Understanding climatic change

The climate of our planet is a complex system resulting from the interaction of five factors: the atmosphere, the oceans, the ice and snow regions (criosphere), living organisms (biosphere) and soils, sediments and rocks (geosphere), while in turn, all are directly related to the sun.

It is only in these terms that we can understand atmospheric energy and matter fluxes and cycles, which is essential to investigate the causes and effects of climatic change. However, there is an additional factor to be taken into account: the anthropogenic factor, resulting from human activity.

From “Greenhouse” to “Oven”

The climate, as we have already stated, is directly related to solar energy, which reaches the Earth’s surface and returns to space in the form of infrared radiation. However, this outgoing energy passes through the atmosphere. The atmosphere contains, in addition to nitrogen, oxygen and argon, a mixture of other different gases (carbon dioxide, methane, nitrous oxide, ozone, water vapour) surrounding the planet and forming an environmental system which is integrated with all the Earth’s components. These gases allow the passage of solar energy but at the same time, sequester and absorb part of it that hits the earth and is re-radiated back to space (approximately 30%; of the remaining amount, 45% is absorbed by the earth and the oceans, and 25% by the atmosphere). The Earth’s natural temperature control system is thus similar to that of a greenhouse and the relevant gases known as “greenhouse gases”. The greenhouse effect also largely enables the presence of water in a liquid state.

The “greenhouse effect” itself is not a problem. What is more, the delicate balance of this system is what has created the conditions for life on the planet. The problem arises because an artificial load of greenhouse gases has been added to the atmosphere. An additional layer of “warm clothing” is being taken on that we do not need and is increasing the heat. The greenhouse is becoming an oven.

Global warming

Although the Earth’s climate is unstable and rather unpredictable – and very sensitive to internal or external factors – the temperature has probably not changed all that much in the last 200,000 years: temperatures during the last ice-age were only 5ºC colder than at present. The Earth’s mean temperature is today approximately 14ºC (without the greenhouse effect it would be -18ºC).

However, over the past 200 years a dramatic rise in temperature has been recorded. The mean temperature of the earth’s surface has increased by between 0.3 and 0.6ºC with respect to the pre-industrial age, with the greatest increase taking place over the past 40 years. Warming of the planet has become evident both on the surface of the sea and of the land, supported by indirect indicators such as glacier retreat. On a world scale, 1998 was the hottest year and the 1990s the hottest decade in history. This trend is directly related with human activities causing an increase of greenhouse gases in the atmosphere.

Carbon dioxide (CO_2), one of the most important of these gases, is involved in a complex global cycle. It is released by volcanic eruptions, by respiration, by soil processes, by combustion of carbon components and by oceanic evaporation. In turn, it is dissolved in the oceans and is consumed during plant photosynthesis. Following the industrial revolution and particularly after the Second World War, industrial activities have released enormous amounts of CO_2 into the atmosphere from the burning of fossil fuels, mainly coal, oil and gas, from underground deposits.

Most carbon dioxide release is caused by the use of fossil fuels to generate energy, industrial processes and transport, but it is also caused by deforestation processes and logging of forests. Agricultural activities and changes in land use produce methane and nitrous oxide release, while industrial processes also release artificial chemicals known as halocarbons (CFCs, HFCs, PFCs).

Chlorofluorocarbons (formed by molecules of carbon, chlorine and fluorides) are totally humanmade and are caused by aerosol sprays, refrigerants and air conditioners. These gases are considered a major contributor to global warming.

Rather than following a linear evolution, the climate follows a non-linear path, with unexpected and drastic “surprises” when the levels of greenhouse effect gases reach a critical point, triggering off other, and hitherto unknown processes. Everything indicates that greenhouse gases generated by human activities will cause dramatic climatic changes in the twenty-first century and beyond, with wide-ranging effects on the environment and on human societies and economies.

The reason of the non-sense

The increase of carbon dioxide and other greenhouse gases responsible for climatic change is a consequence of present production and consumption models, which promote an excessive use of non-renewable fuels as well as inappropriate land-use models.

In general, the release of greenhouse gases from fossil fuels and the model of consumption typical of modern industrialized society go hand in hand: the richer the country, the greater are the releases. Thus, the United States heads the list, recording 24% of such releases.

The industrialized countries have exploited and consumed more fossil fuels, forests and other resources than the South, enabling them to reach their present degree of wealth and power. Along the way, they have placed humanity at such risk that it is in danger of succumbing. It is only right that the major responsibility for avoiding the social, environmental and planetary crisis should fall on them.

When the future catches up with us

Very few people seriously doubt that the Earth’s climate is changing and, that if measures are not adopted the whole of humanity will enter a period of intensified climatic imbalance. Climatic models predict that if the present trends of releases continue unchanged, in the year 2100 the temperature will have increased by between 1.4ºC and 5.8ºC. These are changes unprecedented in recorded history. Within a century – almost no time in the history of the Earth – our descendants and those of other living beings may have to face temperatures much higher than those prevailing during much of their process of evolution. The consequences for many species, including humans, could be catastrophic.

One of the central forecasts made by climate experts is that extreme phenomena, such as storms, hurricanes, floods, droughts and severe winters will become increasingly frequent, with serious

consequences on human living conditions. However, the impacts will not be the same all over the planet. Some regions (particularly the dry areas in the Third World) will become drier, causing land degradation, while others will suffer from considerable cooling, due to changes in the Gulf Stream. In general, there will be an increase in sea level (with forecasts ranging from 9 to 88 cm for the year 2100) as warming of the water reaches ocean depths.

One possible ecological impact is the destruction of most of the Amazon forest by the end of the twenty-first century, resulting from drought. The loss of forests on a world scale would release even more carbon dioxide, exacerbating climatic change.

Those most vulnerable to the impacts of climatic change are likely to be those in adverse social and economic conditions: lower-income people in Southern countries, poor urban sectors in general, the residents of coastal areas and islands and the inhabitants of semi-arid lands. Increasing exposure to natural disasters such as floods, droughts, landslides, storms and hurricanes will be more serious in sectors that are in a situation of greater risk.

To illustrate more clearly the seriousness of the impacts foreseen, let us examine case by case what the experts are forecasting:

* An increase in sea level: although it is hard to measure changes in sea level, it is calculated that over the past 100 years, sea level has increased between 10 and 25cm. Indications are that this change is largely due to the increase in temperature that has taken place over the past 100 years. On this timescale, ocean volume expansion due to heat could be part of the cause, with the rest due to contraction of glaciers and loss of ice caps. The thickness of sea ice in the Artic dropped in the 1990s by more than a metre from twenty or thirty years before. The generalized loss of the earth’s ice caps would trigger erosion in arctic regions, changing hydrological processes and releasing carbon dioxide and methane into the atmosphere.

* Coastal zones: with an increase in sea level, coastal regions will suffer serious flooding. Bangladesh, one of the poorest countries in the world, is also the most vulnerable to an increase in sea level. Its population is seriously affected by storms. Natural catastrophes have already caused damage up to 100 km in-land and it is terrifying to image how far they could reach with an accelerated increase in sea level.

* Rainfall: an increase has been observed in high latitude regions in the Northern Hemisphere, particularly during the winter, while after the 1960s, rainfall has decreased in the sub-tropics and tropics from Africa to Indonesia. Forecasts are for an increase in rainfall on a worldwide scale, but trends at local scales are much less certain. More rain and snow would imply more humid soil conditions in the winters of high latitudes, but the increase in temperature could imply drier soils in the summer.

* Health: the transmission of many infectious diseases is directly related to climatic factors, as the agents of infection and their transmitting organisms are sensitive to factors such as temperature, water, general humidity and in particular soil humidity, and wind. This is particularly applicable to diseases transmitted by living organisms such as malaria which is transmitted by a mosquito. Although not unanimously accepted, some forecasts are that climatic change and changes in meteorological patterns will affect the scope (both altitude and latitude), the intensity and seasonality of many infectious diseases.

* Agriculture: the increase in the rate of evaporation will contribute to salinization of irrigated

agricultural land. Soil degradation caused by climate, added to the increase of plagues, droughts and floods could cause a loss of between 10% and 15% of the grain production of Africa, Latin America and Asia over the next fifty years. If this forecast is right, and if the present model of unequal distribution of the appropriation of resources remains unchanged, the risk of increased hunger in impoverished countries is very high.

* Forests: climatic change may affect the health and composition of the planet's forests. Some forecasts indicate that in a period of one hundred years there could be a displacement of between 150 and 550 km in climatic zones for some forests. In mountainous regions, some plant species and communities, particularly of trees, could completely disappear because of displacement towards higher latitudes of species living near high-mountain borders. Migration, which takes place by adaptation of disseminated seeds to more appropriate zones would be limited due to the lack of space for seeds to establish themselves. Deciduous forests (which lose their leaves every year) would move towards higher latitudes, replacing, in many regions, coniferous forests. Studies carried out in Switzerland suggest that an increase of 3ºC in temperature would cause an invasion of deciduous trees in the sub-Alpine belts and the invasion of coniferous trees in the Alpine zone.

Furthermore, there are species of trees that have developed a comparative advantage that enables them to survive in very specific soil and climate conditions. A change, however minimal, in their conditions would affect them severely, and could even lead to their disappearance.

Many changes can take place in forests because of subtle alterations in the competitive balance between the species. For example, an increase in temperature would certainly change the interval between the flowering season and the season when leaves are shed; however, the effects could be different for different species.

Finally, all this implies that biological diversity is in danger, as the probable pace of climatic change forests will be subject to will be greater than the pace at which they can adapt.

* Water resources: changes in river currents may affect the underground water table. The increase in sea level may cause entry of salt water into coastal aquifers. Water sources may be degraded or disappear, increasing competition.

* Increase in droughts and floods: it is estimated that the changes in hydrological cycles will cause an extension and intensification of desertification processes in various parts of Africa, while in South-East Asia a decrease in monsoons in some regions is already being felt. In other regions such as Nepal, Burma and India, these changes have caused large-scale floods.

* Soil and water pollution: flooding will contribute to spreading toxic chemicals used in industrial agricultural models.

All these factors added together will imply the collapse of numerous fragile ecosystems (forests and coral reefs, for example), that cannot respond sufficiently quickly to sudden changes in temperature, causing a drastic increase in the rate of loss of species. The loss of biodiversity could even trigger a series of catastrophes bringing about extinction of life on the planet as we know it.

Article based on information from: "Cause & Effect - What is Climate Change?", Risingtide, Climate Justice Network, http://www.risingtide.nl/greenpepper/climate/causeandeffect.html ; "Climate Change Information Kit", UNFCCC, http://unfccc.int/resource/iuckit/fact01.html ; Global Climate Change Student Guide, ARIC, http://www.doc.mmu.ac.uk/aric/gccsg/introduction.html ; "Climate Change",