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Local Ocean Acidification Caused by Mariculture Activities in Coastal Areas of Bolinao, Northwestern Philippine

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Ocean acidification (OA) due to anthropogenic CO_2 emissions is a dominant driver of long-term changes in carbonate chemistry such as pH and pCO_2 in the open ocean. However in coastal areas, local and regional drivers interact with the anthropogenic CO_2 emissions and cause complex changes in seawater pH. High productivity in coastal ecosystems itself changes pH. Due to increase in coastal populations, increasing utilization of coastal areas for mariculture activities can be anticipated and the degradation of environment due to such activities are of concern. However, the relationship between such degradation and local OA has not been well documented so far. Here we examined possible impacts of extensive mariculture activities and ecosystem productivity in Bolinao, Northwestern Philippine, on seawater pH and other carbonate parameters.

We conducted temporal, 24-hr measurements of pH, pCO_2, etc. at the aquaculture and reef sites in Bolinao in March 2011 (dry season) and September 2011 (wet season). The aquaculture site is located in the narrow channel where hundreds of mariculture structures can be found. The reef site is located in the shallow Seagrass meadow which faces the open ocean. We also conducted spatial measurements of pH, pCO_2 , etc. around the same sites in September 2012 (wet season) and March 2013 (dry season). To see the longer trend, we deployed pH loggers at aquaculture and reef sites in the surface from March 7 to May 21, 2014 (at the aquaculture site until May 4 because of the sensor breakage) in the dry season and from September 28 to December 6, 2014 in the wet season. In Bolinao area, salinity during dry season is kept at 33 PSU or so and does not differ so much from the open ocean, while salinity during wet season decreases to 20 PSU or lower in all areas in the surface.

The snapshot measurements showed that at the reef site pH (pCO_2) was increased (decreased) significantly compared to the offshore values both in dry and wet seasons, whereas at the aquaculture site pH (pCO_2) was unchanged or decreased (increased) depending on the time. The long-term pH data also showed that the aquaculture site had lower pH compared to the offshore level, sometimes reaching as low as 7.5, while the reef site had higher pH sometimes reaching above 8.5 in the daytime. The daily pH variations at the aquaculture site was typically 0.2-0.3 unit, while those at the reef site was 0.5 or more. From these results, we conclude that the aquaculture site exhibits pronounced OA due to local influence from the mariculture activities, and the reef site has buffers against OA mainly caused by high primary productivity of seagrasses in the area.

Keywords: Ocean acidification, pH, Mariculture, Seagrass meadow