EFFECTS OF GLOBAL CLIMATE CHANGE ON AGRICULTURE AND WATER RESOURCES

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Abstract
It is accepted that one of the most important environmental problems of the present century will be climate change. This will give rise to changes in weather patterns, and an increase in the frequency and severity of extreme events such as flooding and drought. In Turkey as in the rest of the world, global climate change will be cause an increase in the severity and frequency of heat waves, sea level rise, and extreme rainfall and flood events in some regions but increased drought in others, in a way that will directly affect living conditions.
In a study of 87 countries by the WMO, Turkey was one of 74 the countries affected by drought. According to various climate models, the East Mediterranean Basin and the subtropical zone which includes Turkey will be experienced a reduction in rainfall especially in winter, but with changes in the duration and severity of rainfall, both flooding and drought are likely. On the other hand, studies on water resources have shown that many catchments' areas of the country will be experienced serious water shortages. Turkey is not rich country in water usage. It has around 1500m^3 per person per year of available water amount, which is expected to fall down to 1000m^3 per year with the climate change and the current rate of growth. As the largest user of water, the agricultural sector is expected to be affected by global climate change more than the other sectors. In this study global climate change and its impact on Turkey's agriculture and water resources will be evaluated.

Keywords: climate change, agriculture, water resources, Turkey.

THE CLIMATE SYSTEM

Climate is averaged condition on weather during long period. Climate system is comprised by the complicated interactions among the atmosphere, the ocean, the cryosphere, the surface lithosphere and the biosphere. Energy from the sun drives the earth's weather and climate, and heats the earth's surface; in turn, the earth radiates energy back into space. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse. The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases – primarily carbon dioxide, methane, and nitrous oxide (Solcomhouse).

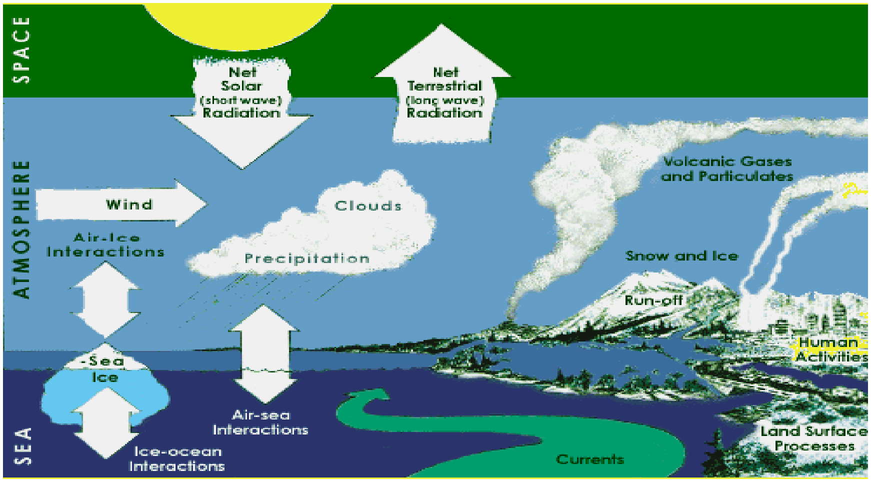


Figure 1. Major Elements of the Climate System (Government of Canada Graphic)

THE CAUSE OF CLIMATE CHANGE

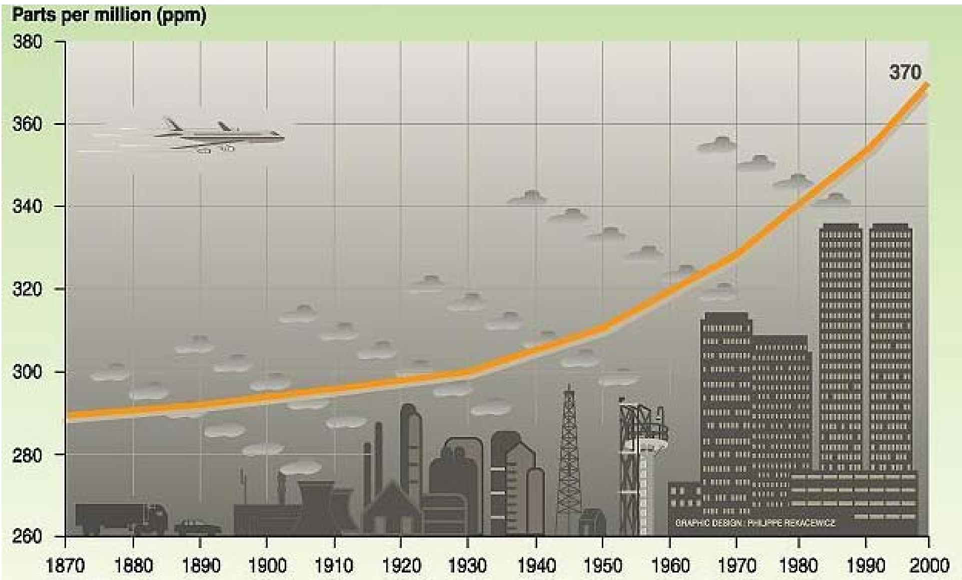


Figure 2. Global atmospheric concentration of CO_2 (UNEP/GRID, data from Mauna Loa Observatory).

Atmospheric CO_2 has increased from a pre-industrial concentration of about 280 ppmv to about 367 ppmv at present (ppmv= parts per million by volume). CO_2 concentration data from before 1958 are from ice core measurements taken in Antarctica and from 1958 onwards are from the Mauna Loa measurement site. It is evident that the rapid increase in

CO_2 concentrations has been occurring since the onset of industrialization. The increase has closely followed the increase in CO_2 emissions from fossil fuels (UNEP/GRID).

PAST, PRESENT AND FUTURE CLIMATE

Climate is the averaged trend of weather, or typically expected conditions. Heat trapping gases emitted from human activities are driving significant changes in the climate. Climate change is one of the biggest issues confronting humanity in the 21st century.

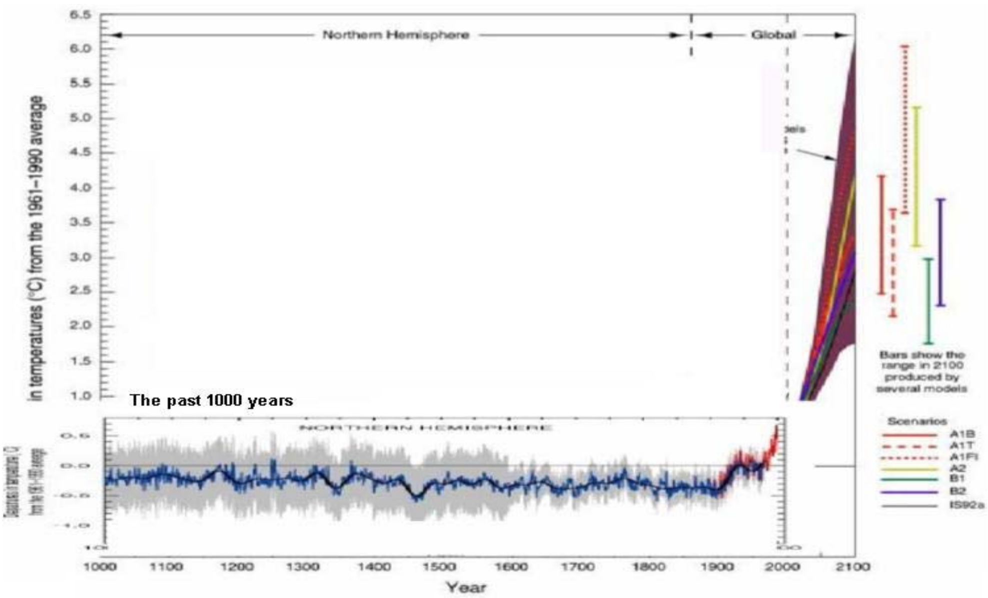


Figure 3. Past, present and future climate. 1000 to 1861, N. Hemisphere, proxy data; 1861 to 2000 Global, instrumental; 2000 to 2100, SRES projections. Data from thermometers (red) from tree ring, corals, ice core and historical resources (blue). (IPCC, TAR, 2001)

OBSERVED CHANGES IN CLIMATE

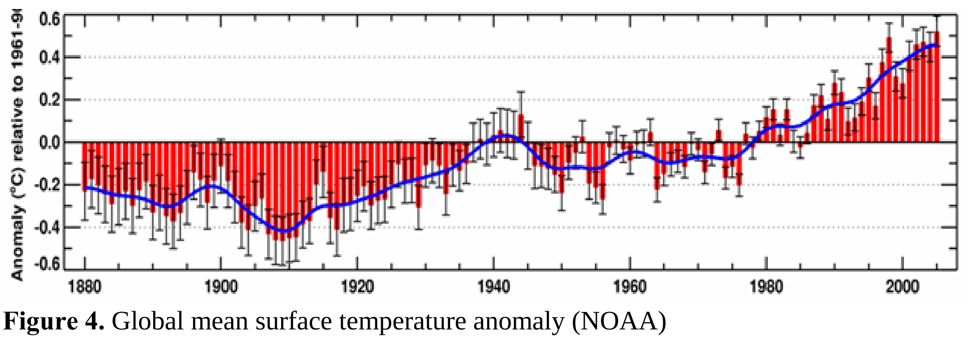


Figure 4. Global mean surface temperature anomaly (NOAA)

Global average surface temperatures increased 0.7°C (IPCC, AR4, 2007)

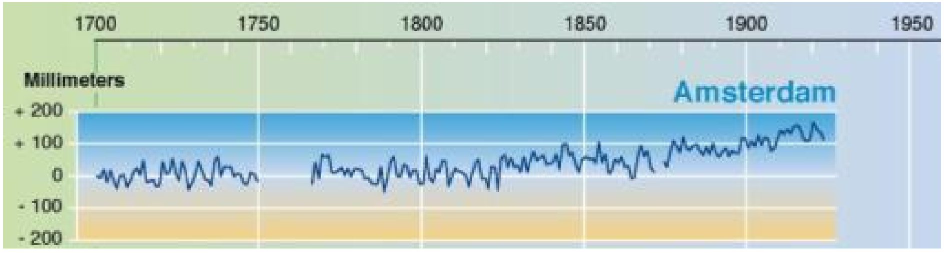
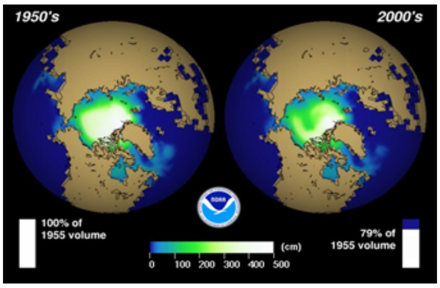


Figure 5. Relative sea level in Amsterdam over the last 300 years.

Global mean sea-level has risen (*1.0 to 2.0 mm/yr, IPCC)*



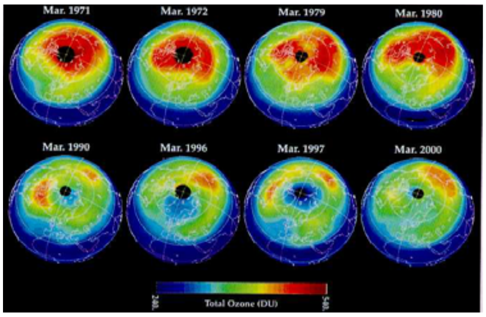


Figure 6. Arctic sea-ice thickness (NOAA)

Figure 7. Maps of total ozone above arctic from 1971 to 2000 (NASA)

Arctic sea-ice thickness declined 79% of 1955 volume and since 1980, ozone depletion and its interannual variation have been observed.

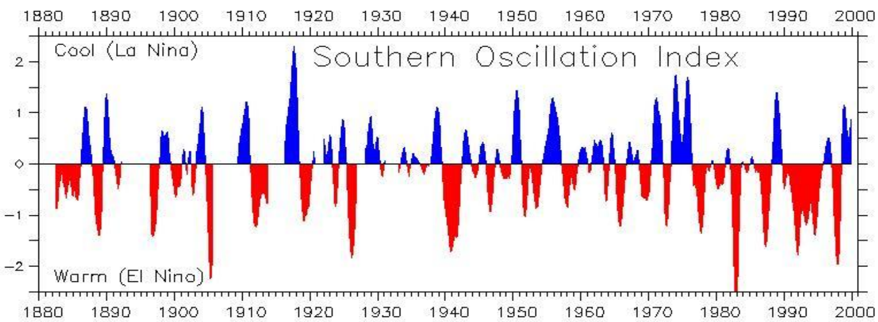


Figure 8. Smoothed 1 year running mean in southern oscillation index (NOAA)

ENSO has been unusual since the mid-1970s;

PROJECTED CHANGES IN ANNUAL TEMPERATURES

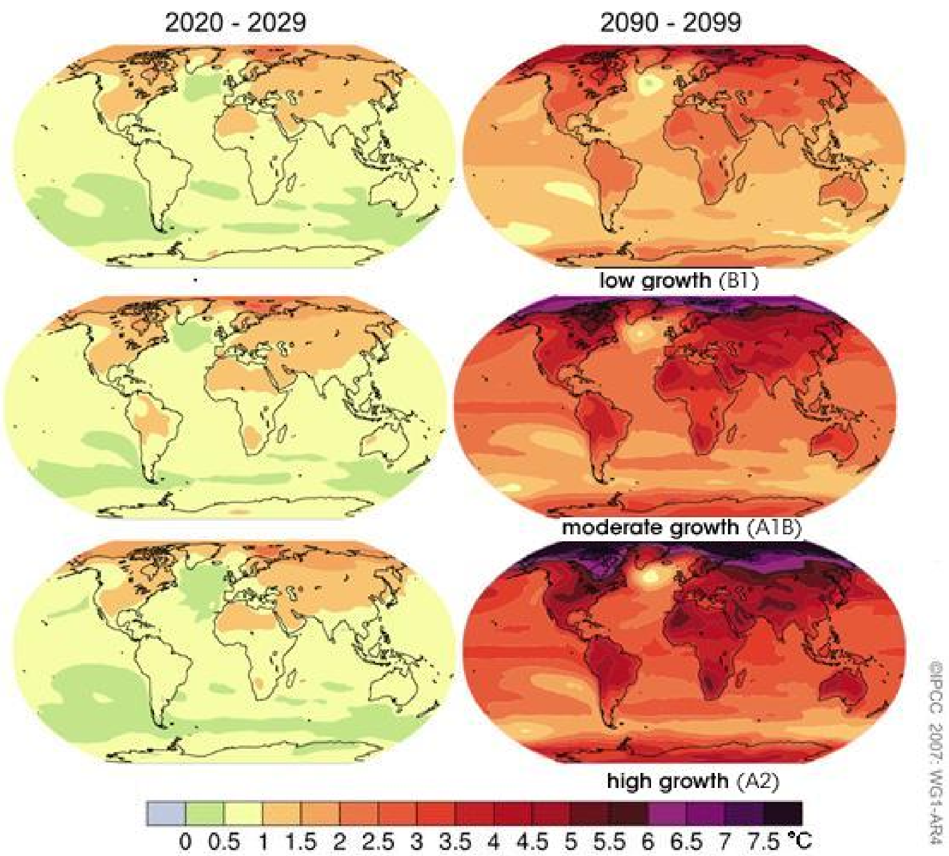


Figure 9. Projected future regional patterns of warming based on three emissions scenarios (low, medium, and high growth). Source: NASA Earth Observatory, based on IPCC AR4, 2007.

Global warming will not affect all places on Earth the same way. Climate models predict that warming will be greatest in the Arctic and over land. Models also give a range of temperature predictions based on different emission scenarios. If humans limit greenhouse gas emissions (low growth), then the temperature change over the next century will be smaller than the change predicted if humans do not limit emissions (high growth). (IPCC, AR4, 2007, WG1)

Most climate change scenarios project that greenhouse gas concentrations will increase through 2100 with a continued increase in average global temperatures (IPCC, AR4, 2007). How much and how quickly the Earth's temperature will increase remains unknown given the uncertainty of future greenhouse gas, aerosol emissions and the Earth's response to changing conditions. In addition, natural influences, such as changes in the sun and volcanic activity, may affect future temperature, although the extent is unknown because the timing and intensity of natural influences cannot be predicted.

Advancements in model simulations, combined with more data on observed changes in climate, have led to increased confidence in projections of future temperature changes. In its 2007 assessment, the Intergovernmental Panel on Climate Change (IPCC) for the first time was able to provide best estimates and likely ranges for global average warming under each of its emissions scenarios. Based on plausible emission scenarios, the IPCC estimates that average surface temperatures could rise between 2°C and 6°C by the end of the 21st century.

PROJECTED CHANGES IN PRECIPITATION

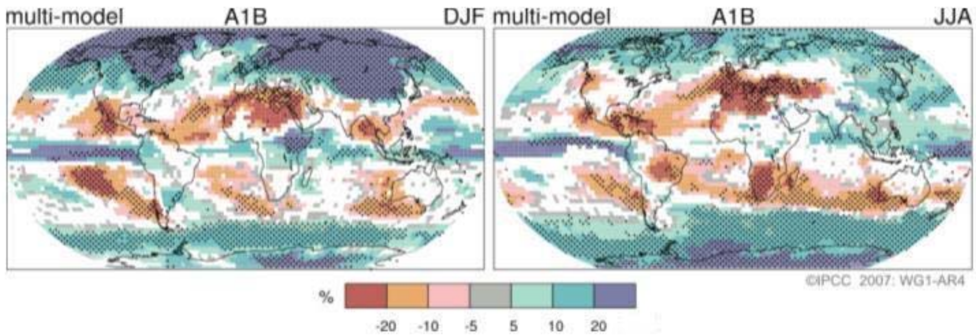


Figure 10. Projected changes in precipitation (IPCC, AR4, 2007, WG1)

Relative changes in precipitation (in percent) for the period 2090–2099, relative to 1980–1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. Both winter and summer months in Turkey there will be more than 20% decrease in precipitation.

THE GLOBAL MEAN FORCING OF THE CLIMATE CHANGE

Greatest mean forcing of the climate change is energy emissions are mostly CO_2, (some non-CO_2 in industry and other related) Non-energy emissions are CO_2 (land use) and non-CO_2 (agriculture and waste).

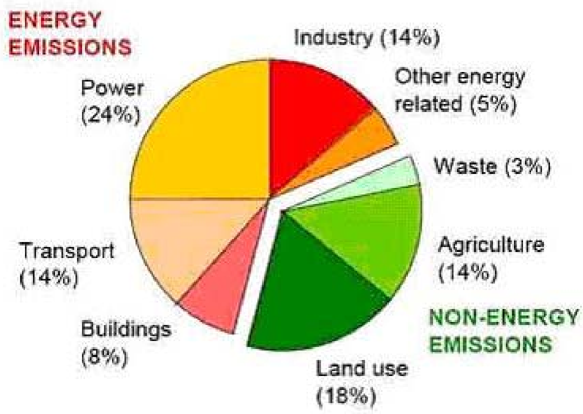


Figure 11. Geenhouse-gas emissions in 2000, by Stern Review, data drawn from World Resource Institute Climate Analysis Indicator Tool (CAIT) on-line database version 3.0.

Agricultural sources of greenhouse gases

1. Livestock (fermentation) (CH_4)
2. Fertilization, Nitrogen fixation N_2O
3. Forest and stubble fire (CH_4, N_2O)
4. Rice production (CH_4)

POTENTIAL CLIMATE CHANGES IMPACT

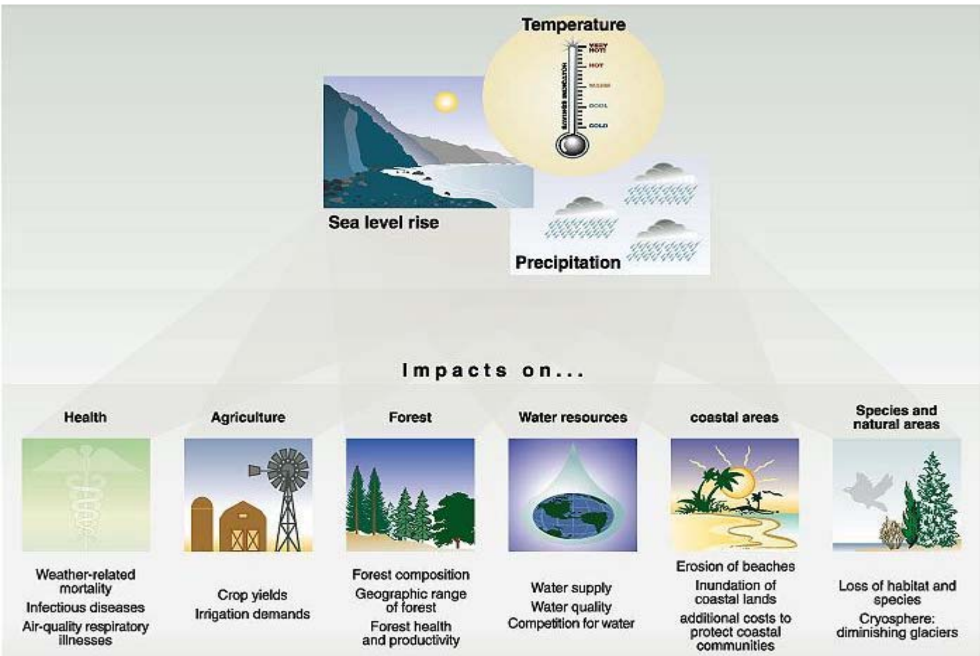


Figure 12. Potential climate change impact (EPA)

Scientists expect that the average global surface temperature could rise 1-4.5°F (0.7-2.5°C) in the next fifty years, and 2.2-10°F (1.4-5.8°C) in the next century, with significant regional variation. Evaporation will increase as the climate warms, which will increase average global precipitation especially northern Europe and Canada. Soil moisture is likely to decline in many regions like Mediterranean and tropics, and intense rainstorms are likely to become more frequent. Sea level is likely to rise in many coastal areas. Climate change magnifies existing health, environment and social problems (Solcomhouse).

CONCLUSION

The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases. It is accepted that one of the most important environmental problems of the present century will be climate change. This will give rise to changes in weather patterns, and an increase in the frequency and severity of extreme events such as flooding and drought. In Turkey as in the rest of the world, global climate change will be cause an increase in the severity and frequency of heat waves, sea level rise, and extreme rainfall and flood events in some regions but increased drought in others, in a way that will directly affect living conditions.

The impact of climate change on agriculture will be translated through changes in temperature, water balance, atmospheric carbon dioxide composition and extreme events (floods/droughts). The impact of global warming on crop productivity and crop yields will depend greatly on the combination of secondary effects. In areas that may receive more precipitation in the future, and can adapt to enhanced CO_2 conditions, greater productivity may be possible, as growing seasons will potentially be extended. In areas where water will become a limiting factor, productivity could potentially be reduced due to the added stress of heat and salinisation. According to the three GCM scenarios only developed countries could be convert negative climate effect to positive with their adaptation capacity. Developing countries only could be mitigating.

Both SRES scenario show reduced cereal yield in Turkey. (M.L. Parry et al.)

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