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Archaeology for Disaster Management

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Abstract

While the importance of interdisciplinary studies has been recognized recently, each research field is becoming more subdivided. Expertise in the research field must be assured yet, on the other hand, joint research with other research areas can effectively expand the depth and reach of research. Based on my own experience, this paper introduces an example of interdisciplinary study combining archaeology, geology, and geotechnology. I show that this interdisciplinary study has a wider social significance than isolated studies in each research area would have had.

Keywords: interdisciplinary study, archaeology, GIS, disaster management, debris flow area

要旨

近年、学際的な研究の重要性が認識される一方で、各研究分野の細分化がますます進展する傾向も見受けられる。まず、自身の研究分野での専門性を確保する必要がある一方で、他の研究分野との共同研究は、自らの研究の幅を広げるために有効である。本稿では、筆者自身の経験を踏まえ、考古学、地質学、地盤工学を組み合わせた学際的研究の一例を紹介する。このような学際的研究は、それぞれの研究領域でおこなわれる研究による社会的意義に加え、新たな社会的意義を創造することがある。

キーワード：学際的研究、考古学、GIS、防災、土砂災害

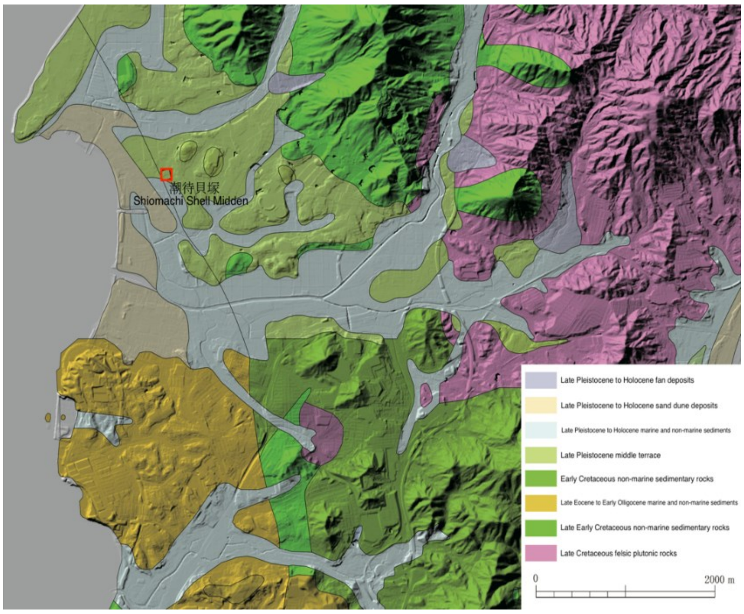
1. Experience in IFERI and TRANS programs

Participating in the IFERI program (Inter Faculty Education and Research Initiative Program) during my post-graduate studies provided me with various opportunities for exchanging academic experience with other students in humanities and social sciences courses (Golob et al. 2008). Most archaeologists focus on Japanese archaeology in Japan and rarely have interdisciplinary studies or international joint research. The program allowed me to host sessions in international conferences, publish articles in English and organize fieldwork abroad. Working in the TRANS program (TRANS Europe-East Asia Education Program) as a research fellow also provided me with such experiences. In this article, I describe how the experience in these programs became valuable for my research activities.

2. An example of an interdisciplinary study

My research interest focuses mainly on Jomon (Japanese prehistory) ancient salt production and mercury production in the early modern period. When I was working at Yamaguchi University, a disaster management research group invited me to join them. Their research plan overlapped with my research interest, especially exploring the GIS (Geographic Information System) which could be helpful to realize patterns of prehistoric settlement distribution. Thus, I decided to join their research.

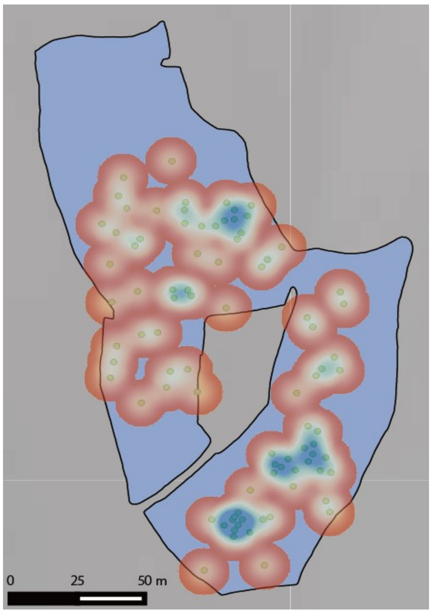
By using GIS, it is easier to make maps. For example, presenting the locations of the archaeological sites while using other geographical maps can show the difference of the environment around the sites (Fig. 1).



(Modified from The Seamless Digital Geological Map of Japan V2 - GSJ, AIST)

Fig. 1: Location of the Shiomachi shell mound

Another example is the distribution of stone adzes in an archaeological site (Fig.2). We know that in the Late and Final Jomon, the number of stone adzes increased in western Japan. Thus, considering the abundance of the adzes, we can assume that the Kokushū site, located in the low land by the river, would probably have been used as cultivated land. According to ethnographical data, adzes were sometimes lost when used to cultivate land. If so, a heatmap may indicate Jomon cultivated land (Kawashima 2016). This example shows that GIS can be used for small parts of archaeological sites.



(Modified from Iwasaki et al. 1992: Fig.27)

Fig. 2: Heatmap of adze distribution at Kokushū

3. Archaeological map of Yamaguchi Prefecture

Every prefecture in Japan provides maps of archaeological site distribution, traditionally paper-based. This site distribution data has been used to prevent the destruction of archaeological sites by development activities, such as the construction of buildings and roads. While most prefectures provide a website for integrated GIS, data can only be seen on a web browser and cannot be downloaded. In these cases, data cannot be used directly for GIS. Some prefectures provide site distribution data upon request, for example, Okayama Prefecture.

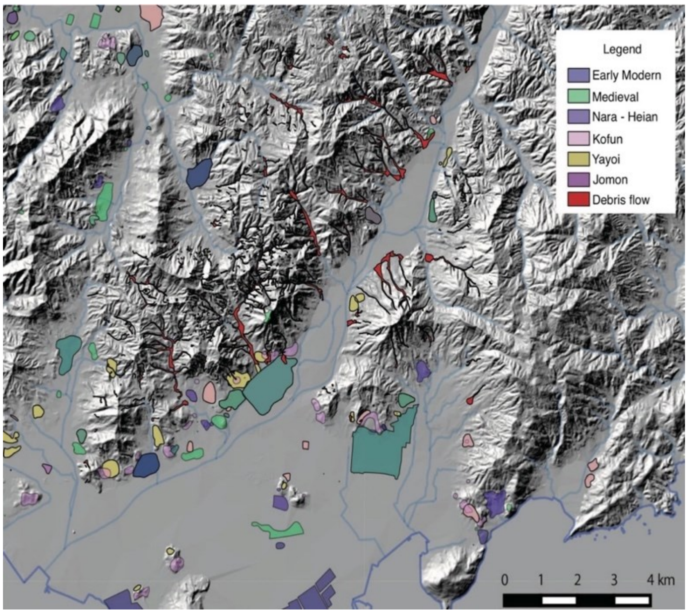
Yamaguchi Prefecture provided a digital map of archaeological site distribution. However, as the software for the map supported only Windows XP, which was supported until 2014, the digital map was not used by archaeologists. I extracted the data from the digital map to use it on GIS, particularly on QGIS, (formerly Quantum GIS) a free open-source GIS software. It took time to arrange the geodetic reference system because the data distributed by Yamaguchi Prefecture used the Japan Geodetic System. The next step was to sort archaeological sites into historical periods: Paleolithic, Jomon, Yayoi, Kofun, Nara-Heian, Medieval, Early Modern. Using these arranged data, it became possible to overlay multiple archaeological site maps and debris flow maps.

In 2009, more than 150 debris flows occurred in Hōfu, Yamaguchi Prefecture. Sediment disaster, such as debris flow, has not been much studied archaeologically, compared to tsunamis, volcanic disasters and earthquakes. As many debris flows, caused by so-called guerrilla rainstorms, have frequently occurred recently, the study on debris flow in historical periods has social significance. In Hiroshima city in 2014, debris flow caused significant damage. One of the reasons for this damage was the construction of residential areas in high-risk areas. Houses and apartment buildings had been constructed on the deposits of former debris flow. This case shows the importance of knowing the historical record of sediment disasters.

4. GIS analysis in Hōfu

Regarding the sediment disaster in Hōfu, we are conducting a GIS analysis of the medieval sites, focusing on the medieval awareness of natural disasters. In the medieval period, landlords expanded their cultivated land and villages increased, for example, in the lowland near the river. Fig.3 below, shows the debris flow (red) and the distribution of archaeological sites along the Saba River. Some of the sites partially overlapped the 2009 debris flow. Also, several medieval villages were located within the sediment disaster caution zone. We will carry out further analysis on the different periods to find the historical transition of the relationship between settlements and their risk of sediment disaster. Together with the GIS analysis, we have conducted sampling of geological cores to find the debris flows which occurred in the past, which can be dated by the carbon 14 dating method

(Sakaguchi et al. 2018). By sampling cores at the damaged area of the 2009 debris flows, the trace of several debris flows could be detected. Local people could have evacuated before the debris flow if this fact had been widely known.



(Modified from Fundamental Geospatial Data, GIAJ)

Fig. 3 Distribution of the sites and debris flows in Hōfu

5. Fieldwork in Yamaguchi and Hiroshima

Besides the fieldwork in Hōfu, we have conducted fieldwork at the riverbed of the Shimada River in Yamaguchi Prefecture and along the Sōzu River in Hiroshima Prefecture. The Shimada River is a major river running through south-eastern Yamaguchi Prefecture. The heavy rain in 2018 caused an overflow and the bank of the river was partially damaged. We conducted sampling cores at the riverbed near the place of overflow (Matsugi et al. 2020b). We obtained 90cm of the core from the contemporary soil, and the topsoil of this core presented the accumulation of sand which was brought by the 2018 flood. We plan to conduct another fieldwork with longer sampling equipment to have cores from deeper soil.

The heavy rain in 2018 caused wide damage in western Japan. The debris flow in the Sōzu River, Hiroshima prefecture, caused severe damage to the Koyaura area.

In this area, a stone monument was established after the debris flow disaster of 1907. Few residents in this area paid attention to the monument. We collected carbon samples for Carbon 14 dating from the farm pond by Sōzu River (Matsugi et al.: 2020a). Based on the carbon dating and historical records in Hiroshima, we assumed that the recurrence intervals of wide-area sediment disasters in Hiroshima were 150-400 years. There must have been more historical disasters that were not documented, and small/regional-scale disasters must have occurred more often.

6. Further research

Our research will be able to reduce the disaster risk in the Chugoku district by clarifying the evidence of sediment disasters that occurred in the past. Data of recent disasters can be helpful to reduce damaged areas. However, as we have learned from the tsunami in 2011, we should be attentive to natural disasters which occur in long intervals. In July 2018, more than 8,000 landslides and debris flows occurred in Hiroshima Prefecture alone. This kind of weak soil made of decomposed granite, distributed in the Chugoku district, will cause sediment disaster again.

While a digital site distribution map has not been published in Hiroshima Prefecture, we try to arrange archaeological site maps for GIS analysis. There are still few studies of sediment disasters compared to other disasters. It is essential to learn the recurrence intervals of sediment disasters and share this knowledge with people and local governments in high-risk areas.

Archaeology is relatively compatible with other research fields because it needs many analyzing methods, such as carbon 14 dating, physical anthropology, zoology and molecular biology. Other research fields in humanities and social sciences can also conduct interdisciplinary studies, allowing post-graduate students to broaden their research interests and develop their future research. Participating in interdisciplinary study programs like IFERI and TRANS would also be an alternative.

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