

## Human activities and forest transition in Japan Sea Coast area with special references to Lake Hiruga and Lake Kitagata in Fukui prefecture, Japan

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Deforestation was caused by not only utilization of its timbers but also utilization for fuel and land transformation to agriculture. Severe deforestation became obvious throughout Japan in 16<sup>th</sup> century and conservation law was enacted by Edo government and feudal lords in the 17<sup>th</sup> century. However, the history of deforestation before the 17<sup>th</sup> century is not well-known since written documents are rare. In this study, the timing and cause of deforestation are detected in Japan Sea Coast area in Fukui prefecture.

Lake Hiruga is located in the coastal area of Wakasa Bay. Many archaeological sites are distributed around Lake Kugushi adjacent to Lake Hiruga. Paddy fields are observed on planes around Lake Kugushi and salt making was active from the 5<sup>th</sup> century to the 8<sup>th</sup> century. From the 11<sup>th</sup> century, land transformation to agriculture was active. Three major public works were recorded in this area in Edo period (from the 17<sup>th</sup> century to the late 19<sup>th</sup> century). Lake Kitagata is located in the coastal area of Japan Sea close to Noto peninsula and a flat large plane spread to southeast and paddy fields have been developed. In the late 19<sup>th</sup> century, a water gate was constructed to make paddies around this area since blackish water prevented from land transformation to agriculture. Also salt making was active in Heian period (AD794 -1185). In both area, deforestation before the development of paddy field is expected.

A core (14KTG01-2: 450 cm) was recovered from Lake Kitagata using a Russian peat sampler and a core (15HG02: 228.5 cm) from Lake Hiruga using a Meckeleth core sampler. Pollen analysis on the sediments from Lake Kitagata and Lake Hiruga was conducted using recovered cores to detect the impacts of human activities on forests.

Human activities were low and the percentages of arboreal pollen was nearly 90 % in all three regions by the 10<sup>th</sup> century. The forests of *Castanea* and *Quercus* subgen. *Cyclobalanopsis* mixed with *Q.* subgen. *Lepidobalanus* and *Cryptomeria* were developed in both area. The most severe deforestation started in the 10<sup>th</sup> century around Lake Hiruga and in the 12<sup>th</sup> century around Lake Kitagata. In both regions, it was accompanied by the increase of Gramineae pollen. This deforestation was probably caused by the land transformation to agriculture and it was irreversible change. This is the timing and origin of the typical satoyama landscape with paddy fields in Japan Sea Coast area today. The timing was earlier in Lake Hiruga probably because the area is close to the capital city, Kyoto.

Salt making is normally considered to consume large amount of wood for fuel. However, the impacts from it was much smaller than the land transformation for agriculture. *Pinus* pollen increased around Lake Hiruga from the 15<sup>th</sup> century and around Lake Kitagata from the late 16<sup>th</sup> to the 17<sup>th</sup> century. It appeared that the forests recovered from the severe deforestation, but other arboreal species did not increase. It was probably caused by the development of secondary forests or plantation of pine trees in coastal area as shelterbelt. In addition, several constructions were recorded around Lake Hiruga from the 17<sup>th</sup> century to the 18<sup>th</sup> century and the increase of *Pinus* pollen was observed in the period. In Lake Kitagata, the increase *Pinus* pollen and Gramineae pollen was also observed in the late 19<sup>th</sup> century. The increases were probably related to the constructions.

Keywords: Lake Hiruga, Lake Kitagata, pollen analysis, land transformation to agriculture