Accounting for surrounding agricultural ditches in groundwater flow modeling at Hokkaido Bibai marsh, Japan

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Functions and values of wetlands (marshes, swamps, peat bogs, and etc.), in particular their rich natural resources and biological diversity, have come to be recognized as significant elements in natural environments (Ramsar convention, 1971). Among developed countries, there have been numerous projects for conservation and restoration of wetlands to harmonize their functions such as water storage, flood control, and water filtration/purification with surrounding watershed and environment. On the other hand, among developing countries, the wetlands including surrounding areas are important landfill and infrastructure development sites for cultivated and residential lands. Thus, there is growth of the demands for applicable management and wise-use of wetlands. In spite of this, due to lack of information, scientific evidences, etc., measures or engineering tools have not been sufficiently taken for evaluating ongoing methods/ techniques for wetland conservation and restoration.

Our study aims to characterize mass movement and circulation systems in wetlands combining with geoengineering properties such as consolidation and strength. Based on such scientific/engineering knowledge, our final goal of the study is to develop an integrated tool which enables simultaneous mass transport of water, greenhouse gases, energy, and nutrients in marshes raking into account geoengineering properties and behaviors of wetland soils, and to evaluate conservation and restoration methods at natural and constructed wetlands in pursuit of site-specific management and wise-use of wetlands.

The study site is the Bibai marshland in Hokkaido, Japan. An intensive field monitoring has been conducted at the marsh: methane emission has been monitored since 2003, methane content distributions have been measured since 2006, and groundwater levels and soil temperatures have been monitored since 2008. At the same time, we have developed and improved integrated flow simulation codes, such as GETFLOWS and HYDRUS, to model movement of water and heat in geospheres from the field scale to the regional scale.

A preliminary modeling and simulation of the water-circulation at the Bibai marsh surrounding agricultural ditches (area of about 1 km x 1.5 km) was executed using GETFLOWS. The model can simulate changes in flow rates of the river flow and the groundwater flow by inputting the rainfall data. As a result, the distribution of the water content and the direction of the groundwater flow on this site were calculated. The model verification and update by using the observed data of the water budget at the Bibai site will be conducted using monitored measured data.