


## 【Grant-in-Aid for Transformative Research Areas (A)】

### The past, present, and future of "misbehaving climate" and humans

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	Project Information	Project Number : 24A101 Keywords : misbehaving climate, human history, age determination, climate modelling, hazard protection

### Purpose and Background of the Research

#### ● Outline of the Research

Climate system has three dynamic modes. The first is well-known "climate change" which essentially is a gradual process, such as the global warming. The second is "extreme weather" which is basically one-time-only event, such as torrential rain. And the third is "misbehaving climate", in which the climate becomes permanently unstable (Figure 1). This third mode constitutes the core of our research area. Our project will examine (i) its reality and mechanisms, (ii) its impact on past civilisations, (iii) its influence on human societies, and (iv) possible adaptation strategies for the future.

Specifically, we will first analyse special sediments called "varves" (which means annually deposited layers) to reconstruct in detail when in the past the climate was "misbehaving". Next, we will determine the impact of "misbehaving climate" on human history, through archaeological studies. In doing so, a cutting-edge dating method will be developed to discern leads and lags between events, as they often provide important clues for examining causal relationships. By introducing climate modeling and disaster scenario analysis methods, we will also examine the mechanism of "misbehaving climate", its impact on human societies, and effective countermeasures.

#### ● Crisis already underway?

International organisations, including the FAO and the WMO of the United Nations, have reported that the increasing frequency of natural disasters has caused economic losses in the order of several trillion USD, as well as millions of human losses.

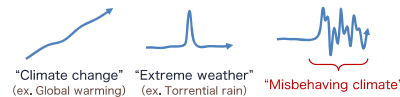


Figure 1. Concept of "misbehaving climate". Recurring disasters have stronger impact on human societies (especially the ones based on agriculture).

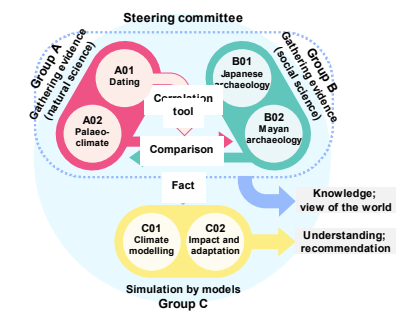


Figure 2. Structure of our research area. We seek for revelations for future through combined approaches of natural and social sciences.

FAO: \$3.8 Trillion Lost to Disasters Over Three Decades  
 13 October 2023 23:42  
 Agence France-Press



FILE - Saito Ene Buqa, right, who said she has lost 100 cows due to drought, and her neighbor Kenia Ole Tigete, left, who said she lost 40 cows, walk past animal carcasses at Hangerani village, near Lake Magadi, in Kenya, on Nov. 6, 2022.

Figure 3. International organisations are sending alert against climate instability.

#### ● Is stable climate exceptional?

Palaeoclimatic records reveal that stable climatic conditions have been limited to the most recent period of approximately 12,000 years. This period of stable climate coincides precisely with the period in which humans developed civilisations (Figure 4). Humans have never sustained civilisations under "misbehaving climate" for a long period of time.

If the climate will "misbehave" again, it is critical to know what the impact would be on human societies, and what adaptation strategies would ever be possible.

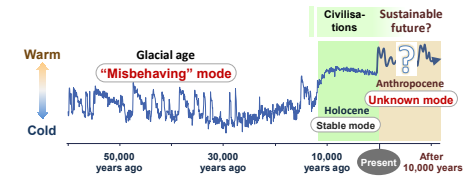


Figure 4. Climate change over the past 60,000 years reconstructed from Greenland ice cores. During the last ice age, it was more common for the climate to be "misbehaving". It has been suggested that the climate may be crossing a tipping point due to global warming, but there is no guarantee that future climate will as stable as today.

### Expected Research Achievements

#### ● A01: Dating

With new dating technologies, the chronological precisions of palaeoclimatic and archaeological records will reach a level of "human sense of time". We will also provide overwhelmingly accurate and high-density dataset for the internationally consensus radiocarbon calibration model IntCal.

#### ● A02: Palaeoclimate

Varved sediments from Lake Suigetsu (Japan) and Lake Petexbatun (Guatemala) will be analysed in detail to reconstruct the history of "misbehaving climate" over the past 70,000 years.

#### ● B01: Japanese archaeology

Through archaeological studies of the Jomon, Yayoi, and Edo periods, and comparing them with palaeo-climatic data, the impact of climatic and volcanic disasters on human societies will be investigated.

#### ● B02: Mayan archaeology and history

We will conduct archaeological, historical and anthropological researches in Maya region to investigate the causal relationships between the rise and fall of Maya civilisation and the "misbehaving climate".

#### ● C01: Climate modelling

We will conduct climate simulation for the past 2000 years using the Earth system model MRI-ESM3, and high-resolution model experiments for selected periods of interest, to understand the characteristics and evolutionary processes of the "misbehaving climate".

#### ● C02: Impacts and adaptation

We will evaluate how "misbehaving climate" would alter the relationships between human and nature from the perspectives of flood risk and plant resource use, and seek adaptation measures. The impact of "misbehaving climate" on the terrestrial vegetation will also be assessed by species distribution modelling.

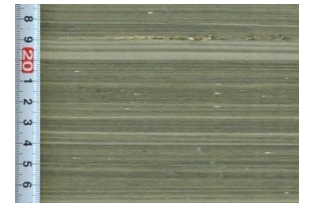


Figure 5. Annually laminated (varved) sediment of Lake Suigetsu, Japan.



Figure 6. Karako-Kagi archaeological site in Nara, Japan. Planned to be excavated in this project.

