Mechanisms and Characteristics of High Speed Reef Rip Current

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BACKGROUND: Tropical and subtropical regions characterized by coral reef and carbonate sandy beach have attracted many tourists, however it gives rise to safety risk of coastal users who just visit a beach but does not know a nearshore current system. For instance, five drowning accidents in Ishigakijima, Okinawa were documented by Japan Coast Guard and were found to be caused by a strong offshore current commonly known as "reef current" in Okinawa in 2004 and 2005. Hence, field study and analysis of drowning accidents in carbonate beaches and coral reef system have been conducted since 2005 in Japan's subtropical regions in Kagoshima and Okinawa Prefectures particularly to establish and describe the strong offshore current mechanisms that is important for utilizing a beach with minimum risk, understanding a circulation of water and sediment transport in a coral reef system.

FIELD OBSRVATION: The entire project includes bathymetry survey by laser and aerial photographs, nearshore hydrodynamics (wave, current, mean water level, tide and temperature) study, drogue and dye experiment, wind observation, numerical simulation of downward current and public awareness program. High speed offshore reef rip current which exceeded 1.2m/s and caused by tide was measured in the summer of 2006, then other type of high speed reef rip current which probably caused by a superimposition of tide, wave and wind effects was measured in the winter of 2007 in Yoshiwara beach, Ishigakijima. In this paper, the later high speed reef rip current event is described. Yoshiwara beach as shown in Photo. 1 is selected as one of the major study sites. Wave gages, ECMs, tide gages and thermometers were installed in lagoons and narrow channel around reef gap, over a reef flat and offshore slope of coral reef as well as a monitoring camera on the beach.

CONCLUSION: The study has revealed that (i) the maximum 20 minute average offshore velocity could be order of 2.0m/s especially during winter season, because the northern wind that is perpendicular to the coast has been almost persistent and generated reasonably high wave, (ii) reef flat (reef edge) and lagoon system has a function to contain mass of water similar to a hydraulic dam or a reservoir, on the other hand a reef gap where an elevation is lower and reef width is narrower has a function to discharge water in the lagoon, (ii) mass of the water contained in the lagoon is dependent on tide, wave and wind. The authors would like to express their special appreciation to whom assist the project nevertheless a risky sea condition and hope the project improve the safe utilization of coral reef and carbonate beach.

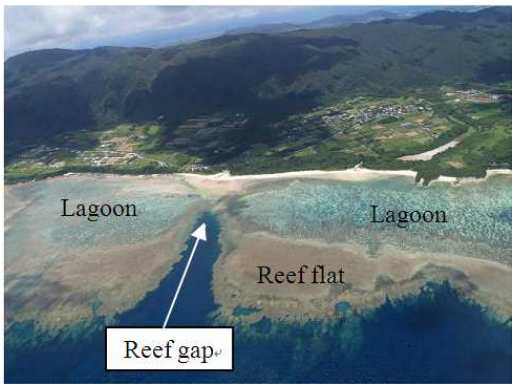

Photo. 1 Overview of Yoshiwara beach.

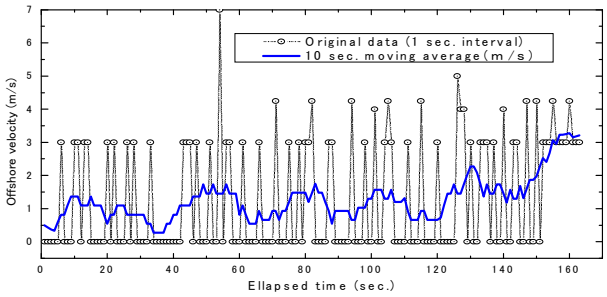

Fig. 1 Offshore velocity of GPS drogue around a reef gap.

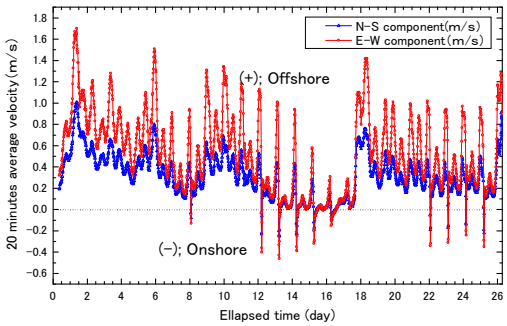

Fig. 2 20-minute average velocity in a reef gap.

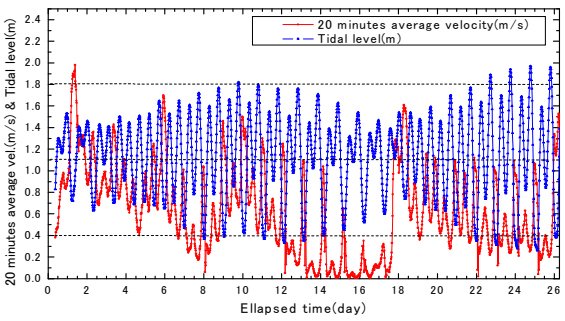

Fig. 3 Correlation between tide and current in a reef gap.