Mangrove vegetation and bird communities around Tegal Port, Central Java,Indonesia

by Slamet Isworo

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Abstract. *Isworo S, Oetari PS. 2020. Mangrove vegetation and bird communities around Tegal Port, Central Java, Indonesia. Biodiversitas 21: 1551-1560.* The ecological balance in Tegal harbor area needs to get serious attention due to the impacts of Tegal Port activities. For this purpose, the diversity of mangrove and avifauna (bird) can be used as bio-indicators of the ecological stability of the area. This study aimed to assess and analyze the diversity of plants and avifauna (birds) that live in mangrove and coastal zones around Tegal Port development area. Data collection was conducted using purposive random sampling method on two sites for vegetation and three sites for avifauna. The importance value index, Shannon-Wiener diversity index and Sorensen's similarity index was calculated for the vegetation. For birds, we calculated the diversity and similarity index as well as identified their conservation status based on the IUCN Red List, CITES and government regulations. In terms of vegetation, *Rhizophora mucronata* and *Avicennia marina* dominate Site 2 (Tegalsari) while *Casuarina equisetifolia* and *R. mucronata* dominate Site 3 (Alam Indah Beach). Overall, the vegetation has low biodiversity index and similarity between sites is also low. For bird, there are 37 species from 18 families. Site 1 (Muara Reja) has the highest number of species with 29 species, followed by Site 2 (Tegalsari) with 25 species, and Site 3 (Alam Indah Beach) with 22 species. The three sites have moderate diversity index and there is high similarity index between sites. All bird species found in the study sites are listed as Least Concern under IUCN Red List, while there are two species protected under national protection law, i.e. *Ardea alba* and *Glareola maldivarum*. In general, the condition of mangrove vegetation around Tegal Port has low diversity. This suggests that the pressure on the environment is quite high, causing only few plant species to be able to live and dominate the ecosystem. The limited vegetation also causes birds community, especially the protected *A. alba* and *G. maldivarum* in Site 2, becomes increasingly difficult to find, because places to find food, breeding places and places to rest are disturbed.

Keywords: Avifauna, birds community, diversity and flatness index, ecological stability, mangrove vegetation

INTRODUCTION

Seaport development is often required to boost national and regional economies to support logistical transportation and distribution. Nonetheless, the development of seaport causes land-use change, particularly the coastal and mangrove area. Seaport development in marine areas includes the construction of docks, breakwaters, dredging of port ponds, shipping lines and dumping activities, while the development in land area includes the construction of access roads and port facilities.

The development of Tegal Port in Central Java Province, Indonesia is planned to utilize coastal and land areas. While this development is in accordance with national and regional regulations (i.e. Huda 2013; Nasution 2017), this development can certainly cause impacts on surrounding environment, including the flora and fauna community existing around the port development area. Flora and fauna are environmental components that support ecological system, so that safeguarding them is important to consider in the development of Tegal Port. Preserving the existence of various species of flora and fauna living in coastal and mangrove ecosystems around Tegal Port is one strategy to mitigate the impacts of its development (Sukardjo 1993). This strategy of retaining and conserving

biodiversity within industrial areas has been increasingly important in industrial sector, as in the case of mining concession (Fiqa et al. 2019), gas refinery (Sudrajat and Putro 2019) and geothermal power plant (Husodo et al. 2020).

Mangroves have special physiological properties in their tissues to adapt with environment with high level of salinity. Mangroves also have adaptations through the root system to support themselves in mud sediments. Mangrove forests in Tegal are communities of mangrove trees that grow along Java Sea coastline and are affected by tides. The condition of mangroves along the coast in Tegal District is very alarming. Most of mangrove forests in Tegal have experienced severe degradation because of conversion into shrimp ponds, exploitation of mangrove trees for firewood and timber as well as coastal abrasion. Currently, efforts to restore mangrove ecosystems in Tegal have been conducted including mangrove areas around Tegal Port, which is conducted by communities and facilitated by the port management. Mangrove ecosystem around Tegal Port is located in the pond area which is no longer used by community. Some species in mangrove and coastal ecosystems in the nearby area of Tegal Port (i.e. Alam Indah Beach) include *Casuarina sp.*, *Rhizophora mucronata*, *Avicennia marina*, and *Terminalia catappa*

(Ong and Gong 2013), which were planted by communities.

Despite hosting flora community, mangrove ecosystem is also a habitat of various species of avifauna (birds). These birds play an important role in maintaining ecological balance and environmental sustainability especially to control pests and facilitate pollination. In many cases, the existence of birds is often used as bioindicators to assess the state of biodiversity in a region, including in mangroves, because these taxa can occupy a vast habitat, have dynamic flexibility and high mobilization, and have very important roles in the food chain and ecological nets (Gustavsson et al. 2011; Bender et al. 2017). Each bird species has different ability to adapt with environment and can quickly respond to environmental changes, so that changes in environmental conditions can affect behavior and metabolism as a form of adaptive flexibility (Newbold, et al. 2013). In a good condition, mangrove forest is as a suitable habitat for avifauna that can provide them food, shelter and breeding ground.

The mangrove forest area around Tegal Port has diversity of species of birds and vegetation that have not been known specifically and scientifically. Although it is not a conservation forest, it is expected to affect the surrounding environment. Therefore, it is necessary to do research on bird diversity and vegetation in mangrove ecosystem around Tegal Port. This study aimed to assess and analyze the diversity of plants and avifauna (birds) that live in mangroves in the Tegal Port development area.

MATERIALS AND METHODS

Study period and area

The fieldwork was carried out from 10 March 2019 to 10 May 2019 in three mangrove areas in Tegal: (1) Muara Reja (109°7'25.787"E 6°50'57.057"S), (2) Tegalsari (109°8'3.58"E 6°50'59.259"S), (3) Pantai Alam Indah (109°8'42.23"E 6°50'56.929"S) (Figure 1). The average temperature at the study site was 28^0 C, the average air pressure ranged from 1009 mb to 1013 mb while air humidity ranged from 77% to 80%. The general overview of study location is presented in Figure 2.

Data collection

Vegetation sampling

Vegetation sampling was conducted using purposive random sampling method by making 5 observation plots with size of each plot 10 x10 m. At observation plot, each individual mangrove was recorded and measured of the diameter at breast height (DBH) and grouped based on strata: trees, poles, and sapling. Category of tree is mangrove with DBH> 10 cm, while pole 10 cm > DBH> 5 cm and sapling DBH < 5cm. Species identification was conducted using guidebooks (e.g. Giesen et al. 2007; Hamzah and Pancawati 2013; Chapman 2016; Hirsch 2016; Tomlinson 2016). Unknown species was labeled with temporary naming, then the samples were collected for further identification.
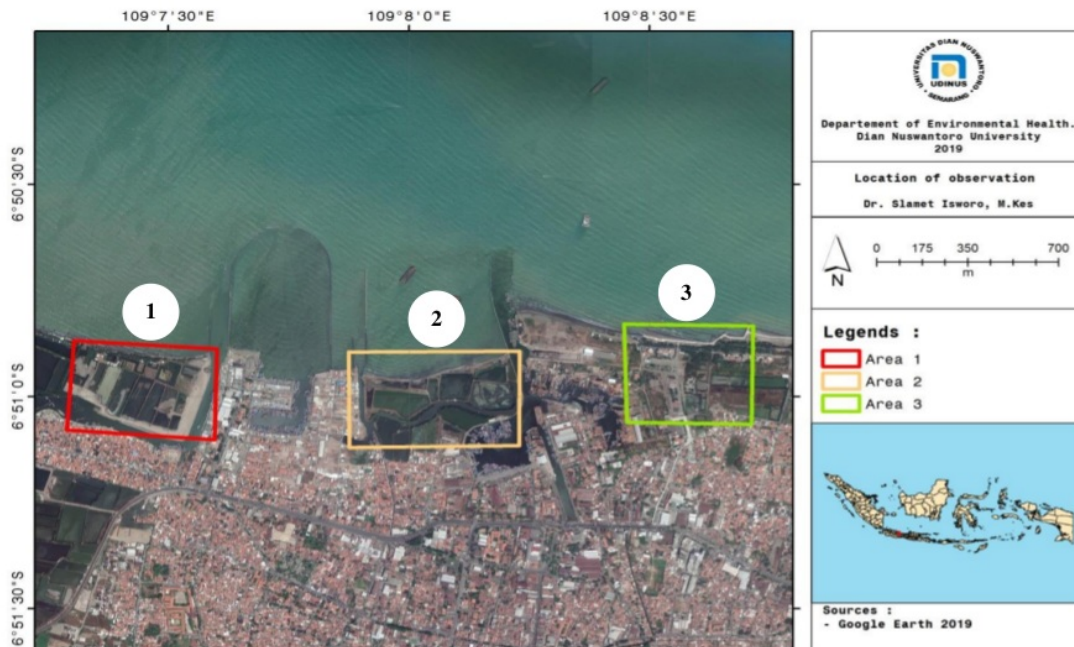

Figure 1. Location of observation in Tegal port, Central Java, Indonesia. A. Muara Reja (area 1), B. Tegal port (area 2), C. Pantai Alam Indah (area 3)

Figure 2. General overview of research sites in Tegal Port, Central Java, Indonesia. A. Muara Reja, B. Tegal port, C. Pantai Alam Indah

Avifauna community

The diversity of avifauna (birds) was recorded either inside and outside the observation plot. The observed species were identified referring to "A Field Guide Book to Birds of Borneo, Sumatra, Java, and Bali (MacKinnon et al. 2010). Each species was determined its conservation status under the Republic of Indonesia regulation (Noerdjito and Maryanto 2001), Red List of the International Union for Conservation of Nature/IUCN (Beumer and Martens 2013), and Implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora/CITES (Raymakers 2006).

Data analysis

The role of each species was assessed using Important Value Index (IVI). The higher the important value of a species, the greater the contribution of this type to the community (Widyastuti et al. 2018). The calculation of IVI was the sum of relative dominance, relative density and relative frequency as follows (Tauseef et al. 2012).

$$IVi = DoRi + DeRi + FRi$$

IVi : Important value of species i
DoRi: Relative dominance of species i
DeRi: Relative density of species i
FRi : Relative Frequency of species i

The relative value for each parameter was calculated as follow:

$$NRi = \frac{ni}{N}$$

NR i : Relative species i (DoR, DeR, FR)
n i : Quantitative value of species i (dominance, density, or frequency)
N : Total quantitative values of all species

To determine the stability of the mangrove community, a species diversity index was for each growth stage according to the following formula:

$$H' = -\sum Pi. lnPi$$

H' : Species diversity index
Pi : Quantitative value of type i/total all quantitative values of all species

The similarity between mangrove communities in the research sites for each growth stage was analyzed using Sorensen index and calculated as follows (Tauseef et al. 2012):

$$S = \frac{2W}{a+b} \ x \ 100\%$$

S : Sorensen similarity index
W : The Lowest number of quantitative values of the species in the two communities compared
a : Quantitative values of all species in the area a
b : Quantitative values of all species in the area b

For birds, the level of species diversity was analyzed using the Shannon-Wiener diversity index (H ') (Lestari et al. 2017).

RESULTS AND DISCUSSION

Mangrove community

For analysis regarding vegetation community, we conducted observation on two sites only, i.e. Site 2 (Tegalsari) and Site 3 (Alam Indah Beach). The results of vegetation analysis in terms of Important Value Index and diversity index are presented in Table 1 for mangroves in Tegalsari (Site 2) and Table 2 for mangroves in Alam Indah Beach (Site 3).

In Tegalsari (Site 2), *Rhizophora mucronata* has the highest Importance Value Index for tree and pole with value of 161 and 192, respectively while *Avicennia marina* has the highest for sapling with value of 114 (Table 1). In Alam Indah Beach (Site 3), the most important at tree level is *Casuarina equisetifolia* IVI of 188, while *Rhizophora mucronata* has the highest IVI index for pole and sapling with value of 160 and 241, respectively.

The biodiversity is reflected by the Shannon-Wiener Index (H ') (Nyein Aye et al. 2019) and presented in Tables 1 and 2. It can be seen that Tegalsari (Site 2) has a higher diversity index for tree and sapling than Alam Indah Beach (Site 3), but the diversity for pole is lower.

The similarity between community is not enough to be known merely through the composition of its species and quantitative calculation using Sorensen similarity index has better in reflecting similarity between sites (Maia and Coutinho 2012). Based on Table 3, Tegalsari (Site 2) and Alam Indah Beach (Site 3) has community similarity of 22.73%, 63.05% and 46.4% for tree, pole, and sapling, respectively.

Avifauna community

In total, there are 37 bird species across the three sites belong to 17 families (Table 4). Based on observations, it shows that the site with the highest species richness is Site 1 (Muara Reja) with 29 species, followed by Site 2

(Tegalsari) with 25 species, and Site 3 (Alam Indah Beach) with 22 species (Tables 5, 6 and 7).

Observations were also conducted on bird activities for three consecutive days in the observation area (Tables 5, 6 and 7). Daily activities can be grouped into flying, descending, looking for food, looking for food on the ground, perching and making noise.

The diversity index of bird species at each observation site is presented in Figure 3. The results show that Site 1 (Muara Reja) has the highest diversity index compared to the other two locations. This is a sign that Site 1 has a more stable avifauna community than the other sites.

Table 1. Importance value index (IVI) and Diversity Index (H ') of mangroves in Tegalsari (Site 2), Tegal Port, Central Java, Indonesia

Strata	No	Name	Do	De	Freq	DoR	DeR	FR	IVI	H'
Tree	1	*Avicennia marina*	197.1	0.02	0.40	32.98	27.91	22.22	83.11	0.36
	2	*Bruguiera cylindrica*	42.4	0.00	0.20	7.09	2.33	11.11	20.52	0.18
	3	*Excoecaria agallocha*	11.5	0.00	0.20	1.92	2.33	11.11	15.35	0.15
	4	*Rhizophora apiculata*	23.9	0.00	0.20	4.00	4.65	11.11	19.76	0.18
	5	*R. mucronata*	322.9	0.05	0.80	54.02	62.79	44.44	161.26	0.33
Total			597.8	0.09	1.80	100	100	100	300	1.20
Pole	1	*Avicennia marina*	70.1	0.02	0.80	12.76	14.10	33.33	60.20	0.32
	2	*Bruguiera cylindrica*	16.6	0.01	0.40	3.02	3.85	16.67	23.53	0.20
	3	*Rhizophora apiculata*	16.9	0.00	0.20	3.07	2.56	8.33	13.97	0.14
	4	*R. mucronata*	440.1	0.12	0.80	80.16	78.21	33.33	191.70	0.29
	5	*Xylocarpus moluccensis*	5.4	0.00	0.20	0.99	1.28	8.33	10.60	0.12
Total			549.0	0.16	2.40	100	100	100	300	1.00
Sapling	1	*Avicennia marina*	194.6	0.12	0.40	50.62	50.00	13.33	113.95	0.37
	2	*Bruguiera cylindrica*	23.2	0.02	0.80	6.05	6.78	26.67	39.49	0.27
	3	*Excoecaria agallocha*	7.3	0.00	0.40	1.91	1.69	13.33	16.93	0.16
	4	*Rhizophora apiculata*	4.1	0.00	0.20	1.08	0.85	6.67	8.59	0.10
	5	*R. mucronata*	146.5	0.09	0.80	38.11	37.29	26.67	102.07	0.37
	6	*R. stylosa*	8.6	0.01	0.40	2.24	3.39	13.33	18.96	0.17
Total			384	0.24	3	100	100	100	300	1.44

Note: Do: Dominance, De: Density, Freq: Frequency, DoR: Relative dominance, DeR: Relative density, FR: Relative frequency

Table 2. Importance value index (IVI) and Diversity Index (H ') of mangroves in Alam Indah Beach (Site 3), Tegal Port, Central Java, Indonesia

Strata	No	Name	Do	De	Freq	DoR	DeR	FR	IVI	H'
Tree	1	*Casuarina equisetifolia*	401.3	0.1	0.6	74.1	71.4	42.9	188.4	0.3
	2	*Hibiscus tiliaceus*	31.2	0.0	0.2	5.8	4.8	14.3	24.8	0.2
	3	*Rhizophora mucronata*	98.4	0.0	0.4	18.2	21.4	28.6	68.2	0.3
	4	*Terminalia catappa*	10.5	0.0	0.2	1.9	2.4	14.3	18.6	0.2
		Total	541.4	0.1	1.4	100	100	100	300	**1.0**
Pole	1	*Avicennia marina*	32.8	0.0	0.4	7.2	4.0	18.2	29.4	0.2
	2	*Casuarina equisetifolia*	61.8	0.0	0.6	13.5	6.5	27.3	47.3	0.3
	3	*Excoecaria agallocha*	101.3	0.0	0.2	22.2	12.1	9.1	43.4	0.3
	4	*Hibiscus tiliaceus*	32.2	0.0	0.2	7.1	4.0	9.1	20.2	0.2
	5	*Rhizophora mucronata*	228.0	0.2	0.8	50.0	73.4	36.4	159.8	0.3
		Total	456.1	0.2	2.2	100	100	100	300	**1.3**
Sapling	1	*Avicennia marina*	43.6	0.0	0.4	3.3	3.4	20.0	26.7	0.2
	2	*Casuarina equisetifolia*	7.3	0.0	0.2	0.5	0.5	10.0	11.0	0.1
	3	*Excoecaria agallocha*	3.8	0.0	0.2	0.3	0.2	10.0	10.5	0.1
	4	*Hibiscus tiliaceus*	3.2	0.0	0.2	0.2	0.2	10.0	10.5	0.1
	5	*Rhizophora mucronata*	1,282.8	0.8	1.0	95.7	95.7	50.0	241.3	0.2
		Total	1,340.8	0.9	2.0	100	100	100	300	**0.7**

Note: Do: Dominance, De: Density, Freq: Frequency, DoR: Relative dominance, DeR: Relative density, FR: Relative frequency

Tabel 3. Sorensen similarity index between Tegalsari (Site 2) and Alam Indah Beach (Site 3), Tegal Port, Central Java, Indonesia

Stratum	Species name	Important value index (IVI) Site 2	Site 3	S (%)
Tree	*Avicennia marina*	83.12		
	Bruguiera cylindrica	20.52		22.73
	Excoecaria agallocha	15.35		
	Rhizophora apiculata	19.76		
	Rhizophora mucronata	161.25	68.18	
	Casuarina equisetifolia		188.40	
	Hibiscus tiliaceus		24.81	
	Terminalia catappa		18.61	
Total		300	300	
Pole	*Avicennia marina*	60.20	29.42	
	Casuarina equisetifolia		47.27	
	Excoecaria agallocha		43.39	
	Hibiscus tiliaceus		20.18	
	Rhizophora mucronata	191.70	195,75	63.05
	Bruguiera cylindrica	23.53		
	Rhizophora apiculata	13.97		
	Xylocarpus moluccensis	10.60		
Total		300	300	
Sapling	*Avicennia marina*	113.95	26.69	
	Casuarina equisetifolia		11.00	
	Excoecaria agallocha	16.93	10.51	
	Hibiscus tiliaceus		10.47	
	Rhizophora mucronata	102.07	241.33	46.42
	Bruguiera cylindrica	39.49		
	Rhizophora apiculata	8.59		
	Rhizophora stylosa	18.96		
Total		300	300	

Table 4. Number of individuals and composition of bird species in Tegal Port area, Central Java, Indonesia

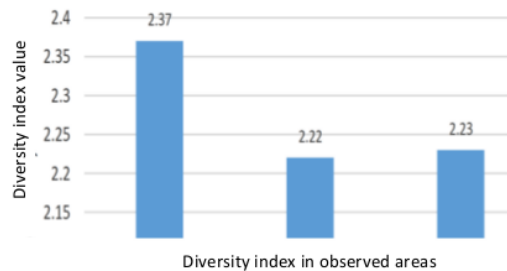| Family	Percentage	Individual
Scolopacidae	4	3
Gareolidae	4	3
Columbidae	4	3
Sternidae	4	3
Cuculidae	4	3
Nectariniidae	4	3
Artamidae	4	3
Chloropsidae	4	3
Pycnonotidae	5	4
Hirundinidae	5	4
Meropidae	5	4
Charadriidae	5	4
Silvidae	5	4
Rallidae	5	4
Apodidae	8	6
Alcedinidae	11	8
Ardeidae	19	14
	100	76

Figure 3. Shannon-Wiener diversity index of bird species at three observation sites in Tegal Port, Central Java, Indonesia
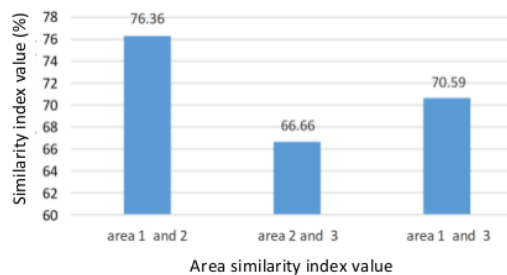
Figure 4. Sorensen's similarity index of bird species between observation sites in Tegal Port, Central Java, Indonesia

Table 5. Bird's activities observed at Site 1 (Muara Reja), Tegal Port, Central Java, Indonesia

Local name	Family	Scientific name	Observed activity
Bambangan Kuning	Ardeidae	*Ixobrychus sinensis*	Fly, find food
Blekok Sawah	Ardeidae	*Ardeola speciosa*	Fly, find food
Bondol Haji	Ploceidae	*Lonchura maja*	Fly, find food
Bondol Peking	Ploceidae	*Lonchura punctulata*	Fly, find food, nest
Burung Gereja Erasia	Ploceidae	*Passer montanus Lonchura*	Fly, perch, find food
Burung Madu Sriganti	Nectariniidae	*Nectarinia jugularis*	Fly, perch, find food
Cangak Abu	Ardeidae	*Ardea cinerea*	Fly
Cekakak Australia	Alcedinidae	*Todirhamphus sanctus*	Fly, perch, find food
Cekakak Sungai	Alcedinidae	*Todirhamphus chloris*	Fly, perch, find food
Cerek Kalung Kecil	Charadriidae	*Charadrius dubius*	Look for food
Cerek Tilil	Charadriidae	*Charadrius alexandrinus*	Look for food
Cici Padi	Silvidae	*Cisticola juncidis*	Fly, perch, find food
Cipoh Kacat	Chloropsidae	*Aegithina tiphia*	Roost, find food
Cucak Kutilang	Pycnonotidae	*Pycnonotus aurigaster*	Fly, perch, find food
Dara Laut Sayap Putih	Sternidae	*Chlidonias leucopterus*	Fly, find food
Kareo Padi	Rallidae	*Amaurornis phoenicurus*	In the bush looking for food
Kapinis Rumah	Apodidae	*Apus pacificus*	Fly
Kirik-Kirik Laut	Meropidae	*Merops philippinus*	Fly
Kokokan Laut	Ardeidae	*Butorides striatus*	Fly, perch, find food
Kuntul Kecil	Ardeidae	*Egretta garzetta*	Fly, perch, find food
Layang-Layang Batu	Hirundinidae	*Hirundo tahitica*	Fly, find food on the ground
Layang-Layang Loreng	Hirundinidae	*Hirundo striolata*	Fly
Merbah Cerukcuk	Pycnonotidae	*Pycnonotus goiavier*	Fly, perch, find food
Raja Udang Biru	Alcedinidae	*Alcedo coerulescens*	Fly, perch, find food
Remetuk Laut	Silvidae	*Gerygone sulphurea*	Noiseless flying
Tekukur bIasa	Columbidae	*Streptopelia chinensis*	Fly, perch, on the ground foraging
Trinil Pantai	Scolopacidae	*Tringa hypoleucos*	looking for food on the beach
Walet Linchi	Apodidae	*Collocalia linchi*	Fly
Walet Sarang Putih	Apodidae	*Collocalia fusiphaga*	Fly

Table 6. Bird's activities observed at Site 2 (Tegalsari), Tegal Port, Central Java, Indonesia

Local name	Family	Scientific name	Observed activity
Blekok sawah	Ardeidae	*Ardeola speciosa*	Fly, find food
Bondol haji	Ploceidae	*Lonchura maja*	Fly, find food
Bondol haji	Ploceidae	*Lonchura maja*	Fly, find food
Bondol peking	Ploceidae	*Lonchura punctulata*	Fly, find food, nest
Burung gereja erasia	Ploceidae	*Passer montanus*	Fly, perch, find food
Burung madu sriganti	Nectariniidae	*Nectarinia jugularis*	Fly, perch, find food
Cangak besar	Ardeidae	*Ardea alba*	Fly, perch, find food
Cekakak australia	Alcedinidae	*Todirhamphus sanctus*	Fly, perch, find food
Cekakak sungai	Alcedinidae	*Todirhamphus chloris*	Fly, perch, find food
Cerek kalung kecil	Charadriidae	*Charadrius dubius*	Look for food
Cici padi	Silvidae	*Cisticola juncidis*	Fly, perch, find food
Cucak kutilang	Pycnonotidae	*Pycnonotus aurigaster*	Fly, perch, find food
Kareo padi	Rallidae	*Amaurornis phoenicurus*	Fly
Kokokan laut	Ardeidae	*Butorides striatus*	Fly
Kowak-malam abu	Ardeidae	*Nycticorax nycticorax*	Fly
Kuntul kecil	Ardeidae	*Egretta garzetta*	Fly, find food
Layang-layang batu	Hirundinidae	*Hirundo tahitica*	Fly, find food on the ground
Merbah cerukcuk	Pycnonotidae	*Pycnonotus goiavier*	Fly, find food on the ground
Raja udang biru	Alcedinidae	*Alcedo coerulescens*	Fly, perch, find food
Remetuk laut	Silvidae	*Gerygone sulphurea*	Noiseless flying
Tekukur biasa	Columbidae	*Streptopelia chinensis*	Fly, perch, on the ground foraging
Terik asia	Gareolidae	*Glareola maldivarum*	Noiseless flying
Bambangan kuning	Ardeidae	*Ixobrychus sinensis*	Fly, perch, find food
Tikusan merah	Rallidae	*Porzana fusca*	looking for food on the beach
Walet linchi	Apodidae	*Collocalia linchi*	Fly

Table 7. Bird's activities observed at Site 3 (Alam Indah Beach), Tegal Port, Central Java, Indonesia

Local name	Family	Scientific name	Observed activity
Bambangan Kuning	Scolopacidae	*Tringa hypoleucos*	Fly, find food
Bondol Haji	Ploceidae	*Lonchura maja*	Fly, find food
Bondol Haji	Ploceidae	*Lonchura maja*	Fly, find food
Bondol Peking	Ploceidae	*Lonchura punctulata*	Fly, find food, nest
Burung Gereja Erasia	Ploceidae	*Passer montanus*	Fly, find food
Cekakak Australia	Alcedinidae	*Todirhamphus sanctus*	Fly, perch, find food
Cekakak Sungai	Alcedinidae	*Todirhamphus chloris*	Fly, perch, find food
Cici Padi	Silvidae	*Cisticola juncidis*	Fly, perch, find food
Cucak Kutilang	Pycnonotidae	*Pycnonotus aurigaster*	Fly, perch, find food
Kekep Babi	Artamidae	*Artamus leucorhynchus*	Fly, perch, find food
Kokokan Laut	Ardeidae	*Butorides striatus*	Fly
Kuntul Kecil	Ardeidae	Egretta garzetta	Fly, perch, find food
Layang-Layang Batu	Hirundinidae	*Hirundo tahitica*	Fly
Loreng	Hirundinidae	*Hirundo striolata*	Fly
Merbah Cerukcuk	Pycnonotidae	*Pycnonotus goiavier*	Fly, find food on the ground
Raja Udang Biru	Alcedinidae	*Alcedo coerulescens*	Fly, perch, find food
Meninting	Alcedinidae	*Alcedo meninting*	Fly, perch, find food
Remetuk Laut	Silvidae	*Gerygone sulphurea*	Noiseless flying
Tekukur bIasa	Columbidae	*Streptopelia chinensis*	Fly, perch, foraging
Trinil Pantai	Scolopacidae	*Tringa hypoleucos*	Fly, perch, find food
Walet Linchi	Apodidae	*Collocalia linchi*	Fly
Wiwik Uncuing	Cuculidae	*Cuculus spulcralis*	Noiseless flying

Table 8. The conversion status of bird species according to three references

Familia	Indonesian name	Scientific name	Conservation status			Population trend **
			(*)	(**)	(***)	
Ardeidae	Kuntul kecil	*Egretta garzetta*	not protected	LC	-	Increasing
Ardeidae	Cangak Abu	*Ardea cinerea*	not protected	LC	-	Unknown
Ardeidae	Cangak besar	*Ardea alba*	protected	LC	-	Unknown
Ardeidae	Kokokan laut	*Butorides striatus*	not protected	LC	-	Decreasing
Ardeidae	Blekok sawah	*Ardeola speciosa*	not protected	LC	-	Unknown
Ardeidae	Kowak-malam abu	*Nycticorax nycticorax*	not protected	LC	-	Decreasing
Ardeidae	Bambangan kuning	*Ixobrychus sinensis*	not protected	LC	-	Unknown
Rallidae	Tikusan merah	*Porzana fusca*	not protected	LC	-	Decreasing
Rallidae	Kareo padi	*Amaurornis phoenicurus*	not protected	LC	-	Unknown
Charadriidae	Cerek-kalung kecil	*Charadrius dubius*	not protected	LC	-	Stable
Charadriidae	Cerek tilil	*Charadrius alexandrinus*	not protected	LC	-	Decreasing
Scolopacidae	Trinil pantai	*Tringa hypoleucos*	not protected	LC	-	Decreasing
Gareolidae	Terik asia	*Glareola maldivarum*	protected	LC	-	Decreasing
Sternidae	Dara-laut sayap-putih	*Chlidonias leucopterus*	not protected	LC	-	Stable
Columbidae	Tekukur biasa	*Streptopelia chinensis*	not protected	LC	-	Increasing
Cuculidae	Wiwik uncuing	*Cuculus spulcralis*	not protected	LC	-	Stable
Apodidae	Walet linci	*Collocalia linchi*	not protected	LC	-	Decreasing
Apodidae	Kapinis rumah	*Apus pacificus*	not protected	LC	-	Increasing
Apodidae	Walet sarang putih	*Collocalia fusiphaga*	not protected	LC	-	Decreasing
Alcedinidae	Meninting	*Alcedo meninting*	not protected	LC	-	Decreasing
Alcedinidae	Raja-udang biru	*Alcedo coerulescens*	not protected	LC	-	Stable
Alcedinidae	Cekakak sungai	*Todirhamphus chloris*	not protected	LC	-	Decreasing
Alcedinidae	Cekakak australia	*Todirhamphus sanctus*	not protected	LC	-	Increasing
Meropidae	Kirik-kirik laut	*Merops philippinus*	not protected	LC	-	Stable
Hirundinidae	Layang-layang batu	*Hirundo tahitica*	not protected	LC	-	Unknown
Hirundinidae	Layang-layang loreng	*Hirundo striolata*	not protected	LC	-	Stable
Pycnonotidae	Cucak kutilang	*Pycnonotus aurigaster*	not protected	LC	-	Decreasing
Pycnonotidae	Merbah cerukcuk	*Pycnonotus goiavier*	not protected	LC	-	Increasing
Chloropsidae	Cipoh Kacat	*Aegithina tiphia*	not protected	LC	-	Unknown
Silvidae	Remetuk laut	*Gerygone sulphurea*	not protected	LC	-	Decreasing
Silvidae	Cici padi	*Cisticola juncidis*	not protected	LC	-	Increasing
Artamidae	Kekep Babi	*Artamus leucorhynchus*	not protected	LC	-	Stable
Nectariniidae	Burung-madu sriganti	*Nectarinia jugularis*	not protected	LC	-	Stable
Ploceidae	Burung-gereja Erasia	*Passer montanus Lonchura*	not protected	LC	-	Decreasing
Ploceidae	Bondol Jawa	*leucogastroides*	not protected	LC	-	Stable
Ploceidae	Bondol peking	*Lonchura punctulata*	not protected	LC	-	Stable
Ploceidae	Bondol haji	*Lonchura maja*	not protected	LC	-	Stable

Note: (*) Indonesian animal protection law (Lubis 2017) (Reeve 2014); (**) IUCN (IUCN 2014) (Beumer and Martens 2013), (***) CITES (Corella 2012); LC = Least Concern.

The similarity of bird communities between sites was analyzed using Sorensen's index (Morelli 2013) and is presented in Figure 4. Communities are said to be the same if Sorensen's similarity value reaches more than 60%. From the calculation, it shows that two areas having the most similarity in bird species composition are observed at Site 1 and Site 2.

In this study, the conservation status of bird species was identified referring to Indonesian government regulations, IUCN (The International Union for Conservation of Nature) and CITES (Convention on International Trade in Endangered Species). The list is presented in Table 8.

Discussion

Mangrove community

In general, the vegetation in Site 2 (Tegalsari) can be categorized as a mangrove forest with *Rhizophora mucronata* and *Avicennia marina* as the main constituent. On the other hand, Site 3 (Alam Indah Beach) can be categorized as coastal forest with the Cypress Sea (*Casuarina equisetifolia)* dominated the area along with species of shrubs in sandy areas. This is justified by important value index (IVI) and diversity index of such species. The IVI describes the role of a plant species in a vegetation community in which the greater the importance value index of a plant species, the greater the role of the species in the community. The important value index can also be said as a quantitative parameter to express the level of dominance of a species in a plant community. The dominant species in a plant community will have a high importance value index, such the most dominant species will have the highest importance value index (Tauseef et al. 2012; Daly et al. 2018).

Each species has an important role in mangrove community, especially at the growth stages of tree and pole (Giesen et al. 2007). It is justified with the fact that at the time of observation, birds used these two growth stages to support their lives, especially for making nests. In Site 2 (Tegalsari), *Rhizophora mucronata* has the highest important value index at tree and pole stages, while at sapling category *Avicennia marina* has the highest index. On the other hand, the tree stage in Site 3 (Alam Indah Beach) is dominated by Cypress Sea (*Casuarina equisetifolia*) while *Rhizophora mucronata* dominates the juvenile stages. This is understandable since Site 3 (Alam Indah Beach) is a tourist area. However, with the dominance of *Rhizophora mucronata* at juvenile stages, it is likely that the vegetation community in this site will be dominated by this species in the future.

Rhizophora mucronata is commonly found to have high density, high frequency and high dominance in mangrove vegetation, indicating that this species has important role in mangrove community and affects the stability of the ecosystem (Lacerda et al. 2017). This also applies to *Avicennia marina*. Species from the genus of Rhizophora and Avicennia generally dominate Indonesian coastal region, showing a strong mutualism between the two families (Sandilyan and Kathiresan 2012). *Rhizophora mucronata* is easy to grow either in areas with high or low

tidal inundation and it is highly halophytic or salt tolerant. *Avicennia marina* has high survival ability in which when damaged it can immediately recovering and grow back. Both species also have dense and intertwined breathing roots which are very effective to capture and hold mud. This is an ideal microhabitat for various species of mangrove crabs, snails and fish, resulting in a symbiotic mutualism between organisms (Singh and Odaki 2004). Besides marine fauna, we also observed bird species from the Ardeidae family nesting on *Rhizophora mucronata* in our study sites. Whereas *Avicennia marina* at the sapling level becomes nesting place of *Leucogastroides sp.*, *Lonchura punctulata,* and *Lonchura maja*.

In term of vegetation similarity, Site 2 and Site 3 has 22.7% of Sorensen's similarity index for tree stage, while for pole and sapling, they have similarity of 63% and 46.4%, respectively. The low similarity is likely caused by the difference in vegetation type in which Site 2 tends to be an area with mangrove forest type, while Site 3 tends to show the type of coastal forest. The community similarity index illustrates the level of structural similarity and species composition of the stands being compared. The similarity index value ranges from 0-100%, where the higher the value of the index of species similarity indicates the higher the level of similarity of species between the two communities compared, can also be interpreted that the higher the index value of the similarity of species (Rani et al. 2018).

The results of vegetation analysis show the current ecological conditions of mangrove vegetation around Tegal Port so that the impacts caused by the port activities can be carried out without damaging the surrounding environment and being sustainable (Tomlinson 2016). In general, the condition of mangrove vegetation around Tegal Port has low diversity. This suggests that the pressure on the environment is quite high, causing only few plant species to be able to live and dominate the ecosystem (Kordas, Dumbrell and Woodward 2016).

Avifauna community

Based on the results, the three study sites consist of 37 species of avifauna (birds) from 18 families. Site 1 (Muara Reja) has the highest number of species with 29 species, followed by Site 2 (Tegalsari) with 25 species, and Site 3 (Alam Indah Beach) with 22 species. Ardeidae is the family with the highest number of species with 7 (19%) of the total species. This shows that mangrove habitat around Tegal Port is suitable for the *Ardeidae* family. This family contains protected species, i.e. *Ardea alba* and *Glareola maldivarum* (Handayani et al. 2018), both are found in Site 2. Site 3 has the lowest number of species since it has coastal forest vegetation with a dominance of *Lonchura punctulata* and *Passer montanus*.

Based on calculations using the Shannon-Wiener diversity index, it is known that Site 1 has the highest diversity. This shows that Site 1 has better avifauna community stability than the other two sites. This is because, in Site 1, there are no species that are very dominating. Shannon-Wiener diversity index is strongly

influenced by species abundance, meaning that if there are one species tends to dominate, it can reduce the diversity index overall (Stirling and Wilsey 2001). In addition, the higher diversity index in Site 1 is also due to the high species richness compared to the other two sites since the value of diversity is directly proportional to species richness.

The Sorensen's similarity index for avifauna in the studied area is 76% between Site 1 and Site 2, 70% between Site 1 and Site 3, and 66% between Site 2 and Site 3. Based on this result, bird communities among the three sites are said to be identified as the Sorensen's similarity value reaches more than 60% with the highest percentage of similarity is between Site 1 and Site 2. The similarity index is used to determine the composition that underlies the presence or absence of a relationship between the number of species that are common in the two community areas and the total species. The result of this study suggests that the bird population living Tegal Port area can move across the three sites. Birds can move from a site to other sites if the site is no longer able to support them, so they will find suitable areas for their lives. The greater similarity index between regions, the more suitable and the higher the chance of a species to move to the area (Hoda et al. 2017).

All bird species found in the study sites are listed as Least Concern under IUCN Red List, while there are two species protected under national protection law, i.e. *A. alba* and *G. maldivarum* (Terik Asia). Based on the Asian Waterbird Census 2008-2015, there are 98 species of settlers and wanderers with 112 thousand individuals observed in Indonesia. Of them, 80 species are categorized as low risk (Least Concern), 11 species approaching endangered (Near Threatened), 2 species are under Vulnerable and 5 species are under Endangered. In 2017, it is predicted that there will be an increase of 142 locations with a total of 103 settlers and wanderers waterbirds monitored, including *G. maldivarum* and *A. alba*. This situation is due to disturbance in the habitat of both birds due to anthropogenic activity (Mundkur, Langendoen and Watkins 2017). *A. alba* is waterbird species that has the behavior of flying more often alone or in small groups, tends to be solitary and unusual in the presence of humans (Green et al. 2016). *G. maldivarum* is a species of bird from the Glareolidae family, living in groups, flying to catch insects in the air, resting on the ground, foraging for food mingling with other scaffolds, but separated by flight. This bird is a type of insectivorous and has habitats in swamps and rice fields, spread to a height of 500 m above sea level (Lestari et al. 2017).

In summary, the impact of the development of Tegal Port causes the reduction of mangrove vegetation, so that the avifauna (birds) community, especially *A. alba* and *G. maldivarum* in Site 2 becomes increasingly difficult to find, because places to find food, breeding places and places to rest are disturbed, they will leave their habitat if there is an ecological imbalance in their habitat.

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