POLICY NOTE 002 • AUGUST 2014

PAKISTAN
Strategy Support Program

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI
A member of the CGIAR Consortium

CLIMATE CHANGE AND EXTREME EVENTS: IMPACTS ON PAKISTAN'S AGRICULTURE

ZHU, T., H. XIE, A. WAQAS, C. RINGLERC M. MOHSIN IQBAL, M. ARIF GOHEER & T. SULSER

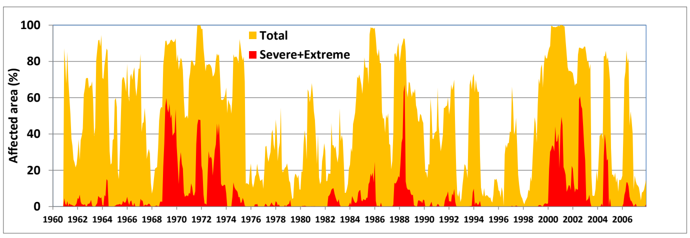
Due to its arid to semi-arid climate, water is the single most constraining factor to Pakistani agriculture. Water resources are heavily appropriated for productive uses, and agriculture is the main user of water resources. Over eighty percent of crop value comes from irrigated agriculture. Demand for water is increasing from population growth and industrial and agricultural development. Moreover, water resources are threatened by drought and long-term climate change through its effect on temperature, precipitation, and glacier runoff.

Given the country's reliance on scarce water resources, its availability and variability remain closely linked to Pakistan's overall economic development. For example, the severe drought of 1999-2002 contributed to the country's economic contraction, while the above average rainfall and availability of irrigation water during 2003-2005 supported agricultural recovery and growth during that period. This policy note presents results of two studies examining effects of drought and climate change on Pakistan's agriculture sector.

DROUGHT PATTERNS

The study on drought trends assessed the spatial and temporal variability of drought in Pakistan over 1960-2007 and estimated the likely future incidence of drought using the Standardized Precipitation Index (SPI), a measure of drought severity used by the Pakistan Meteorological Department for monitoring purposes. Principal component analysis was used to assess the variability of the SPI field across space and time.

Figure 1: Drought cycles and affected areas, Pakistan



Source: Xie et al. (2013).

While no trend in drought severity was seen during 1960-2007, the results show that droughts exhibit cyclical behavior, in which periods of intensive droughts occur every 16 years, followed by wet periods. Three major drought-intensive periods were identified—the late 1960s, the mid-1980s and the late 1990s—all of which lasted four to five years and were followed by a wet period (Figure 1).

Furthermore, the results show that drought tends to occur simultaneously in central and southern Pakistan, the key agricultural regions of the country. During the three main periods identified, more than 90 percent of Pakistan was affected, and the area under severe and extreme drought was as high as 50–60 percent at times.

IMPLICATIONS OF DROUGHT FOR PAKISTAN'S AGRICULTURE

The large spatial extent of drought-affected areas, in addition to their long duration, undoubtedly pose great challenges for water management in Pakistan. Droughts tend to cover key agricultural areas of the country, making it difficult to reduce adverse impacts through inter-regional trade within Pakistan.

However, the results also suggest that the pattern of drought follows a long cycle of 16 years. Periodicity implies predictability. If long-term periodicity exists, drought-preparedness measures can be developed that reduce adverse impacts on agriculture and Pakistan's economy.

CLIMATE CHANGE IMPACTS

The study on climate change uses a global water and food projections model and four climate scenarios (combining two Global Circulation Models with two emissions scenarios) to assess impacts on water availability, water supply, agricultural production, agricultural commodity trade, commodity prices, and food security (per capita calorie availability) in Pakistan.

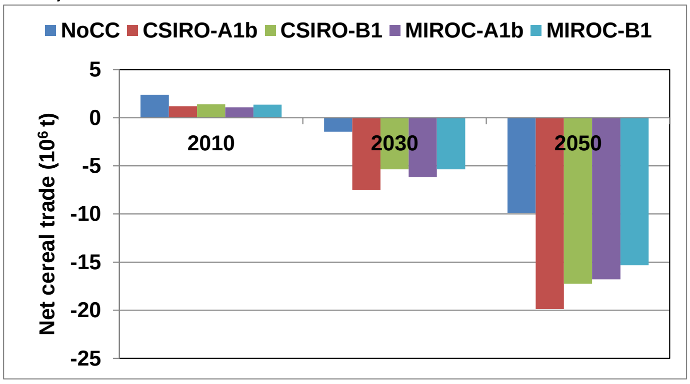
The results show that the hydrological impacts of climate change over the entire Indus River Basin (IRB) are inconsistent, with some scenarios projecting an increase and others showing a decrease in mean annual runoff. However, runoff is generally projected to increase in the Pakistani portion of the IRB, with an increase in irrigation water supply in three out of four climate change scenarios.

Despite the increase in runoff, the negative impact of climate change on crop production is evident across all scenarios. The results show a considerable decline in the yields of key staple crops, such as wheat, maize and rice, due to higher temperatures and a shortening of the growing season under a warmer climate. As a result, global food prices for these staples are projected to increase between 14 and 32 percent. Reduced production nationally, combined with higher international food prices due to negative climate change impacts elsewhere, affect

Pakistan's food security negatively; and per capita calorie availability by 2050 declines as a result.

Even without climate change, Pakistan is expected to become a more significant net food importer over time, due to a combination of moderate growth in agricultural production and growing water scarcity in the face of rapid population growth. Importantly, Pakistan's trade position will further deteriorate with climate change, as net cereal imports rise by 55 percent to 100 percent, depending on the scenario, compared to a situation without climate change.

Figure 2: Climate change impacts on net cereal trade, 2010–2050, Pakistan



Source: Zhu et al. (2013).

FOOD AND WATER SYSTEM ADAPTATION OPTIONS

To address the possible negative impacts of climate change for Pakistan, the study assessed a range of adaptation options related to food production and water management. Three scenarios envision stronger agricultural productivity growth through investment in agricultural research and infrastructure, such as more high-yielding varieties, with heat and drought tolerance traits, and greater irrigated area. Two scenarios focus on water resources, expanding reservoir storage and increasing irrigation efficiency. The last scenario combines the best food and water-based adaptation options.

The scenario outcomes show that a large increase in agricultural research, focusing on productivity improvements, and improved irrigation efficiency, through adoption of advanced irrigation technologies and management, are the best strategies. Such investments would enable irrigation water demand to be fully met by 2050 and would lead to dramatic increases in yields of staple crops. Such a scenario could even allow Pakistan to export wheat (though this assumes that other countries do not pursue similarly aggressive adaptation options).

While all adaptation scenarios lead to slight improvements in calorie availability, adaptation will be insufficient to bring nutritional quantity and quality back to the no-climate-change level. To achieve this would require large additional adaptation investments in other key food-producing countries to reduce international market prices through increased production and exports.

The storage scenario suggests that increasing reservoir storage without considering other adaptation options cannot improve crop productivity and production. However, this does not necessarily deny other benefits that more reservoir storage may provide, such as hydropower, flood protection, or controlled release of environmental flows, especially as Pakistan's storage-to-runoff ratio is well below that of other arid countries.

CONCLUSIONS

The two studies reviewed here suggest that, to minimize negative impacts of drought and long-term climate change, both drought risk reduction and long-term climate change adaptation strategies should be integrated into agricultural development policies. Drought mitigation requires concerted efforts in agricultural and water resources management across the country, such as flexible trade policies in drought years and changes in reservoir release rules ahead of droughts. To achieve the kinds of improvements in agricultural production and irrigation efficiency needed to adapt to the negative impacts of climate change, a range of options are available. These include accelerating cultivar improvement programs, strengthening crop management research, expanding agricultural extension and education, strengthening infrastructure in rural areas, accelerating irrigation management reforms, allocating irrigation water more flexibly across provinces, and accelerating drip expansion.

FURTHER READING:

Xie, H., C. Ringler, T. Zhu and A. Waqas. 2013. Droughts in Pakistan: a spatiotemporal variability analysis using the Standardized Precipitation Index. Water International 38(5): 620-631.

Zhu, T., C. Ringler, M. Mohsin Iqbal, T.B. Sulser and M. Arif Goheer. 2013. Climate change impacts and adaptation options for water and food in Pakistan: scenario analysis using an integrated global water and food projections model Water International 38(5): 651-665.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
2033 K Street, NW • Washington, DC 20006-1002 USA
T: +1.202.862.5600 • F: +1.202.467.4439
Skype: ifprihomeoffice • Email: ifpri@cgiar.org

This publication has been prepared as an output of the Pakistan Strategy Support Program. It has not been peer reviewed. Any opinions stated herein are those of the author(s) and do not necessarily reflect the policies of the International Food Policy Research Institute (www.ifpri.org), its partners, or its collaborators.