Climate change and food security: risks and responses

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Editor's note

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Climate change threatens to reverse the progress made so far in the fight against hunger and malnutrition. As highlighted by the latest assessment report of the Intergovernmental Panel on Climate change (IPCC), climate change augments and intensifies risks to food security for the most vulnerable countries and populations. The earliest and the more impacted are the most vulnerable countries and populations, including in arid and semi-arid areas, landlocked countries and small island developing states. Climate change will also have broader impacts through effects on trade flows, food markets and price stability and could introduce new risks for human health.

This paper provides an overview of the cascading impacts of climate change on food security and nutrition, from physical impacts on agro-ecosystems to livelihoods and food security. It describes how the cascade of impacts acts on a series of vulnerabilities. It presents ways to adapt and build resilience to climate change to ensure food security and nutrition.

Risks: Climate Change impacts on food security – Overview of latest knowledge

Climate change is profoundly modifying the conditions under which agricultural activities are conducted

Climate change has both direct and indirect impacts on agricultural production systems. Direct impacts include effects caused by a modification of physical characteristics such as temperature levels and rainfall distribution on specific agricultural production systems. Indirect effects are those that affect production through changes on other species such as pollinators, pests, disease vectors and invasive species. Pests and diseases are likely to move, following climate change, affecting areas previously immune, and thus less prepared, biologically and institutionally, to manage and control them, with potentially higher negative impacts. These changes may also counter-balance direct positive effects of climate change in high-latitude regions. Such indirect effects are much more difficult to assess and project given the high number of interacting parameters and links, many of which are still unknown.

The projected impacts of climate change on major crop yields are now well documented based on two decades of research. Studies show that climate change has already negatively affected wheat and maize yields in many regions, as well as globally. According to results from major agricultural model inter-comparison projects, despite remaining uncertainties related to how models account for the representation of combined carbon dioxide fertilization, ozone stress and high temperature effects, there is agreement on the direction of yield changes, with strong negative impacts especially

at higher levels of warming and at low latitudes. Potential impacts on other crops than major cereals have been less studied. Climate change affects animal productivity and health as well as yields of forages and feed crops.

Evidence shows that in various regions climate change is contributing to decreased productivity and dieback of trees. This can jeopardize the contribution of forests to the resilience of agricultural systems, such as for instance water and temperature regulation and the provision of habitats for important species like pollinators. Climate change affects capture fisheries and the development of aquaculture, as a result of both gradual atmospheric warming and associated physical (sea and inland water surface temperature, ocean circulation, waves and storm systems) and chemical changes (salinity content, oxygen concentration and acidification) of the aquatic environment.

Increased occurrence of coral reef bleaching has been observed. Various fish species are already migrating pole ward. A large-scale redistribution of global marine fish catch potential is forecast, with a decrease of up to 40 percent in the tropics, and an increase of 30 to 70 percent in high-latitude regions. In the Mediterranean, arrival of invasive species from lower-latitude regions has been noticed at an alarming rate. Abundance and species diversity of riverine fish are particularly sensitive to disturbances in the quantity and timing of water flows, and especially to lower water levels during dry seasons, which may be exacerbated by human action.

Favorable conditions for all productions will move geographically. Optimizing these conditions will thus require changes in crops, livestock, trees, and aquatic species breeding and management, even to benefit from potential positive effects.

Impacts on production translate into economic and social consequences, affecting food security

Impact translates from climate to the environment, to the productive sphere, to economic and social dimensions, bringing a range of additional risks on availability of food, on access to food and utilization of food, as well as on the stability of these characteristics, for both farm and non-farm households (Figure 1).

At the farm/household level, climate change impacts may reduce income level and stability, through effects on productivity, production costs or prices. Such variations can drive sales of productive capital, such as cattle, which reduces long-term household productive capacity, and can also affect expenses on health and education. Exposure to risks lowers incentives to invest in production systems.

At national level, exposure to climate risks can trigger shocks on agricultural production and food availability, with risks of market disruptions, increases in agricultural commodity prices (food and feed), impacting accessibility and stability of food supplies for the entire population. This triggers macro-economic effects for countries for which agriculture is an important part of GDP and/or constitutes an important source of employment.

At global level, climatic shocks impacting areas of global importance for food supplies can have remote impacts through effects on: (i) supply flows and food price spikes, with increased market volatility; and (ii) impacts on bilateral contracts and/or import/export behavior, with disruption of trade patterns. Trade is expected to play a major role in adjusting to climate-change-driven shifts in food production patterns.

Climate change affects food security in all its dimensions: access, availability, utilization and stability

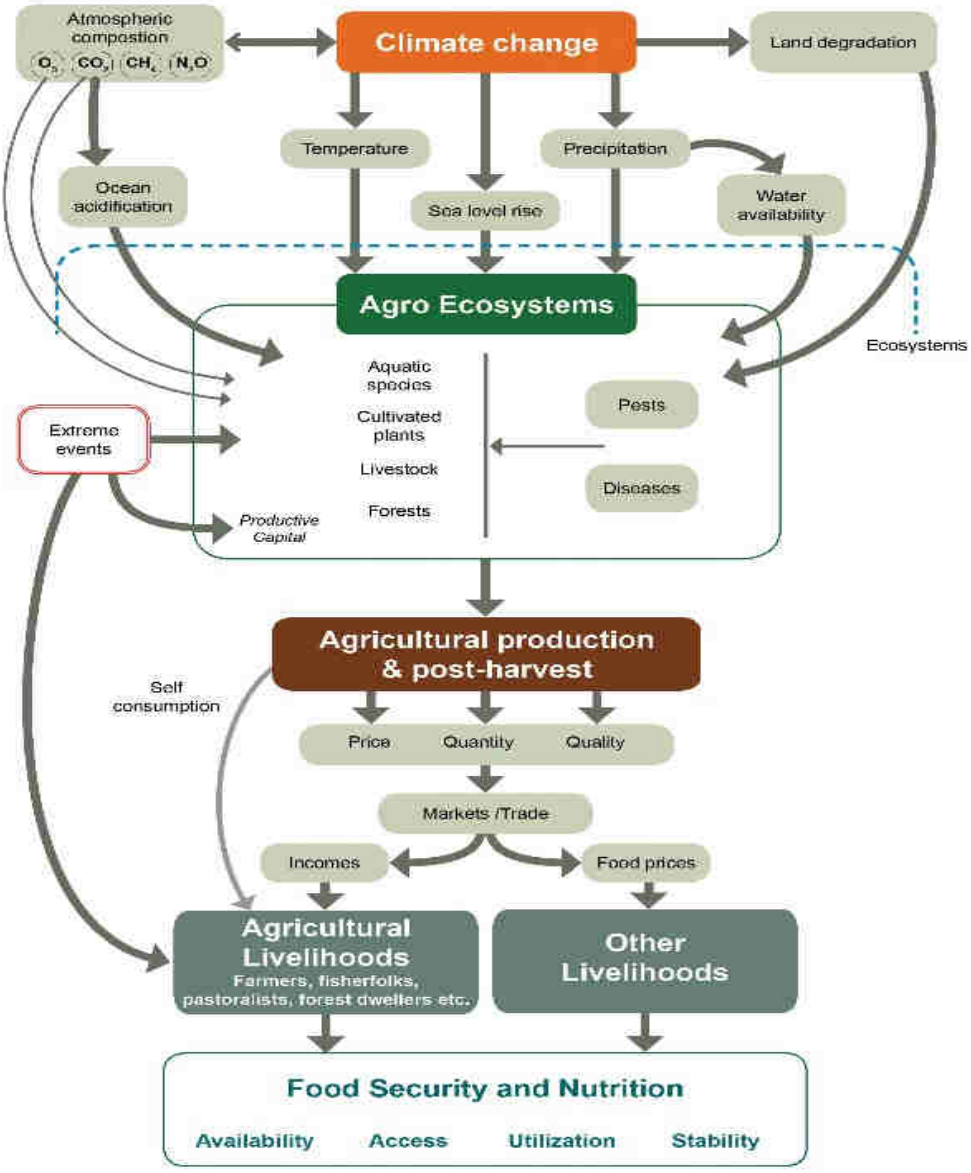
As shown above, climate change affects food availability. Climate change will impact the livelihoods and income of small-scale food producers and also, through food price increases and volatility, the livelihoods of poor net food buyers, restricting access to food. Impacts of climate change on nutrition have been much less studied. Studies point to potential changes in the nutritional quality of some foods (e.g. reduced concentration in proteins and in some vitamins and minerals), due to elevated CO_2, particularly for flour from major cereals and cassava.

Climate change can have a variety of impacts on the quality of drinking water, which is key to the good absorption of nutrients. Climate change has been found to have an impact on food safety, particularly on incidence and prevalence of food-borne diseases. Increased climate variability, increased frequency and intensity of extreme events as well as slow ongoing changes will affect the stability of food supply, access and utilization.

The net impacts of climate change on food security and nutrition depend on the magnitude of the climate change effects themselves, and on the underlying vulnerabilities of food systems. At each stage of the "cascade of impacts", vulnerabilities exacerbate net impacts. In addition, vulnerability can increase over time if systems/households face repeated shocks that steadily erode their asset base and capacity to respond. The populations at greatest risk are those that are dependent on agriculture and natural resources, with livelihoods that are highly exposed to climate change impacts, and who have very limited capacity to respond. In some cases, to cope with risks and changes, the only option can be to migrate, nationally or internationally, with a range of implications.

Figure 1

Schematic representation of the cascading effects of climate change impacts on food security and nutrition. (FAO, 2016)



Responses: ensuring food security and good nutrition in the context of Climate Change

Building resilience of households and agriculture systems for Food security and nutrition

Ensuring food security and good nutrition in a changing climate will require to build resilience at all levels, from households and agricultural systems to broader levels, mobilizing a wide range of instruments.

Adequate, well-designed social protection would tackle some of the main vulnerabilities of households to climate risks. In a recently released report, FAO, IFAD and the World Food Programme (WFP) showed that it would be possible to end extreme poverty and hunger by 2030, by combining public investment in social protection with public and private efforts to raise investment levels in productive sectors. These actions will need to be supplemented by disaster risk reduction and disaster risk management (DRR/DRM) strategies to address the risks of extreme events, prioritizing the reduction and proactive management of risks rather than reacting to events.

To address water scarcity, adaptation measures can include water harvesting and storage, access to irrigation, improved irrigation technologies, as well as agronomic practices that enhance soil water retention such as minimum tillage and increase in soil carbon and organic matter, among others.

Adaptation measures for crops can include changes in crop management, especially planting dates, the use of adapted varieties or breeds, with different environmental optima and/or broader environmental tolerances, including currently neglected crops. A range of adaptation options is available for livestock production at different scales: animals, feeding/housing system, production system and institutions, including. Breeding livestock but also feed crops and forages for adaptation-related traits.

Healthy, diversified forest ecosystems are more resilient, better able to cope with stress, recover from damage and adapt autonomously to change. Restoring degraded forests is a major strategy for increasing resilience.

Fishing and fish-farming practices and management will need to adapt to changing species composition and location and increased risks at sea. Changes in the distribution of fish will require adapting fishing effort, with flexible allocation and access schemes and avoiding exacerbating the overexploitation of fisheries or impacting habitats. Aquaculture adaptive practices include water quality monitoring, species selection, selective breeding, genetic improvement, site selection, and improved cage and pond construction.

Increasing the diversity within production systems will help spread risks. This can take many forms: combining different types of production (crop, forest, fish and animal) in different ways; increasing the numbers of different species, populations, varieties or breeds; increasing the use of materials that are themselves genetically diverse such as crop multilines. Adaptation action can be conducted at landscape level, for instance watershed protection and management, fire management, erosion control, coastal zone management, and pest and disease control. Adopting a landscape approach to management includes taking into consideration the physical and biological features of an area as well as the institutions and people who influence it. It will require appropriate institutions and policies to improve coping capacities of communities.

Invest in resilient agricultural development

Climate change adaptation investment could be joined-up with regular agricultural investment programmes to scale-up effects. Public investment can help guide, enable and increase returns to private investments. Investments of farmers, fishers and forest dwellers need to be supported by increased capacity to take collective action. Mutualized systems to assess risks, vulnerabilities and adaptation options can ground the set-up of early warning systems, help assess adaptation options and orient individual decisions.

Managing genetic resources requires large collective investments to preserve, characterize and valorize genetic resources, and also to revise the goals of breeding programmes. Breeding programmes take time to attain their goals and therefore need to start many years in advance. Improvements to in-situ and ex-situ conservation programmes for domesticated species, their wild relatives and other wild genetic resources important for food and agriculture, along with policies that promote their sustainable use, are therefore urgently required.

Enable adaptation through policies and institutions

Appropriate policies and institutions at national and international levels are needed to enable, support and complement adaptation of food producers, especially small-scale food producers. Dedicated policies and institutions are needed for the prevention and management of specific risks and vulnerabilities that can be modified by climate change, such as water scarcity, plant pests, animal diseases, invasive species and wild fires. Securing land tenure is paramount to enable farmers to benefit from the value added on the land and to encourage them in adopting a long-term perspective. Collective management of natural resources, including land and water requires specific institutions, often at local level. Policies and institutions need to account for the specificities and needs of pastoral systems and indigenous peoples.

Improving land use and management, or changing farming systems often imply significant up-front costs, and/or reduced income during the transition period. Specific policies and instruments are needed to enable those investments and facilitate the transition. Gender-specific support services are needed, recognizing the differentiated roles of household members in production, consumption and the reproduction of the family unit over time.

Market development and better linkages of smallholder and family farmers to domestic, national and regional markets are important to support adaptation actions. Policies will be needed to reduce financial risks, lower transaction costs, facilitate monetary transactions, and facilitate long-term investments.

The vulnerability to climate change of the agriculture sectors and of food security calls for better recognizing their importance and specificities in national climate-related instruments like adaptations plans, and for integrating climate change concerns in food security and agricultural policies. The countries that have included adaptation in their INDCs generally insisted on the importance of food security and of the agriculture sectors.

Strengthened regional and international cooperation will be needed to facilitate exchanges of knowledge on production systems and on adaptation options, undertake vulnerability assessments, exchange and value genetic material and practices, manage fish stocks and other transboundary resources, as well as to prevent and manage transboundary risks, like plant pests and animal diseases.

Acting now on climate change, to ensure food security and good nutrition for all, now and in the future

Climate change brings a cascade of risks from physical impacts to ecosystems, agro-ecosystems, agricultural production, food chains, incomes and trade, with economic and social impacts on livelihoods and food security and nutrition. Reducing vulnerabilities and increasing resilience of food security in the face of climate change calls for multiple interventions, from social protection to agricultural practices and risk management. To be the most effective such interventions have to be part of integrated strategies and plans, that should be gender-sensitive, multiscales, multisectors and multistakeholders, elaborated in a transparent way, considering different dimensions (social, economic, environmental) of issues and different time scales.

Actions by different stakeholders are needed in the short term to enable responses in the short, medium and long term. Some medium- and long-term responses will need immediate enabling action and planning, and immediate investment, for instance in: forestry, livestock breeding, seed multiplication, R&D, innovation and knowledge transfer to enable adaptation. Greatly expanded efforts to respond to climate change are needed immediately to safeguard the capacity of food systems to ensure global good security. A paradigm shift towards agriculture and food systems that are more resilient, more productive, and more sustainable is required.

Bibliography/ More information

- FAO/OECD, 2012. *Building resilience for adaptation to climate change in the agriculture sector.* Proceedings of a joint FAO/OECD Workshop. Rome, FAO.

- FAO/IFAD/WFP. 2015. *Achieving zero hunger: the critical role of investments in social protection and agriculture,* Rome (available at http://www.fao.org/3/a-i4777e.pdf).

- HLPE. 2012. *Food security and climate change. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security,* Rome.

- IPCC. 2013. *Climate change 2013: the physical science basis.* Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J., Boschung, A., Nauels, Y., Xia, V., Bex & P.M., Midgley, eds. Cambridge, UK, and New York, USA, Cambridge University Press.

- IPCC. 2014a. *Climate change 2014: synthesis report.* Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Core Writing Team, R.K. Pachauri & L.A. Meyer, eds. Geneva, Switzerland, IPCC.

- IPCC. 2014b. *Climate change 2014: impacts, adaptation, and vulnerability*. Part A: Global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. C.B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea & L.L. White, eds. Cambridge, UK, and New York, USA, Cambridge UniversityPress.