Manilkara
Volume 01 Edisi 02, Februari 2023
Halaman: 62-71

https://doi.org/10.33830/Manilkara.v1i2.4654.2023
E-ISSN: 2964-0164

Relationship Between Bird Communities and Environmental Changes in Tandung Village, Tinambung District, Polewali Mandar Regency, West Sulawesi Province

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Diterima: 10 Jan 2022 | Disetujui: 02 Feb 2023

ABSTRACT

Indonesia's coastal region is known for its richness and diverse natural resources. However, the region is experiencing a transformation from mangrove ecosystems to the traditional pond cultures. This was happening in West Sulawesi that could damage the ecosystem in the long term, especially for the bird community. This study aims to inventory bird species in the bird community on the coast of Tandung Village, Tinambung District, Polewali Mandar Regency, West Sulawesi Province. In addition, we also study the bird community structure, find out the correlation among the bird communities, and the environmental condition during the inventory. In this study, we used a fixed-radius point count method to record birds. Field guide titled Burung-burung Pulau Paparan Sunda dan Wallacea di Kepulauan Indonesia was used to identify the species of observed birds. The results showed that of the 27 species recorded, there are 5 species with a high relative abundance, such as *Egretta garzetta*, *Himantopus leucocephalus*, *Actitis hypoleucos*, *Ardeola speciosa*, and *Calidris ruficollis*. Only *H. leucocephalus* is identified as a protected bird by the Indonesian government, while *Calidris ruficollis* is protected internationally as its conservational status (Near Threatened). The diversity index is moderate level, but it is decreasing day by day of observation, followed by the dominance index, evenness, and species richness. A high correlation between the two bird communities with two adjacent days of observation indicates similarity composition of community structure with different temporal scales and similar spatial scales. The map of environmental conditions shows changing weather in the period of observation sequentially from bright sky to cloudy and heavy rain and back to the normal bright sky at the last period of observation. The response of the bird community to the condition was by flying away when the weather is cloudy and rainy so that may decrease the diversity.

Keywords: transformation, a fixed-radius point count method, bird community, coastal region, wetlands.

INTRODUCTION

Indonesia is one of the biodiversity hotspots with the highest in the world. Besides, Indonesia also has some locations with the route for migratory birds in the East Asian Australasian Flyway sites. The migratory birds are commonly found on the wetlands such as rivers, lakes, and coastal ponds, either shrimp ponds or fish ponds. The wetlands are used by the bird, for stopping oversite after a long journey escaping the winter season with few food resources to the warm places with abundant food, including the coasts of Indonesia.

Indonesia coastal regions are known for its richness and diverse natural resources, which is mangrove ecosystem as one of the largest in the world. Its size was approximately 3.2 million ha, although this was the decreased size from 4.25 million ha (Arbit *et al.,* 2015). However, in West Sulawesi there has been a conversion from mangrove ecosystem to traditional pond cultures. for the economic reason. Consequently, there are many cases found that local community do the intensification to pond that could damage to nature in the long term (Sigit, 2013). The inventory of the bird communities is urgently needed to be done.

West Sulawesi provides the good quality habitat for the bird communities. This is supported by relevant research recently in the region, such as the diversity and species conservation status for avifauna on the Mampie Widlife Reserve in the Polewali Mandar Regency (Karim *et al.,* 2016), non-coastal avifauna on the Makmur Jaya Village in the Pasangkayu Regency (Rahayu, 2019), and the variation of bird diversity in the oil palm land in North Mamuju (Ramlah *et al.,* 2021). However, relevant research of bird community structures on the unprotected coastal wetlands does not yet to be carried out. Due to these findings, the bird community structures are necessarily to be documented. This study aims to inventory the species of bird community, identifying the bird community structure, to find out the correlation among the bird community, and to describe the environmental condition during the inventory of species in the bird community in the West Sulawesi.

RESEARCH METHOD

In this study, we used a fixed-radius point count method (Hutto *et al.,* 1986; Bibby *et al.,* 1992) to record birds in the coast of Tandung Village, Tinambung District, Polewali Mandar Regency, West Sulawesi Province (see Figure 1). Using the method, we observed flying birds by standing at a large rounded area of four fish ponds. The radius of the area was 100 meters (Volpato *et al.,* 2009) and no bird count was performed outside the area. We did birdwatch at 06.00 AM to 08.00 AM Central Indonesia Zone Time. We used the direction of compass while the birds were flying to avoid double counting. We used 6 different days of observation at the same time from September to December 2022. The period 6 days of observation are symbolized as Point_date month year. There are Point_180922, Point_021022, Point_231022, Point_061122, Point_271122, and Point_041222. Field guide titled *Burung-burung Pulau Paparan Sunda dan Wallacea di Kepulauan Indonesia* by Eaton *et al.* (2022) was used to identify the species of observed birds. IUCN Red List and PermenLHK no. 92/2018 are used to identify the conservation status of the observed birds. GPS Garmin 64s was used to mark the coordinate of the location.

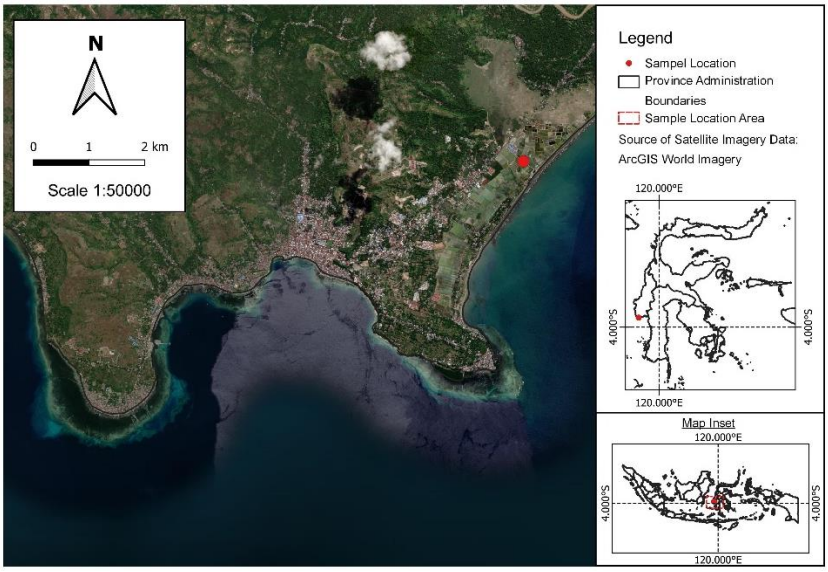

Figure 1. Map Location of this study in the coast area of Tanjung Village

After fieldwork, we calculate the relative abundance each species through DAFOR scale (Hearnshaw & Hughey, 2010) in Microsoft Excel 2013. DAFOR were consisting of Dominant by 51-100%, Abundant by 31-50%, Frequent by 16-30%, Occasional by 6-15%, Rare by 1-5%, and the last but not least, Not present form 0%. We analysed the Shannon Diversity Index, the Simpson Dominance Index, Pielou's evenness, and Pearson's correlation among the community each day. RStudio version 2022.12.0+353 (R Core Team, 2021) was used for statistical computing: the *vegan* package (Oksanen *et al.,* 2022) for measuring diversity, dominance and evenness, while the *psych* package (Revelle, 2022) for correlation and data visualisation.

To obtain the information about the abiotic environment, Landsat 8 satellite imagery between September 2022 and December 2022 were downloaded from the USGS Earth Explorer. Lay outing obtained satellite imagery with the marked coordinate was done by QGIS version 3.16.14-Hannover (QGIS.org, 2022) to visualize the weather condition during fieldwork period.

RESULT AND DISCUSSION

Five species whose relative abundance (RA) should be of concern

The result showed 27 species found during 6 days of observation. The most abundant species was *Egretta garzetta* or Little Egret (Table 1), followed by *Himantopus leucocephalus* or White-headed Stilt as a frequent species. Occasionally, few species were observed such as *Actitis hypoleucos* or Common Sandpiper, *Ardeola speciosa* or Javan-pond Heron, and *Calidris ruficollis* or Red-necked Stint. From these five species, only White-headed Stilt was protected by national government: Permen LHK No. 92/2018. On the other hand, Red-necked Stint has a more concern status i.e. Near Threatened (NT), while this species is not protected nationally by government law.

Table 1. Species Occurrence in the 6 days for the measurement of Relative Abundance (RA) and DAFOR (Dominant, Abundant, Frequent, Occasional, Rare) scale (LC : Least Concern; NT: Near Threatened)

English Name	Scientific Name	The number of Individuals	IUCN Red List Status	Nationally Protected?	RA (%)	DAFOR scale
Common Sandpiper	*Actitis hypoleucos*	17	LC	No	5.842	Occasional
Kentish Plover	*Anarhynchus alexandrinus*	6	LC	Yes	2.062	Rare
Sunda Teal	*Anas gibberifrons*	6	NT	No	2.062	Rare
Great Egret	*Ardea alba*	10	LC	Yes	3.436	Rare
Intermediate Egret	*Ardea intermedia*	3	LC	No	1.031	Rare
Purple Heron	*Ardea purpurea*	7	LC	No	2.406	Rare
Javan-pond Heron	*Ardeola speciosa*	20	LC	No	6.873	Occasional
Striated Heron	*Butorides striata*	2	LC	No	0.687	Rare
Red-necked Stint	*Calidris ruficollis*	24	NT	No	8.247	Occasional
Little-ringed Plover	*Charadrius dubius*	4	LC	No	1.375	Rare
Whiskered Tern	*Chlidonias hybrida*	1	LC	No	0.344	Not Present
White-winged Tern	*Chlidonias leucopterus*	1	LC	No	0.344	Not Present
Glossy Swiftlet	*Collocalia esculenta*	3	LC	No	1.031	Rare
Wandering Whistling-duck	*Dendrocygna arcuata*	6	LC	No	2.062	Rare
Little Egret	*Egretta garzetta*	90	LC	No	30.928	Abundant
Pied Stilt	*Himantopus leucocephalus*	47	LC	Yes	16.151	Frequent
Black-headed Munia	*Lonchura atricapilla*	7	LC	No	2.406	Rare
Blue-tailed Bee-eater	*Merops philippinus*	4	LC	No	1.375	Rare
Eurasian Whimbrel	*Numenius phaeopus*	7	LC	Yes	2.406	Rare
Pacific Golden Plover	*Pluvialis fulva*	6	LC	No	2.062	Rare
Common Tern	*Sterna hirundo*	4	LC	No	1.375	Rare
Little Tern	*Sternula albifrons*	3	LC	No	1.031	Rare
Wood Sandpiper	*Tringa glareola*	3	LC	No	1.031	Rare

English Name	Scientific Name	The number of Individuals	IUCN Red List Status	Nationally Protected?	RA (%)	DAFOR scale
Common Greenshank	*Tringa nebularia*	6	LC	No	2.062	Rare
Marsh Sandpiper	*Tringa stagnatilis*	1	LC	No	0.344	Not Present
Common Redshank	*Tringa totanus*	2	LC	No	0.687	Not Present
Collared Kingfisher	*Todiramphus sanctus*	1	LC	No	0.344	Not Present

Little Egret or *E. garzetta* was the commonest bird found on the coastal areas, including the fish pond. It is known that this bird has a large population with increasing population trend (IUCN Red List, 2023). They commonly occupy most wetlands for building their nests and for breeding activities. Recently, the breeding activities by *E. garzetta* was confirmed successfully with estimated population size was a hundred nesting pairs (Hilaluddin *et al.,* 2003). These activities are contributing to the successful of survival and fitness of Little Egret from generation to generation.

White-headed Stilt or *H. leucocephalus* was recently a member of the Black-winged Stilt genus (*Himantopus* sp.) with their worldwide distribution, except the Antartic (del Hoyo *et al.,* 1996). However, nowadays, this species is classified as separate species and recognized as an international migratory wader because this species is recorded in Sri Lanka (De Silva, 2000), Taiwan (Chung Yu Chiang *pers. comm.* in Minton *et al.,* 2017) and Japan (Tomohiro *pers. comm.* in Minton *et al.,* 2017). Additionally, the quite frequent sighting of the birds was recorded between Northern Australia and Indonesia. For example, flag sightings on its right tibia marked at Broom in North-Western Australia was founded at Sidoarjo Fish Ponds in East Java becoming the first recorded overseas movement of this species (David Drynan, Australian Bird and Bat Banding Scheme *pers. comm.* in Minton *et al.,* 2017). These evidences support the idea that White-headed Stilt becomes the migrant bird that may visit West Sulawesi, Indonesia.

The relatives, Black-winged Stilt or *H. himantopus* has a growing population trend (BirdLife International, 2023). However, the White-headed Stilt's population trend is still remained unknown. Frequent visits to the wetlands in Indonesia and the government support for wetland conservation from through the membership of the Partnership of East Asian Australasian Flyway for the migratory bird may become a basis of the protection status for the White-headed Stilt nationally.

Actitis hypoleucos or Common Sandpiper is another common bird, especially shorebirds. This species was easily found on the lakes and ponds (Orians & Wittenberger, 1991). This species will occupy large size and deep-water bodies. This typical wetland is similar to the Tandung, which has a large and deep pond (Nummi *et al.,* 2021), like ponds along the coast of West Sulawesi. This species also has a successful breed elsewhere with a hundred fledglings at one location (Holland & Yalden, 1994). This information supports that Common Sandpiper could be occasionally observed on the ponds in West Sulawesi.

Javan-pond Heron or *A. speciosa* is the commonest bird, especially heron group in Indonesia. Recently, most of studies provide the sighting direction to this species with high number of individuals in many locations in Indonesia, such as mangrove ecosystem (Ginantra *et al.,* 2020), paddy fields (Maisyaroh *et al.,* 2021; Megantara *et al.,* 2021), and coastal areass (Ramadhani *et al.,* 2022). No doubt that this species becomes occasional bird that is easily found on the wetlands.

Calidris ruficollis or Red-necked Stint is known as one of migratory species included as sandpiper group, the relative of Common Sandpiper. Small in size, but heavily depended on migration on the East Asian-Australasian Flyway due to its large distribution range (del Hoyo *et al.,* 1996; Lappo *et al.,* 2012; Gholami *et al.,* 2017). One individual can migrate more than 9400 km to the northern hemisphere, while another one has completed its nonstop flight approximately 5350 km (Mu *et al.,* 2020). This species is

classified as NT or Near Threatened because the population is decreasing currently (IUCN Red List, 2023), averaging -1.6% per year (Studds *et al.,* 2017; BirdLife International, 2023). Even though no protection from the Indonesian government, the inevitable fact about this species important for conserving the stopping site for this species, like fishpond in Tandung, West Sulawesi.

The diverse bird community correlated among another during observation

Following the assumption that each day has different bird community, the result of ecological measurement (Table 2 and Fig. 2) shows variety. The first day or Point_180922 shows the lowest diversity index, dominance index, evenness, and species richness. However, the next day shows the highest diversity index which is calculated at approximately 2.410 at Point_021022 or bird community at 2 November 2022. This index at second day followed to third and fourth days are indicated as moderate level. Instead of stable at moderate level, the diversity index, dominance index, and evenness tend to decrease after second day of observation.

Table 2. Diversity, Evenness and Evenness each point of observation in the fish ponds

Ecological Measurement	Point_ 180922	Point_ 021022	Point_ 231022	Point_ 061122	Point_ 271122	Point_ 041222
The number of individuals	29	46	91	20	13	92
Species Richness	6	17	21	11	7	14
Shannon Diversity Index	1.092	2.410	2.373	2.233	1.778	1.618
Simpson Dominance Index	0.502	0.872	0.859	0.875	0.805	0.623
Pielou's Evenness	0.609	0.851	0.779	0.932	0.914	0.613

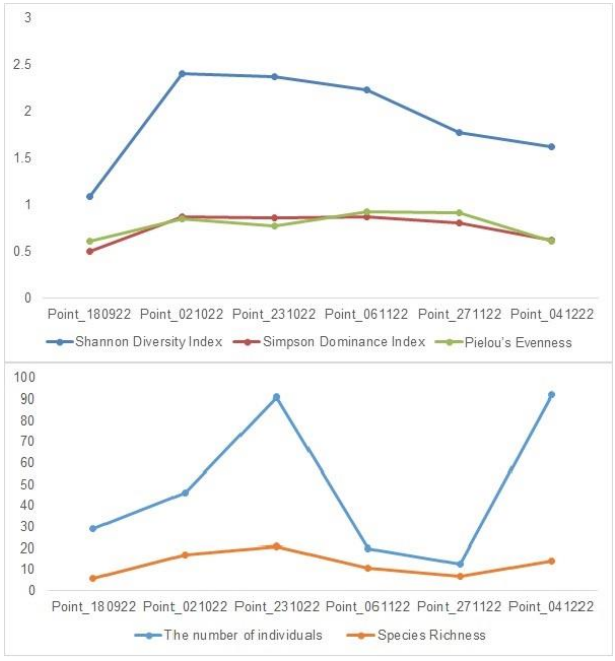

Figure 2. Diagram of ecological measurement in time series during 6 days of observation

Instead of the assumption describing different bird community each day, the Pearson's correlation result (Figure 3.) shows that a high correlation between Point_180922 or first day and Point_021022 or second day. There is also another high correlation among Point_271122 or fifth day and Point_041222 or the sixth day. This result breaks the assumption that each day has different bird community.

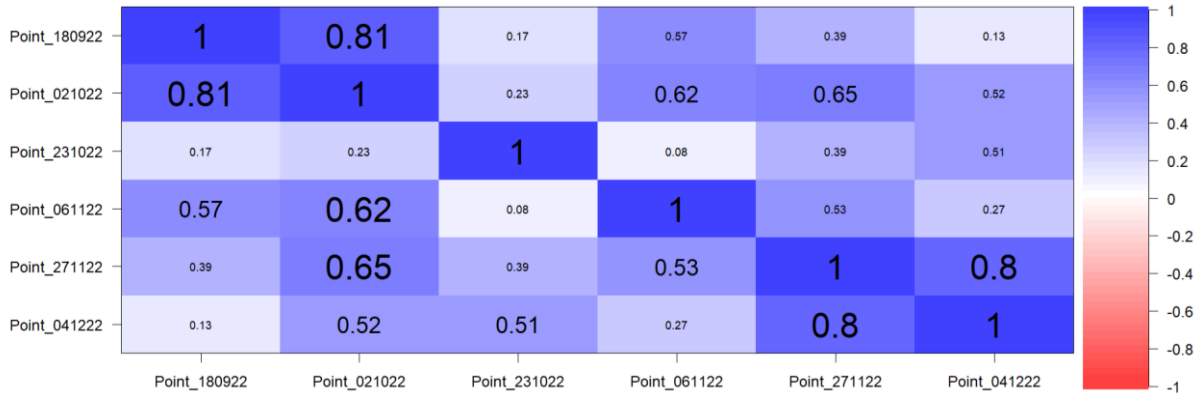

Figure 3. Pearson's Correlation plot among points in the fish ponds

Bird community is one of the biological indicators for the biodiversity of an area. Bird community can talk about how the diversity is. Bird community can reflects the whole biodiversity in one place. Vielliard (2000) supports the bird community becomes an indicator of biodiversity based on the result of quantitative surveys in Brazil. However, the complex system could be breakdown by identifying the bird community structure such as the diversity, dominance, evenness and composition. This study shows the variety of most index at the same location and different period of observation. This variety could be response of the bird community to landscape composition by showing the spatial similarity of the bird communities. Jokimäki & Kaisanlahti-Jokimäki (2003), agrees that bird community similarity in an one area was about the same as the similar habitat in different area. Relevant to this study, two bird community which are observed in the two adjacent periods of observation, for example bird community at the Point_180922 and Point_021022, shows the high correlation that indicated a similarity among these two bird community. However, this composition makes low level at species richness and total number of indiviuals. Temporal variability could be the factor controling the composition of bird community (Jokimäki & Kaisanlahti-Jokimäki, 2003). To understand the large-scale of ecological process, the bird community similarity could be measured.

The bird community may shift to move away when the sky becomes cloudy

The result of mapping weather condition (Figure 4.) provides the information about abiotic environment surrounding A point as the observation location. The first map is the weather condition at the first day at Point_180922 or first period of observation, followed by second period of observation at map No. 2 (Point_021022), third period of observation at map No. 3 (Point_231022), fourth period of observation at map No.4 (Point_061122), fifth period of observation at map No. 5 (Point_271122), and the sixth period of observation at map No. 6 (Point_041222). Map number 1 and 2 shows the sky is bright. However, map number 3 starts to describe that the sky is not bright anymore in all area. The next map number 4 shows the sky is still cloudy with more additional cloud concentrated to the land, not the sea. The map number 5 shows the sky is almost covered by the cloud, which brings the raindrop indicated with the overall light blue. The map number 6 describes that the sky is come back to normal bright with no cloudy anymore.

This map shows the spatial patterns of bird community similarity bring the bird repsonse to the landscape composition on their habitat. Zurita & Bellocq (2009) explain that the trade-off among local extinctions and the extra-regional invasion through species using recently habitats is probably the mechanism generating the observed community similarity patterns. This trade-off could be seen to the

observed bird community moves away from the habitat in fish pond when another species of bird comes, for example, Little Egret, and the sky was being covered by darker cloud. This darker cloud which was concentrated to the land, not the sea, could be indicator of raindrop falling down to the ground as soon as possible. The darker cloud covering the land can be seen at the map number 3 or on the 23 October 2022, map no. 4 or on the 06 November 2022 and map no. 5 or 27 November 2022. As the heavy rain and high speed of wind happened during November 2022, the bird community on those 3 days was moved away to get shelter for a while. This activity of the bird community on the 3 days mentioned before informs low level of diversity index, dominance index, and evenness due to most birds moving away. Furthermore, the panic situation can give stress to the certain species of birds so that the birds leave as soon as possible and changing the structure of bird community on the fish pond in Tandung, West Sulawesi.

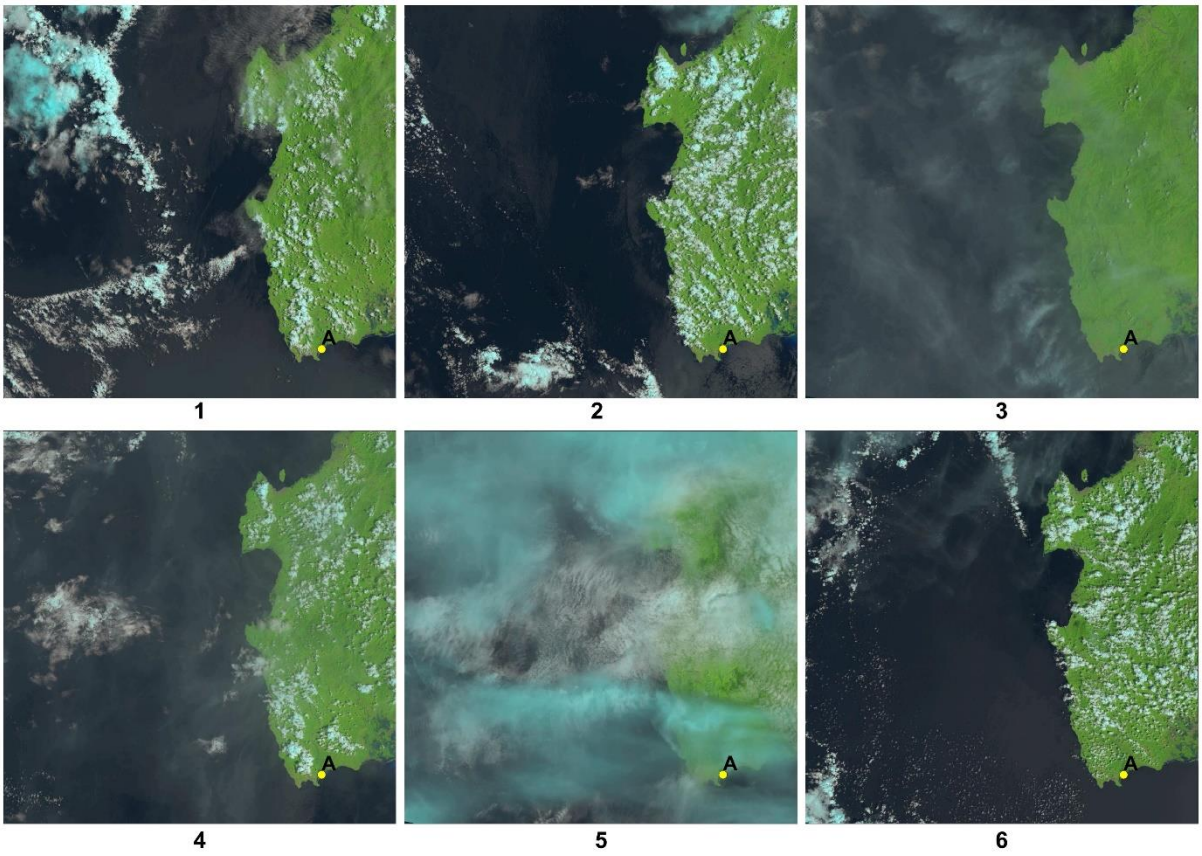

Figure 4. The map of weather condition in the location A and its surroundings during 6 periods of observation

CONCLUSION

Referring to the identification results, it can be concluded that there are 5 species out of a total of 27 species that have relatively high to moderate abundance values, namely in a row from the highest value as follows Little Egret, Pied Stilt, Common Sandpiper, Javan-pond Heron, and Red-necked Stint. The high correlation between the two bird communities with two adjacent days of observation indicates the similarity in the composition of the community structure with different temporal scales and similar spatial scales. The response of the bird community to relatively dynamic weather conditions is by flying away during cloudy and rainy weather which results in a decrease in the value of diversity.

ACKNOWLEDGEMENT

We would like to say thank you to Yusuf Yulianto, Nurul Afiah, Hikmah, Surahmi, Adinarto, Resliani Rarru, and Arina for helping data collection during sampling in the fieldwork.

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