令和2年度　環境科学院　修士論文内容の要旨

Assessment of mangrove regeneration in abandoned aquaculture ponds using multi-temporal satellite imagery
(多時点衛星画像を用いた放棄養殖池のマングローブ再生評価)

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Mangroves are highly productive forest ecosystems that can recolonize their habitat after a major disturbance, such as land use conversion. They provide vital ecosystem services, including shoreline protection and habitat for other organisms, that are dependent on their size and spatial arrangement. Globally, mangrove forests have decreased in area and have become fragmented, especially in Southeast Asian regions where aquaculture is a major driver of loss. This study conducted a spatiotemporal analysis of mangrove forest change in relation to aquaculture pond development in Panguil Bay, southern Philippines, using 30m spatial resolution satellite images. It also mapped abandoned aquaculture ponds that have been recolonized by mangroves. The study analyzed Landsat 5 and 8 images for 3 periods (1993-2000, 2000-2010, 2010-2020) and processed them on the Google Earth Engine cloud computing platform. Image classification was performed using a supervised random forest classification approach. Several water and vegetation indices, Grey Level Co-Occurrence Matrix (GLCM) texture measures, and shape metrics were tested as additional input features to the classifier. The area, perimeter, and number of patches of pond and mangrove classes were then computed to analyze their spatial pattern and determine the dominant land transformation process for each period. Based on a decision tree algorithm, the transformation processes of ponds and mangroves were identified.

A preliminary testbed result shows that the GLCM measures were useful in separating water from vegetation but did not add to the classification accuracy as this was already achieved by using the Automated Water Extraction Index (AWEI) and Enhanced Vegetation Index (EVI). AWEI and EVI were also effective in discriminating ponds from other water bodies. The Mangrove Vegetation Index (MVI) was effective in discriminating mangroves from other types of vegetation. Shape metrics did not improve the classification accuracy because of the low spatial resolution in relation to the objects being observed.

From 1993 to 2000, ponds lost 4km^2 in area while mangroves gained 12km^2. From 2000 to 2010, ponds gained 10km^2 while mangroves lost 4km^2. From 2010 to 2020, ponds lost 25km^2 while mangroves gained 17km^2. Mangroves that recolonized abandoned ponds made up 29 percent of the total mangrove area in the study site in 2020. The co-occurrence of pond retraction and mangrove expansion between 1993 and 2020 may be related to the enactment of Department Administrative Order 76 in 1987 which established mangrove buffer zone areas and Republic Act 7161 in 1991 which banned cutting of all mangrove species in the Philippines. During the 3 study periods, the sequence of landscape transformation processes for ponds was fragmentation (breaking up of area into separate patches), aggregation (patch mergence), and attrition (patch reduction). Meanwhile, mangroves underwent creation (patch formation), followed by attrition, and creation again. Despite the decrease in total pond area, pond aggregation and increase in the total volume of fish production from brackish water ponds indicates aquaculture pond system intensification. Intensive pond systems require less land but higher inputs of fertilizers and feed which can affect water quality in the area.

The study provides a workflow for mapping mangrove-recolonized ponds and spatial pattern change using open access data and a cloud-based platform. Since the workflow is implemented on Google Earth Engine, it can be replicated in other regions and used for mangrove scenario planning and policy making. The study's findings show that identifying spatial patterns can provide additional insight on the landscape dynamics. It also suggests the necessity of further studies on the conditions surrounding mangrove recolonization of ponds and the integration of spatial pattern analysis in mangrove monitoring.