Numerical simulations of mass transports processes in the lagoon of Funafuti Atoll,Tuvalu

*Kai Koike[1], Eiji Masunaga[2], Hiromune Yokoki[3]

1. Graduate School of Science and Engineering, Ibaraki University, 2. Ibaraki University, Center for water Environmental Studies, 3. Department of Urban and Civil Engineering College of Engineering, Ibaraki University

Understanding oceanic structures in atolls, formed by coral reefs, is essential for maintaining their ecosystems and environment. Contaminated water due to poorly sewage treatment outflows into the lagoon in Funafuti Atoll, Tuvalu (Fujita et al., 2013). However, water exchange between the lagoon and open ocean is limited through narrow channels on the coral reef. Therefore, the sea water in the lagoon is isolated from the open ocean and the lagoon is a highly closed ocean area. Contaminated water discharged from the urban area would causes deterioration of coral reefs, which leads to the changes in the form of the atoll and the loss of the land.
This study attempted to reproduce flow structures and mass transport processes in Funafuti Atoll lagoon by using the SUNTANS model (Fringer et al., 2006). In order to reproduce the typical flow structure in the lagoon, the model was forced by tides and six wind conditions (wind speed and direction). In addition, transport processes of contaminated water from the urban area were reproduced by a passive tracer model.
Numerical results showed that the wind stress strongly influences the flow field in the lagoon compared to the tidal forcing. In the middle of the lagoon, the tidal current generated weak currents, approximately 0.008 m/s. On the other hand, when the wind speed is 5m/s, the flow speed in the middle of the lagoon reached 0.1 m/s. According to numerical runs with three wind direction patterns, northeast winds enhance transports of contaminated water from the lagoon to the open ocean. 83% contaminated water from the urban area flowed into the open ocean within 20 days by northeast winds with the speed of 5m/s. Under the northwest and 5m/s wind condition, water from the urban area stays inside of the lagoon for a long time. 35% of contaminated water flowed into the open ocean within 20 days in this condition. This study suggests that the wind condition plays a significant role in transport processes of contaminated water between the inside of the lagoon of Funafuti Atoll and the open ocean.

