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Climate change impacts –projections for the future

Present atmospheric concentrations of greenhouse gases are higher than ever since several hundred thousand years. The recent rate of increase of greenhouse-gas forcing has been unprecedented over at least 20 thousand years. It is very likely that man-induced greenhouse-gas emissions have been the dominant cause of the observed global warming.

There has been an increasing body of evidence of the ongoing global warming. Each of the five years since 2001 belongs to the six globally warmest years in the 165-year observation period and the two warmest years on record are 1998 and 2005.

Projections of more intense warming in the future are robust results of different climate models. Even if concentrations of greenhouse gases were to be stabilized now, the global mean temperature would continue to rise. The future warming depends on scenarios of the socio-economic development and on the mitigation policy (curbing the greenhouse gas emissions). Different climate models, and for different scenarios, foresee that the temperature in 2011-2030 is likely to be higher than the temperature in 1980-1999 by 0.64-0.7 °C. In 2100, the 65% probability range of warming for various SRES scenarios is 1.5-5.8 °C, compared to 1980-1999. The temperature rise is not likely to be uniform – higher warming has been projected in the North than in the South, and over the land than over the ocean. Winter minimum temperature is projected to increase more than winter mean temperature in Europe.

Projected precipitation changes differ regionally, yet are model-specific and loaded with high uncertainty. Often the presently dry areas are likely to become drier, and those presently wet - wetter. There are generally consistent patterns of change in water availability – increases in high latitudes and decreases in mid-latitudes. Mean annual precipitation is likely to decrease over much of Europe (in particular, the Southern and the Central Europe). However, intensity of rainfall events is projected to increase even in regions where the mean annual precipitation is likely to decrease. Changes in extremes are likely to be more dramatic than in means. Climate change may cause increase of summer droughts in continental interiors. In much of Southern Europe, both a rise in temperature and a drop in precipitation (and a drop in the number of precipitation days) is foreseen for the summer. Heat waves will become more frequent, intense and long lasting.

Since the climate and freshwater systems are intimately interwoven in a complex way, any change in one of these systems induces a change in the other. Water availability is determined by climate-driven precipitation, evaporation (dependent on temperature, radiation, humidity, and wind speed) and snowmelt. All hydrological processes are affected by climate change; therein essential variables in water management, related to water availability, are river discharges, and water levels in rivers, lakes, and ground; and soil moisture being of primary importance for natural and cultivated vegetation.

Agriculture plays different roles in the climate change context. It is a driver of climate change (emission of greenhouse gases - nitrous oxide and methane), a victim of climate change (regional crop yield loss due to intensification of heat waves, droughts, and floods), a beneficiary of climate change (carbon dioxide fertilization and positive changes due to longer vegetation season, gains in agricultural area), and a controller of climate change (soil carbon, carbon sequestration).

Agriculture in Europe is temperature-limited in the North and North-East and moisture-limited in the South and South-East. Climate change is likely to reduce the former

limitation and to exacerbate the latter. However, at the time horizon of 2050, it is likely that the average aggregate impact of climate-related change on agriculture in Europe is positive.

It is likely that impacts will be differentiated over the continent, i. e. categories of winners and losers will occur. Gains in agricultural area are expected, e.g. in Russian Federation, but in the South of Europe shrinking of agricultural areas is likely. Increasing temperature for mid- and high latitudes (e.g. Scandinavia) will be largely beneficial, extending the length of the growing season. Northwards expansion of suitable cropping areas is expected. In the South, disadvantages are likely to be predominant, threatening some production systems. Even small warming (or reduction in precipitation) jeopardizes crop and pasture yield in dry areas. However, increase in water use efficiency and carbon dioxide fertilization are also projected. Increase in yield variability is likely. Response of crop yields to climate change varies widely, depending on the species, cultivar, soil conditions, and other features of locations.

Since further warming cannot be avoided, there will be a need for adaptation. Among short-term adjustments one can mention changes in agronomic practices (date of planting, harvesting, change in varieties, external inputs, fertilizers, conservative tillage, more efficient irrigation), while long-term changes refer to land use, and development of suitable crop types, resistant to location, water, weed, pest. Since irrigation demand is likely to grow while the water availability drops, improvements in efficiency of irrigation are needed (“more crop per drop”).

Climate change is likely to impact the global food markets. Agricultural flows are projected to increase, with agricultural products of the temperate zone to be exported to the tropical zone. A category of environmental refugees can grow in less developed areas, where agricultural production systems have been adversely affected, while the population grows further.

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