Assessment of river sediment and nutrient loading into coastal waters of Northern Okinawa Island, Japan in relation to coral reef communities

（河川から流出する堆積物および栄養塩がサンゴ群集に与える影響　～沖縄本島北部の沿岸水域での検証～）

Hokkaido University, Graduate School of Environmental Science
Division of Environmental Science Development, Course of Global Environmental Management
Miki McAlinn

Coral reefs are one of the most biodiverse and valuable ecosystems on Earth. Millions of people worldwide depend on coral reefs for their food security, their role as natural breakwaters offering coastal protection from storms, floods, and erosion. However, coral reefs are threatened by multiple natural and anthropogenic stressors. Among them, coral degradation caused by sediment and nutrient has been documented in reefs from around the world and in Japan, including Okinawa Island. However, evidence on the effects of sediment and nutrient loads from river discharge on coral reefs remains limited due to a general lack of spatially well-resolved, long-term monitoring data on sediment and nutrient discharges into coastal areas as well as the status of coral reef communities in the surrounding areas.

Here, to address this problem, I used a combined approach based on a long-term (2004 – 2015) simulation of sediment and nutrient loads from 13 coastal rivers draining into the coastal waters of Northern Okinawa Island and existing field observations on coral reef communities along the same coast for the same period. Simulations from the hydrological model showed high sediment runoff generated from rivers draining large watersheds (e.g., Fukuchi, Aha, Arakawa Rivers), and high nutrient runoff from watersheds with a high proportion of agricultural land use (e.g., Fegatta, Fukuchi, and Taira Rivers). Furthermore, a significant percentage of the total sediment and nutrient runoff by watershed occurred in subbasins receiving heavy precipitation and characterized by steep slopes. Annual results from sequential *t*-test analysis of regime shifts showed significant increases in mean coral cover and coral fish at several monitored stations 1 to 2 years following significant decreases in sediment and phosphorous (but not nitrogen) mean discharge from nearby rivers. These changes sometimes also were accompanied by a significant shift towards a stronger correlation between the two variables. Similarly, results from Granger causality analysis showed that in some cases, the combined sediment and nutrient runoffs from neighboring rivers provided statistically significant information to reconstruct trends in coral reef fish abundance at nearby monitored stations with a lag of 1 to 2 years. Together, these results suggest clear temporal relationships between river sediment and nutrient discharge and the status of coral reef communities in the receiving coastal waters of Northern Okinawa Island. Additionally, by identifying which of the 13 rivers has the highest runoffs, this study can inform future monitoring programs to collect field data from those rivers. Nevertheless, long-term observation data on daily sediment and nutrient as well as data on the status of coral reef communities collected at finer temporal resolutions from each location are required to produce more robust results and should be a priority for future research.