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Potential Diversity of Plant Species Against Sulfur Absorption in the Banyuputih River Situbondo, East Java

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Abstract The diversity of plant species not only serves as a barrier to seawater intrusion but also provides protection from land to sea, originating from Mount Ijen flows the Banyuputih river in the Situbondo region, East Java. The Situbondo-Banyuwangi regency area is a strategic area, so it needs to be preserved its environmental ecosystem. The diversity of mangrove forests, natural sand beaches and riverbank vegetation can be an indication of environmental protection and preservation. The diversity of cultivated and wild plant species also has an indication of the pH state. Likewise, the types of flora around the Banyuputih river have an indication that they can reduce the impact of the infiltration of sulfur levels, thus contributing to groundwater sources. This study aims to determine diversity of flora species along the riverbanks and sand beaches in the environment of the highway at the mouth of the Banyuputih river in Situbondo regency, which is allegedly contaminated with sulfur material from Mount Ijen. To support the environmental function, it is equipped with data on the depth of groundwater sources, location elevations and river water's pH. The methods used in this research were survey, open-ended interviews, semi-structured and in-depth interviews. The survey results are then collected and diagnosed and the scientific name is determined. Species diversity was recorded around Banyuputih river, Banyuputih sub-district including 26 families (60 species), mangroves 11 families (13 species) and Banongan sand beach 8 families (11 species). The sulfur levels along the Banyuputih river indicate that the diversity of flora has the potential to filter sulfur levels, so the water resources can be utilized for living. Meanwhile, the existence of the diversity of coastal forests and mangroves functions as a barrier to sea water intrusion, wind and tsunami.

Keywords Banyuputih river, Situbondo regency, Flora, Sulfur

1. Introduction

Indonesian is an island with an approximately 17.508 islands and length of beaches approximately 81.000 km [5]. There are very large biotic and abiotic in coastal resources. Magrove ecosystems are found in intertidal areas where deposition of sediment occurs [11]. The are dominated by trees, shrub, herb, liana, epiphyte, saprophyte and associated organisms occupying environment at the land or sea. The most important coastal natural resources is mangrove forest. The objectives of this research is to reveal the existence of flora around the Banyuputih river, sand beach and magrove ecosystems in Banyuputih district, Situbondo regency. The area of Banyuputih district is 481.670 km^2 consisting of five villages that have sand beaches, river estuaries. Most of the Banyuputih sub-district is flat land with an altitude of 5–60 m above sea level, flat soil conditions and legosol soil characteristics. Most of the people along the Banyuputih river are inhabited by the *Madurese* and it can be indicated from their language accent. Diversity in the coastal environment of southern Java consists of mangove forest, coastal forest and coral reef forest [4,6].

The relationship between humans and the utilization of biodiversity (organisms) in the environment they live in is known as ethnobotany activity [4,12]. Local wisdom are human behavior that is passed down from generation to generation through stories or tales that are not written by word of mouth [7,4,12].

Mount Ijen is a volcanic mountain, located between Banyuwangi and Bondowoso districts and has an altitude of 2.386 m above sea level (ASL). The content of sulfur and calcium elements (Sulfur and Calcium) which is brought from the top of Mount Ijen is a problem that can be overcome for health problems of organisms. The people of the coastal area of Situbondo district-Banyuwangi are the environment affected by the disturbance of sulfur elements [13,14]. The research reveals that the diversity of flora is related to the intrusion of Sulfur levels along the Banyuputih river.

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Figure 1. Map of Situbondo Regency (star-study area)

2. Materials and Methods

The study was conducted through surveys and direct observations in muara sungai Banyuputih Situbondo-Banyuwangi, in May-October 2020 (Fig. 1). This research methods are collecting the plant materials, drying, mounting, preparation and preservation of plant specimens [1,3,8, 11]. The identification and nomenclature of the listed plants were based on the Flora of Java and Flora Malesiana [3,6]. The methods employed were survey, open-ended interviews, semi-structured and in-depth interviews [4]. Meanwhile, the altitude of the research location was carried out using GPS. In determining the water condition: color and pH of the water in Banyuputih river are using pH paper.

3. Results and Discussion

Banyuputih river environment

Madurese peoples generally engaged in the agricultural sector, rice processing, moor and yards. Therefore, along the Banyuputih river, various cultivated plants are planted such as: tebu (*Sacharum officinarum*), banana (*Musa paradisiaca*), mango (*Mangifera indica*), pete (*Parkia speciosa*), coconut (*Cocos nucifera*), cassava (*Manihot utilisima*), rice (*Oryza sativa*), corn (*Zea mays*) etc. (Table 1). The diversity of cultivated plants and wild plants as well as environmental factors such as soil and river flow in the area have an indication that it can reduce the impact of sulfur infiltration, thus contributing to water sources. The smell of sulfur around the Banyuputih neighborhood has decreased compared to the location near Mount Ijen (Wiyono, 2017; personal interview, 2020). Sugarcane cultivation has superior growth with very good sugar content, while irrigation uses Banyuputih river. [2,12] reported local wisdom in customary law is used as the main source in managing river resources.

Banyuputih river at an altitude of 42 m above sea level (ASL); position S. 07° 45' 06.85"; E. 114° 14' 33.04" has yellow water, pH 4-4-5, slightly sulfuric odor with a pH of 4-4.5 (Fig. 2 A, B). [13] explained that the acidity in Mount Ijen is less than pH 4 which consists of Calcium, SiO2, Aluminum, Fe, SO4 and Potassium [Wiyono, 2017]. The diversity of plants around the Banyuputih river has an influence on the level of sulfur concentration in its groundwater sources. The depth of groundwater (well) is 12-15 m, but at this time the people around the river are starting to utilize PDAM water sources.

Table 1. River Banyuputih

No	Local name	Scientific name	Family	Habitus and location
1	Ceplikan	*Ruellia tuberosa*	Acanthaceae	Shrub Banyuputih
2	Mangga	*Mangifera indica*	Anacardiaceae	Tree, Banyuputih
3	Kijaran	*Lannea coromandelica*	Anacardiaceae	Tree, Banyuputih
4	Mbote	*Calocasia esculenta*	Araceae	Herb, Banyuputih
5	Kambil	*Cocos nucifera*	Arecaceae	Tree, Banyuputih
6	Jambe	*Areca catechu*	Arecaceae	Tree, Banyuputih
7	Biduri	*Calotropis gigantea*	Asclepiadaceae	Shrub Banyuputih
8	Wedusan	*Ageratum conizoides*	Asteraceae	Shrub, Banyuputih
9	Sundel	*Borreria alata*	Asteraceae	Herb, Banyuputih
10	Kerinyu	*Eupatorium inulifolium*	Asteraceae	Shrub, Banyuputih
11	Gletang	*Tridax procumbens*	Asteraceae	Herb, Banyuputih
12	Ketul	*Bidens biternata*	Asteraceae	Herb, Banyuputih
13	Tempuyung	*Emilia sonchifolia*	Asteraceae	Herb, Banyuputih
14	Bandotan	*Ageratum conyzoides*	Asteraceae	Shrub, Banyuputih

No	Local name	Scientific name	Family	Habitus and location
15	Randu alas	*Bombax* sp.	Bombaceae	Tree, Banyuputih
16	Randu	*Ceiba petandra*	Bombaceae	Tree, Banyuputih
17	Tusuk konde	*Heliotropium indicum*	Boraginaceae	Herb, Banyuputih
18	Teki	*Cyperus rotundus*	Cyperaceae	Herb, Banyuputih
19	Kate mas	*Euphorbia heterophylla*	Eupborbiaceae	Herb, Banyuputih
20	Jarak pager	*Jatropha curcas*	Euphorbiacaeae	Shrub, Banyuputih
21	Patikan	*Euphorbia hirta*	Euphorbiaceae	Herb, Banyuputih
22	Mbako	*Nicotiana tabacum*	Euphorbiaceae	Shrub, Banyuputih
23	Pohong	*Manihot utilisima*	Euphorbiaceae	Shrub, Banyuputih
24	Kaliandra	*Calliandra haematocephala*	Fabacaeae	Shrub, Banyuputih
25	Pete	*Parkia speciosa*	Fabaceae	Tree Banyuputih
26	Orok-orok	*Crotalaria striaca*	Fabaceae	Shrub Banyuputih
27	Tom	*Indigofera sumatrana*	Fabaceae	Shrub, Banyuputih
28	Rendetan	*Mimosa invisa*	Fabaceae	Shrub, Banyuputih
29	Kacangan	*Centrosoma pubescent*	Fabaceae	Liana, Banyuputih
30	Mlandingan	*Leucaena leucocephala*	Fabaceae	Shrub, Banyuputih
31	Gamal	*Glerisedia maculata*	Fabaceae	Shrub, Banyuputih
32	Putri malu	*Mimosa pudica*	Fabaceae	Shrub, Banyuputih
33	Sengketan	*Hyptis suaveolens*	Labiatae	Shrub Banyuputih
34	Waru	*Hibiscus tiliaceus*	Malvaceae	Tree, Banyuputih
35	Sidoguri	*Sida rhombifolia*	Malvaceae	Shrub, Banyuputih
36	Mimba	*Azadirachta indica*	Meliaceae	Tree, Banyuputih
37	Nangka	*Artocarpus heterophyllus*	Moraceae	Tree, Banyuputih
38	Awar-awar	*Ficus septica*	Moraceae	Shrub, Banyuputih
39	Serut	*Streblus asper*	Moraceae	Shrub, Banyuputih
40	Kelor	*Moringa oleifera*	Moringaceae	Tree, Banyuputih
41	Pisang	*Musa paradisiaca*	Musaceae	Herb, Banyuputih
42	Jambu klutuk	*Psidium guajava*	Myrtaceae	Shrub, Banyuputih
43	Salam	*Eugenia polyantha*	Myrtaceae	Tree, Banyuputih
44	Blimbing wuluh	*Averrhoa carambola*	Oxalidaceae	Tree, Banyuputih
45	Pandan ri	*Pandanus tectorius*	Pandanacae	Tree, Banyuputih
46	Nomlang	*Pasiflora foetida*	Passiforaceae	Liana, Banyuputih
47	Katu	*Sauropus androgynus*	Phyllantaceae	Shrub, Banyuputih
48	Jagung	*Zea mays* L.	Poaceae	Grass, Banyuputih
49	Alang-alang	*Imperata cylindrica*	Poaceae	Grass, Banyuputih
50	Rumput gajah	*Pennisetum purpureum*	Poaceae	Grass, Banyuputih
51	Bambu	*Dendrocalamus asper*	Poaceae	Tree, Banyuputih
52	Tebu	*Sacharum officinarum*	Poaceae	Shrub, Banyuputih
53	Lulangan	*Eleusine indica*	Poaceae	Grass, Banyuputih
54	Alang-alang	*Imperata cylindrica*	Poaceae	Grass, Banyuputih
55	Ranti	*Solanum nigrum*	Solanaceae	Shrub, Banyuputih
56	Pokak	*Solanum torvum*	Solanaceae	Herb, Banyuputih
57	Pulutan	*Triumffeta indica*	Tiliaceae	Shrub Banyuputih
58	Pecut kuda	*Stachypeta jamaicensis*	Verbenaceae	Shrub, Banyuputih
59	Telekan	*Lantana camara*	Verbenaceae	Shrub, Banyuputih
60	Kayu jati	*Tectona grandis*	Verbenaceae	Tree, Banyuputih

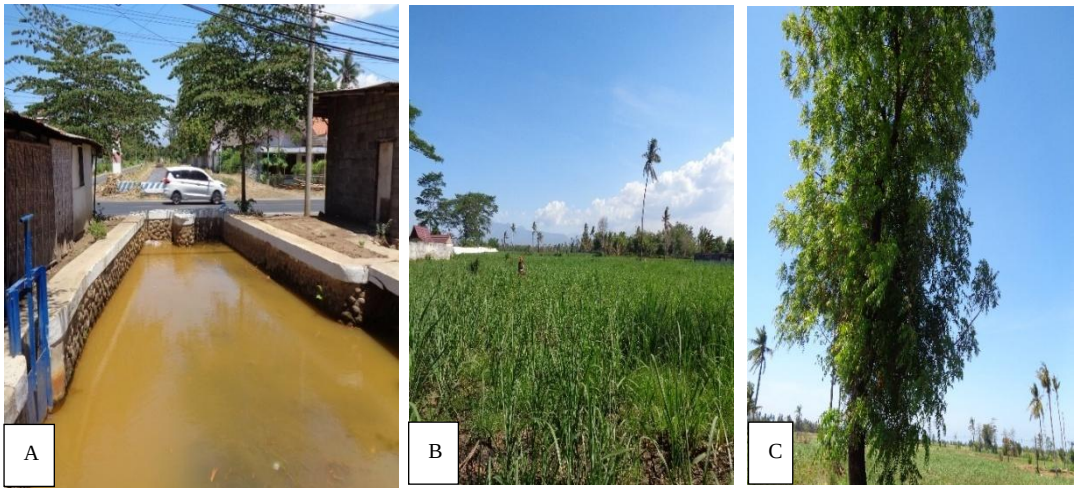

Figure 2. A. Banyuputih river, Daendeles road. B. Research locations for sugarcane cultivation (*Sacharum officinarum*) and C. Mimba trees (*Azadirachta indica*). Photo, J. Batoro

Table 2. Sand beach

No	Local name	Scientific name	Family	Habitus and Locatition
1	Kambil	*Cocos nucifera*	Arecaceae	Tree, Banongan
2	Biduri	*Calotropis gigantea*	Asclepiadaceae	Shrub, sand beach, Banongan
3	Cemara laut	*Casuarina equisetifolia*	Casuarinaceae	Tree, sand beach, Banongan
4	Balaran	*Ipomoea pes-caprae*	Fabaceae	Liana, sand beach, Banongan
5	Singkil	*Prema* sp.	Lamiaceae	Shrub, sand beach, Banongan
6	Ketapang	*Baringtonia asiatica*	Lechythidaceae	Tree, sand beach, Banongan
7	Sidoguri	*Sida rhombifolia*	Malvaceae	Shrub, sand beach, Banongan
8	Pandan ri	*Pandanus tectorius*	Pandanaceae	Tree, sand beach, Banongan
9	Nomlang	*Pasiflora foetida*	Passiforaceae	Liana, sand beach, Banongan
10	Rumput	-	Poaceae	Grass, sand beach, Banongan
11	Mimba	*Azadirachta indica*	Meliaceae	Tree, sand beach, Banongan

Table 3. Mangrove area

No	Local name	Scientific name	Family	Habitus and location
1	Daruju	*Acanthus ilicifolius*	Acanthaceae	Herb, mangrove or sand beach
2	Bintaro	*Cerbera odollam*	Apocynaceae	Tree, mangrove
3	Nipah	*Nypha fructicans*	Arecaceae	Tree, mangrove
4	Api-api	*Avicenia marina*	Avicenniaceae	Tree, mangrove
5	Teruntum	*Lumnitzera littorea*	Combretaceae	Tree, mangrove
6	Kayu buta	*Exoecaria agallocha*	Euphorbiaceae	Tree, mangrove
7	Kebiul	*Caesalpinia crista*	Fabaceae	Tree, mangrove
8	Gedangan	*Aegiceras corniculatum*	Myrsinaceae	Tree, mangrove
9	Paku laut	*Achrostichum speciosum*	Pteridaceae	Shrub, mangrove
10	Tanjang	*Bruguiera cylindrica*	Rhizophoraceae	Tree, mangrove
11	Bakau	*Rhizophora apiculata*	Rhizophoraceae	Tree, mangrove
12	Tinggi	*Ceriop tagal*	Rhizophoraceae	Tree, mangrove
13	Bogem	*Sonneratia alba*	Sonneratiaceae	Tree, mangrove

The existence of a mangrove environment is also needed to absorb nitrogen (N) and phosphorus (P) waste released for intensive shrimp pond activities in the sand beach area, Banyuputih district, Situbondo regency [9,10]. The type of sea pine plant, cemara laut (*Casuarina equisetifolia* L.) is a type of immigrant originating from the Australian continent which grows very well (Figure 3). Banongan beach area, Situbondo district, has a height of 12 m above sea level

(ASL), position S 07° 42' 30.25"; E.114° 13' 24. 84" is now being developed into a local tourism business with natural beauty and sunrise. Banongan beach flora diversity includes mimba trees (*Azadirachta indica*), kambil (*Cocos nucifera*) and sea pine (*Casuarina equisetifolia* L.) etc. (Table 2). The major magrove flora commonly find and the estuary Banyuputih for example api-api (*Avicenia* spp.), bakau (*Rhizopora* spp.), kerinyu, telekan (*Lantana camara*), grass etc. (Table 3). *Canavalia maritima* endemic to the coatal dunes located, on sandy beaches in the southern region of the the island of Java [5]. This type has not been found, maybe the location is less extensive. [11] reported magrove diversity in Papua New Guinea more than 37 species. In the other hand over 50 plant species found in mangrove vegetation in Thailand [6]. The existence of the diversity of coastal plants and mangroves serves as a barrier to intrusion of sea water, wind and tsunami.

Figure 3. Sand beach in river autfall Banyuputih Banongan, Situbondo district. A. Distribution *Ipomoe pescaprae*, mimba (*Azadirachta indica*), *Cocos nucifera* and cemara laut (*Casuarina equisetifolia* L.)

4. Conclutions

Species diversity was recorded around Banyuputih river, Banyuputih sub-district covering 26 families (60 species), mangroves 11 families (13 species) and Banongan sand beach 8 families (11 species). Sugarcane, tebu (*Sacharum officinarum*) cultivation has superior growth with very good sugar content, while irrigation uses Banyuputih river. The research reveals that the diversity of flora is related to the intrusion of Sulfur levels along the Banyuputih river. The existence of the diversity of coastal plants and mangroves serves as a barrier to intrusion of sea water, wind and tsunami.

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