DRAGONFLIES DIVERSITY AND LAND COVER CHANGES IN THE BATUBOLONG RIVER, WEST LOMBOK DISTRICT

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ABSTRACT

West Lombok District is the second largest district in Lombok Islands. The diversity of dragonflies (Order Odonata) as a bioindicator of environmental quality has not been widely studied in the West Lombok region. This study aimed to determine the species diversity of dragonflies (Order Odonata) found in Batubolong River, West Lombok District and its relation to the occurring land cover changes. This study was carried out by using a descriptive explorative method, where the sampling technique was done by means of line transects. Maps of study and sampling locations as well as land cover changes were made using ArcGIS 10.4.1 software based on primary and secondary data. The results showed that there were 11 species of dragonflies with a Shannon-Wiener diversity index value (H') of 2.212 (medium diversity), a population density index (C) of 0.126 (low dominance), and a species evenness index (E) of 0.923 (high uniformity). Our study also found two rare species of dragonfly in Lombok Island i.e., 3 individuals of *Nosoticta emphyla* (Lieftinck, 1936) with 9% relative abundance and 1 individual of *Drepanosticta berlandi* (Lieftinck, 1939) with 3% relative abundance. The discovery of *D. berlandi* in Lombok is the third time after the findings in 1896 and the 19th century. Analysis of satellite data around the sampling area within the period 2013-2020 showed that there has been an increase in land cover of 6,149.29 m^2. The increase in land cover changes may have caused the disappearance of several Odonata species in the sampling location.

Keywords: Batubolong River, diversity, dragonfly, land cover, Odonata

INTRODUCTION

West Lombok District is among districts in West Nusa Tenggara Province, Indonesia, located at 115°49.12'04"-116°20'15.62"E and 8°24'33.82"-8°55'19"S and is directly adjacent to Mataram City, Central Lombok and North Lombok Districts and the Indian Ocean (BPS Statistics Lobar 2021). The West Lombok District has a large area with relatively dense population and settlements in the West Nusa Tenggara Province (NTB). Biodiversity in this district is similar to that in other cities/districts in the province. The West Lombok District has several forests and extensive beaches, rivers and a Nature Tourism Park (Taman Wisata Alam/TWA) managed by the provincial office of the Natural Resources Conservation Center of the NTB (Rahmawati *et al.* 2019). Several tree species as birds' habitat as well as rice fields and plantations in several areas of the district still exist. There are also various types of dragonfly species in various areas of West Lombok District. Dragonfly (Odonata) is a good bioindicator of water quality (Dolný *et al.* 2013; Koneri *et al.* 2020).

The damselfly (Suborder Zygoptera) and the common dragonfly (Suborder Anisoptera) are members of the Order Odonata of the Phylum Arthropoda. Various types of dragonflies are identified in various spots in West Lombok District. The habitats of the damselfly and the dragonfly are scattered at various points, ranging from forests, rice fields, areas close to housings to areas far from s ettlements, hot and open areas to shady and closed areas. Several study

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locations regarding dragonflies have been reported in the West Lombok area, namely the Batubolong River and Pusuk area (Kosterin 2014), Kerandangan TWA (Rahmawati *et al.* 2019) and Suranadi TWA (Ilhamdi *et al.* 2021). Changes in land cover and forest land conversions contribute to the decreasing diversity of various fauna species, especially several types of dragonflies that are vulnerable to environmental changes. Several types of dragonflies inhabit several areas of West Lombok Regency which are still beautiful because dragonflies choose to live in a safe and comfortable place for their reproductive activities, especially in the life of their nymphs (Ansori 2009; Dolný *et al.* 2011). The Batubolong River is a river that has its headwaters in Lembah Sari Village, Batulayar District and passes through Batubolong Hamlet, West Batulayar Village and has an estuary on the Batubolong beach, Batulayar District. This study aimed to observe the diversity of dragonflies (Order Odonata) in the Batubolong River, West Lombok District and to determine the impact of the recent changes in land cover around the river area toward dragonfly diversity. The results of this study will be compared with previous studies that have taken data in the Batubolong River, West Lombok.

MATERIALS AND METHODS

This study was carried out by using descriptive explorative method for identifying the types of dragonflies (suborder Anisoptera) and damselfly (suborder Zygoptera) in the Batubolong River. Sampling was carried out for 4 months from April 2021 (rainy season) up to July 2021 (dry season) in the middle part of the Batubolong River (Fig. 1).

The purposive sampling technique was used with line transects. Environmental parameters observed were water pH and temperature, Total Dissolved Solids (TDS), Electrical Conductivity (EC), altitude, wind speed, air temperature and humidity. Documentation of dragonflies was carried out by using a camera, while the identification of dragonflies was conducted by using references from Irawan & Rahadi (2018), Kosterin (2014), Steinmann (1997) and GBIF.org. The Relative Species Abundance, Species Diversity Index, Population Density Index and Species Evenness Index were then calculated based on the data obtained from the field. Maps of study and sampling locations as well as land cover changes were developod by using ArcGIS 10.4.1 software based on primary and secondary data.

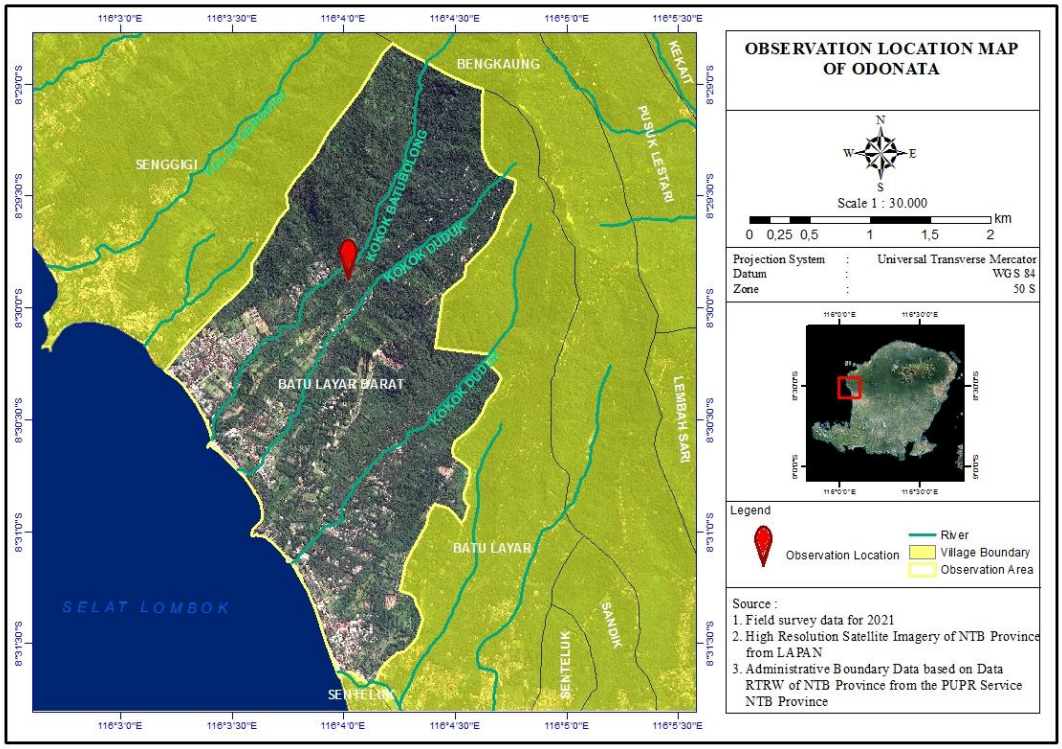

Figure 1 Map of the study location in the Batubolong River, Batulayar Barat Village, Batulayar Subdistrict, West Lombok District

The Relative Species Abundance was calculated using the formula:

$$RSA = \frac{ni}{N} \times 100\%$$

where:
RSA = Relative Species Abundance
ni = Number of individual dragonflies i
N = Number of individuals of all (total) types of dragonflies

The Shannon-Wiener diversity index (H') was calculated using the formula:

$$H' = - \Sigma (pi \ln pi)$$

where:
H' = Shannon-Wiener Diversity Index
pi = Ratio of the number of individuals of one species to the total number of individuals in the sample within the plot (n/N)

Diversity index criteria:
H' < 1 = Low diversity
1 < H' < 3 = Medium diversity
H' > 3 = High diversity

Population density/dominance index (C) was calculated using the formula:

$$C = \sum_{i=1}^{n} \left[\frac{n}{N}\right]^2$$

where:
C = Dominance Index
ni = Number of individuals of one species
N = Total individuals of all species

Environmental community criteria based on dominance index:
0.00 ≤ C ≤ 0.30 = Low dominance
0.30 ≤ C ≤ 0.60 = Medium Dominance
0.60 ≤ C ≤ 1,00 = High Dominance

The Evenness Index of species at the sampling point was calculated using the formula:

$$E = \frac{H'}{\ln S}$$

where:
E = Evenness Index
H' = Shannon-Wiener Diversity Index
S = Number of species

Environmental community criteria based on Evenness Index:
0.00 < E < 0.50 = Small uniformity/depressed community
0.05 < E < 0.75 = Moderate uniformity/ unstable community
0.75 < E < 1.00 = High uniformity/stable community

RESULTS AND DISCUSSION

Landscape and Canopy in the Batubolong River Sampling Area

Batubolong River is a type of river with small to large granite rocks adorning the river (Fig. 2). Various types of canopy plants over the riverbanks providing shady and beautiful ambiance are dominated by various types of bamboo, ivory mahogany (*Dysoxylum gaudichaudianum*), cembirit/kumbi (*Tabernaemontana sphaerocarpa*), pacific walnut (*Dracontomelon dao*), tamarind (*Tamarandus indicus*), mahogany (*Swietenia mahagoni*), acacia (*Acacia* sp.), kapok (*Ceiba pentandra*), mango (*Mangifera indica*), sugar palm (*Arenga pinnata*), cashew (*Anacardium occidentale*), black rosewood (*Dalbergia latifolia*), and sengon (*Paraserianthes falcataria*). Several types of shrubs and medium-sized trees growing along the riverbanks include lantana (*Lantana camara*), siam weed (*Chromolaena odorata*), quickstick (*Gliricidia sepium*), largeleaf rosemallow (*Hibiscus macrophyllus*), various types of bananas (*Musa* sp.), bandicoot berry (*Leea aequata* L.) sparrow mango (*Buchanania arborescens*), taro (*Araceae*), grasses (*Graminaceae*), vines such as spurred butterfly pea (*Centrosema virginianum*), sweet leaf (*Sauropus androgynous*), papaya (*Carica papaya*), ferns (*Pteridophyta*), and turmeric (*Curcuma* sp.).

Figure 2 Landscape area at the dragonfly observation point on the Batubolong River
Notes: A & B = River view during rainy season (4 April 2021); C & D = River view during dry season (6 July 2021). Source: Personal data (2021).

Most of the Batubolong River stream is far from the residential area. Only the downstream is close to the residents' villages. The canopy cover area on the Batubolong River is in the class I-IV category (Class I: 0-25% canopy cover, class II: 26-50% canopy cover, class III: 51-75% canopy cover, and grade IV: 76-100% canopy cover) (Buckley *et al.* 2018; Hendriks 2020).

Topographical and Water Physical-Chemical Parameters in the Batubolong River

Table 1 presents the results of topographical and water physical-chemical parameters measurement in the Batubolong River.

In the topographical aspect, the Batubolong River which passes through the area around the Batulayar Barat Village is still at a low altitude (20 - 40 masl) with the highest air temperature of 36.1 °C and the lowest is 25.1 °C at the sampling time. The neutral water pH (6.5) combined with low TDS (TDS = 66 ppm), and low EC values (EC= 136 µs/cm) indicate that river water quality was still within the range of standard water quality (Khairunnas & Gusman 2018). The river water is also free of total dissolved solids and low in electrical conductivity; thus, it is safe as drinking water (Afrianita *et al.* 2017; Gasim *et al.* 2015). The standard of total dissolved solids for drinking water is below 1,000 ppm (WHO 1996). The water temperature (25 - 28 °C) of the Batubolong River is still in the moderate category which is very good for the development of nymph larvae of several types of dragonflies. In the water bodies, medium to small fish and small crabs are found which can be a threat to dragonfly nymphs.

Table 1 Measurement of topographical and water physical-chemical parameters in the Batubolong River

No.	Topographical and water physical-chemical parameters	Measurement results	Observation date
1.	Altitude (masl)	20 - 40	6 July 2021
2.	Air temperature (°C)	30.4 - 36.1 25.1 - 28.9	4 April 2021 (10.56 - 13.53 WITA) 7 June 2021 (10.07 - 12.13 WITA)
3.	Humidity (%)	74 - 86 57 - 65	4 April 2021 (10.56 - 13.53 WITA) 7 June 2021 (10.07 - 12.13 WITA)
4.	Water pH	6.5	4 April 2021 and 7 June 2021
5.	Soil pH	5.8	4 April 2021
6.	Total Dissolved Solid (TDS) (ppm)	66	7 June 2021
7.	Electrical Conductivity (EC) (µs/cm)	136	7 June 2021
8.	Water temperature (°C)	27 - 28 25	4 April 2021 (10.56 - 13.53 WITA) 7 June 2021 (10.07 - 12.13 WITA)
9.	Wind speed (knot)	0.0 - 1.6 0.0 - 0.5	4 April 2021 (10.56 - 13.53 WITA) 7 June 2021 (10.07 - 12.13 WITA)

Dragonfly (Odonata) Diversity in Batubolong River

The observed dragonflies (Odonata) at various points on the Batubolong River is presented in Table 2. The distribution map of dragonflies (Order Odonata) found at the sampling location on the Batubolong River is presented in Figure 3.

Table 2 Dragonflies (Odonata) distribution in the Batubolong River

No.	Suborder and species name	Total	Observation time	Coordinate point	Perch and brightness	Altitude (masl)	Air temperature (°C) / humidity(%)
A.	Suborder Zygoptera						
1.	*Euphaea lara lombokensis* (McLachlan, 1898)	5	10.50 WITA, 04/04/2021 and 06/07/2021	-8.497485, 116.065951	- On a rock, on a small branch - 200-300 lux (shady)	20	30 / 86
2.	*Pseudagrion pilidorsum declaratum* (Lieftinck, 1936)	5	10.50 WITA, 04/04/2021 and 06/07/2021	-8.497485, 116.065951	- On a rock, on a small branch - 200-300 lux (shady)	20	30 / 86
3.	*Nosoticta emphyla* (Lieftinck, 1936)	3	13.53 WITA, 04/04/2021 and 06/07/2021	-8.497350, 116.066083 -8.496795, 116.067063	- On the leaves and twigs of the Lantana (*Lantana camara*) and Kirinyuh (*Chromolaena odorata*) trees - 200-1500 lux (shady - bright)	40	36.1 / 74
4.	*Drepanosticta berlandi* (Lieftinck, 1939)	1	11.01 WITA, 06/07/2021	-8.496795, 116.067063	- Under the leaves and stems of trees on the river - 200 lux (shady)	40	28.7 / 66

Table 2 (Continued)

B.	Suborder Anisoptera						
5.	*Orthetrum testaceum soembanum* (Forster, 1903)	5	11.11 WITA, 04/04/2021 and 06/07/2021	-8.497503, 116.065891	- On a wooden branch - < 2,000 lux (hot)	20	31.5 / 81
6.	*Neurothemis ramburii* (Brauer, 1866)	3	11.32 WITA, 04/04/2021 and 06/07/2021	-8.497597, 116.065791	- On a wooden branch - < 2,000 lux (hot)	20	30.4 / 85
7.	*Trithemis festiva* (Rambur, 1842)	3	11.35 WITA, 04/04/2021 and 06/07/2021	-8.497597, 116.065791	- on the rock - < 2,000 lux (hot)	20	30.4 / 85
8.	*Orthetrum glaucum* (Brauer, 1865)	2	11.45 WITA, 04/04/2021 and 06/07/2021	-8.497597, 116.065791	- on the rock - < 2,000 lux (hot)	20	30.4 / 85
9.	*Agrionoptera insignis insignis* (Rambur, 1842)	1	11.39 WITA, 06/07/2021	-8.495512, 116.068244	- On the taro leaves - 2,000 lux	20	28.9 / 57
10.	*Orthetrum sabina* (Drury, 1773)	1	11.04 WITA, 06/07/2021	-8.496763, 116.067334	- On the branches of the bush - < 2,000 lux (hot)	20	34.5 / 45
11.	*Diplacodes trivialis* (Rambur, 1842)	2	11.41 WITA, 06/07/2021	-8.495515, 116.068239	- On stones and twigs - < 2,000 lux (hot)	20	28.9 / 57

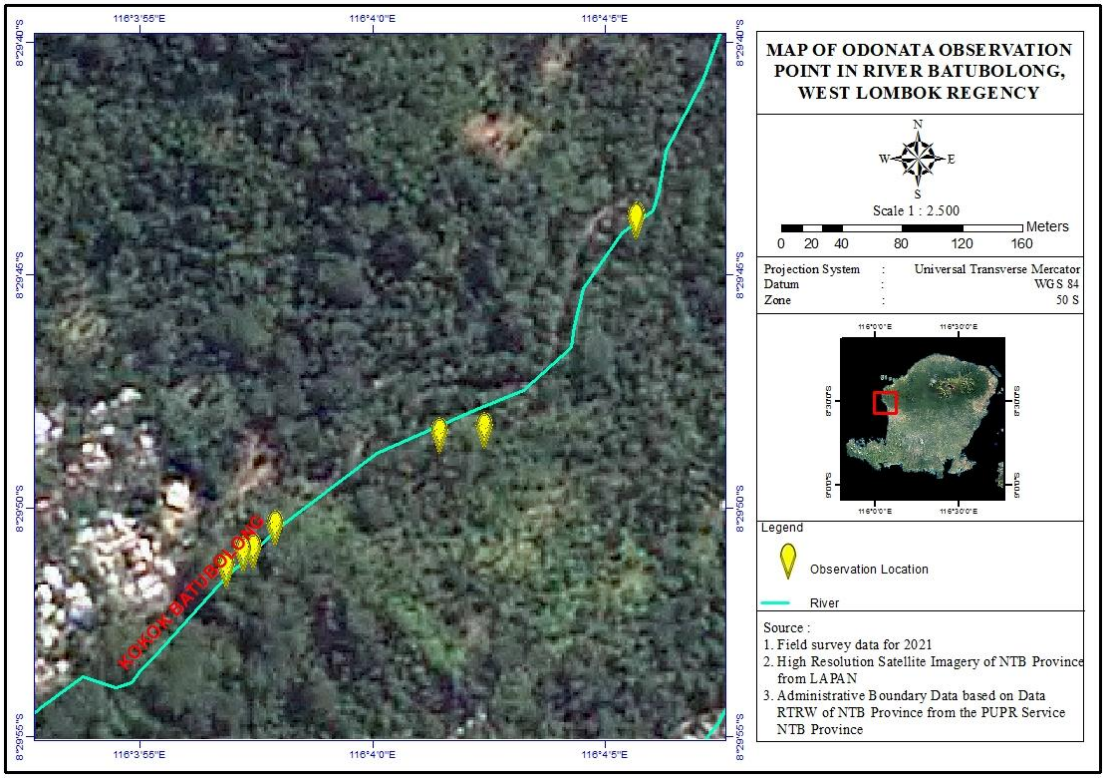

Figure 3 Distribution map of dragonfly (Order Odonata) at sampling locations on the Batubolong River
Note: Several species have the same location point.

Sampling was carried out in the rainy (April) and dry (July) seasons. More dragonfly species were found in April (rainy season) than in July (dry season). Dragonfly species found both in the rainy and dry seasons were: *Euphaea lara lombokensis* (McLachlan, 1898), *Pseudagrion pilidorsum declaratum* (Lieftinck, 1936), *Nososcticta emphyla* (Lieftinck, 1936), *Orthetrum testaceum soembanum* (Forster, 1903), *Neurothemis ramburii* (Brauer, 1866), *Trithemis festiva* (Rambur, 1842), and *Orthetrum glaucum* (Brauer, 1865). Species of dragonflies (Order Odonata) that were only found during sampling in July (dry season) were *Drepanosticta berlandi* (Lieftinck, 1939), *Agrionoptera insignis insignis* (Rambur, 1842), *Orthetrum sabina* (Drury, 1773), and *Diplacodes trivialis* (Rambur, 1842).

During the rainy season, the river water is abundant so that dragonflies have more opportunities to reproduce because water is a medium for dragonflies to lay eggs and develop larvae. The canopy and the light intensity also determine the types of dragonfly species existing around the river. Dragonflies which prefer hot areas in the Batubolong River are: *Orthetrum sabina* (Drury, 1773), *Diplacodes trivialis* (Rambur, 1842), *Orthetrum testaceum soembanum* (Forster, 1903), *Neurothemis ramburii* (Brauer, 1866), *Trithemis festiva* (Ramburi, 1866). 1842), and *Orthetrum glaucum* (Brauer, 1865). This findings is in agreement with the work of Buchori *et al.* (2019). On the other hand, dragonflies which prefer shaded to moderate light areas in the Batubolong River are: *Euphaea lara lombokensis* (McLachlan, 1898), *Pseudagrion pilidorsum declaratum* (Lieftinck, 1936), *Nososcticta emphyla* (Lieftinck, 1936), *Drepanosticta berlandi* (Lieftinck, 1939), and *Agrionoptera insignis insignis* (Rambur, 1842).

Relative Species Abundance, Species Diversity, Population Density and Species Evenness Indices

Table 3 presents the calculation results of Relative Species Abundance, Species Diversity, Population Density and Evenness Indices.

Euphaea lara lombokensis had the highest relative abundance of 21%, followed by *Pseudagrion pilidorsum declaratum* and *Orthetrum testaceum soembanum* of 15%, respectively, indicating that these species were able to breed and adapt well to the Batubolong River. These three species are easy to find in rivers or streams having clean water with water pH close to neutral. The calculation results on the Shannon-Wiener Diversity Index (H') of 2.212 (medium diversity category) indicated that the dragonfly species found in the sampling area were relatively few. The medium diversity may be caused by the crowded activity of the population around the river, especially in the downstream. At several points in the sampling area, there were logged trees and cowsheds owned by residents. Therefore, it is necessary to expand the sampling area, especially in the upstream part which is still in the form of primary forest, considering that some dragonflies are very sensitive to community activities and environmental changes.

Table 3 Calculation of relative species abundance, species diversity, population density and evenness indices

No.	Species Name	Total	pi	RSA	ln pi	H'	C	E
1.	*Euphaea lara lombokensis* (McLachlan, 1898)	7	0.212	21%	1.551	0.329	0.045	
2.	*Pseudagrion pilidorsum declaratum* (Lieftinck, 1936)	5	0.152	15%	1.887	0.286	0.023	
3.	*Nososcticta emphyla* (Lieftinck, 1936)	3	0.091	9%	2.398	0.218	0.008	
4.	*Drepanosticta berlandi* (Lieftinck, 1939)	1	0.030	3%	3.497	0.106	0.001	
5.	*Orthetrum testaceum soembanum* (Forster, 1903)	5	0.152	15%	1.887	0.286	0.023	
6.	*Neurothemis ramburii* (Brauer, 1866)	3	0.091	9%	2.398	0.218	0.008	
7.	*Trithemis festiva* (Rambur, 1842)	3	0.091	9%	2.398	0.218	0.008	
8.	*Orthetrum glaucum* (Brauer, 1865)	2	0.061	6%	2.803	0.170	0.004	
9.	*Agrionoptera insignis insignis* (Rambur, 1842)	1	0.030	3%	3.497	0.106	0.001	
10.	*Orthetrum sabina* (Drury, 1773)	1	0.030	3%	3.497	0.106	0.001	
11.	*Diplacodes trivialis* (Rambur, 1842)	2	0.061	6%	2.803	0.170	0.004	
	Total	33	1	100%	28.615	2.212	0.126	0.923

Notes: pi = Ratio between the number of individuals of a species with the number of individuals of all species (n/N); RSA = Relative Abundance; H' = Shannon-Wiener Diversity Index; C = Dominance Index; E = Evenness Index.

Nososticta emphyla is a beautiful and rare dragonfly with only 3 species found in the sampling location (RSA = 9%). This dragonfly has a characteristic of having a metallic purple combined with black colors on the thorax. The last 3 segments at the end of the abdomen have a bright purple color. Lieftinck (1953) described an adult male of *N. emphyla* dragonfly found on Flores Island has a deep reddish-purple color on the head. Kosterin (2014) described *N. emphyla* dragonfly as having purple color gradually changing to citron-yellow on the thorax on the abdominal segments 1-3 with purple and brilliant cobalt blue on segments 8-10. This dragonfly is classified as rare on Lombok Island and is only found in the Batubolong River area. According to the IUCN Redlist, *N. emphyla* is in the Data Deficient (DD) category and its presence is only recorded in the Nusa Tenggara Islands, namely Lombok Island, Sumbawa Island and Flores Island (Dow 2020). *N. emphyla* is found in the Batubolong River at coordinates -8.497350, 116.066083 and -8.496795, 116.067063. When found, this dragonfly were flying across the riverbank and then perched on the nearby Lantana (*Lantana camara*), Kirinyuh (*Chromolaena odorata*) and bamboo trees. These dragonflies tend to be shy and will fly up into taller trees when caught.

Drepanosticta berlandi (Lieftinck, 1939) was the rarest needle dragonfly found at the sampling point because only one male was found in immature condition. According to the IUCN Redlist, this species is endemic to the island of Lombok and is recorded 2 times, namely in 1896 at an altitude of 2,000 masl as many as 2 males and in the 19th century as many as 1 male (Kalkman 2009). The latest data indicated that in 2016, *D. berlandi* was also found on Sumba Island, East Nusa Tenggara in forest areas in the Manupeu Tanah Daru and Laiwangi Wanggameti National Parks, with high humidity, wet vegetation and dense canopy (Irawan & Rahadi 2018). When found in the Batubolong River, *D. berlandi* was perching on the leaves under a shady tree. *D. berlandi* is classified as a long needle dragonfly with a body length of 5.96 cm. *D. berlandi* is categorized as DD (Data Deficient) in the IUCN Red List or the distribution and population data are still lacking so that the risk of extinction of this dragonfly is still unclear (Kalkman 2009).

Several quite rare dragonfly species of the suborder Anisoptera (large dragonflies) were found in the Batubolong River. Dragonfly *Orthetrum testaceum* subsp. *soembanun* (Foerster, 1903) is one of the large dragonflies that is quite sensitive to environmental changes and is only found in rivers or streams that are still clean. According to a report from GBIF.org (2012-2019), the dragonfly *Orthetrum testaceum* subsp. *soembanun* is only recorded in the islands of Nusa Tenggara (Lombok Island, Sumbawa Island, Flores Island, Alor Island and Rote Island). In addition, the dragonfly *Orthetrum testaceum* subsp. *soembanun* is also reported to be in the Batubolong River on Lombok Island (Kosterin 2014) and in the Manupeu Tanah Daru and Laiwangi Wanggameti National Parks on Sumba Island (Irawan & Rahadi 2018). This dragonfly mating behavior can be seen during copulation and oviposition. At the time of copulation, the male and female dragonflies form a tandem formation, namely the female attaches the end of the abdomen (appendage) to the male secondary genitalia (segments 1–2 on the ventral abdomen), while oviposition is when the female lays her eggs on the substrate with an ovipositor (Loiola & De Marco 2011). The uniqueness of oviposition behavior in dragonflies *Orthetrum testaceum* subsp. *soembanun*, happens when the female lays her eggs in the water, the males fly over them to guard them (Irawan & Rahadi 2018). At the sampling time of our study in the Batubolong River, the male *Orthetrum testaceum* subsp. *soembanun* dragonflies were at the river, while the female *Orthetrum testaceum* subsp. *soembanun* perched on tree branches at the top of the river.

Another rare large dragonfly found in the Batubolong River is *Agrionoptera insignis* subsp. *insignis* (Rambur 1842). According to GBIF.org data between 1997-2020, this dragonfly is only found in 3 locations in Indonesia, namely Java Island, Kalimantan Island and Papua Island. Another report states that this dragonfly has been found in the Batubolong River (Lombok Island) (Kosterin 2014) and in the Manupeu Tanah Daru and Laiwangi Wanggameti National Parks on Sumba Island (NTT) (Irawan & Rahadi 2018). At young age, this dragonfly is similar to *Lathrecista asiatica*, especially in terms of the

pattern on the thorax and abdomen. If you look closely, the two species have different thorax patterns. *Agrionoptera insignis insignis* has a thinner (flat) abdomen with a slightly thicker septum than *L. asiatica*. At the end of *Agrionoptera insignis insignis* abdomen there are 3 black segments, while in *L. asiatica* only the last 2 segments are black.

Land Cover Changes around the Sampling Locations on the Batubolong River

The analysis results of land cover changes using satellite imagery data for the period 2013-2020 around the dragonfly sampling locations on the Batubolong River is presented in Figure 4, Figure 5 and Table 4.

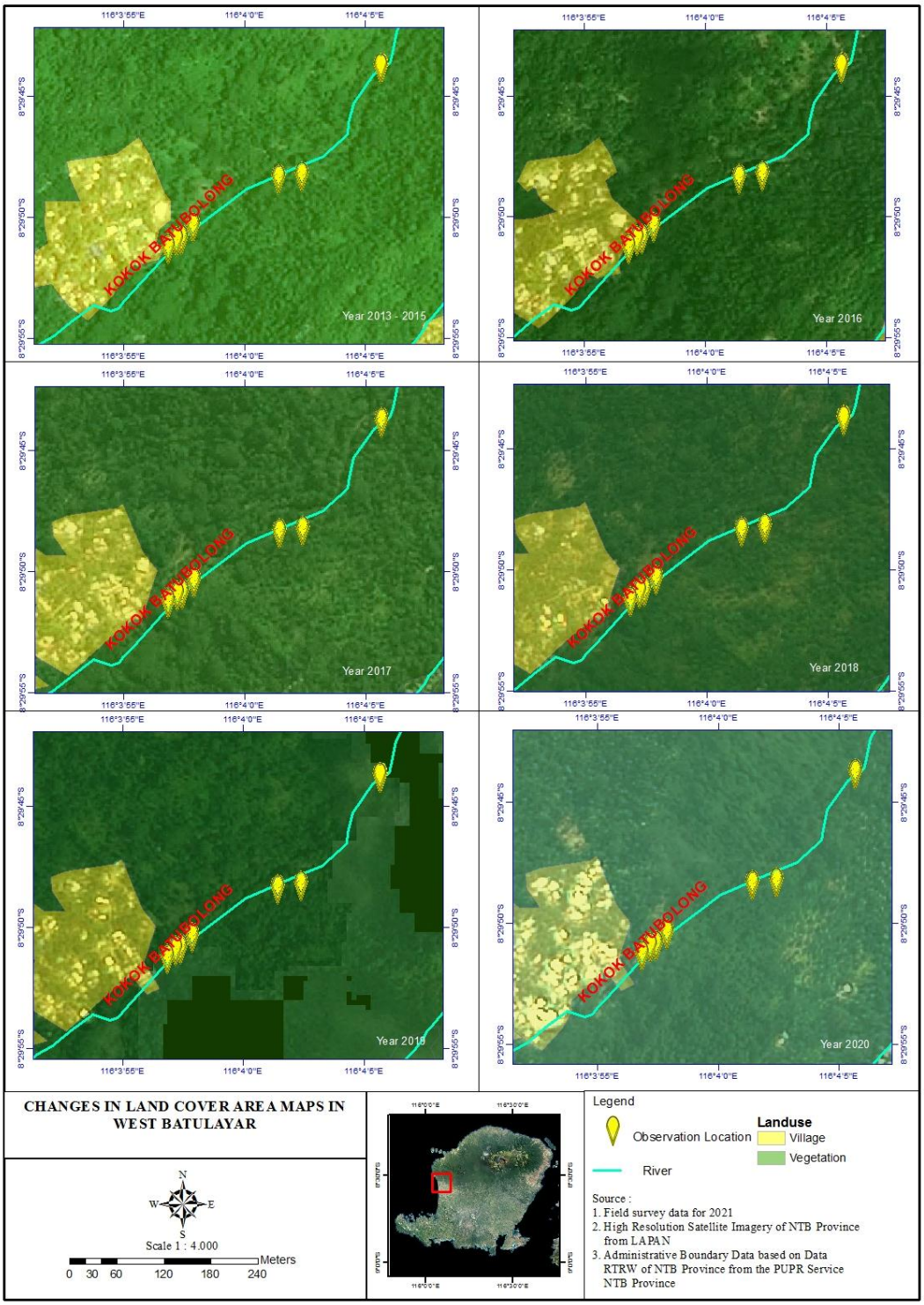

Figure 4 Map of land cover changes around the sampling locations for the period 2013-2020

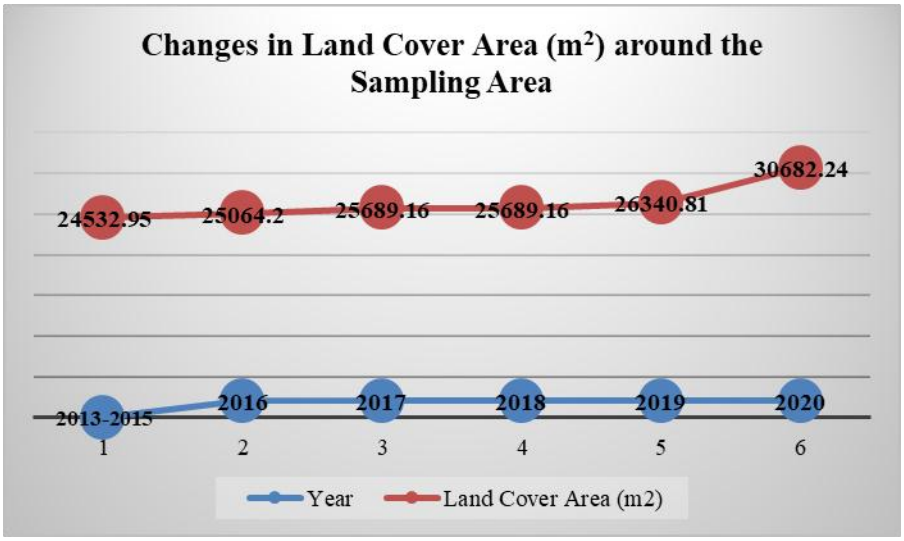

Figure 5 Land cover changes in area surrounding the sampling locations
Notes: Spatial analysis using GIS applications obtained from: 1) High Resolution Satellite Map of NTB Province from LAPAN (2021); 2) Map of NTB Provincial RTRW Administrative Data from PUPR NTB Province.

Table 4 Land cover area around the Batubolong River

No.	Year	Land cover area (m^2)
1	2013-2015	24,532.95
2	2016	25,064.20
3	2017	25,689.16
4	2018	25,689.16
5	2019	26,340.81
6	2020	30,682.24

Notes: Spatial analysis using GIS applications obtained from: 1) High Resolution Satellite Map of NTB Province from LAPAN (2021); 2) Map of NTB Provincial RTRW Administrative Data from PUPR NTB Province

The largest land cover of 30,682.24 m^2 occurred in 2020 (Table 4), or an increase in land cover area of 6,149.29 in the period of 2013-2020. The occurring land cover changes may cause changes in the existing biodiversity, especially in the dragonfly population (Kosterin 2014). Previous studies of Kosterin (2014) reported several dragonflies species found in the middle of the Batubolong River in February 2014. The research data regarding dragonflies obtained by Kosterin (2014) is quite diverse. There are differences in the dragonfly species data previously obtained by Kosterin (2014) compared to the data in our study in 2021. The data difference is regarding the dragonflies diversity on the Batubolong River. The data comparison is presented in Table 5.

Table 5 Data comparison of Odonata research on the Batubolong River (Middle Part) between 2014 and 2021

No.	Aspect	Kosterin (2014)	Our study (2021)
1.	Month of research	Februari	April – Juli
2.	Number of Odonata species found	11	11
3.	The odonata species found by Kosterin (2014) and in our study (2021)	1. *Euphaea lara lombokensis* (McLachlan, 1898) 2. *Pseudagrion pilidorsum declaratum* (Lieftinck, 1936) 3. *Nosoticta emphyla* (Lieftinck, 1936) 4. *Orthetrum testaceum soembanum* (Forster, 1903) 5. *Trithemis festiva* (Rambur, 1842) 6. *Orthetrum glaucum* (Brauer, 1865) 7. *Agrionoptera insignis insignis* (Rambur, 1842) 8. *Orthetrum sabina* (Drury, 1773)	
4.	The odonata species found by Kosterin (2014), but not found in our study (2021)	1. *Pantala flavescens* (Fabricius, 1798) 2. *Trithemis lilacina* (Förster, 1899) 3. *Rhyothemis phyllis* (Sulzer, 1776)	
5.	Odonata species found in our study (2021), but not found by Kosterin (2014)		1. *Drepanosticta berlandi* (Lieftinck, 1939) 2. *Diplacodes trivialis* (Rambur, 1842) 3. *Neurothemis ramburii* (Brauer, 1866)

The numbers of Odonata dragonflies found in 2014 and 2021 are the same, but of different species. The difference may have been caused by: 1) the difference in study period and 2) the land cover changes occurring around the middle of the Batubolong River. In 2014, it rained almost every month, except in September. In February 2014 the rainy season started with 111 mm of rainfall and 11 rainy days (BPS-Statistics Lobar 2015). Meanwhile, April 2021 was the rainy season, where river water was overflowing. In July 2021, it was the beginning of the dry season which dried up the Batubolong River. In the middle of August 2021 it rained intensively. In 2021, as much as 34.8% of Indonesia's territory experienced above normal dry conditions (wetter dry season, namely the dry season rainfall is higher than the climatological average) (BMKG 2021). The weather changes indicates that there has been a climate change that occurring between 2014 and 2021 which can affect the diversity of various kinds of invertebrates, including the Order Odonata (Brook *et al.* 2006; Clausnitzer *et al.* 2009). Changes in the environment around the forest due to human disturbances can cause changes in the diversity of the Order Odonata (Buchori *et al.* 2019; Dolný *et al.*, 2013; & Šigutová *et al.*, 2019).

Species *Drepanosticta berlandi* (Lieftinck, 1939) was found at the beginning of the dry season, at an altitude of 40 masl. According to Harabiš & Dolný (2010), the distribution of dragonfly is determined by several ecological factors, one of which is the altitude range. *D. berlandi* is a rare dragonfly recorded only on the Lombok Island and is a new species found on Sumba Island (Irawan & Rahadi 2018). Meanwhile, *Trithemis lilacina* was first discovered on Sumbawa Island by Förster in 1899, by Lieftinck in 1936 and 1953 on Lombok Island (Steinmann 1997). Based on data from GBIF.org, *T. lilacina* was recorded only on islands of Lombok, Sumbawa, Flores and Timor (Bánki *et al.* 2021).

CONCLUSION

There are differences in dragonfly research data between those obtained by Kosterin (2014) and the ones found in our study in 2021, in terms of different species found. Our study discovered a rare needle dragonfly, namely *Drepanosticta berlandi* (Lieftinck, 1939) which has never been reported before in the Batubolong River. Satellite data showed that there has been a change in land cover in the period 2013-2020 around the Batubolong River. The government and residents are expected to continually preserve the environment around the Batubolong River by wisely utilizing the natural resources to support the sustainability of the existing rare dragonfly species.

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