought preparedness and resilience in Uzbekistan? Please rank from the easiest to most difficult to implement.

10) Do you have any previous experience of dealing with droughts? If yes, when? Was it a severe drought or mild? What did you do to cope with drought and its impacts?

11) IF such a drought is expected next year, what should your organization do to be prepared for this?