HAVE CLIMATE AND ATMOSPHERIC CHANGES AFFECTED FOREST GROWTH IN FINLAND?

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After the latest Ice Age trees began their comeback to Finland about 8000 years ago. The first invaders were birch and Scots pine; Norway spruce came several millenia later. The climatic history of Finland can be studied year by year using subfossil trees found in the lake sediments in Lapland. The annual rings show that the climate has fluctuated in longer and shorter cycles. They also show that our climate was clearly warmer than now during the Atlantic period some 5000 years ago.

The development of Finnish forests in the 1900s

The main forms of utilizing Finnish forests were for centuries slash and burn, hunting and tar distillation. These activities devastated large areas of forests especially in the eastern part of the country and in Ostrobothnia. The active use of wood as raw material for forest industries began after the "Small Ice Age" in the 1800s. In the first part of the last century the use and growth of forests were in balance at the level of 55 mio m³/year. Beginning in the 1970s a rapid increase of forest growth by 50 % took place. This was mainly due to intensive management of forests after the World War II (ditching, regenerating of low productive forests, thinning of young forests, some fertilization etc.). Air pollution, discussed in the 1980s, had no negative impact on forest growth.

Variation and trends of tree growth in Europe

Thousands of long term growth plots and experiments in several European countries indicated in the 1980s that tree growth had increased exponentially during the whole century. The Finnish Forest Research Institute (METLA) and the University of Freiburg in Germany launched an European-wide research program on this topic. After four years of work the result was clear. In South- and Central-Europe tree growth had increased in a way that could not be explained by silvicultural measures or the age structure of forests. The main cause was nitrogen deposition, which had been at the level of 25 to 40
kg/hectare/year for several decades. In Northern Europe no growth trend was visible in trees not explainable by management activities.

Impacts of climate on forests

The latest climate scenarios propose an increase of the annual mean temperature by 3-7 degrees and the precipitation by 5-40 % by the year 2080. The temperature rise is expected to be highest in wintertime.

The adaptation of trees to a temperature rise can be evaluated using old provenance trials established by Professor Olli Heikinheimo in the 1920s. Heikinheimo was not a climatologist. He only wanted to test, if tree seed can be moved from south to north and vice versa. Now the Lappish tree origin planted in different parts of the country show the capacity of adaptation. Sample stands regenerated using seed from Lapland have grown in 80 years in Southern Finland about double as much as in Lapland without problems (annual mean temperature 4 degrees Celsius higher than in Lapland).

Professor Seppo Kellomäki has estimated the adaptation of trees to increasing temperatures in plastic tents heated and CO²-fertilized all year round. After measuring photosynthesis and tree growth he concluded that the estimated climate change might increase wood production by 20-30 % in the southern and 50 % in the northern part of Finland. The simulations also indicate that broadleaved trees profit more than conifers in warming climate. Tree species composition is not predestined by nature. In Finland it is mainly regulated by man using silvicultural measures like thinning and young stand management.

Climate change can also have negative impacts on forests. Warming climate can increase the risk of decaying fungi and insects from the south. Warm winters without frost are very harmful for wood transportation. Root damages caused by heavy machines increase root rot (Heterobasidion sp.). Already today root rot is the most expensive damage in Finnish forests (loss of income 35 mio. €/year).

Conclusions

There is a wide consensus about the existence of physical processes in the atmosphere (increase of greenhouse gases), which have impacts on climate. The multitude of processes and their interactions make the modelling and the estimation of the speed of climatic changes much more uncertain. In the 1990s the cyclic North Atlantic Oscillation (NAO) has resulted in warm winds coming to Finnish Lapland in wintertime in the same way as many times before. The varying impacts of the Golf stream and the sooner or later coming Ice Age make long-term prognosis still more uncertain. Also the best models give only very rough estimates about very complex physical, chemical and ecological processes in nature.

The impacts of climate change on Finnish forests are on the basis of measured and modelled information mainly positive. The possible warming of summers, increased precipitation and longer growing seasons will presumably increase forest growth especially in Northern Finland. Higher winter temperatures, on the contrary, are harmful for wood
harvesting and the health of forests (fungi and insects). Long warm periods in the winter can increase the transpiration of Norway spruce causing growth loss in the following summers.

Long annual ring chronologies based on old and subfossil pines in Lapland give us more scale and perspective than short term climatic measurements. The 8000 years long chronology show several dramatic changes in our climate in the past. Compared to these events the climatic variability and changes in the 1900s have been quite small.

Annual rings and measuring tree growth in an hourly basis in different parts of Finland do not yet have any indications that climate change could be detected in tree growth. Also climate statistics do not yet show any dramatic long-term changes. The increase of temperature after the so called Small Ice Age (1600 - 1850) can be clearly detected. Nevertheless our climate was in the 1930s and more pronounced in the 1200s warmer than now.

The increase of CO$_2$ and other greenhouse gases are a threat to our climate. Although the magnitude of the change is uncertain, the fight against it is justified. The ways to do this are clean energy (hydro, nuclear, sun, wind and bioenergy) and the use of biomass as the sink of carbon. By doing so we can hope that the threat of man-made climate change will go over in the same time or a little bit longer as the use of fossil fuels will end.

**Literature:**

