Modeling of water and material flow for the quantification of mangrove carbon budget

*Takeo Onishi[1], Shinpei YOSHITAKE[2], Mitsutoshi Tomotsune[3], Miyuki Kondo[6], Nobuhide Fujitake[4], Morimaru Kida[4], Kazutoshi Kinjyo[5], Ohtsuka Toshiyuki[2]

1. Faculty of Applied Biological Sciences, Gifu University, 2. River Basin Research Center, Gifu University, 3. Faculty of Education and Integrated Arts and Sciences, Waseda University, 4. Graduate School of Agricultural Science, Kobe University, 5. Faculty of Agriculture, University of Ryukyu, 6. National Institute for Environmental Studies

Mangrove forest is the most C-rich ecosystem in the Earth. Since large NPP in the tropical climate, and small HR in the reductive soil, it has specifically large NEP. On the other hand, the amount of material flowing out from the system cannot be ignored. Since mangrove forest existing at the intertidal zone, there is a periodical exchange of water between sea and the mangrove ecosystem due to the tidal fluctuation. Thus, to calculate carbon budget of mangrove ecosystem, estimate of carbon outflow from the system through water flow is necessary. In this study, as for a case study, net annual discharge of the mangrove forest of the Fukido River located at the Ishigaki Island is estimated for the purpose of quantification of DIC flux of mangrove forests. In addition, the outline of DIC transport model which is being developed by our group will be reported.
The area of the study site is about 0.2km^2, and its watershed area is 2.27km^2. The most part of the watershed is covered by forest. Though three small streams are flowing into the study area, except for heavy rainfall, discharge is about 0.1m^3, which can be ignorable for our analysis. To construct water flow model, we conducted leveling survey at 712 points to get the detail elevation data. Based on topographic data, horizontal Saint Venant equation is adopted as the governing equation for water flow of the study site. The finite element methods was applied to the governing equation with 68,345 triangle elements of 34,708 nodes. For about boundary condition, tidal level is given at the river mouth, and river inflow from the upstream is assumed as 0. For the initial condition, water level is assumed as 0m. Compared with observed discharge at the river mouth, the calculated discharge is following the actual trends of discharge. Comparison between observed water levels with calculated values at a several points in the creeks and swamps also shows fairly good coincidence. On the other hand, actual changing rate of water levels during the ebb tide period is much larger than calculated values, indicating that water flow between creek and swamp is not well simulated. Based on the model, annual net discharge into the ocean is estimated as 1.3m^3/s. We are now developing the model which incorporates DIC production and transport mechanism into the developed water flow model. The DIC production and transport model consists of CO_2 production from soil respiration, CO_2 transport by advection and diffusion, and CO_2 degassing from water to the air. Coupled with ecological, pedological measurements conducted at the study site, we expect to realize the detail carbon budget calculation of mangrove forests.

Keywords: Mangrove, DIC, water and material flow model

