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## **Climate extremes and agriculture, food security and ecosystems**

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### **Background**

Cropland and pastures are one of the largest terrestrial biomes in the planet, covering 40% of the land surface. In developing countries, nearly 70% of the people live in rural areas, where agriculture is the main supporter of livelihoods. Agriculture, fishing and other services and products obtained from ecosystems feed the ca. 6000 million people living today. Although enough food is produced in the world, over 800 million people are food-insecure, and 200 million children below 5 years of age are malnourished. One of the greatest challenges that humanity faces will be to provide food and other vital services to the ca. 10000 million people expected by the end of this century. Trends in population growth and changes in diet patterns will increase the demand for food quantity and quality (greater protein demand), posing a great pressure on already pressed food-, and services-producing systems, inducing additional demands for new land and resources, in particular water. To meet this challenge, continued progress in technical and institutional capacity will be necessary to increase production under the new evolving climate conditions. Maintaining the integrity of food-, and services-producing managed and natural systems is of paramount importance for the provision of their services.

### **IPCC AR4**

The Fourth Assessment Report of the IPCC (AR4) has established that warming of the climate system is unequivocal and that continued GHG emissions at or above current rates would cause further warming and changes in the global climate system. Among the expected changes, shifts in some regional-scale climate features, as some aspects of extremes, are important for food-, and services-producing systems: increases in frequency of extreme temperature, heat waves, heavy precipitation and tropical cyclones, shifts in extra-tropical wind, temperature and precipitation patterns, changes in annual river runoff and water availability, causing many areas to suffer decreases in water resources, or increases in area affected by drought, are most relevant. Food supply and ecosystems are among the key sectors/systems that could produce key vulnerabilities. Here I review some of the key finding of AR4 on weather and climate extremes. My aim is to present some examples of how extremes can affect some vital processes for humans, in order to derive a framework that would allow a better understanding of how such process affect them.

## **Crops**

Climate variability and extreme weather and climate may lower crop yields beyond the impacts of mean climate change. Extreme temperatures (hot but also cold) at critical development stages may lower long-term yields. Much uncertainty remains about future projections of changes in crop yield due to the poor representation in models of changes in extreme temperatures. Recent studies show that growing-season temperatures in the tropics and subtropics by the end of this century will exceed the most extreme seasonal temperature recorded in the last century, which could dramatically affect crop productivity and food security. Water availability is a key resource for agriculture. Rain-fed crops dominate agriculture production throughout the world, including many semi-arid areas. Droughts are a major threat to these food-producing systems. In continents like Africa up to 1/3 of the population are exposed to drought. In many LDC there is a close relationship between GDP and rainfall, and the impacts of droughts are long-lasting. Further, river runoff is expected to decrease in many areas of the world that are now subject to reduced precipitation. Increases in crop irrigation requirements are projected to globally increase due to global warming. Droughts have been increasing and are expected to continue doing so, thus directly affecting rain-fed crops and reducing water resources for irrigation. Much of the most productive land is in the low lands and is subject to inundations. Tropical storms, with their strong winds, heavy rain and surges threaten many highly productive areas, as well as human infrastructures. Heavy rainfall can originate excess soil moisture and increase production losses. Increase flooding in low-land can equally reduce crop productivity.

## **Livestock**

Pastures and livestock production systems occur under most climates, and vary from extensive pastoralist, commonly in low-rainfall areas, to intense livestock systems where animals are fed kept and indoors or range though confined areas. Thermal stress reduces productivity, conception rates and is potentially life-threatening to livestock. Increase variability in weather and climate is likely to have far greater impacts on livestock production than changes in mean climate conditions. Increases in drought in semiarid rangelands can have large effects on animal mortality, and increase land degradation.

## **Fisheries**

Global fisheries production is rising, mainly due to aquaculture, which currently accounts for about 1/3 of all captures. Climate change impacts on fisheries cannot be understood without considering fishing pressures. A number of threats to fish production have been identified, but how this will transfer into fisheries production remains unclear. Climate variability is a major determinant of fish distribution and abundance, but how these affect fisheries varies from region to region. The frequency and intensity of extreme events can alter fisheries and aquaculture production. Temperature extremes or changes in water salinity are shown as examples of the kind of extremes that could affect this sector.

## **Food security**

Food security comprises four main dimensions of food supplies: availability (i.e., production, trade), stability of supplies, access, and utilization. All these dimensions will likely be affected

by climate change, the net result being that the number of people at risk of hunger will likely increase, depending on development pathways. However, major uncertainties remain to be solved, among them the role of extreme events on food stability.

### **Ecosystems (fire)**

Disturbances are an integral part of ecosystems. While there are many disturbances, few are able to produce disasters as recorded by the ISDR, fire being the most important one. I will concentrate on using fire as an example of how extreme weather and climatology can affect fire. Climate extremes, such as heat waves or droughts, are the major agents of change in fire-danger. A number of modelling exercises across various biomes show that in most fire-prone systems fire danger will tend to increase and with it the probability of fire, particularly of large fires. Fires are most damaging when they occur at the wild-land urban interface, threatening lives and human assets. Human actions can increase fire risk, in particular due to ill-conceived planning. In many semiarid areas, such as in Mediterranean type areas, abandonment can increase vegetation growth, encroachment and increase the hazardousness of the landscapes. Afforestation with flammable conifers can add to it as well. Other extremes can interact with fire, either before (drought, thus increasing fire hazard), or after fire (reduced regeneration potential) or extreme rain (increased erosion, offsite effects). Pest outbreaks or other stressors (pollution), can increase flammability and thus fire intensity. Increased frequency can rapidly alter vegetation characteristics. Weather extremes can bring fires to where these were not common, thus increasing the potential for change. Changes in fire regime due to climate change can impair the provision of services by fire ecosystems in many parts of the world.

### **Summary**

In summing up, projected changes in extreme climate events will have more serious consequences for food production and food insecurity than will changes in projected means of temperature and precipitation. Similarly, changes in extremes can directly or indirectly, through disturbances like fire, affect many world ecosystems. While messages on impacts from extremes abound in AR4, many of the purported impacts still suffer from poor representation in impact-models of these phenomena. Impacts studies must incorporate weather and climate extremes to better account for future vulnerabilities.