Historical migration and land development around the eastern Himalaya

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Abstract: Mountain environmental changes caused by human impacts in the Himalayas have caught the attention of conservationist, scientists and administrators over the last 30 years. Particularly in Solu-Khumbu area in eastern Nepal, it has often been stated that deforestation (deforestation by human impact with fire) has accelerated during the latter half of the 20th century because of population growth. In this study, dated charcoal and buried humic soil layers (including humus materials), both of which are the evidences of forest fires indicate past deforestation and agricultural land development by tribal migration around eastern Himalayas (eastern Bhutan to north-eastern India (Arunachal Pradesh)). Around the eastern Bhutan to Arunachal Pradesh area, human impacts such as population growth by tribal migration may have accelerated environmental and agricultural changes after ca. 2 k yrs BP, mainly. Relatively intense agricultural land formation that occurred since ca. 1 k yrs BP (mainly after ca. 0.5 k yrs BP) was due to tribal migration.
Key words: Buried Humic Soil Layers, Hisitorical land development, Radiocarbon age, Arunachal Pradesh (India), Bhutan.

Introduction

Deforestation in Eastern Himalayan area is poorly understood except for that of recent years, which is documented in historical records. Soil studies are significant methods in reconstructing environmental changes in the past. Palaeosols such as buried soil, and charcoal fragments and fossil pollen in soil provide clear information on local palaeoenvironments. In the western and central Himalaya and Tibet, soil studies have been conducted to try to reconstruct the past environment. Caine *et al*. (1982) reported a podozonic paleosol near Namche Bazar (Nauje), eastern Nepal, which indicates mid-Holocene environmental changes.

Saijo (1993) indicated evidence of forest fire in historical times in the middle mountains, near Kathmandu, central Nepal. Iwata (1994) observed many buried soil layers containing charcoal fragments in the southeastern part of Tibet and eastern Nepal, and concluded that expansion of Tibet and immigration of Sherpa people caused this palaeosoil formation. Saijo (1993) and Iwata (1994) emphasized that charcoal fragments in soil and buried humus layers are evidences of human factors contributing to forest destruction. And Iwata *et al*. (1996), Miyamoto (1998) and Miyamoto (1999) reported deforestation since the 3 k yrs BP round the central Himalayas in Nepal.

In this paper, fieldwork around the Nepal and eastern Bhutan and north eastern India Himalayas areas are dated charcoal and buried humic soil in Eastern Himalaya are reported as a preliminary report.

Materials and Methods

Study Area: The observation and sampled sites are located around the eastern Himalayas (Solu-Khunbu area in Nepal, eastern Bhutan and North Eastern India, Arunachal Pradesh), which is surrounded by mountains. (Fig.1). Almost all sampled and observed site are located over 2000 m a.s.l.

Method: Soil profiles were observed at various exposures along paths and risers of the terraced fields and ridge of paddy fields. Charcoal fragments and organic rich parts of soil were collected at the exposure localities for radiocarbon (^{14} C) dating were taken at the exposure localities. Radiocarbon ages were obtained from charcoal fragments and humus soils taken from soil layers. From bulk humus soil, acid-insoluble humus, mainly composed of humus acid and humin, wereas extracted with the following physical and chemical assays: Samples from which rootlets, worms, and gravels were removed were and boiled with 1N or 6N HCL for one hour in order to remove fresh organic materials. After the top clear solution was poured away, the residue (acid insoluble humus) was washed with distilled water. Measured ^{14}C ages was calibrated using the calibration program OxCal ver. 3.10 (Bronk Ramsey, 2001). This type flow of the study flow is shown in Fig. 2.

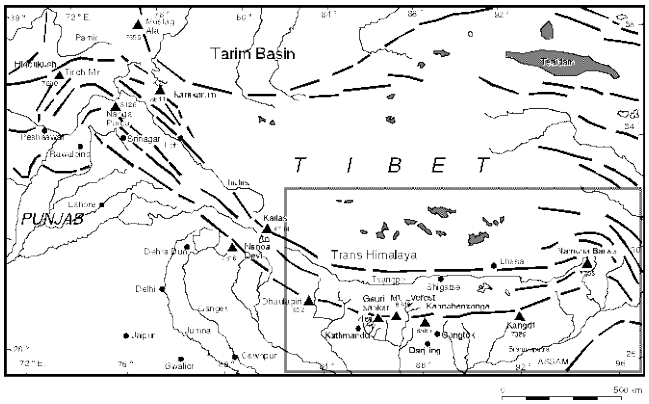

Fig. 1. Himalayan high mountain area and studied area. Enclosed area is shown in Fig. 4.

Results

Fig. 3 shows the typical columnar section from which samples for radiocarbon dating were taken. This soil section represents typical site around Ziro area, Arunachal Pradesh, India. In this area, relatively thin layers (about less than 20 cm) were observed exposure in common. Buried stump in paddy fields are distributed many sites is not only around Ziro area but surrounding area. Ridge of paddy fields is built by human impact, and buried stumps are detected under threat condition that a surface is carbonized.

Fig. 4 shows a schematic ages of collected 26 sites in the state of Arunachal Pradesh and eastern Bhutan by AMS ^{14}C dating method is (Conventional radiocarbon age).

In eastern Nepal, radiocarbon ages indicate oldest value is ca. 4.1 K yrs BP and youngest age shows ca. 0.1 k yrs BP.

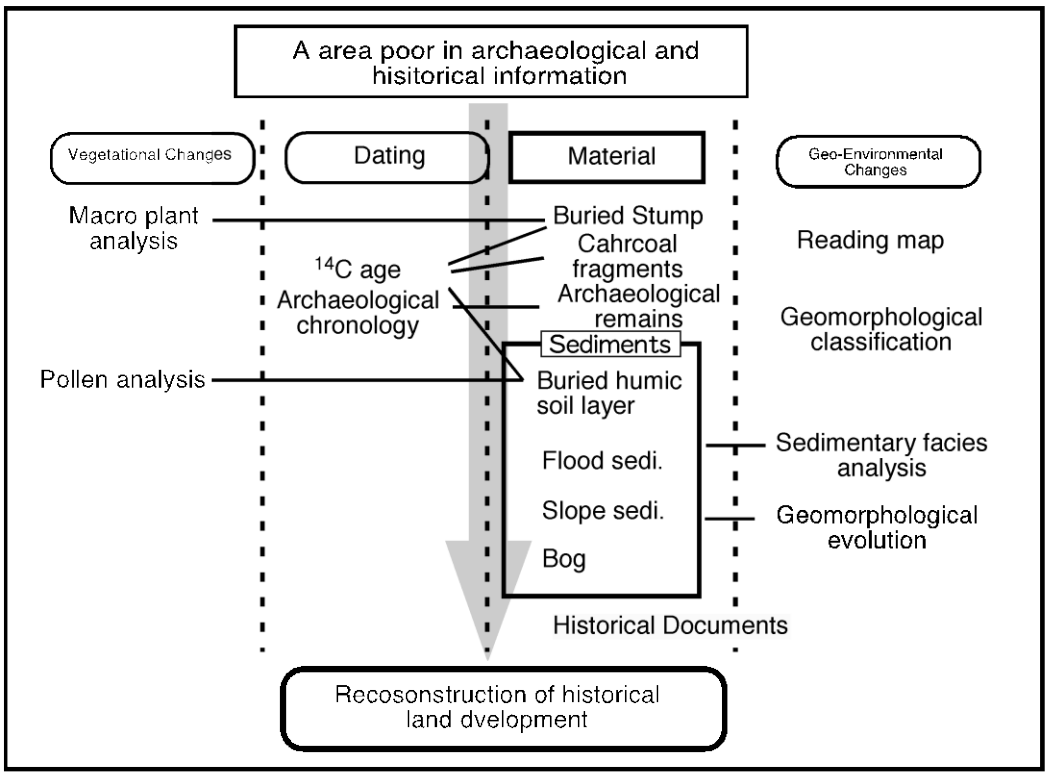

Fig. 2. Study method (Miyamoto *et al.*, 2009)

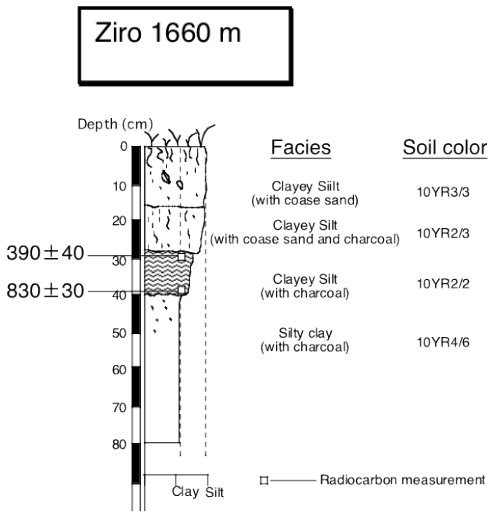

Fig. 3. Typical Buried humic soil layer and radiocarbon age in nort eastern India (Miyamoto *et al.*, 2011)

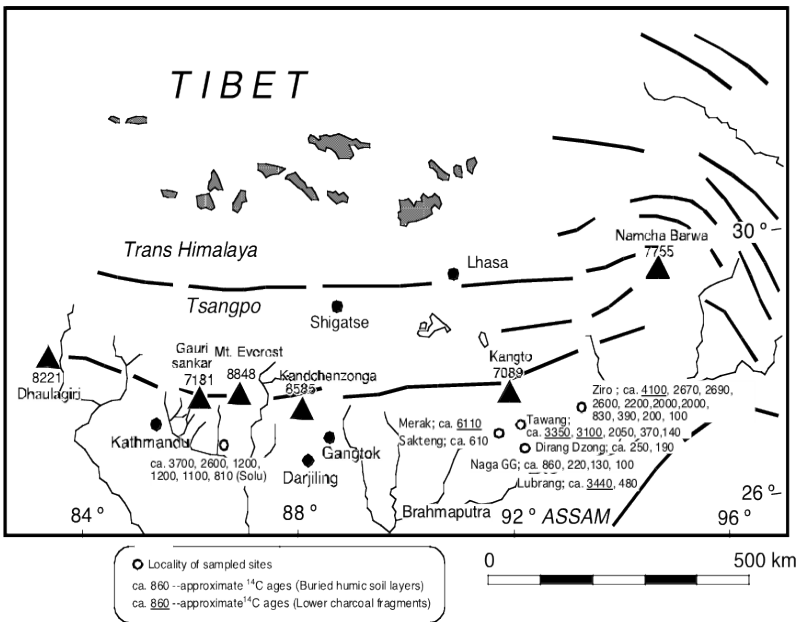

Fig. 4. Results of radiocarbon ages around eastern Himalaya

Discussion

Based on the above results, we will discuss on the time difference between the area of tribal migration and land development time in the eastern Himalaya.

Almost the range of dated radiocarbon age range are mostly distributed aroundare ca. 2.7 k, ca. 2 k, ca. 0.8 - 0.1 k yrs BP except for the without oldest age ca. 4.1 k yrs BP in Ziro. In Taiwan area, it is distributed since ca. 2 yrs BP without ca. 3 k yrs BP in charcoal fragments. On the other hand, around Dirang area (including Lubrang and Naga GG), the oldest age ca. 3440 yrs BP in Lubrang is projected, and another ages are almost indicate since ca. 1 k yrs BP. In addition, measurements of the eastern Bhutan (Sakuteng and Merak) are distributed ca. 610 k yrs BP.

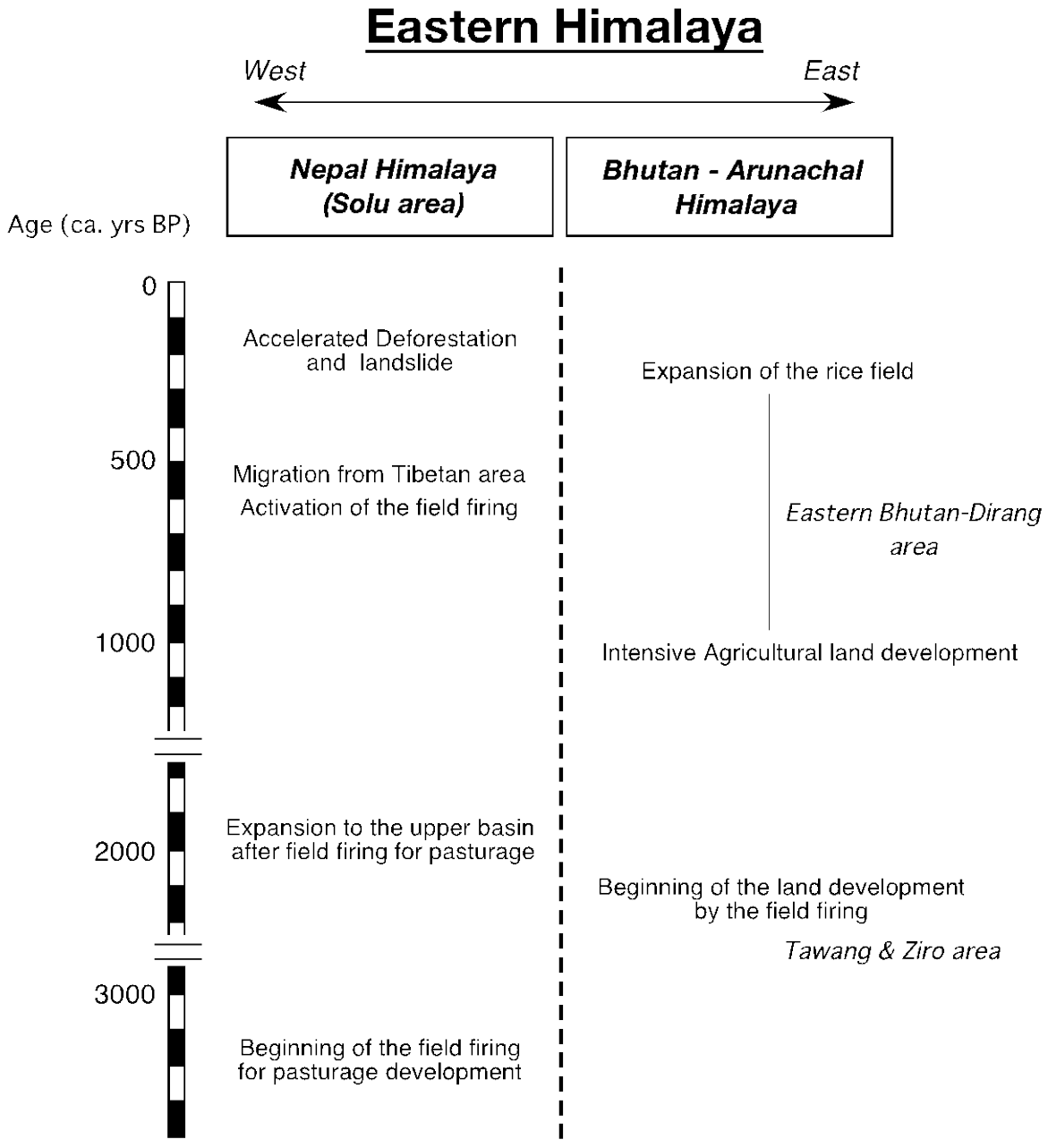

Fig. 5. Chronology of land development in the eastern Himalayas

Buried stump under the rice field indicates occurred at ca. 2000 yrs BP, which is older than the buried humus layer. The oldest value of the buried humus layer was ca. 3700 yrs BP, and it was confirmed in as the land development period in Nepal Himalayas (Fig. 5). However, in east Bhutan to Arunachal Himalayan area, where cereal cultivation is done, it can not be same as that of the eastern Nepal area. As forest or bush fire was done in many areas, it can be estimated that some developmental activities in the early days were undertaken since ca. 2000 yrs BP in the present shifting cultivation field. We can estimate that the full-scale development concentrated at ca. 1000 - 340 yrs BP, the formation age of the buried humus soil layer.

The value of the ca. 2000 yrs BP which got it is derived from this study time can be supposed to show the early period value of development of the land improvement activity value. In other words, because forest or bush fire is done in many areas, it can be estimated with the thought that a development activity concerning of early days was done since ca. 2000 yrs BP in the cultivation of present shifting cultivation field. We can estimate that the full-scale concentrate development started at ca. 1000-340 yrs BP of the formation time of the buried humus soil layer. About the cause of land development is estimated as the, migration of tribes is estimated (Miyamoto, 1998; Miyamoto *et al*., 2009; Miyamoto *et al*., 2011), but the details do are not become clear.

Conclusions

In this study, dated charcoal and buried humic soil layers (including humus materials) are analyzed around Eastern Himalayas (Eastern Bhutan to Arunachal Pradesh, north-eastern India), both of which are evidence of forest fires which indicate past deforestation and agricultural land development by tribal migration around Eastern Himalayas (Eastern Bhutan to Arunachal Pradesh, north-eastern India). Around the eastern Bhutan to Arunachal Pradesh area, human impacts such as population growth by tribal migration may have accelerated environmental and agricultural land changes after ca. 2 k yrs BP, mainly. Relatively intense agricultural land formation that occurred since ca. 1 k yrs BP (mainly after ca. 0.5 k yrs BP) was due to tribal migrations.

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