Quantification and Application of "Climate-Risk" based on the tree-ring proxy data

*Akira Harada[1], Kei Yoshimura[2], Tsukasa Mizutani[2]

1. Institute of Industrial Science, The University of Tokyo, Yoshimura Lab, 2. Institute of Industrial Science, The University of Tokyo

In recent years, human activities have also influenced climate change, and there has been much discussion and research on how global climate change affects our lives in a different phase than in the past.
At the same time, many researchers have been fascinated by the concrete changes that climate change has brought to human society since the dawn of history. Over the past 100 years, such research has produced many results since the late 20 s, thanks to the advent of proxy data and big data, but there are still many challenges.
For example, the range of influence of proxy data has not been confirmed, and the waveform of proxy data is used for direct comparison with historical events, so that the influence of climate on human society is only implied. In this study, we hypothesize that climate change with a period of 10 years, which is equivalent to the span of a person's life, has influenced human society, and use signal processing techniques to open a new horizon for the relationship between climate change and history.
First, since proxy data at close distances are considered to show similar waveforms, the range of influence of proxy data was determined by comparing correlation values using an autocorrelation function. The correlation value became smaller as the distance from the reference proxy data became larger, and it was confirmed that the correlation value converged to around 0.2 after a certain distance. From this, we were able to define the spatial representative distance (Spatial Representative Distance = SRD) mathematically. We confirmed that SRD reflects geographical features.
We then tried to index climate change on the basis of the resulting SRD, which allowed us to detect unsteady climate change through short-time frequency analysis (Short Time Fourier Transform = STFT), and weighted climate change by proxy data, mainly in inverse proportion to distance, using the climate influence factor (Climatic Impact Factor = CIF) as an index to quantify the climate change at any point and year. The CIF thus calculated was considered to indicate the impact of climate change on human society, for example, in a very good fit with wheat price trends, supporting the hypothesis.
Finally, we discussed the relationship between the CIF and historical events. We analyzed the mechanism of the occurrence of famines identified in historical records by using the correlation between the CIF and wheat prices. The comparison between regional vulnerability to climate change and war estimated by the CIF suggested that climate does not directly affect war.
The results of this study are expected to serve as a basis for quantitative and sequential discussions on the relationship between climate and human society in regions where proxy data and human activity data are available.

Keywords: Proxy data, Spatial Representativeness, Signal processing , History, Climate

