LONG RHYTHMIC WATER LEVEL VARIATIONS IN LAKE SAIMAA COMPARED WITH THE FLUCTUATIONS IN SOME CLIMATOLOGICAL ELEMENTS.

By

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Abstract

A rhythm of about 30 years can be established in the water level variations in the Lake Saimaa. The same rhythm seems to appear in the precipitation fluctuations in Helsinki.

The aim was to examine the long rhythmic water level variations in Saimaa and compare them with the fluctuations in precipitation, temperature, and air pressure. The water level observations were made with a gauge placed in the southern part of *Suur-Saimaa*. The drainage area is 62,130 square kilometers, the percentage of lakes 19.6. Observations on precipitation in Helsinki and Uppsala, air temperature in Helsinki, and air pressure differences Copenhagen—Stykkisholm have been used as comparison observations. Since the comparison is between places with partly deviating climatological conditions, it is evident that an approximative similarity only can be expected. The research is based on annual means. In order to discover the rhythmic fluctuations the so-called frequency method and levelling analysis have been used.

The arithmetic mean of the observations is denoted M and the dispersion σ. The number of cases over a period of 10 years, higher than $M+\sigma$, is written m and the number of cases over the same period, lower than $M-\sigma$, is denoted n. Next, the differences $m-n$ were computed for as

many 10-year periods as possible, e.g. for the water level in Saimaa for the periods 1847—56, 1848—57 etc. The course of the differences m—n gives an idea of the possible variations. (1)

The observed value for a year may be y. The means

$$\bar{y} = \tfrac{1}{2}(y_n + y_{n+1}); \bar{\bar{y}} = \tfrac{1}{5}(\bar{y}_n + \cdots \bar{y}_{n+4}); \bar{\bar{\bar{y}}} = \tfrac{1}{10}(\bar{\bar{y}}_n + \cdots + \bar{\bar{y}}_{n+9})$$

were now computed. The levelling given by the last one was used in the comparisons.

The following table gives the values M and σ used in the frequency method and the observation periods.

TABLE 1.

	Observation place	Observation period	M	σ
Water level	Saimaa, Lauritsala[1])	1847—1953	350 cm	39 cm
Precipitation	Helsinki	1847—1953	665 mm	122 mm
	Uppsala	1851—1953	542 »	93 »
Temperature	Helsinki	1829—1953	4.5 C	1.1 C
Air pressure difference	Copenhagen — Stykkisholm	1846—1948	5.7 mm/Hg	2.0 mm/Hg

Figure 1 gives the results of the frequency method. In the water level variations in Saimaa 3 rhythms with a mean period of about 30 years can be established. The fluctuations in precipitation in Helsinki and in the water level of the Saimaa show a relatively parallel course from about the beginning of the 1890's; in the earlier years there are considerable deviations. The course of precipitation in Uppsala deviates considerably from these elements. According to the figure, there are two distinct rhythms: the minimum of the first wave appears at the end of the 1870's, that of the second wave probably at the beginning of the 1950's. It is possible that the latter long rhythm is divided into two parts in the middle of the second decade of this century. In assessing the results a fact that must be considered is that older observations on precipitation are not reliable and give too small values. This can be seen, for example, in the first part of the series for Helsinki.

The temperature in Helsinki seems to be the only one of the elements considered which has a clear secular course. From about 1880 the average annual temperature has increased continuously.

1) The zero of the gauge is NN+72,31 m.

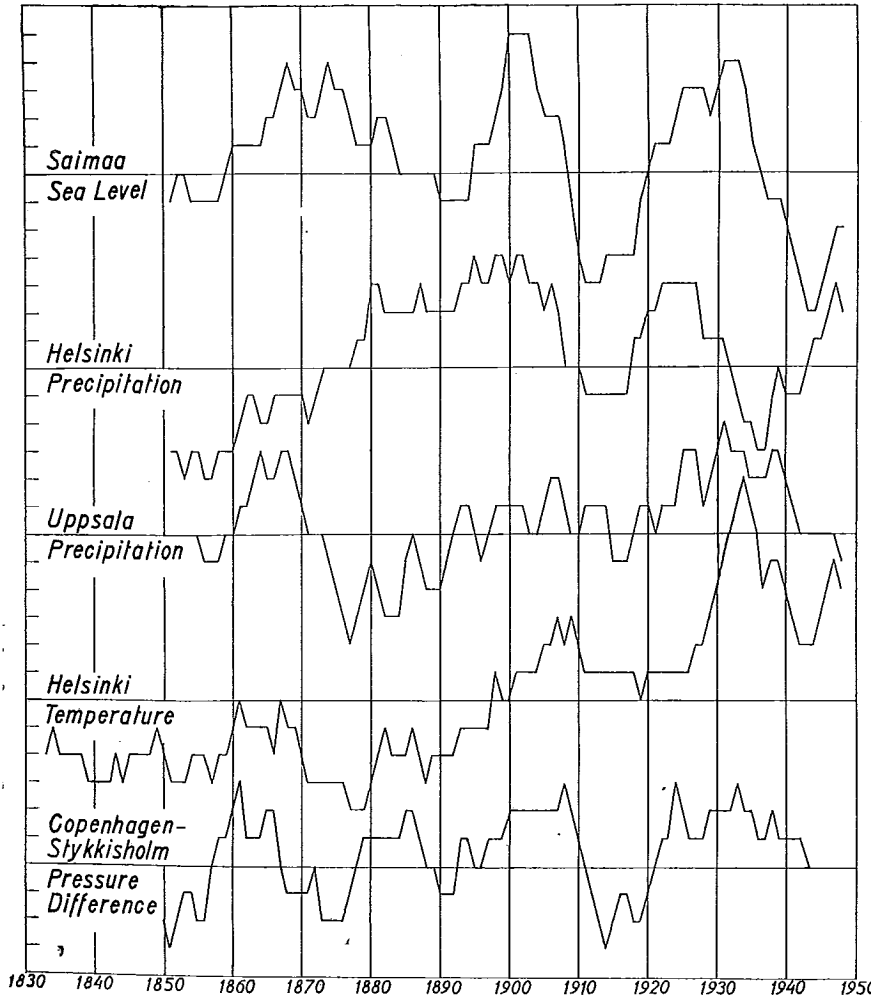

Fig. 1. Frequency diagram for the extreme values.

The above fluctuations seem to correspond to some degree with the long variations observed in the circulation of the atmosphere. In order to establish this fact, the air pressure differences Copenhagen—Stykkisholm have been examined. A great difference means a strong W-current, which causes the increase in precipitation and temperature. Slight pressure differences, on the contrary, generally have the opposite influence. According to the diagram, a parallel course can be noted, especially from about 1890, for the different elements and the pressure difference.

The results based on the levelling analysis (Figure 2) are, as a whole, similar. The water level in Saimaa and precipitation in Helsinki show approximately the same rhythms. As above, the precipitation in Uppsala deviates from them. The temperature in Helsinki shows a distinct secular course and, moreover, rhythms which seem to correspond to the rhythms of the pressure difference.

These results show that the water level in Saimaa and precipitation in Helsinki probably have a rhythm period of about 30 years. In research into the periodicity of the water level in Saimaa the harmonic analysis based on observations for the period 1847—1936 gave the largest amplitude, 23.7 cm, for a peried of 29 years, and the following amplitude, 18.3 cm, for a period of 6.3 years (3). Using the harmonic analysis for the observations of 1847—1953, we get the largest amplitude, 21.5 cm, for the period 6.6 years and the next largest, 21.2 cm, for the period of 30 years. Considering the kind of material involved, the two results are practically identical.

Long water level variations in the lakes as well as fluctuations in climatological elements do not, as is well known, follow constant periods, and it is therefore more appropriate to speak of rhythms. The prognostic use of the results of harmonic analysis is therefore problematic. The prognostic value, for example, of the research into the water level variations in Lake Vänern by LINDQVIST is therefore poor (2). Though there seems to be no cause to compute the future water level values for Saimaa it may, however, be appropriate, when estimating the water level, to take into consideration 30-year rhythm mentioned above. It seems that the water level in Saimaa, which in the middle of the twenties was very high, is now reaching the highest value of its 30-year rhythms. The 6—7 year rhythm, which appears distinctly in the harmonic analysis, must be taken into consideration.

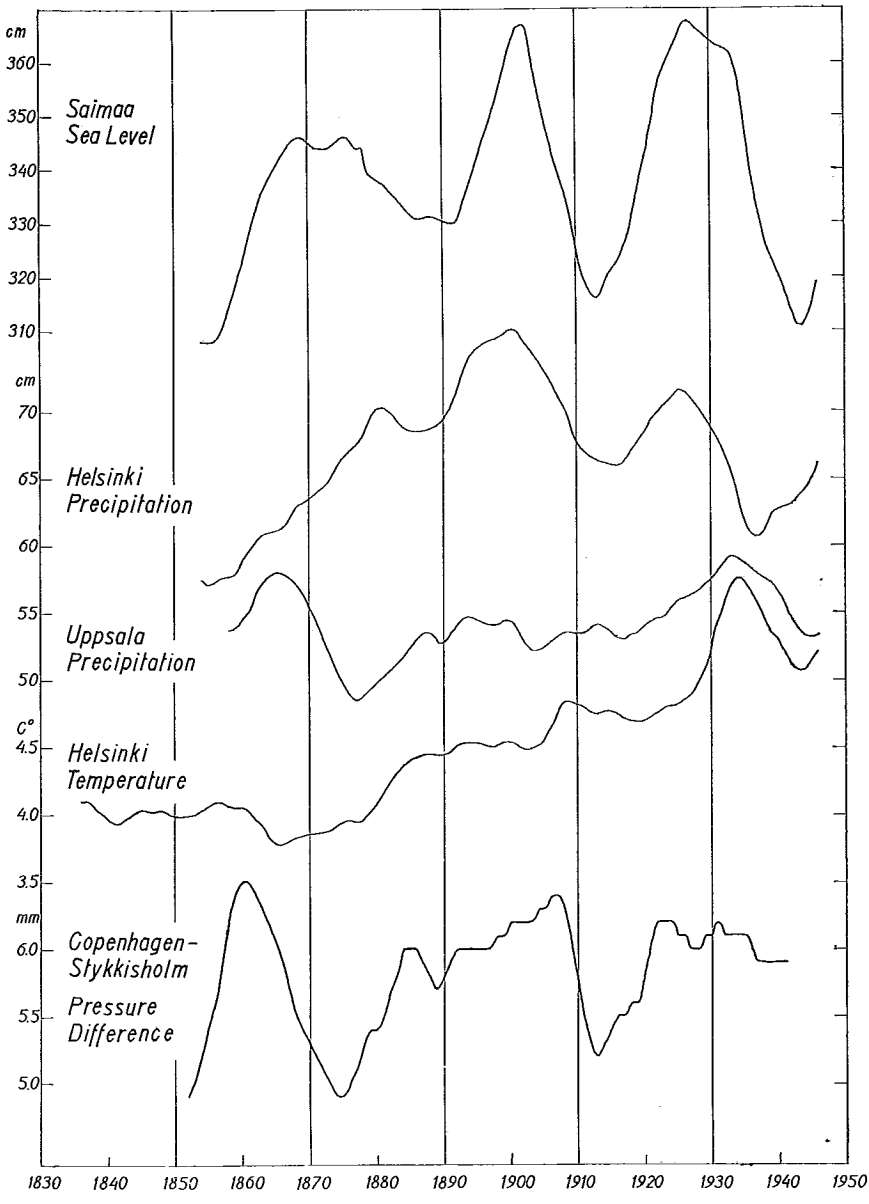

Fig. 2. Levelled values.

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