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Land Use Analysis with Odonata Diversity and Composition using the ArcGIS in Malang and Batu, East Java

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Abstract

This study aims to analyze the diversity, composition, and community structure of odonata in the highland and lowland ecosystems and the type of lotic and lentic waters and analyze the description of land use and its relationship with diversity odonata. There are 8 research locations namely Sumber Maron, Sumber Sirah, Sumber Taman, Bureng River, Umbul Gemulo, Arboretum, Coban Rais River, Coban Talun River. Measurement of biotic and abiotic factors in odonata habitat and land use analysis using GPS and ArcGIS program ver 10.5, data analysis using the Shannon Wiener diversity index (H'), evenness index (E), Important Value Index (IVI), and similarity index Bray-curtis. The results showed that the total number of Anisoptera in lotic aquatic ecosystems was 619 individuals divided into 13 species from 3 families, in the lenticular aquatic ecosystem was 533 individuals divided into 15 species from 3 families. This study concludes that the diversity of species in the highlands is higher than in the lowlands, and the diversity in the lentic ecosystem is higher than that of the lotik ecosystem and odonata has its own tolerance to land use as their habitat especially with minimal human disturbances.

Keywords: composition, diversity, land use, odonata

INTRODUCTION

Indonesia has around 250,000 species of 751,000 insect species found on earth [1]. Insects are members of arthropods which have the most common morphological characteristics, which have six feet (Hexapoda), there are two types of insects based on the presence of wings, groups of insects that have wings called Pterygota and which have no wings are called Apterygota [2]. Dragonfly is the oldest type of insect that can fly from the Pterygota group [3].

Dragonflies are divided into two major types, namely sub-order Anisoptera and Zygoptera, Sub Order Anisoptera is a type of dragonfly that is often found and very easily observed because of its large, long cylindrical shape body. The wings have the same length but the rear is wider than the front wing, the wings stretch when the position is perched. This dragonfly is usually included in a great plot who likes to hover [4]. Sub-order Zygoptera has a cylindrical shape with a body that is very slim like a needle, so many often call it a needle dragonfly. Has the same front wing and rear wing shape. When perching wings generally close vertically, Zygoptera dragonflies are very strong to fly so rarely seen floating around somewhere [4].

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Dragonflies can be used as an indicator of the quality of aquatic ecosystems because the life span of dragonflies is spent around the waters such as rice fields, rivers, lakes, swamps, ponds [5]. The existence of insects in an area can be influenced by land use in the area, especially waters, because it is widely known that the life span of dragonflies is mostly spent in freshwater waters in the nymph phase before metamorphosing the skin during nymph (molting) into adult dragonflies and making it an aerial insect [6]. The landscape environment is an external factor that affects organisms both directly and indirectly. Each organism has its own environment to be influenced by other organisms because of the contact environment [7].

This research is very important to do because the existence of odonata is very important for the environment, the existence of odonata affects many aspects of agriculture, and can also be used as aquatic bioindicators. This research is expected to be used as a step towards odonata conservation seen from the habitat and its existence related to land use.

MATERIAL AND METHOD

Collecting data population

Obtaining data odonata using the method of direct observation (*search and direct observation*). This method is carried out by calculating the total number of individuals per species are found throughout the study area [8].

Observations begin at 09.00 - 12.00 am and are continued at 13.00 - 16.00 pm [9]. The length of the sampling area has been determined by making an imaginary line along the 500 m with 3 replications along the river flow for the type of lentic ecosystem and 500 m at the lotic starting with 3 repetitions, the width of the bending area is limited, namely tracking 3 m to the right and 3 m to the left from the edge of line and repetition of 3 days per location [10].

Microhabitat Variable Measurement and Biotic and Abiotic Factors

Microhabitat variable measurements were used to influence the effect of each microhabitat factor on many types of odonata found.

Table 1. Microhabitat variables with modifications and measurement methods

No	Microhabitat variable	Measurement methods
1	DO	Measured by using DO meter
2	Light intensity	Measured by using lux meter
3	Wind velocity	Measured by using anemometer
4	River flow speed	Measured by drifting the ping pong ball and calculated the speed with the stop watch
5	Humidity	Measured by using higrometer
6	Altitude	Measured by using GPS
7	pH	Measured by using pH meter
8	Water temperature	Measured using a water thermometer
9	Air temperature	Measured using a thermometer

Source: (Orr, 2003)

Mapping the Composition of Area Landscapes (ArcGIS 10.5)

Landscape structure is a way to explain the spatial pattern of landscape elements, which contains the size, shape, composition, number, and distribution of ecosystems in the landscape [11].

The landscape development process in the research area is as follows; the eight research sites were carried out landscape analysis using the Global Positioning System (GPS), tracking around 500 m around the sampling area using GPS satellite imagery with the center of the observation track as the center of the circle, then analyzing the coordinates with the ArcGIS 10.5 program, then describes a new map of the research area that contains information on the composition, shape, size, number, and distribution of sites in the landscape and analyzes to see land relations with several species that dominate in one location [10].

RESULTS AND DISCUSSION

Observations of Odonata diversity include types of Anisoptera and Zygoptera carried out in 8 different locations, divided into two types of aquatic ecosystems lotic and lentic at various altitude, found the total number of Anisoptera in lotic aquatic ecosystems is 619 individuals divided into 13 species from 3 families, while for the lenticular aquatic ecosystem is 533 individuals divided into 15 species from 3 families. Sub-order Zygoptera total number in lotic aquatic ecosystems is 133 individuals divided into 7 species from 4 families, while in the lenticular aquatic ecosystem total 88 individuals divided into 6 species from 4 families.

Odonata diversity in the highlands (979 - 1726 masl)

The highest diversity of Anisoptera in the AR location (lentic, highland) is found in the number of Anisoptera is 170 individuals from 12 species with diversity of Anisoptera species with an H index value of 1.83 (Figure 1A) included in the good category with the dominating species are species *Orthetrum sabina* with 72 individuals and *Pantala flavescens* with 36 individuals. The lowest diversity index of the order of Anisoptera is in UG (lentic, highland) the number of Anisoptera found as many as 92 individuals from 7 species with a value of H 'index of 1.22 (Figure 1A).

Pantala flavescens is one of the most dominating types in Pune city with high tolerance for environmental change [12]. *Orthetrum sabina* is a dragonfly that is very tolerant of extreme changes in environmental biotics, nymphs/naiads of this species are very strong against natural changes even tolerant of waters with saline levels and are found throughout the aquatic community [13].

The highest Zygoptera diversity index value was SCT (lotik, highland) found Zygoptera species as many as 38 individuals from 6 species with an index value of 1.51 (Figure 1A), the species that dominated the SCT were *Agriocnemis pygmaea* and *Rhynocypha fenestrata*. The lowest diversity of Zygoptera is in UG (lentic, highland) where 16 individuals from 3 species were found, with the most species found being *Agriocnemis femina*.

Agriocnemis pygmaea is a species that is mostly found in waters with small to middle flows and is a very common category [14], *Agriocnemis pygmaea* is a species that is very tolerant of environmental changes [15]. The genus Coenagrionidae is found in highland rivers

with high air humidity and good water quality [16].

Odonata diversity in the lowlands (309 - 360 masl)

The highest diversity of Anisoptera is location SS (lentic, lowland), there are 152 individuals from 10 species with a diversity index value of 1.95 (Figure 1B) with the most species found is *Orthetrum sabina* with 40 individuals. While the lowest index value is SB (lotic, lowland) found 98 individuals from 8 species with an index value of 1.29 with the most species found being *Orthetrum sabina* with a total of 64 individuals.

The highest diversity of Zygoptera is SS (lentic, lowland), there are 29 individuals from 4 species with a diversity index value of 1.13 (Figure 1B) with the most species found is *Agriocnemis femina* with 17 individuals. While the lowest Zygoptera diversity value is SB (lotik, lowland) with a value of 0.68 with the most species found is *Agriocnemis femina* with 8 individuals.

Species *A. pygmea* and *A. femina* in the common and very common category [14], because they have resistance to environmental changes and extreme water quality compared to other species [15].

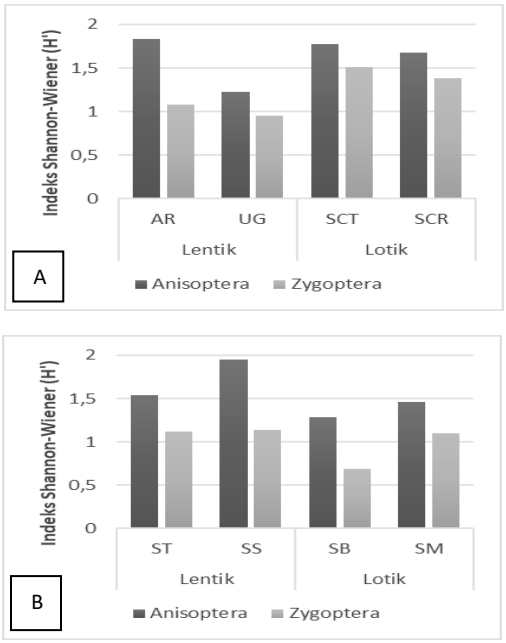


Figure 1. Diversity index: A. Highland, B. Lowland. Description: ST=Sumber Taman; SS=Sumber Sira; SB=Sungai Bureng; SM=Sumber Maron; AR=Arboretum; UG=Umbul Gemulo; SCT=Sungai Coban Talun; SCR=Sungai Coban Rais

Distribution of odonata in the highlands (979 - 1726 masl)

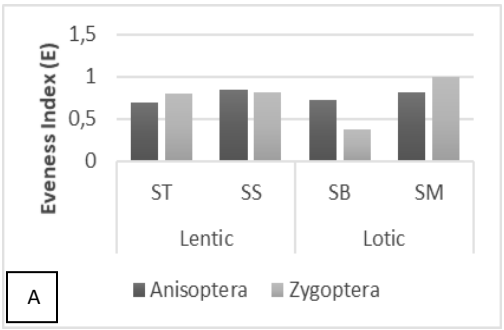
Eveness of the sub-order Anisoptera in the highlands obtained the highest value on the SCR with a value of 0.8 (Figure 2) included in the good category of stable distribution, while the sub-order Zygoptera had the highest evenness value at the SCT location with a value of 1, 69. This is because the Zygoptera found at the SCT is very even though only 6 species are found but have an even distribution of species in one location.

The highlands have good quality biotic and abiotic factors compared to the lowlands, which is directly proportional to the high species of Zygoptera found. Light and ecological factors have a large influence on insects such as the length of life and activities [17].

Distribution of odonata in the lowlands (309 - 360 masl)

The highest index evenness of the sub-order Anisoptera is on the SS with an index value of 0.84 (Figure 2) which is included in the good category with the distribution of species more stable, the highest evenness Zygoptera is at SM with a value of 0.99. Because at the SS and SM locations there are many types of vegetation where dragonflies breed and activities, the pattern of dragonfly distribution is greatly influenced by the place where dragonflies live.

Diversity and distribution of dragonfly types depend on food and the state of their habitat [18] and altitude affects the presence of dragonflies due to temperature and environmental factors [19].



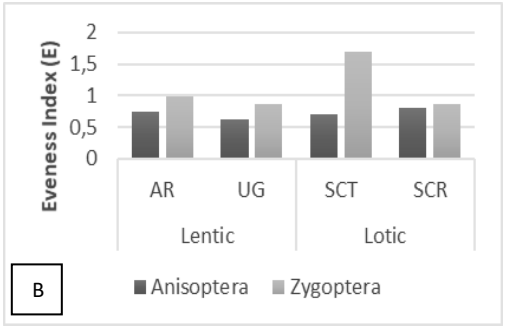


Figure 2. Species evenness index: A. Lowland, B. Highland. Description: ST=Sumber Taman; SS=Sumber Sira; SB=Sungai Bureng; SM=Sumber Maron; AR=Arboretum; UG=Umbul Gemulo; SCT=Sungai Coban Talun; SCR=Sungai Coban Rais

Important Value Index (IVI) Sub-Order Anisoptera in various aquatic ecosystems

Orthetrum sabina is a dragonfly species which in the naiad or imago phase is very resistant to environmental changes, this type of dragonfly can dominate the entire location because of its ability, in the lotik waters the value of 61.4 is higher than bending which is only 54.3. Furthermore, the *Pantala flavescens* which received an index value of 25.4 in lentic aquatic ecosystems, this occurs because the genus Pantala is a dragonfly who prefers to be in calm waters with small to moderate currents. All species that dominate in all locations are from the genus Libellulidae with a percentage above 50% of the species *Orthetrum sabina*. The species Ortherum sabina dominates because this species is very resistant to environmental changes.

According to previous research *Orthetrum sabina* and *Pantala flavescens* species have the highest IVI values and also dominate and have an important role in community structure [20]. *Orthetrum sabina* and *Pantala flavescens* are common odonata species and have a very wide distribution, especially in the tropics [21].

Important Value Index (IVI) Sub-Order Zygoptera in various aquatic ecosystems

The family Coenagrionidae has a suitable habitat with the lotic ecosystem because it is supported by flying from species in this family that are quite high and have good adaptation in the environment. *Agriocnemis femina* and *Agriocnemis pygmaea* from the Coenagrionidae family are two species with the highest index value in each aquatic ecosystem, because these two species have habitat compatibility to be able to adapt well in their environment, the family Coenagrionidae is commonly found in relatively low water flow [22].

Lotic aquatic ecosystems are dominated by species *Agriocnemis pygmaea, Agriocnemis femina*, and *Vestalis luctuosa* with index values of 49.3; 47.05; and 35.02 (Table 2), whereas in the lentic aquatic ecosystem dominated by species *Agriocnemis femina, Pseudagrion pruenosum*, and *Agriocnemis pygmaea* with index values of 82.2; 53.8; and 17.9.

Odonata population similarity in all study locations

Based on the results obtained by the suborder Anisoptera divided into 3 large groups (Figure 3), namely group 1 (SS), group 2 (ST, SB, UG, AR) and group 3 (SCT, SCR, and SM). The highest similarity value is on ST and SB with a similarity value of 0.86, which means there is a high similarity between the sub-order Anisoptera composition found in these two locations, then the SCT and SCR were scored 0.8 means that there are high similarities in the two locations. The lowest similarity is in the SS by forming its own group, which means that the similarity of composition of Anisoptera is relatively far found with other locations.

The similarity index value of the Zygoptera sub-order was found in 3 large groups (Figure 3), group 1 (ST, SB, UG), group 2 (SM, AR, SS), and group 3 (SCT and SCR). The highest similarity value in group 1 is ST and SB with a value of 0.78, which means there is a high similarity between the two locations, in group 2 is SM and AR with similarity values of 0.67 and group 3 SCT and SCR with a value of 0.65 .

The location of ST and SB has a high similarity in the two sub-orders, this can occur because of the close distance between the two locations where the distance allows dragonflies to migrate from one place to another to hunt or breed. Furthermore, SCT and SCR which have high similarity values in two sub-orders, this is because the same type of aquatic ecosystem, community structure and similar environment between the two locations, community structure in the form of good environmental quality and being in a dense vegetation of trees supports the existence of species of dragonflies in the area.

Table 2. Important Value Index of Odonata)

Sub-Order Anisoptera				
No	**Species**	**Family**	**IVI (%)**	
			Lotic	**Lentic**
1	*Orthetrum sabina*	Libellulidae	61,475	54,301
2	*Orthetrum crysis*	Libellulidae	25,287	15,701
3	*Neurothemis ramburii*	Libellulidae	19,633	11,011
4	*Orthetrum pruenosum*	Libellulidae	17,371	6,419
5	*Diplacodes trivialis*	Libellulidae	13,776	8,809
6	*Paragomphus sp*	Gomphidae	10,827	14,151
7	*Pantala flavescens*	Libellulidae	10,827	25,408
8	*Orthetrum glaucum*	Libellulidae	9,534	19,405
9	*Onycothemis cuminicola*	Libellulidae	9,050	0,000
10	*Anax guttata*	Aeshnidae	8,888	4,404
11	*Crocothemis salvilia*	Libellulidae	6,909	6,607
12	*Brachythemis contaminata*	Libellulidae	4,283	16,215
13	*Zyxoma sp*	Libellulidae	2,141	4,217
14	*Gynacantha musa*	Aeshnidae	0,000	7,495
15	*Agrinoptera insignis*	Libellulidae	0,000	4,029
16	*Lathrecista asiatica*	Libellulidae	0,000	1,827

Sub-Ordo Zygoptera				
No	**Species**	**Family**	**IVI (%)**	
			Lotic	**Lentic**
1	*Agriocnemis pygmaea*	Coenagrionidae	49,306	17,955
2	*Agriocnemis femina*	Coenagrionidae	47,050	82,273
3	*Vestalis luctuosa*	Calopterygidae	35,020	14,545
4	*Pseudagrion pruenosum*	Coenagrionidae	27,415	53,864
5	*Rhynocypha fenestrata*	Chlorocyphidae	26,663	0,000
6	*Ceriagrion calamineum*	Coenagrionidae	9,948	13,409
7	*Coeliccia membranipes*	Platycnemididae	4,598	17,955

Wealth types and structure of plant composition in an area will form a better community, so that the habitat of an area is able to provide various resources [23].

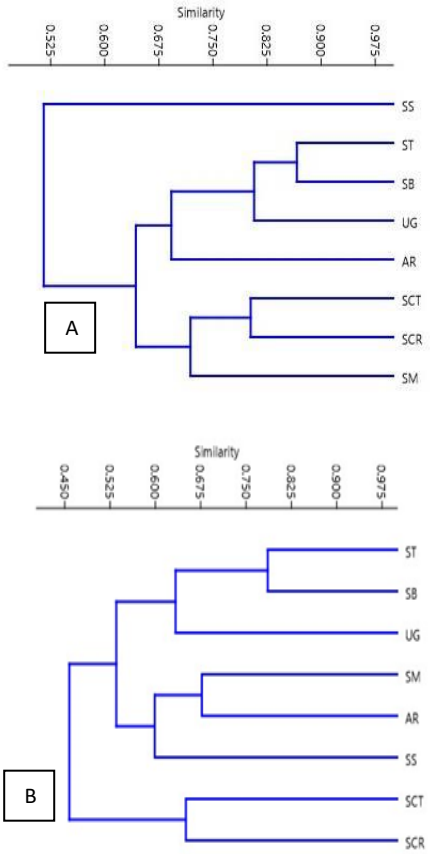


Figure 3. Dendogram of the Similarity Index of Bray-Curtis, A. Sub-order of Anisoptera, B. Sub-order of Zygoptera

Effect of abiotic factors on the diversity of odonata species

The PCA results showed that at the SM location has a high current speed and wind speed and at the SB location it has high air temperature, water temperature and wind speed, but this correlates negatively with diversity, this results in the inferred species diversity being inferred not suitable with odonata habitat.

The whole of abiotic factors is in locations in the highlands characterized by low air and water temperatures and high diversity. In the lowlands it is characterized by high temperatures and high water temperatures and high wind speeds but is not followed by high diversity and evenness.

Location of AR and SCT sub-order Zygoptera characterized by high DO and high species evenness but negatively correlated with light intensity and pH, in quadrant III the location of

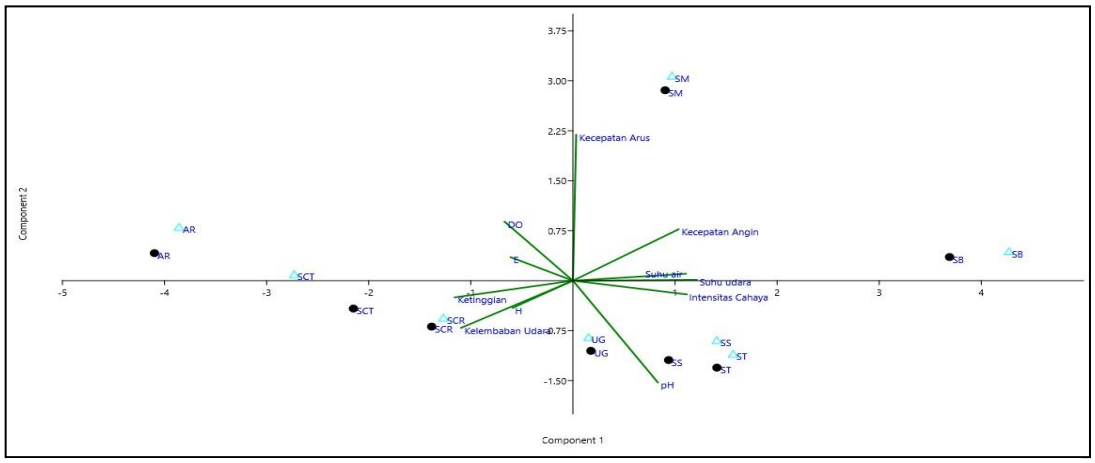


Figure 4. PCA analysis of the relationship between biotic and abiotic factors with odonata diversity.

SCR and SCT sub-order Anisoptera are characterized by altitude, humidity, and high species diversity but negatively correlated with wind speed, water temperature and air temperature, in quadrant IV there are 3 location points ST, SS, and UG which are characterized by light intensity, and high pH but have a negative correlation with DO and evenness of the species.

Landscape analysis of land use

Usage is a constituent component of land use and landscape depiction or landscape, land use greatly influences the existence of a population odonata can even regulate an ecosystem, changes in land cover every time must change with the existence of natural or human activities and automatically affect the life of a population in around including odonata.

Sumber Maron

Sumber Maron has 6 classifications of land use in the form of agricultural area, plantations, waters, residential area, vegetation area, and road. Agricultural area dominates with a percentage of 45.72% (table 3) of the total area of land samples taken, dominated by lowland agricultural crops such as rice and sugar cane. Aquatic areas which are restricted by residential area and vegetation area have a land cover percentage of 20.65% with 3 edges without buffer zones directly adjacent to patches of plantations, agricultural area and residential area.

Sumber Sira

Agricultural area (patch) dominates the land sample area (matrix) with a percentage of 48.04% with a limiting edge between patches in the form of vegetation area, plantations and waters. The water area has a percentage of 0.44% (table 2) of the entire matrix and is not directly adjacent to the corridor area (road). The water area has a lot of edge which results in high biodiversity in the area.

Arboretum Sumber Brantas

The area of agricultural area dominates with a percentage of 43.97% of the entire sample area (matrix). The water area has an area with a percentage of 1.03% (table 3) which forms a corridor and forms an edge directly adjacent to a patch in the form of a forest.

The corridor of the road is formed which divides the matrix and stretches past patches in the form of forests, residential area, and agricultural area but not directly adjacent to the area of the water where the sampling is carried out. This makes the fauna biodiversity around the waters not much disturbed because it is in a natural forest or a homogeneous landscape, because if the sampling area is on a heterogeneous landscape, the biodiversity will be disrupted.

Coban Rais River

Patches in the form of natural forests dominate very large areas with a percentage of 85.10% (table 3) from all matrices or sample areas taken, with plants in the form of Acacia trees (*Accacia mangium*) and Pinus (*Pinus merkusii*). Waters area including the type of corridor has an area of 2.81% which is directly adjacent to the natural forest patch. There are 3 edge borders between corridors (rivers) and natural forests.

Coban Talun River

Agricultural area dominates land use with a percentage of area in one sample area of 67.24% (table 3) which is dominated by horticultural agriculture such as carrots (*Daucus carota*), and

corn (*Zea mays*), there are two types of corridor namely natural corridor (river) and artificial corridor (road) which is directly adjacent to the patch in the form of agricultural area.

Bureng River

The vegetation area is a useless area with vegetation in the form of grass and shrub plants and rarely trees with minimal land use for humans, dominating the total area of 65.65% (table 3). The waters has an area of 5.12%, agricultural land has an area of 11.85% and is dominated by typical lowland agricultural crops in the form of rice and corn.

Sumber Taman

Agricultural land dominates the landscape area with a percentage of 48% (table 3), agricultural land is dominated by rice, corn and sugarcane. The plantation contains cassava and coconut plants with an area percentage of 10.50%. The waters have a percentage of 0.21%, which is surrounded by areas of shrub vegetation, grass and aquatic plants and there are several trees of trembesi species (*Samanea saman*), sengon (*Albizia chinensis*) and bamboo (*Bambuseae*).

Sumber Taman is included in the interior type because it is in the middle of a patch (vegetation area), the Garden Source landscape is included in the heterogeneity landscape because it has many types of patches that spread and there are many types of edges, this makes interest in a species that requires more than one landscape element as habitat.

Umbul Gemulo

The spring area has edge borders with vegetation and settlement areas. The size of the matrix (settlement) compared to the area of vegetation influences the diversity of species in that place if the matrix has environmental quality and disturbances, the diversity of species will be low due to displacement or death of species that are intolerant of many disturbances.

The abundance relationship of the Sub-order Anisopteran with land use

The study of the relationship of dragonfly species Anisoptera was taken to dominate in all locations (Table 2), *Orthetrum sabina* is a sub-order Anisoptera dragonfly that dominates in all locations. It is found that the results of 3 land use categories have a negative correlation between residential area, plantation and road (table 4). the high land use in these 3 categories makes the abundance of odonata smaller, meaning that this dragonfly does not have habitat suitability in these 3 categories if the land use area is too large.

Neurothemis ramburii, Orthetrum glaucum and *Diplacodes trivialis* negative correlation in 5 categories except the forest and water categories with a positive correlation, this shows that the 3 species have habitat suitability in the form of forest and water categories (table 4). The availability of water or water areas greatly influences species abundance, species in the tropics are influenced by waters in the tropics [13].

Some sub-orders of the anisoptera are very resistant to environmental changes and bad environmental conditions, there are several categories that have high levels of human disturbances which also affect the diversity and abundance of odonata. for example the categories of residential area, roads and vegetation areas (table 4).

The suitability of habitat influences species abundance, especially in natural forest areas because the forest area provides opportunities for animals that live in it because of the heterogeneity of a vegetation in the forest [24].

The abundance relationship of the Sub-order Zygopteran with land use

Forests are compatible with most sub-order Zygoptera species but in these two species have low abundance in the forest category. Meaning that the *Agriocnemis pygmaea, Vestalis luctuosa, Coeliccia membranipes*, and *Rhynocypha fenestrata* matches the waters and forest which affects the high abundance of species, the five categories of negatively correlated indicate the wider area of land use, then the low abundance of species in that location. The diversity of odonates in the tropics is largely due to the high diversity of aquatic habitats in the tropics [10].

Different from the Anisoptera, in the sub-order Zygoptera which has a small amount and abundance. this is because the tolerance level of Zygoptera is lower than that of Anisoptera. Zygoptera is more negatively correlated in several categories such as residential area, agriculture, vegetation areas, and roads. this shows that Zygoptera has a low range of habitat tolerance compared to Anisoptera (table 4).

Fragmented landscapes are followed by vegetation with minimal canopy and low availability and quality of water. This situation makes it possible not to provide adequate corridors to facilitate dissemination, to limit the relationship of odonata in the city [25].

Table 3. Percentage of land use

No.	Land use clasification	Study sites (masl)							
		SM (330)	SS (360)	AR (1726)	SCR (1298)	SCT (1261)	SB (309)	ST (358)	UG (979)
1	Plantation (%)	14,19	22,88	3,68	2,17	1,88		10,50	10,46
2	Agricultural (%)	45,72	48,04	43,97	8,90	67,24	11,85	48,00	20,14
3	Residential area (%)	20,65	8,28	16,02	1,02	7,02	14,71	18,18	52,79
4	Spring/river (%)	1,83	0,44	1,03	2,81		5,12	0,21	0,43
5	Road (%)	0,01	0,88	1,39		1,01	2,67	3,02	4,80
6	Vegetation area (%)	17,60	19,49				65,65	20,09	11,38
7	Forest (%)			33,92	85,10	22,85			

Table 4. Correlation of the Odonata with land use

Sub-Order Anisopteran								
No.	Species	Residential	Agriculture	Plantation	Waters	Road	Veg. area	Forest
1	*Orthetrum sabina*	-	+	-	+	-	+	+
2	*Orthetrum crysis*	-	-	+	+	-	-	+
3	*Neurothemis rumphii*	-	-	-	+	-	-	+
4	*Orthetrum pruenosum*	-	+	-	+	-	-	+
5	*Diplacodes trivialis*	-	-	-	+	-	-	+
6	*Paragomphus sp*	+	-	+	-	+	-	-
7	*Pantala flavescens*	-	+	+	-	+	-	+
8	*Orthetrum glaucum*	-	-	-	-	-	-	+
9	*Onycothemis cuminicola*	+	+	+	+	-	-	-
10	*Anax guttata*	-	+	-	+	-	-	+
11	*Crocothemis salvilia*	-	+	+	-	-	-	+
12	*Brachythemis contaminata*	-	+	+	-	-	+	-
13	*Zyxoma sp*	-	+	-	-	+	-	+
14	*Gynacantha musa*	+	-	-	-	+	-	+
15	*Agrinoptera insignis*	+	-	-	-	+	-	+
16	*Lathrecista asiatica*	-	+	+	-	-	+	-
Sub-Order Zygooptera								
No.	Species	Residential	Agriculture	Plantation	Waters	Road	Veg. area	Forest
1	*Agriocnemis pygmaea*	-	-	-	+	-	-	+
2	*Agriocnemis femina*	+	+	+	-	-	-	-
3	*Vestalis luctuosa*	-	-	-	+	-	-	+
4	*Pseudagrion pruenosum*	+	+	+	-	-	-	-
5	*Rhynocypha fenestrata*	-	+	-	+	-	-	+
6	*Ceriagrion calamineum*	+	+	-	-	+	-	+
7	*Coeliccia membranipes*	-	-	-	+	-	-	+

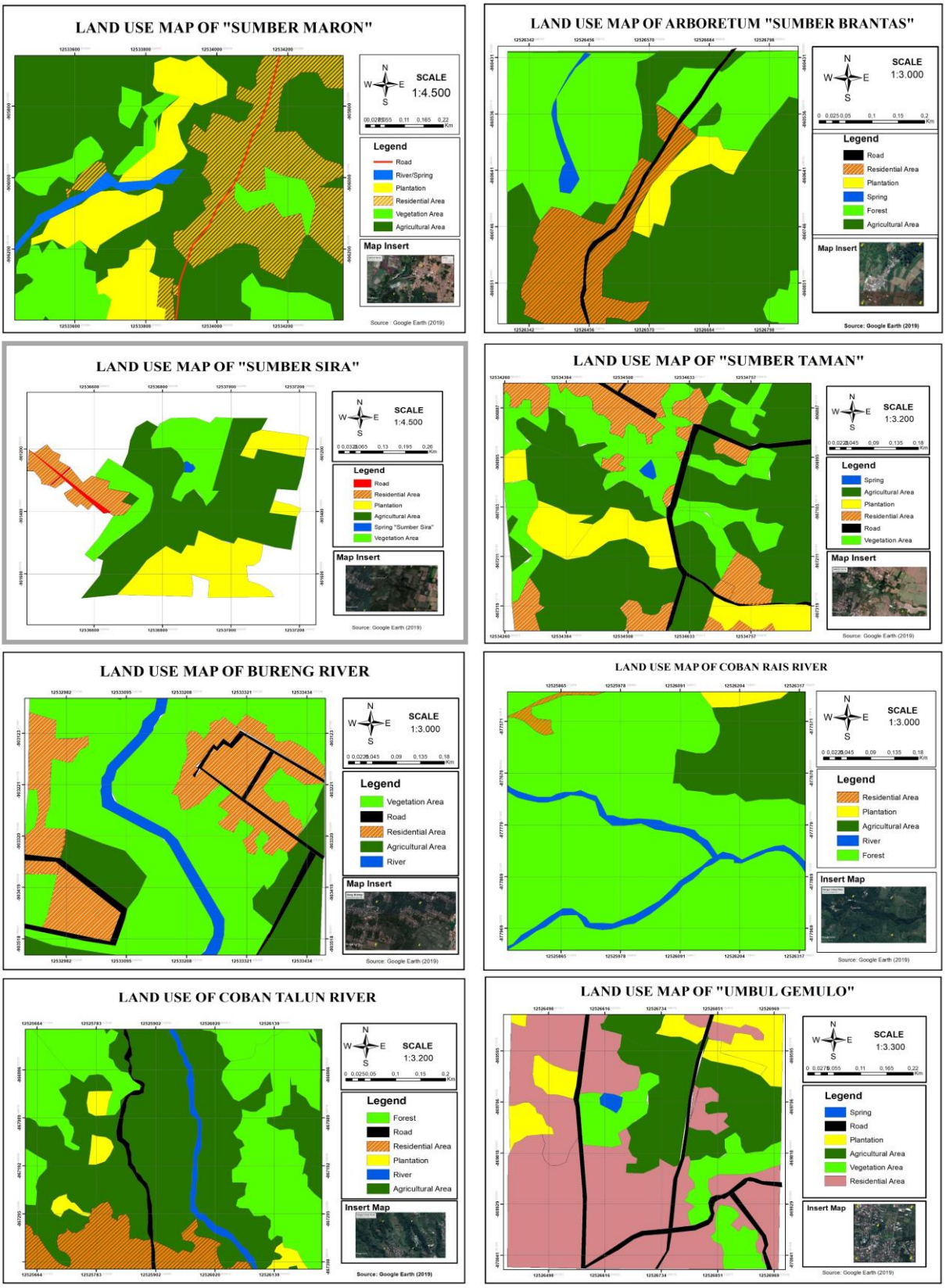


Figure 5. Map of land use in all locations

Conservation efforts are carried out with the existence of a land use relationship with an abundance of odonata so that the community can know the life tolerance and habitat of odonata seen from the structure of land cover in an area, because each odonata species has a different tolerance of life. So the existence of this research can be used by the research community as the beginning of conservative actions for odonata

CONCLUSION

The odonata diversity in the lotic aquatic ecosystem of the Anisoptera sub-order has a higher index in the highlands than in the lowlands, but the lentic has the highest index of all locations at Sumber Sira. while the highest index zygoptera is at 2 lotic stations in the highlands.

Land use proportion with less human disturbances makes the diversity of the odonata higher because it has components that support a good habitat suitability as a place of life for dragonflies

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