A Study on Seed Dispersal by Hydrochory in Floodplain Restoration

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Abstract

A floodplain has a function as a retarding basin and provides habitats for various organisms inhabiting the wetland. It is thought that this function is kept by transportation of various materials (including seed of plants) by flood water. Flooding events can be an important process for seed dispersal to the floodplain. In this study, we examined sediment transported by flood water at the artificial restored floodplain (Azame-no-se). We found that seeds were transported by flood water to the floodplain. We also found distances from the flow-in site were related to the seed dispersal in the floodplain.

Keywords: floodplain, river restoration, seed dispersal, hydrochory

Introduction

A floodplain is land generated by flooding or moving of river channels and composed by the deposit transported from the river. A floodplain has a function as a retarding basin and provides habitats for various organisms inhabiting the wetland. However, floodplain wetland area has been decreasing sharply by urban development and river regulation. Therefore, floodplain restoration projects are currently conducted all over the world, including the Kissimmee River (Middleton 1999) in Florida in the United States and the Skjern River (Danish Ministry of Environment and Energy 1999) in Denmark in Europe. In Japan, the Ministry of Land Infrastructure and Transport is implementing restoration of a floodplain wetland in the Azame-no-ze area of a mid-order stream of the Matsuura River.

In recent years, hydrochory (seed dispersal by water) has been focused on plant dispersal in riparian areas. For example, Goodson et al. (2003) found a correlation between vegetation establishment and weight or grain size of sediment that was transported by water. Jansson et al. (2005) found that hydrochory increases species richness of riparian plants. However, these studies were focused on seed dispersal by stream at normal time (not flooding time) stream-stage with seed traps installed for a long period (months), which cannot exclude the possibility of anemochory (seed dispersal by wind), so it is insufficient to show that the seed dispersal was surely performed by hydrochory.

We aimed to find the evidence of hydrochorous seed dispersal to a floodplain by flood water and to explain how the seeds disperse in a floodplain by flood water. Specifically, we examined sediment transported by flood water at the artificial restored floodplain, Azame-no-se. We also assessed the process of vegetation regeneration in the Azame-no-se area.

Methods

Study area

Aiming at “rehabilitation of a floodplain wetland” and “restoration for a close relationship of humans with wildlife,” the Azame-no-se Rehabilitation Project began in The Matsuura River in 2003. The rehabilitated Azame-no-se Wetland is an approximately 1,000-m (3,280-ft) long and 400-m (1,310-ft) wide floodplain and has an area of 6 ha. The wetland serves both as a storage basin of floodwater (except for the design flood discharge) and a foothold of wetland restoration activities. The Azame-no-se area was used as rice paddy field and did not have any hydrological connections to the Matsuura River before the restoration. After the restoration, Azame-no-se area was excavated about 5 m, and the hydrological connectivity was restored. The site consists of some ponds, creeks, and a terraced rice paddy, with each nurturing a variety of creatures. The Azame-no-se area is currently hydrologically connected to the Matsuura River only by the creek, and at flooding

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time, the floodwater flows into the whole site. Sediments and many living things (including seeds of plants) also flow into the area with flood water.

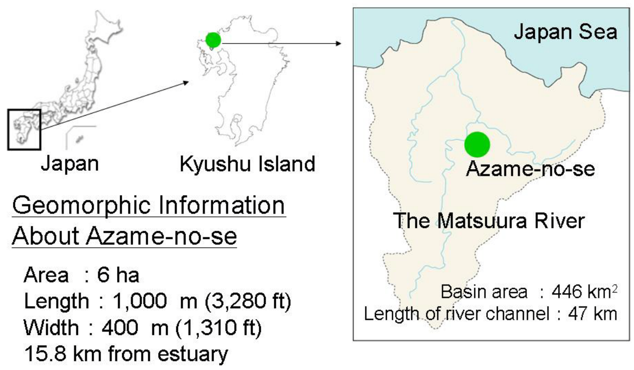

Figure 1. Geographical location of the study site.

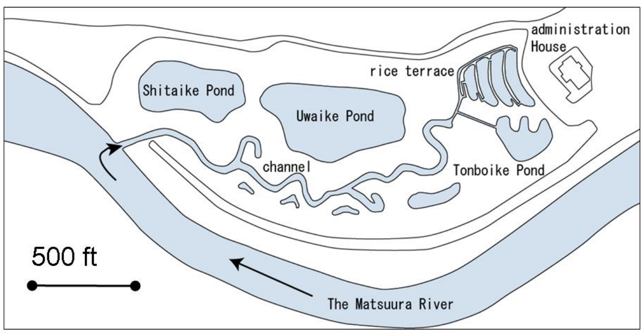

Figure 2. Overview of the Azame-no-se area.

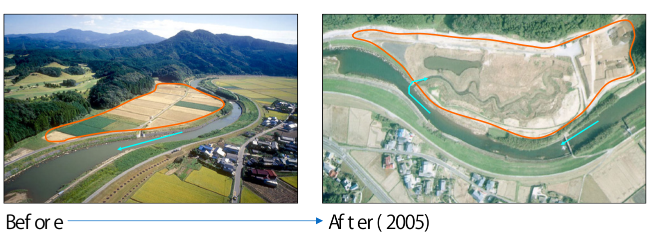

Figure 3. Photos of the Azame-no-se area (left: before rehabilitation; right: after rehabilitation).

Field investigation

Approximately 40 sampling points were established to collect seeds in flooding sediment at Azame-no-se in June 2004 and April 2006. Six frames of seed traps, with each made of a stainless frame (20×20 cm) covered with an unwoven cloth, were installed at each sampling point. At each point, four frames were used for germination trial to determine the number of germinated seeds and the number of species, and the remaining two frames were used for sediment analysis to determine dry weight and median particle size of sediment.

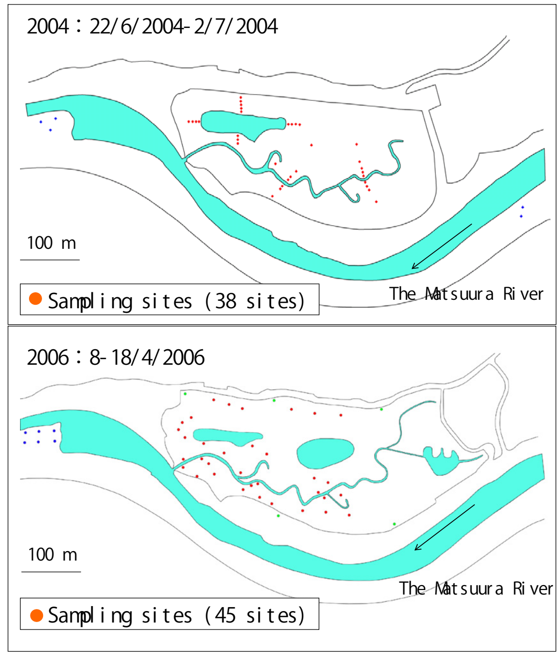

Figure 4. Sampling sites of field investigation (upper: 2004; bottom: 2006).

Germination trial

Sediment samples were promptly removed to germinate them after each flooding event. We analyzed the germination trial by seedling emergence method. We used wooden plant pots in the trial, with one plant pot for one sediment sampling site. Each plant pot was kept wet during the trial. Some plants considered as the same species were planted out to another pot together to identify the species of germinated plants, and the plants were cultivated until they showed their characteristics. Then, we determined the number of germinated seeds and the number of species.

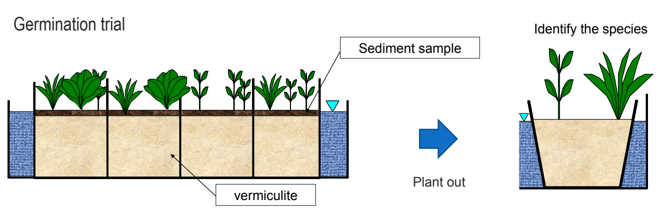

Figure 5. Image of germination trial.

Results

Germination trial

From the germination trial, 6,229 seedlings (1,025 seedlings/m^2) were identified to 96 species in 2004, and

3,178 seedlings (441 seedlings/m^2) to 77 species in 2006. Many identified plants were arable weed including *Rorippa islandica* and *Lindernia procumbens*. Some marshy and alien plants were also found. The marshy species included *Gratiola japonica* and *Rotala pusilla.* Among the alien species, *Eragrostis curvula* and *Solidago altissima L.* were found, which have threatened Japanese native plants.

Relationship between the number of seedlings and distance from flow-in site

We categorized seed trap sites to three groups depending on the distance from the flow-in site: 0–50 m,50–100 m, and 100–200 m. Then we compared the number of seedlings and weight of sediments among groups. We made the comparison using data from 2004 and 2006. We found that the number of seedlings tended to be larger at the seed trap site located near the flow-in site.

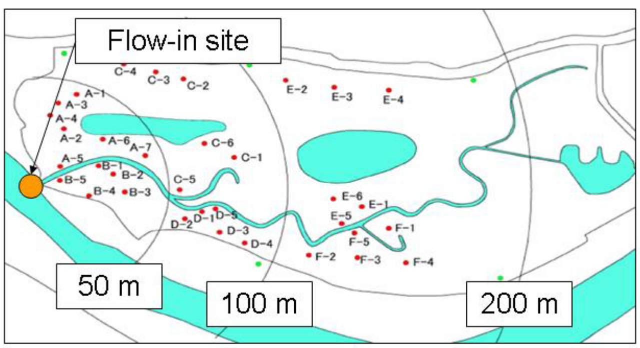

Figure 6. Categorized seed trap sites.

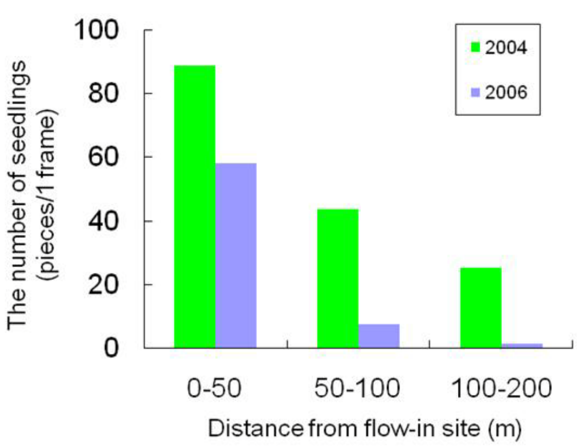

Figure 7. Relationship between the number of seedlings and distance from flow-in site.

Conclusions

This study shows that seeds are transported by flood water to the floodplain. Many identified plants were arable weed, but some marshy plants were also found, including some endangered species. We also found that distance from the flow-in site was related to the seed dispersal in the floodplain.

References

Danish Ministry of Environment and Energy. 1999. The Skjern River Restoration Project. Danish Ministry of Environment and Energy, National Forest and Nature Agency, Copenhagen.

Goodson J.M., A.M. Gurnell, P.G. Angold, and I.P. Morrissey. 2003. Evidence for hydrochory and the deposition of viable seeds within winter flow-deposited sediments: The River Dove, Derbyshire, UK. River Research and Applications 19:317–334

Jansson R., U. Zinko, D.M. Merritt, and C. Nilsson. 2005. Hydrochory increases riparian plant species richness: A comparison between a free-flowing and a regulated river. Journal of Ecology 93:1,094–1,103

Middleton, Beth. 1999. Wetland Restoration, Flood Pulsing and Disturbance Dynamic. John Wiley & Sons, New York.