

Influence of the Climate on the History of the Humankind

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Abstract: Human history began about 12,000 years ago, when man attempted for the first time to communicate his experiences by means of drawings and paintings on the walls of the caves in which he lived. During this time, a larger part of the Earth was covered with ice than today. At the end of this cold period, the Earth warmed for several thousand years until around 3,000 to 4,000 BC, when a maximum average temperature was reached. At that time, the earth was sparsely populated and warmer than now. Man was able to avoid climatically unfavourable regions by migrating to more suitable environments. As the Earth warmed, plants and animals moved northward and forests developed throughout Europe. Agriculture and animal husbandry were first introduced in Eurasia about 10,000 years ago, taking several millenia for these practices to spread to other regions. Before then, men had been nomadic and lived as gatherer and hunter until they began to settle in order to harvest crops and raise herds. In the Middle Ages, from 950 to 1300, the Earth became warmer. The population increased. From 1350 to 1850 it became colder: diseases and crop failures increased causing a population decrease. Since about 1850, a rather rapid warming started again. Furthermore, worldwide industrialization has brought about an increase in the use of energy. Due to the consumption of fossil fuels the concentrations of some gases, which are intensifying the greenhouse effect of the atmosphere, have raised. The amount of CO₂ has already increased by 30%, and if the use of fossil fuels continues to rise CO₂ concentration could double already by the year 2035. The rate of warming thus will accelerate during the coming decades and the temperature could possibly reach levels higher than man has ever experienced before. The effects on world economy and food and water supply for the world population are still largely unpredictable.

Although the evolution of humankind from *Homo Erectus* to *Homo sapiens* lasted approx. 1.8 million years, the beginning of its history is not considered until ca. 12,000 years ago (approx. the end of the last ice period), when man tried to describe for the first time his own history using cave paintings.

The climate of the Earth is characterised during the Quaternary through a sequence of cold and warm periods. We are now in the Holocene-warm-period, which followed the last ice period (Weichselian). Ice periods are long periods of persistent glaciations of non-polar areas, which are usually ice-free in a warm period. The average July-temperature during the Weichselian ice period was 9–10 °C in Central Europe. The most significant Quaternary ice and warm periods are: Elsterian ice period (approx. 350,000 years before present: BP), the Holsteinian warm period (approx. 300,000 years BP), the Saalian (Illinoian) ice period (approx. 210,000–125,000 years BP), the Eemian (Sangamonian) warm period (approx. 125,000–115,000 years BP), the Weichselian (Wiscosinan) ice period (approx. 115,000–12,000 years BP), and the Holocene warm period (12,000 years ago) (see Chapter 1.7).

Thus modern humankind has not been confronted with an ice period yet; it knows only a warm period. The Earth, at the beginning of the Holocene, warmed over several thousand years up to a high point around 5,000–6,000 years BP. The air temperature was probably higher than today. Up to this time the world-population was only about 20 million people (see Table 1.13-1). Regions with an unfavourable climate could be avoided through migrations because man was not settled yet and the Earth was only thinly populated.

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The Earth's climate shows marked oscillations in the air temperature as well during the Holocene; their causes are not yet clear. The period of the Middle Ages (950–1350) counts as a warm episode. The period of 1350–1700 – called »Little Ice Age« – was colder than most episodes during the Holocene (see Table 1.13-2).

Since about 150 years the Earth warmed up again and the mountain glaciers shrank. Most climatologists worry that the Earth will warm above the natural oscillation because of the increase in the concentration of the long-lived greenhouse gases (CO₂, CH₄ and N₂O) in the atmosphere. Since the beginning of industrialisation, the emission of these gases has risen vigorously. CO₂ alone has increased by around 31.4% and might double by the year 2035 if international measures for its reduction are not consequently applied. Therefore, the temperature can rise more quickly and reach values that have not been experienced by humankind. The consequences for the world economy and the provision of food and water are difficult to predict. Future generations will be particularly affected. The worries of scientists are justified considering

Table 1.13-1: Estimation of the development of the world-population from earlier times to 2050.

Year	World-population
- 8000 BC	ca. 2 million
- 3500 BC	ca. 20 million
0	ca. 200 million
1800 AD	ca. 1,000 million
1995 AD	ca. 6,000 million
2050 AD	*ca. 9,000 million

* Based on United Nations estimate

Table 1.13-2: Warm and cool periods in Europe after the last ice age (Based on HUPFER 1996 modified).

3500–600 BC	Egyptian, Greek periods: from 3500 BC the Sahara dries up. Temperature in Central Europe 1–1,5 °C lower than today with cool and wet summer	Until approx. 500 BC flourishing Egyptian development. 750–550 BC Colonisation of the Mediterranean Region by the Greek. 1200–1000 BC Indo-European mass migration.
200 BC–380 AD	Roman period: a little cooler than today with more precipitation.* After 300–400 AD drier.	98–117 AD expansion of the Roman Empire. 218 BC Hannibal crosses the Alps
380–750	Period of mass migration: Cool and wet.	375–568 Central and North European mass migration. 410 conquest of Rome by the Westgoths.
950–1250	Middle Ages: Temperature similar to present. At the beginning more precipitation later dry.	800–1000 voyages of the Vikings. Colonisation of Iceland and Greenland. wine-growing as far as north-west Europe.
1250–1350	Climate transition. Cooling in Greenland and Iceland as well as in South and East Europe. Cooling in Central Europe not until 1315	Increase of the arctic sea ice extent. Displacement of the Vikings by the Inuit because of cooling. Crop failure and famine and decrease of the population in Europe.
1350–1850	»Little Ice Ages«: About 1 °C colder than today. Cool in winter and very wet in summer 1800–1815 volcanic eruptions with global consequences.	1490 beginning of the colonisation of America, Asia, and Africa. Migration from the north to the south. Crop failure, epidemics and famine. 1525 Peasant-war. 1618–48 Thirty years' war. 1789 the French Revolution.
1880–now	Warming: The global mean temperature increases. The first maximum about 1940. Strong increase since 1980.	Industrial development. World wars. Increase of the agrarian production. Introduction of the synthetic chemistry. Environmental pollution.

* see HEIDE (1997)

the continuous growth of the world population. The Earth, with a population of approx. 6 billion people, is already overpopulated and the increase goes on, although slower now, by approx. 1.5% per year (see Table 1.13-1).

Settlement at the end of the Weichselian Ice period

Sketches and paintings on cave walls found in several regions give us information about this time. The ones in Central France and North Spain (Dordogne, Pyrenees, Cantabria) are about 15,000 years old or older and display the animals they knew and hunted (bison and other cattle, mammoth, rhinoceros, horses and deer). During these periods humankind lived in caves in ice-free areas which had a completely different vegetation from today. A treeless vegetation (tundra) prevailed because the summer temperature was +10 °C. In northern Russia a hunter camp was found at a latitude of 65° N with storage of mammoth-bone and remainders of a dwelling, which had been erected with this bone.

From Asia early humankind migrated towards America and Australia. Since large amounts of water were

fixed as ice, the sea level was about 100 m lower than today (see Chapter 3.10). Thus, there was a land connection in the area of the Bering Strait between Siberia and Alaska. Because the land connection between Southeast Asia and Australia was almost complete, people managed to cross the remaining water strait. It was ascertained from measurements of the radioactive carbon isotopes ¹⁴C in organic remainders, that the first human arrived approx. 40,000 years BP in Australia.

It has been proven that a relatively large amount of people came to America during the Weichselian Ice period across the Bering Strait. Further migration to the south was facilitated presumably through the presence of an ice-free corridor and through periods with a mild climate. Areas with little precipitation were ice-free. It remains controversial, however, whether the first American inhabitants came across the Bering strait only. There are references that isolated groups from warmer regions (Australia, Africa and Southeast Asia) reached the coast of South America by accident 15,000–20,000 years ago or earlier. There is some evidence that coastal inhabitants of these regions were driven »without intention« over the sea through wind and currents until they were stranded on the American coast.

last several centuries major floods occurred along the German and Dutch coast, that have led to 100,000 or more victims, although the rise of sea-level was slight in comparison to the post-glacial time. Through these events the Dollart and the Zuidersea (North Sea) emerged as bights in the tidals flats. In the year 1951 a storm surge flooded a large area along the Dutch coast, whereby over 1,800 persons died and 46,000 houses and farms as well as 200,000 cattle were lost (SMAAL 1996). Sea-level rise in the 20th century was approx. 2 mm per year.

The first important developments

The southern parts of Europe and Asia were effected less during the last glacial period by frost and low temperatures; for this reason they had better conditions for a faster development of tools and techniques, which facilitated the survival of prehistoric man.

The inhabitants of this region lived in caves until 10,000 BC, hunting sheep and goats. Archaeological findings in the northern Near East indicate that several kinds of grains were used for human consumption at that time. Further proof for this developmental stage can be found in the grinding tools located in the Shanidar caves. Because of the greater availability of wild game and caves in the mountains they probably preferred to live there at first.

Later findings of food grains in areas with unsuitable climate for the occurrence of its wild type and results of pollen analysis from lakes in Zagros Mountains (region between Turkey, Syria, Iraq and Iran) are counted as evidence for the systematic cultivation. It is likely that cattle farming began simultaneously. The archaeological findings of large quantities of bones from young sheep offer proof for the beginning of animal husbandry.

The use of wild plants for cultivation, the development of agriculture and the domestication of wild animals were decisive steps in the history of humankind. Since the family had to pay attention to the domesticated animals and planted fields, they gradually became settled farmers and the first rural settlements were built. Hunters and collectors became farmers and shepherds. A shift from the mountains to the plains took place simultaneously because the conditions for agriculture were more favourable there. In dry areas the agriculture could be established effectively as river water was used for artificial irrigation.

Agriculture spread from the Mediterranean region and reached forests in Central Europe about 7,000 BP, which changed the vegetation of Central Europe. The starting point in the cultivation of grains can be derived from pollen analysis. Often land free of boulders near rivers was used first. The forests were cleared not only for the fields but also for settlements. The domestic animals ate the tree-saplings, so forests lost to some extent new recruits and

became less dense over time. The rural economy was not always successful, and some negative effects were observed. For example, the soil became salty because of artificial irrigation. The clearing also led to mud avalanches, which sometimes wiped-out entire settlements, and led to crisis. With the development of the cities and shipbuilding, deforestation and clearing were intensified, and the requirement for wood increased.

Later, with the beginning of industrialisation, a large part of the population was migrated to the cities and did no longer participated in the agrarian production. Most people lost their knowledge of natural processes and today many hardly know anything about the dependence of humankind on the conservation of ecological balances on Earth.

Favourable and unfavourable climate phases

Draining the Sahara

Cave paintings, about 7,000–8,000 years old, from North Africa, some even from the central Sahara, prove that a moister climate prevailed there at this time. They show elephants, rhinos, hippopotami, antelopes, giraffes etc. The display of the hunting of hippopotami with the help of boats amid the Sahara is remarkable. Also, cave paintings 5,500 BP up to the time of the early Pharaohs point to a moister climate than today. This is confirmed through sediment analyses of lakes and rivers from this region that are now dry. The Sahara with nearly 9 million km² is the largest desert of the world today – a hyper arid area – with large parts receiving no precipitation for years at a time. BUTZER (cit. in LAMB 1989) successfully showed on the basis of material from Egyptian cultures, that elephants and giraffes became rare by 4,900 BP already. Around 4,600 BP giraffes and rhinos had disappeared entirely. In Northwest Africa a small population of elephants remained, which declined gradually and fully disappeared by about 1,700 BP

From reconstruction of the postglacial climate it is known that the subtropical high-pressure zone clearly was further north at this time. Thereby monsoon rain reached into the Sahara farther north than today. In the warmest post glacial phase the summer-low-pressure-zone probably extended from the Sahara to the Mediterranean region. According to an estimate the average annual precipitation over the centre of the Sahara (Caffra-Tabbiest) amounted to 200–400 mm at about 8,000 BP and fell to 50–150 mm around 5,000 BP. Somewhat south of it in the area around the Lake Chad the precipitation was two to five times higher. The rivers originating from the Tibesti mountain never fell dry during the year (see Chapter 1.14). Starting approx. 5,500 BP the drying of this region and the simultaneous decline in the Nile-flooding coincided with an almost world-wide climate change. After the above

mentioned post glacial warming a slow cooling started world-wide. For instance the glaciers of the European Alps advanced measurably for the first time after the end of the last ice period.

Development of the Egyptian, Greek and Roman culture

The flourishing Egyptian culture at the time of the Pharaohs, that found its most famous expression through the building of pyramids and temples as well as important performances in art and literature, took place after 4,900 BP as desertification of the Sahara became obvious.

However, the climate in North Africa, even if the Nile-flooding had diminished, was still favourable. According to SUZUKI (cit. in LAMB 1989) the enslavement of the farmers and shepherds from the surrounding areas created the basis for the ascent of Egypt. Agriculture was improved through introduction of agricultural techniques and irrigation projects in the Nile valley. This more than compensated for the disadvantages as the dryness increased in different areas.

The times after 3,000 BP were – as old records show – cooler, but more humid than today. This contributed favourably the cultural and political developments in the countries in the Mediterranean region. The productivity of the region increased. Further proofs of a colder climate were the warmer clothes and the use of slanted roofs instead of flat roofs in Greek buildings. The occurrence of beech trees, which grow in moderately humid areas, also indicates a moister and cooler climate than today. Later, as it became warmer, the beech disappeared from the region.

When Rome was founded in 753 BC, Greeks, Phoenicians, and Carthaginians were already highly developed with respect to navigation, agriculture, and trade. The Phoenicians circumnavigated Africa about 2,600 BP.

From 332 BC until 625 AD, the Greeks and later the Romans occupied Egypt. The humidity in North Africa created a favourable climate for an agrarian development. The region became the breadbasket of the Romans and rich blooming settlements emerged, which were later conquered by the desert.

Colonising of Greenland through the Vikings

The Vikings were able to undertake long voyages with sailing vessels between the continents. In the time 850–1100 they reached England, France, Italy, Arabia, and Russia among other countries. In the year 870 they were successful, through the decline of sea ice, to establish themselves in Iceland. In the year 982 a group around Erik The Red travelled even further to the west and discovered Greenland (GRIBBIN and GRIBBIN 1990). At first they lived in the south-east (Österbygd) and in addition a group moved

to the north-west and founded Vesterbygd. They dedicated themselves – like in Iceland – to agriculture and cattle-breeding and exchanged goods with Iceland and Scandinavia i.e. trading walrus tusks and polar bear skins.

Between 1197–1203 the climate worsened. Vesterbygd was either given up or destroyed after a dispute with the natives, the Innuits (Inanities). An expedition from the other settlement found only free running sheep (LAMB 1989). Österbygd persisted even though conditions were unfavourable. As the ice advanced still further in the 15th century, the food in Greenland became very scarce. The sheep starved. Furthermore, the ocean-current probably changed and sea-mammals disappeared from the seacoast. Due to the increase in sea ice the sea way to Iceland and to North America was interrupted, which a group of people around Leaf Erickson had settled about 1,000 years BP. An expedition from Iceland to Greenland in 1540 did not find any survivors. The average size of persons buried in the cemetery of Herjolfsnes was only 164 cm in comparison with 177 cm at the time of Erik The Red about five centuries earlier.

Altogether the Vikings lived on Greenland almost 500 years. In contrast to the Innuits, which had settled Greenland as well as North America and Siberia much earlier, the Vikings did not learn to adapt to the extreme climate changes although there was contact between the Inuit and Viking populations through the exchange of goods. The Innuits manufactured clothes and boats from pelts but the Vikings had to get wood from Europe to build boats, since no trees grew in Greenland. The Innuits lived where food was to be found; in contrast, the Vikings were settled because of the agriculture and cattle farming. The Vikings could have probably survived if they had taken over some of the natives' customs and had relied more on the resources of the sea.

The warm phase during the Middle Ages

From approx. 1040 onwards there was a climatically favourable period. The mean air temperatures were similar to those found at present, and agriculture expanded. Some technical, agricultural innovations and rapidly increasing populations were observed during this time in Europe. Generally, agriculture expanded, e.g. in England both to the north as well as to higher altitudes, in south-west to 400 m and in Southern Scotland to 300 m above sea level. A type of grain – probably barley – could be cultivated during the 12th century through the warm phase in northern Norway (Malinge) (69.5° N) and rye in the area around Trondheim (63.5° N). Thus the forests, which were previously cleared for shipbuilding, recovered and expanded to higher altitudes. The displacement of wine growing to the north can be seen as further proof for the comparatively

high temperature during the Middle Ages in Europe. There were vineyards in England with evidence of 30–100 years continuous operation and some even over 100 years. Because of the current warming wine growing is expanding once again in England.

The medieval development lasted in Central and Northern Europe until the end of the 13th century, although the climate already cooled both in Greenland as well as in Eastern Europe and Southern Europe. In the middle of the 14th century the climate in Central Europe became cooler and wetter, and wine growing was given up in England. With an almost world-wide cooling in 1350, the »Little Ice Age« had begun.

Consequences from the »Little Ice Age«

As already described, the arctic region showed a clear cooling trend from the end of the 12th century which started first through isolated freezing in South Greenland. Probably because of the warm Gulf Stream this development was observed in Central Europe only after 1310. The change was very abrupt. Especially drastic was a period of several years starting in 1315 which were very moist with numerous flooding-disasters. In Eastern Europe summer heat and drought led to large problems. This development is confirmed through analyses of tree-rings from wood earlier buildings (dendrochronology). Because of the cold the upper timberline in the mountain region receded and the northern forest border moved simultaneously to the south (see Chapter 1.11). The ring-width of trees shrank as well.

The grain could not mature because of the long cold winters and high humidity in the summer (the feared green years). Production sank and prices rose; the price trend can be counted thus as climate index (Fig. 1.13-2). The loss of farms began before 1200 already in northern Norway where about 1,000 farms existed during the Viking period. The conditions for fisheries near the coast improved and the population expanded there. The number of abandoned farms and villages in North and Central Europe increased rapidly. Depending on the region, 60–95% of the farms had been abandoned, and the population declined. In addition the soil leached out and oxen for ploughing became scarce. Especially hard hit were Iceland, Norway, and eastern Europe. The aggravated situation in agriculture led to migrations.

The problems concentrated in the cities. There occurred in 15th century in different countries like in Scotland, Denmark, Sweden and Germany to social disturbance, which contributed to wars. The peasant-wars in Germany also should be mentioned which culminated in the large riot of 1525.

After the discovery of the Americas, new crops like potatoes and corn were brought from South America to

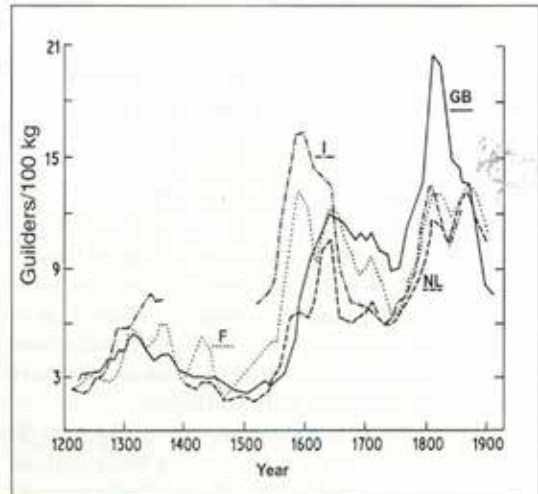


Abb. 1.13-2: Development of wheat prices in western England (GB), Italy (I), France (F) and the Netherlands (NL) from about 1200 to 1900. The price rises around 1300 and 1550–1650 can probably be attributed to climate anomalies. The other one around 1800 probably has to do with climate as well as with the Napoleonic wars. The volcanic eruptions especially of the Tambora (1815) (Java) (see Table 1.4-1) had world-wide consequences intensifying this price rise.

Europe. In the late 17th century and during the 18th century the use of the potato spread to eastern and northern Europe. After the famine of 1772, the government in Hungary and later in Russia even ordered potato cultivation. This had a great effect because of the frequently bad grain harvests during the 18th and 19th century that resembled the wet years in the 14th and 15th century. Through the potato production, Europeans avoided a renewed famine. However, in 1845 a potato fungus (*Phytophthora infestans*) spread. Ireland was especially affected, and the so-called Irish potato-famine led to a population decline of 25%. It did not recover for a considerable period of time. In some areas – like in northern Norway – agriculture did not recover until 1930, after a considerable warming of the high northern latitudes.

Dryness in the Sahel

The region between the southern Sahara and the humid savannah in the northern tropics is called the Sahel. It extends in west-east direction from Senegal over Mali, Niger, Chad, Sudan to Ethiopia. Because of the extraordinary drought in the years 1972–1973, in which 100,000–200,000 persons and approx. 4 million cattle died, this climatically disadvantaged region attracted world attention. According to GRASSL and KLINGHOLZ (1990) the summertime low pressure systems, which bring rain to the region, have shifted some 100 km southward since the 1950s.

Climate and diseases

Climate changes have often been involved directly or indirectly in the outbreak of diseases and epidemics, just as droughts and floods lead to the breakdown of the sewage-system. The hygiene worsened and the conditions for a mass-multiplication of pathogenic agents or carriers improved. In the 14th and 15th century the persistent periods of cooling and wetness were interrupted through very dry and warm weather. Humankind as well as animals and plants were exposed to a strong physiological stress. Because of the malnutrition as a result of the bad harvests the susceptibility to disease rose. The medieval society experienced an economic and social collapse.

An awful disease was produced by ergot blight (*Claviceps purpurea*), a fungus which blackened the kernels of rye in damp harvests. Only a small amount of the poisoned grain in the baked bread could cause the disease which led to death. Whole villages sometimes met this fate; domestic animals were often infected and died. Another disease with great consequences was the bubonic plague (the black death), a bacterial infection (*Yersinia pestis*) which is carried mostly by rats. They lost their habitats after exceptional rains and floods and invaded the village. The pestilence raged in the years 1348–1350. The death rate was very high, probably 25 million people died. Europe lost approx. a third of its population.

As a consequence of this collapse the Norwegian population could not recover for two centuries and the life expectancy sank e.g. in England from 48 years to 38 years.

LAL (cit. in LAMB 1989) evaluated the Indian estimation of the world-population of earlier times. From this research it is clear that Europe experienced a significant decline in its population from the beginning of the Middle Ages to the end of the »Little Ice Age«. These developments may be attributed mainly to diseases and famines, rather than wars and massacres:

Years	Population	
1000 AD	200–300	million
1200 AD	190–200	million
1388 AD	170	million
1550 AD	120	million
1600 AD	130–140	million

Further epidemics occurred in Europe, e.g. the severest typhoid fever in the years 1816–1819. At the same time the plague raged in south-east Europe and in the eastern Mediterranean region. Cholera broke out in the Bengals in 1816–1817, and expanded from there to neighbouring countries. In addition many famines were observed in the years 1816–1817. The number of disasters connected with climate anomalies was very high at this time.

Intensive volcanic eruptions were other causes for bad harvests and diseases. The strongest was the Tambora

eruption (April 1815) in Indonesia that injected dust and a large quantity of sulphur dioxide into the atmosphere. The consequence of the aerosol-layer (sulphuric acid) in the stratosphere (see Chapter 1.4), formed there within months, was a global cooling and very cold and wet summers in many middle latitude regions.

Climate and migrations

Climate change in the history of mankind led to many migrations. For example:

- Between 120 and 114 BC. the North Sea had several storm tides, which drove back the coastline of Denmark and Germany. Moreover a cold spell led to the advancing of the glaciers. According to LAMB (1989) these so-called cimbric tides triggered migration over a long period from the north to the south.
- British agriculture collapsed in 1879 due to a low summer temperature of 13.7 °C and a doubling of precipitation. The rural population emigrated to the industrial cities and to the southern countries in the British overseas colonies. The population declined by approximately 100,000.
- In 300–800 AD intense dryness occurred in inner Eurasia. This caused migrations from the east to west. Nomads, who lost the pastoral ground for their cattle and other groups wandered westward to Europe and infiltrated the Roman empire.

Conclusion

For many years food supply was a not problem in the industrialised world. This positive development is also due in large part to the long favourable climate and drought free years. The grain production in the United States has at least doubled in comparison with 1959. Western Europe has also profited from this favorable climate phase since 1933. For example, in Ireland, the agrarian growth period extended on average from 8 to 9 months (period with air temperature >6 °C), and the feed-period for cattle during winter decreased simultaneously. This improvement of the production is due to scientific and technical progress through the introduction of more productive cereal crops and improved mechanisation. However, this development cannot go on endlessly. Today population increases in many regions of the world quicker than food production and many of these countries face water shortages. According to statements of international organisations approx. 20% of the world-population suffer already from water shortages (see Chapter 3.31). The enhanced greenhouse effect and the increase of extreme-events (drought, flooding, storms) could lead to a marked reduction of agricultural production in the affected regions."