A change in attitudes regarding the importance of climatic fluctuations

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Having taken part in two symposia sponsored by the Geographical Society of Finland (1951 and 1976) on the influence of climatic variations and fluctuations on nature and the activities of man, the author is aware that a certain change in attitudes regarding the significance of the climate has taken place among biogeographers in the intervening period. Nowadays there seems to be a tendency to play down the influence of climatic variations on crops and growth phenomena, for instance. One reason for this may lie in the acceleration of technological advances, accompanied by rapid industrialization and urbanization. The whole land use pattern has changed over large areas in Finland, and new methods for primary organic production (in agriculture, fishing and forestry) have been introduced. No economist today would try to correlate fluctuations in the economy with variations in climate, as was the case only a few decades ago. We also talk more frequently about 'man-made climate', although opinions regarding the increased carbon dioxide content of the atmosphere, for instance, are as divergent today as they were 25 years ago. The author stresses the importance of the climatic hazard coefficient and evaluates the complexity of the ecoclimatic triangle. Man’s influence on nature seems to have increased so much that it tends to obscure the continuing primary importance of the climate itself.

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The interactions between the climate and nature and between the climate and man are complicated ones. During a symposium arranged by the Geographical Society of Finland in 1951 the various effects of the climatic 'improvement' in the 1930's on organic life were discussed. This climate fluctuation, which included the warmest summers for a century (see i.a. diagrams in Heino 1978), could be clearly detected in higher yields per hectare, good forest regeneration in the north and a northward extension of the distribution of a number of animal and plant species. The papers from this symposium (published as volume 75 of *Fennia* in 1952) were well received by the scientific community as a timely report on a problem which greatly interested both geophysicists and biologists at that time.

Partly as a follow-up to this, the Society discussed the same problems again at a meeting in 1976, at which the optimistic approach of the previous occasion was in some sense absent. The climatic 'improvement' of the late 1930's had, as was expected, given way to a colder trend in the 1950's and 1960's, but more important in this connection, industrialization in Finland had accelerated markedly between the early 1950's and the early 1970's. The result was a more cautious approach to the problems of climatic fluctuations and their effects on plant and animal life. The alteration in the structure of the whole economy, the heavy impact of industrialization on the environment and the new methods used in agriculture, fishing and forestry all tended more or less to neutralize or eliminate the effects of climatic variations of fluctuations on primary organic production.

The influence of man on the climate itself has, in fact, developed into a much more important subject of research than we could appreciate in 1951. The use of fossil fuels has increased rapidly: whereas the world consumption of oil was about 500 mill. tons in 1950, it had risen to about 2500 mill. tons by 1975; the consumption of coal has increased by about 100% over the last 20 years. This has led to an increased content of dust and sulphur in the air, which has had a profound effect on man's environment.

Nowadays we talk about a 'man-made climate' and tend to play down the importance of the climate itself for organic production. Nevertheless, the use of fertilizers, for instance, cannot eliminate the effects of climatic variations. It must be admitted, however, that there are other factors which are increasingly
changing economic base for agricultural production in general in the developed countries, the problem of 'over-production', etc. (see below).

In this respect the problems of agriculture in Finland are quite different from those encountered 25 years ago, when we still followed the practice of the previous centuries in striving to increase production 'over-production', etc. (see below).

Not many decades ago economists correlated fluctuations in the general economy of the country with the relative success or failure of the harvests. Today it is almost impossible to find such a simple correlation between economic fluctuations, yields of cereals and climatic variations. The period between the previous symposium and the present one happens to coincide with that phase in the history of man which has seen the most rapid, and for our environment of land, water and air the most far-reaching, industrial and technical development, both in a beneficial and a detrimental direction. (This trend has slackened off slightly during the present decade.)

In short, the interaction between climate, nature and the activities of man. The width of each arrow indicates approximately the importance of the connection between the components concerned.

One aspect of the problem of climatic fluctuation which was mentioned at the symposium in 1951, but not touched on at all in 1976 is the variability of the climatic series (or crop and growth series, for instance) over a certain period.

In northern latitudes the growth processes depend on the annual variations in the summer temperature, i.e. the variation coefficient, or as I have called it in this connection the 'climatic hazard coefficient' (see Hustich 1950) for growth series of different kinds tend to be higher towards the northern latitudes, a factor which has to be considered in all ecological studies. The climatic hazard coefficient (v), as understood by the author, is simple:

\[ \sigma = \frac{\Sigma (x - M)^2}{n} \]

where \( M \) = mean, \( n \) = number of years, \( x \) = the annual values of a series, \( \sigma \) = standard deviation, \( v \) = variation coefficient.

The variation coefficient of the temperature series in Finland increases towards the north, as, of course, also do those for yields of cereals and tree growth. Climatic fluctuations also sometimes seem to exercise an over-accentuated effect on growth, as reflected in the higher variability of the crop and growth series than of the climatic series. This climatic hazard coefficient is a concept which should be of some importance in evaluating the problems of the relationship between climate, nature and the activities of man (see Fig. 1).

Figure 2 illustrates how the growth and crop series which in the northern latitudes are mainly influenced by the temperature, increase in variability towards the north. Towards the southern latitudes where the growth and crop series are influenced mainly by precipitation, the variation coefficient increases from the middle latitudes towards the lower and drier latitudes. Although drawn entirely from intuition (Hustich 1950), Figure 2 happens to indicate almost the correct variation coefficient for the precipitation series at the drier latitudes (see Hare 1976, p. 44). It is somewhat surprising, in fact, that so little interest until recently seems to have been shown in the concept of 'climatic hazard coefficient'.

The high variation coefficients of both the climatic and the organic production series imply that we cannot rely upon data from one year alone or only from a few years when describing climates or growth and production phenomena, particularly in the north or in areas bordering on deserts. Note, for example, the degree to which the July isotherm may shift northwards in good summers and retreat southwards again in cold ones. The biological consequences of this fact for Finnish conditions were probably first pointed out by Kujala (1927), when discussing seed formation in the pine at northern latitudes (see also Thomas 1960 with regard to northern Canada).

In addition to the over-accentuated effect of sudden climatic variations or fluctuations on growth and organic production (see below), we may also observe a 'lag effect'. This is depicted in its simplest form in Figure 3, which shows the one-year lag in length increment in the secondary shoots of pine in northern Finland and Norway (see Hustich 1945, 1969).

Two kinds of short-term climatic change may be distinguished:
1. variations in temperature, precipitation, hydrology, etc., occurring from year to year and measurable i.a. by the 'climatic hazard coefficient', as illustrated above, and
2. longer, more or less periodic climatic fluctuations of the kind which occurred in the 1930's, for instance.

The periodicity (or quasi-periodicity, see Hare 1976, p. 39) of climatic fluctuations has long been a topic of great interest, such fluctuations having at times been related to sun spots, etc. Interest seems to have diminished more recently (note, however, Siren 1961, Bray 1971, and others).

Recent discussion has been focussed extensively upon the effect of human activity on the climate and on climatic fluctuations, although as Hare (1976, pp. 92-93) points out, 'at the macroclimatic level, i.e. the general circulation and its regional anomalies, the influence of man is not yet proven, though a variety of hypotheses have been put forward and defended'.
He goes on to claim that "the role of man at this global level is still controversial, and existing models of the general circulation are not capable of testing the effects in a conclusive way".

In this connection it may be useful to recall the discussion entered into at the previous symposium, particularly the highly relevant remarks made by Erik Pálmen (1952, pp. 52–53) and the late Kurt Buch (1952, pp. 33–55) concerning the increase in the amount of carbon dioxide in the atmosphere and its impact on the general circulation and possible relevance for any 'warming' or 'cooling' of the climate (see also Buch 1949, Heino 1978). Dunbar (1976, p. 190) writes that he finds "if difficult to believe that even carbon dioxide in the atmosphere, water vapour, freon, or any other substance produced by man's efforts is going to compete seriously with Nature in changing our climate".

The papers in this volume speak for themselves. They are written by prominent Finnish specialists in their various fields of science. There is, however, a marked difference between the approach adopted by some of these authors to the problems of climatic fluctuations and their effects on various aspects of nature and human activity, and the attitudes of the participants in the symposium held 25 years ago. The role of the climatic variations and fluctuations are now more in the background than in the papers published in 1952.

Heino's diagrams illustrate the exceptional nature of the climatic improvement experienced in the 1930's, but they also show clearly the slow deterioration which set in in the 1950's. The 1960's constituted climatically a rather unfavourable decade from man's point of view, while the summers of the early 1970's have again been more favourable, though not yet as markedly so as in the 1930's.

Heino also makes a comparison between the period 1961–75 and the 'normal period' 1931–60. But what is this 'normal period'? As the young newspaper article (Helsingin Sanomat, Sept. 15th, 1949) points out, while the summers of the early 1970's have again been more favourable, though not yet as markedly so as in the 1930's.

Varjo's paper particularly stresses the fact that nowadays the general economic situation influences agricultural production both quantitatively and qualitatively to a greater extent than does the climate itself. The correlation between such factors as the destruction of stres., and the natural environment with increasing industrialization, the electrification of the lakes and new land use patterns. Nevertheless, there are many bird species which seem to be more numerous now than in earlier times, one reason being simply the greater amount of information available due to the larger numbers of observations. A similar experienced view of the complex nature of the interactions which govern the 'ecological triangle' (see Fig. 1 above) was expressed during the previous symposium by Nordman (1952, pp. 60–68) regarding variations in the distribution of insects.

In 1956 Erkamo published an important paper dealing with the influence of the climatic fluctuation of the 1930's on the vegetation and flora of Finland, in which he described the northward shift in the distribution of many species and the northward extension of seed formation in some tree species. As he points out here, however, he has not been able to follow up his earlier observations. It would have been interesting to know, for instance, the extent of the backlash effect of the unfavourable temperatures of the 1950's and 1960's on the growth phenomena and distribution data which he discussed then. In his present paper he chooses to illustrate mainly the close correlation between phenological data and spring temperatures. In this connection the unpublished thesis by Johnson (1965) on the relation between climate and vegetation in Sweden is of interest.

The influence of climate and the changing environment on breeding in certain bird species in Finland is discussed by v. Haartman. Against a background of many years of ecological observations, he stresses particularly such factors as the destruction of the natural environment with increasing industrialization, the electrification of the lakes and new land use patterns. Nevertheless, there are many bird species which seem to be more numerous now than in earlier times, one reason being simply the greater amount of information available due to the larger numbers of observations. A similar experienced view of the complex nature of the interactions which govern the 'ecological triangle' (see Fig. 1 above) was expressed during the previous symposium by Nordman (1952, pp. 60–68) regarding variations in the distribution of insects.

The correlation between such factors and the recent climatic fluctuations. Of particular interest are his comments regarding the failure of the reforestation projects in northern Finland in the 1960's, especially in 1962 and 1968, which he attributes to the extended drought and the condition of the seedlings, making them susceptible to pests and diseases". In a previous paper Mikola wrote that the "bright optimism which had previously prevailed in regard to the prospects of forestry in Lapland was gradually replaced by serious concern" (Mikola 1971, p. 120).

Referring to the natural regeneration at the timberline on mountains in Finland which was a consequence of the climatic improvement in the 1920's and 1930's, Kallio has stated recently (1975, p. 24) that "thousands of seedlings from the latest warm
period in the low alpine belt in N. Inari and Utsjoki ... have been killed by freezedrying, a common ecological eliminator of pine'. Thus the rather optimistic view of pine reproduction at the timberline given, albeit cautiously, for instance in my paper of 1958, has not entirely been fulfilled. This picture may again be changed, however, by the warmer summers of the early 1970's.

The opinions of the forest scientists regarding the question if the forest is retreating or advancing in the north (or how far northwards cutting of timber can be extended) are, of course, mainly based on the climate and growth in the period concerned. Thus, the opinions vary from time to time due to the complex chain reaction between climate, nature and development.

interest in the study of the effects of climatic fluctuations increased iudustrialization and urbanization and the marked effects, locally at least, of the activities of man upon the climate. The discussion concerning the marked effects, locally at least, of the activities of man (see Fig. 1) is becoming more complicated due to the recent climatic fluctuation. This does not seem possible today.

Future research must nevertheless continue to take account of annual variations in climate, and also of short-term climatic fluctuations of the type discussed during the 1951 symposium, and to a lesser extent in 1976. The details of how climatic changes affect biological processes and the ecological chain systems still remain largely an unsolved problem.

I finished my concluding remarks at the symposium 25 years ago with the words, "The recent climatic fluctuation has probably passed its culmen, as some of the above statements point out. But irrespective of whether the culmen of this climatic fluctuation has been reached or not, it can be assumed that the correlation between climate and its consequential phenomena will remain much the same century after century" (Hustich 1952, p. 117). The first part of this quotation seems to have proved correct, but the validity of the latter part remains a rather more complicated question, as the interaction between climate and the activities of man has become a so much more complex matter over recent years.

REFERENCES


