学 位 論 文 内 容 の 要 旨/Dissertation Abstract

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学 位 論 文 題 名/Title of Dissertation

A simple approach for estimating freshwater discharge from a tidal wetland stream to a brackish lake
（湿原を流域に有する感潮河川から汽水湖への簡便な流出量推定）

Quantifying freshwater discharge from rivers to estuaries is essential for understanding land–sea interactions and assessing the influence of riverine inputs on estuarine ecosystems. This study focuses on the Bekambeushi River system, which drains one of Hokkaido's most pristine watersheds. Characterized by extensive wetlands and forests and only limited agricultural influence, this basin offers a valuable opportunity to

investigate natural hydrological processes in a tidal wetland river flowing into a brackish lake. Although previous research has examined the ecological significance of the Bekambeushi River with respect to estuarine productivity, few studies have addressed the challenge of estimating river discharge. Therefore, quantifying freshwater discharge into Akkeshi Lake is of particular importance, especially under strong tidal influence.

Field surveys were conducted during 2018–2019 and 2020–2022, comprising eleven observation campaigns. From April 2018 to October 2019, continuous monitoring was conducted at multiple hydrological stations, including measurements of (1) water level, (2) electrical conductivity, and (3) water temperature in the lower reaches of the basin.

Short-term velocity and discharge measurements (4) using Acoustic Doppler Current Profilers (ADCPs) were carried out at two stations. In 2020–2022, the observation network was expanded to the upper basin to characterize hydrological conditions across the entire watershed.

Based on continuous observations of water levels across the entire basin and electrical conductivity in the downstream reaches, the eight riverine stations excluding Akkeshi Lake and Akkeshi Bay, were classified into four hydrological domains: 1. lower brackish zone, 2. middle brackish zone, 3. tidal freshwater zone, and 4. non-tidal zone. (Figure 1.1). Because freshwater discharge must be estimated as close as possible to the river mouth, where tidal impacts are strongest, the conventional stage–discharge (Stage- Discharge) relationship is not applicable in this system.

To overcome the difficulty of obtaining long-term discharge records in this tidally influenced wetland river, this study used both the boat-mounted M9 and the fixed SonTek-IQ Plus to derive short-term continuous discharge

time-series using the Index- velocity method. While this combination provides accurate short-period flow dynamics, continuous long-term ADCPs deployment is not feasible in such environments. Therefore, an additional method was required to infer long-term discharge using readily available hydrometeorological data.

In response, this study proposes a simple and cost-effective approach that establishes a relationship between local rainfall and discharge rates measured by ADCPs at the tidally affected river mouth. Discharge rates showed a strong correlation with cumulative precipitation over the preceding six days. Using this empirical relationship, daily discharge estimates of the Bekambeushi River were compared with those of the nearby Kushiro River, a major gauged river with similar climatic and topographic settings showing strong agreement. Given these similarities, the calculated discharges are considered reasonable as first-order estimates for the Bekambeushi River.

This study provides new insights into hydrological monitoring in tidal wetland rivers and presents a practical methodology for discharge estimation where conventional Stage- Discharge approaches fail and long-term flow records are unavailable. The findings contribute to a better understanding of freshwater–seawater interactions in pristine estuarine systems and offer a framework for ecological assessment and resource management in comparable coastal wetlands.