学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Sediment-water interactions of degrading floodplain waterbodies in the Ishikari River
（石狩川の氾濫原水域における堆積土砂と水の相互作用）

Floodplain waterbodies (FWBs) have degraded worldwide due to the expansion of agricultural and urban areas. In lentic or semi-lentic FWBs, the internal factors such as sediment properties (i.e., organic matter: OM, nitrogen: N, and phosphorus: P) could play an important role in the formation of water quality by acting as an internal source. The aim of this dissertation was to understand sediment properties and its effects on water quality in FWBs in the Ishikari floodplain, Hokkaido, Northern Japan.

In Chapter 2, sediment data of 29 FWBs were collected twice and the potentially important controlling factors of sediment properties were quantified. Both data were used to investigate the spatial variation and temporal changes in sediment properties in relation to their controlling factors. The temporal changes in sediment properties over decades were largely driven by FWB morphometry, especially in the small and shallow FWBs due to suitable habitat for macrophyte that led to OM deposits. Therefore, rate of change in OM differed among FWBs depending on their morphometry. Increases in OM and OM to TN (total nitrogen) ratio were observed, while TP (total phosphorus) decreased. In addition, the rate of change in OM positively correlated with the rate of changes in TN and TP.

In Chapter 3, water quality (summer and autumn) and sediment properties data were collected twice (around 2005 and 2019) to examine the relationship between sediment and water. Nine FWBs were selected for intensively investigating the main factors that dictated water quality and seasonally variable water-sediment interactions. Sediment correlated with the concentration of chlorophyll-a (Chl-a) in both data sets, but the correlated sediment properties differed between years and seasons. In 2005, sediment TN correlated with Chl-a in both seasons. In contrast, in 2019, relationship differed between seasons. Water quality changed across the seasons under the strong effects of water temperature. However, water temperature did not control Chl-a directly but controlled (de)nitrification and P(im)mobilization potential. As a result, N and P became the limiting nutrient for Chl-a in summer and autumn, respectively.

In Chapter 4, the influence of OM on P adsorption efficiency in FWBs sediment was investigated. Six samples that differ substantially in the OM content were collected in the field used in the laboratory experiment to test P adsorption efficiency by Langmuir adsorption isotherm. The results from adsorption experiment provided only a partial support to the prediction OM content would have a positive relationship with P adsorption efficiency. The adsorption efficiency in two highest OM level did not line

arly increase to be consistent with the clear and positive relationship seen for the lower OM% sample s. This is possibly because the saturation of OM in sediment that contained very high OM% level acc umulated P mainly in organic form, while other sediment samples in the non-saturated condition accu mulated mainly P in inorganic form.

These findings demonstrated that FWB morphometry played vital role in the change of sediment pr operties of FWBs, which can affect water quality of FWBs depending on season. Furthermore, it is e xpected that the reduction of OM and P in sediment could substantially accelerate the FWBs restoratio n processes when water quality improvement is a goal in sustainable management of biodiversity and water resources.