WATER QUALITY, CORAL AND SEAGRASS SURVEY IN FUKIDO ESTUARY, OKINAWA, JAPAN

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INTRODUCTION

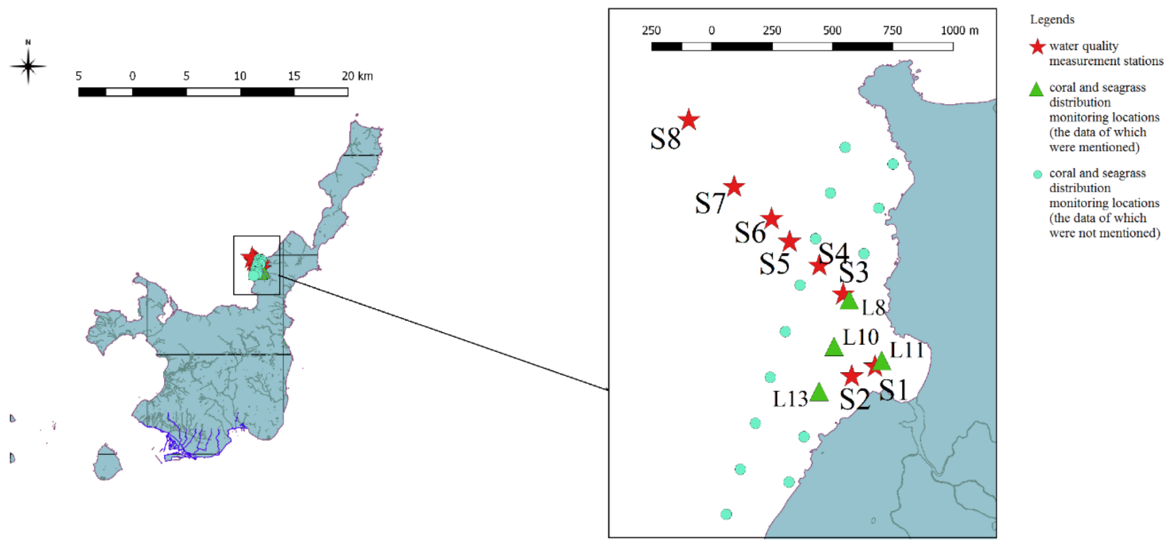
Ishigaki island is situated in the Okinawa prefecture and is the second largest island of the Yaeyama island group whereas Fukido river flows near the west coast of the Hirakubo peninsula. The Fukido river is lined with a mangrove and shelters a wide range of flora and fauna. This mangrove is located in the coastal area and receives nutrient and sediment loads which in turn affect the seagrass and coral distribution. Sufficient nutrient supply is a prerequisite for coral and seagrass growth and fluctuation in the nutrients or sediments inflow or outflow can adversely affect the environment. These sediment and nutrient supply vary depending on various factors like time of the day or year, season etc. The Fukido river has 0.12 km^2 of mangrove swamp which is home to adjacent coral reefs and seagrass beds. Some of the coral reefs in Fukido estuary area are subject to coral bleaching. To understand the water parameters (temperature, dissolved oxygen, salinity and turbidity), nutrient distribution (Total Nitrogen, Ammonium and Nitrate+Nitrite), field observations were conducted in eight points on September 3, 2016.

OBJECTIVES

The primary objectives of the experiment were to undertake the water quality analyses in the Fukido estuary, observe seagrass and coral distribution and its seasonal and yearly difference and also observe coral bleaching.

METHODOLOGY

Eight stations (S1, S2, S3, S4, S5, S6, S7 and S8) were used for data collection of water quality analyses. The stations for data collection for water quality analyses and locations of photo capturing are shown in map (Fig. 1). Water resistant camera with GPS lock (AW100, Nikon) was used to capture pictures. The camera clicked photos of underwater samples while floating on the water surface. Later the photos were manually filtered and coral/seagrass conditions were observed through the photos.



Fukido Estuary

Fig. 1: Location map

Keywords: Total Nitrogen, Salinity, Dissolved Oxygen, Nitrate, Turbidity

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Coral species detection and classification were done using the photos captured by the camera. Later photos captured during different seasons were compared to observe seasonal difference in the condition of the coral reefs and seagrass beds. The photos were also used to observe the condition of coral bleaching. Data were collected four times a year to observe the seasonal differences in different parameters. Here the observations done from the data collected on September 3, 2016 are mentioned. For the water quality analyses, samples were collected in the eight stations in surface layer and bottom layer of the water body. The collected samples were brought back to the laboratory for nutrient analyses. Total Nitrogen (TN), Ammonium (NH_4) and Nitrate+Nitrite (NO_3+NO_2) were analyzed. Vertical distribution of temperature, turbidity, salinity and dissolved oxygen (DO) were also measured using a portable multi-parameter water quality meter (AAQ 125: JFE Advantech Co., Ltd.).

Dissolved inorganic nutrients (NO_3-N and NH_4-N) and total nitrogen (TN) were determined spectrophotometrically using a continuous flow analyzing system (swat-TNTP system: BL TEC K.K.) based on the Japanese Standards Association JIS K 0170 (Japanese Standards Association, 2011). The following methods were used: for NH_4-N, alkaline phenate method with hypochlorite and sodium nitroprusside (indophenol blue); and for NO_3-N and TN, cadmium coil reduction followed by sulfanilamide reaction in the presence of N-(1-naphthylethylenediamine) dihydrochloride. TN samples were digested using the potassium peroxodisulphate method and heated at 120 ^{o}C for 40 min in an autoclave (Grasshoff et al., 1983).

RESULT

After analyzing the water samples collected in the stations, results of different parameters were noted and observed (Fig. 2). After the data sampled from the water samples collected in the surface layer and bottom layer of the stations were compared, it could be seen that the level of TN remained the same in both layers in S1 while it varied in the other stations. In case of S2 to S8, TN level was higher in surface layer compared to bottom layer. In case of NH_4, the amount varied in all the stations in both layers. The variation was especially remarkable in S2, S3 and S4. For the data of Nitrate and Nitrite, no specific trend could be noticed as the levels fluctuate in all the stations and in both the layers. While the amount of NO_3 and NO_2 is very small in S2 to S7, S1 and S8 show comparatively large amount of NO_3+NO_2 in surface and bottom layer respectively.

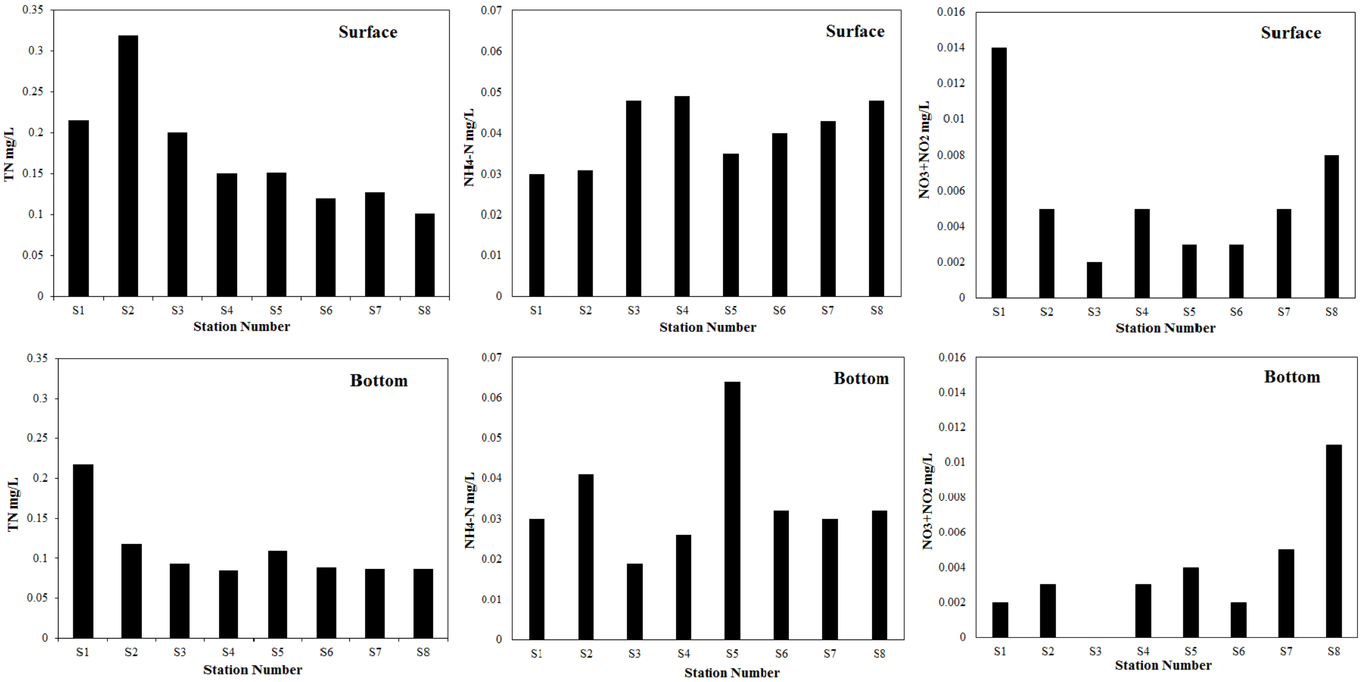

Fig. 2: Nutrients distribution (TN, NH_4-N and NO_3+NO_2) in surface (above) and bottom (below) layer

Among the different water parameters, temperature, turbidity, salinity and dissolved oxygen (DO) were measured (Fig. 3). From the data of S1, it could be seen that temperature, salinity and DO remained constant regarding the water depth whereas turbidity was almost zero upto 50 cm of depth and started to fluctuate after that. At 70 cm depth, the peak was as high as 400 FTU. In S2, temperature, salinity and DO remained unchanged throughout the depth. Turbidity at S2 was zero upto almost 120 cm depth where it showed a mild fluctuation. In S3, temperature and salinity were fixed but DO showed variation with depth. DO in S3 remained almost the same upto about 100 cm depth but started to slightly increase after that. Turbidity in S3 was found to be very high compared to S1 or S2. At around 130 cm depth, the peak was as high as almost 1200 FTU. This was the effect of sediment rising from the bottom of the bed due to river current. In S4, temperature and salinity remained the same as the previous stations. But, turbidity in S4 was comparatively higher than S1 and S2 but lower than S3. Turbidity was seen to be near zero upto almost 130 cm but reached as high as almost more than 500 FTU when the depth reached almost 140 cm. DO in this station showed similar trend as the DO data collected in S3. In S5, temperature, salinity and DO almost remained constant with respect to depth. The turbidity was comparatively lower in S5. In S6, temperature and salinity remained constant. DO showed a very slight fluctuation whereas turbidity exhibited a very scattered trend. In S7, temperature, salinity and DO remained unchanged throughout the depth. Turbidity was very minimal in amount. Only at the depth of more than 200 cm, turbidity showed a higher peak. In S8, temperature and salinity remained unchanged. DO displayed a very slight increase after the depth crossed 300 cm. Turbidity was almost nil upto 370 cm where it showed a sudden peak and was measured to be slightly above 200 FTU.

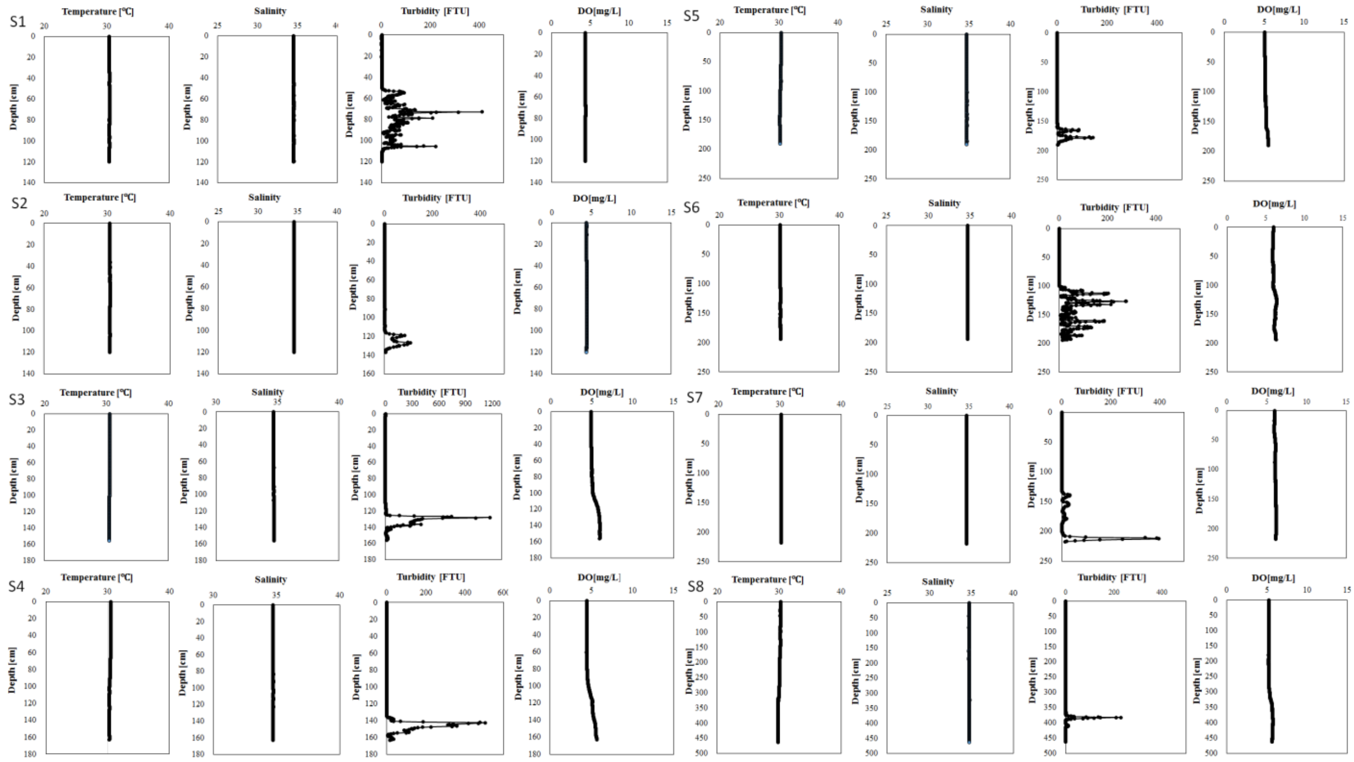

Fig 3: Water parameters distribution (Temperature, Salinity, Turbidity and DO)

After observing the photos, it could be seen that in L8, plenty of seagrass was present. Among them Umishoubu (*Enhalus Acoroides*) was also present which was a member of ‘hydrocharitaceae’ family and a specialty of Okinawa coastal region. Same type of seagrass was found in L10 as well (Fig. 4).

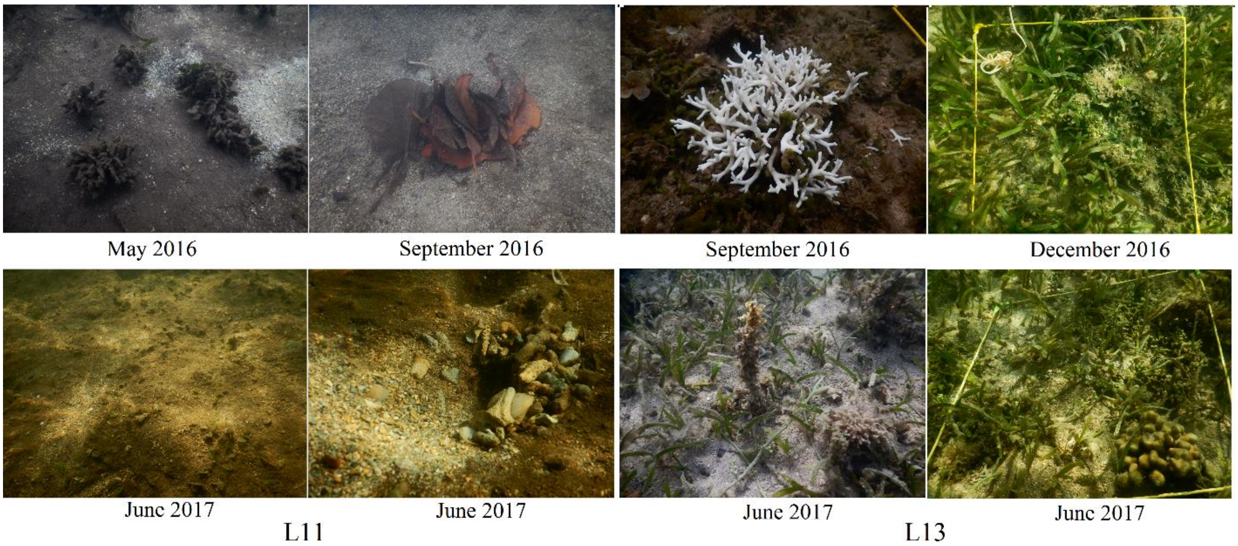

Fig. 4: Photo captured in L8, L10, L11 and L13 in different seasons

L11 was the nearest to the coast and the most affected by mangrove which explained the sediments and leaves at the water bed. L13 had seagrass and sediment deposition as well as evidence of coral bleaching.

DISCUSSION

Amount of TN was higher in surface layer of all stations compared to bottom layer except in S1 where the level of TN was same in both layers. S1 is the closest to the coast and its position affects its water quality. The amount of TN varied greatly depending on the station which meant that the nutrient load was different in different station. The data also showed the trend of TN decreasing. All the stations showed Ammonium to be present. The level of Nitrate and Nitrite varied depending on the stations but Nitrate and Nitrite amount proved that the nitrification and denitrification processes were ongoing. However, the amount of Ammonium was higher than NO_3+NO_2 which was unusual. All the stations showed same, moderate temperature which remained unchanged with depth. Salinity data showed that the seawater throughout the stations was not stratified but well mixed. Vertical distribution of DO showed slight fluctuation in S3 and S4 which might have a correlation with the high peak of turbidity. Turbidity varied based on stations which could be caused due to different sediment inflow and outflow. High turbidity in S3 and S4 could be because of sediment rise from the bottom of the river.

In case of coral and seagrass, some coral bleaching was noticed in September of 2016 in L13. Leaves were found in the water bed in September of 2016 in L11. The same location showed more sediment in June, 2017. In L8, the situation remained almost the same throughout different time of the year though June 2017 showed more sediment compared to before. In L10, plenty of seagrass was found in all seasons. L13 showed lesser coral or seagrass and more sediment in June 2017 compared to before.

CONCLUSIONS

Around the world, there are not many monitoring data regarding coral reefs or seagrass. However, it is necessary to undertake this sort of research to monitor and maintain the environment. Australia has some projects to monitor the coastal environment. Japan Government also supervises some research projects but those are too broad and not very specific. Our target is to focus on a small area but monitor its condition very specifically. We plan on analyzing the data of Total Phosphorus (TP), Phosphate (PO_4), Chlorophyll-a and C:N ratio of bottom sediments in future and keep monitoring the coral and seagrass condition.

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