Local potential analysis of freshwater swamp ecosystem in Tasik Serai Timur village as a learning resources material of ecosystem for high school students

Meidamayani S1*, Y H Adisendjaja2, and Amprasto2*

1Master Program of Biology Education, Department of Biology Education, Universitas Pendidikan Indonesia, Bandung, West Java, Indonesia.
2Department of Biology Education, Universitas Pendidikan Indonesia, Bandung, West Java, Indonesia.

*meidamayanisitepu@upi.edu amprasto@upi.edu

Abstract. Freshwater swamp in Tasik Serai Timur Village is one of 22% freshwater swamps in Sumatra. It is a part of biosphere reservation of Giam Siak Kecil of Bukit Batu Riau which is included among eleven biosphere reservation in Indonesia. It has ecological and economic functions to be preserved. One of many ways to preserve it is by teaching about it to the students. There have been many researches discussing about using its local potentials as a learning resource, but there are just limited numbers researches on local potentials of freshwater swamp, especially at Tasik Serai Timur village which can be used as the source of learning materials on ecosystems. The research methodology used here was descriptive method. The data was obtained by using explorative observations in the field and interviews with the people living around the research spot. From the result of the research, Local potentials found were abiotic and biotic components, types of interactions, and adaptations made by biotic components in freshwater swamps in the village of Tasik Serai Timur village. It is found that local potentials on freshwater swamp in this village can be used as learning resources for senior high students based on basic competence 3.10 and 4.10.

1. Introduction

Living creatures need freshwater to survive and continue living. That need is limited to the amount of freshwater which only around 3% from all waters on earth [1]. Freshwaters can come from dams, inundations, purified sea water, and freshwater swamp [1][2]. The uniqueness of the freshwater swamp ecosystem is the adaptation of flora and fauna to periodic standing water and minimal herbaceous plants [2][3]. The uniqueness and high species of flora and fauna in the freshwater swamp ecosystem causes abuse and damage to this area [4]. The freshwater swamp ecosystem generally is used by the people as agricultural area because its soil is alluvial, but only 22% of swamp ecosystems which were left in Sumatera [2]. One of the places which still had the freshwater swamp is Tasik Serai Timur village. This village was the transition zone of biosphere preservation of Giam Siak Kecil in Bukit Batu, Riau, approved by United Nation Educational, Scientific and Cultural Organization (UNESCO) in 2009 as one of among the same kinds in Indonesia. The width of the transition zone of this preservation was 304,123 ha and freshwater swamp ecosystem was included in this site. Freshwater swamp ecosystem in Tasik Serai Timur village was 5 ha [5].
The freshwater swamp ecosystem of Tasik Serai Timur village was periodically inundated by rainfall. Ecologically the freshwater swamp ecosystem had a function as a source of water reserves, preventing flooding where rare animals such as cranes foraged for food. The freshwater fish wealth in this ecosystem was used economically by the community as a source of daily livelihood [5]. Based on this, the freshwater swamp ecosystem could be used as a strength of local potential. Local potential was a resource in a particular area and as a source or strength owned by each region to be utilized in certain activities and one of which is education [6]. However, the wealth of local potential in the freshwater swamp ecosystem in Tasik Serai Timur village was disturbed by humans by excessive fish encroachment so that some types of fish such as arowana fish disappeared [5]. These environmental problem was caused by people who did not understand how to maintain and preserve existing local potentials. Therefore, increasing awareness of the environment in this ecosystem had to be done.

Solving the problem in freshwater swamp ecosystems in Tasik Serai Timur village could be done with education based on local potential and related to environmental themed material, one of which was ecosystem material [5] [6]. Local potential could be used as a source of learning in ecosystem material so it was expected to make the learning process more meaningful. Through learning based on local potential, students could be invited to make observations in the environment directly so that they could connect between concepts with real conditions and can improve students' cognitive abilities and attitudes towards the environment [8] [9] [10]. This could be achieved by looking at learning resources. Learning resources were defined as any places or environments, objects, and people that possessed information which could be used as a means for students to make changes in behavior [11] [12]. Adequate learning resources also have an effect on improving the results of the learning process [13]. Based on this it could be concluded that learning resources were expected to come from environments close to students. Therefore, it was necessary to analyze the local potential of the freshwater swamp ecosystem in Tasik Serai Timur village which could be used as a source of learning, especially for high school grade X ecosystem learning material.

2. Methods
The research used a descriptive method. The data was taken by conducting semi-structured observations and interviews with the community using this area. Explorative observations were made by observing and recording biotic and abiotic components, types of interactions and adaptations carried out by biotic components. The study population was the entire local potential of the freshwater swamp ecosystem in the Tasik Serai Timur village, while the research sample was the local potential of the freshwater swamp ecosystem in the Tasik Serai Timur village.

3. Results and Discussion
Based on the results of exploratory observations in the freshwater swamp ecosystem in Tasik Serai Timur village, the data shown in Table 1.
Table 1. Explorative observation data

| No | Observation Component | Information |
|----|------------------------|-------------|
| 1  | Biotic                 | Types of Animal |
|    |                        | Sepat Fish (*Trichopodus leerii*), Black Sepat Fish (*Trichopodus pectrolas*), Tapah Fish (*Wallago microporgon*), Selais Fish (*Cryptopteru lais*), Sparrows (*Passaridae malaccensis*), Shrubs (*Halcyon smyrnensis*), Cocaine Monkeys, Dragon fish (*Cryptopteru lais*), Sparrows (*Passaridae malaccensis*), Shrubs (*Halcyon smyrnensis*), Kokah Monkeys, Dragonflies, frogs and Water Insects. |
|    |                        | Endangered and protected animals: White Herons (*Mycteria cenerea*) and Swamp Hawk (*Circus approximans*). |
|    |                        | Types of Plants: Vines (*Liana sp*), Mushrooms (*Ganoderma sp*), Swamp Grass (*Lepironia articulata*), Pandanus Plants (*Pandanus amaryllifolius*), |
|    |                        | Rare plants: Kantung Semar (*Nepenthes mirabilis*). |
| 2  | Abiotic                | Inundations, light intensity, soil type, water pH, climate and weather. |
| 3  | Adaptations           | Morphological and physiological. |
| 4  | Types of Interactions  | Predation, symbiosis, and competition. |

3.1. Biotic Components

Referring to Table 1 found several biotic components in the freshwater swamp ecosystem of Tasik Serai Timur village. In addition to possessing ecological benefits, freshwater swamp ecosystems also had economic benefits such as freshwater fish used as a source of people livelihood. Besides being sold as freshwater fish, it was also processed into other forms of food such as salted and salai fish (smoked fish). Figure 1 shows several types of fish commonly consumed and used by the community. Apart from various types of fish found, there were also various species of birds included in rare and protected birds such as white herons (*Mycteria cenerea*). White herons were the only birds breeding in certain areas and looking for food around mangroves, swamps, rice fields, ponds and other mud flat areas located in coastal areas [14].

Figure 1. (a) Sepat Fish (*Trichopodus leerii*), (b) Black Sepat Fish (*Trichopodus pectrolas*), (c) Tapah Fish (*Wallago microporgon*), (d) Selais Fish (*Cryptopteru lais*)

In addition to the diversity of freshwater fish species and birds, there were also plant diversity counterbalancing the freshwater swamp ecosystem in Tasik Serai Timur village. Apart from having ecological benefits in the ecosystem, some plants were also used by the community in their daily needs. For example nepenthes used as a cake wrap, pandanus leaves were woven into mats, and rattan
wood was used as garden tools such as baskets. Figure 2 shows various types of plants in the freshwater swamp ecosystem of Tasik Serai Timur village.

![Image](a) ![Image](b) ![Image](c)

**Figure 2.** Plants (a) Andau Plant, (b) Pandan Plant (*Pandanus amaryllifolius*), (c) Kantung Semar (*Nepenthes mirabilis*)

One of the plants with high ecological benefits in the freshwater swamp ecosystem of Tasik Serai Timur village was the Kantung Semar. Through the photosynthesis process *Nepenthes mirabilis* had contributed to reducing the concentration of carbon dioxide (CO₂) gas in the air which was one of the causes of global warming [15]. In addition, the presence of Kantung Semar in the ecosystem was a provider of nectar and shelter for insects in the vicinity [16]. But with the various benefits of the Kantung Semar, the threat of losing it happened now largely due to forest fires and excessive use by the surrounding community. This could be the reason for the need for community understanding to preserve these plants, one of the ways was with local potential based education that could be included in the ecosystem materials of high school students.

### 3.2. Abiotic Components

The abiotic component was the non-living component making up the ecosystem and consisting of the physical environment affecting the biotic components. The abiotic components found affecting the freshwater swamp ecosystem in Tasik Serai Timur village are puddles or inundations, light intensity, soil type, water pH, climate and weather. The unique abiotic component, especially the type of soil in the freshwater swamp ecosystem caused various types of animals and plants to make the freshwater swamp ecosystem area as their habitat. Freshwater swamp ecosystem was an ecosystem with 70% of it was always inundated, this caused content of oxygen and carbon dioxide that were suitable in the water to support the life of living things in this ecosystem [2]. Based on observations, oxygen and carbon dioxide content would be higher in areas that were overgrown by swamp purun grass than those that were not. The volume of water that periodically receded in the freshwater swamp ecosystem was influenced by rainfall.

The intensity of light in the absence of plants was higher than in populations of pandanus plants. Low light intensity in pandanus population areas caused competition between pandanus plants and andau plants to capture incoming light for photosynthesis. Freshwater swamp ecosystems generally had alluvial soil types. Alluvial soils were fertile soils and were rich in mineral salts [2] [17]. Therefore, this area had been illegally converted into oil palm plantation land by the surrounding community.

The degree of acidity or pH of water or soil in the ecosystem had a major influence on the tolerance level of living things. The degree of acidity was divided into three; acidic, neutral and basic. Every living thing could tolerate the three levels of acidity [18]. Freshwater swamp ecosystem had a pH of 6, this was caused by decaying purun grass during the dry season. Climate and weather in freshwater swamp ecosystems affected rainfall intensity. The rainy season in the freshwater swamp ecosystem of Tasik Serai Timur village occurred in August-December and the dry season occurred in January-July. Rainfall patterns could affect biotic components for survival. Birds such as herons, swamp falcons, and small birds began to find food in low tide season because it made easy for them to hunt on fish.
3.3. Adaptation of Biotic Components in Fresh Water Swamp Ecosystem

Changing abiotic components cause biotic components to morphologically and physiologically adapted [2]. Every living thing that was unable to survive would look for new environmental conditions or move from an ecosystem. Animals and plants in freshwater swamp ecosystems adapted to survive in periodically formed inundations.

3.3.1. Morphological Adaptation. The presence of standing water caused plants in the freshwater swamp ecosystem to do morphological adaptations to the root of the breath [2]. Pandanus plants in the freshwater swamp ecosystem of Tasik Serai Timur village did morphological adaptations because these ecosystem conditions were generally inundated. The existence of a pool of water made it difficult to breathe the roots, so the roots of this plant were the type of breath root. In addition, this plant also had lenticels (holes in the bark) so that gas exchange could occur. Pandanus had fruit similar to jackfruit which was food for monkeys around the freshwater swamp ecosystem. This also caused the morphological state of the stems of pandanus plants to have thorns as protectors from their predators.

3.3.2. Physiological Adaptation. Physiological adaptation was the way living things adjust to the environment through the function of work on their organs in order to survive. Freshwater fish in freshwater swamp ecosystems made physiological adaptations by osmoregulation. Osmoregulation was the process of controlling the concentration of solutes and balancing the acquisition and loss of water by animals. Freshwater swamp ecosystems did not have salinity, but fish still needed mineral salts to balance their bodies, therefore fish did osmoregulation in their bodies.

3.4. Types of interactions

Every living thing needed another creature to be able to grow and develop. Animals and plants found in the freshwater swamp ecosystem of Tasik Serai Timur village interacted to fulfil their daily needs. The interactions found can be seen in Table 2.

Table 2. Types of interactions between biotic components in the freshwater swamp ecosystem in Tasik Serai Timur village

| No | Type of Interaction          | Description                                                                 |
|----|------------------------------|-----------------------------------------------------------------------------|
| 1  | Prediction                   | Swamp hawks preyed on sepat fish as food.                                   |
| 2  | Symbiosis parasitism         | Metasecaria parasites (Clinostomum sp) infected sepat fish.                 |
| 3  | Symbiosis Commensalism       | Fern plants (Nephrolepis biserrata) attached to palm trees.                 |
| 4  | symbiosis mutualism          | Lichen: the relationship between algae and fungi attaching to plants in freshwater swamp ecosystems. |
| 5  | Competition                  | Competition between pandanus and andau plants in the fight for sunlight.   |

High school grade X ecosystem material was published in Basic Competence (KD). 3.10. Analyzing information/data from various sources about the ecosystem and all interactions taking place in it and 4.10. Presenting work that shows interactions between ecosystem components (food webs and biogeochemical cycles). Based on the KD learning process, it was expected that it at least direct students to be able to analyse the components and interactions in an ecosystem. The concept of ecosystem was one of the most contextual concepts and close to the student environment. To be able to introduce the concept of ecosystems in learning, it would be more meaningful if learning resources use ecosystems known directly by students. Local environment could be in the form of real conditions and phenomena existing in the surrounding environment such as the physical environment, social, understanding, beliefs, and local insights Local potential can be used as a learning resource [20].

Based on the results of the data obtained, it was found that the diversity of animal and plant biotic components occupying freshwater swamp ecosystems in Tasik Serai Timur village, abiotic
components supporting the growth of biotic components, types of interactions, and physiological and morphological adaptations. The results of these data were very sufficient to be used to teach ecosystem material to grade X senior high school students because the components found can be included in the ecosystem in accordance with KD demands. 3.10 and 4.10. Besides being able to be used as a source of student learning, learning exploiting local potential also gave students the possibility to see firsthand the objects related to the learning [8]. Apart from the existing environmental problems students could also be taught to be able to overcome the surrounding environmental problems and in particular conservation issues [9][20]. This is very necessary as an effort to conserve freshwater ecosystems from problems caused by human consumption in the use of fresh water in everyday life [22][23]. There had been many studies proving that learning resources utilizing local potential could make learning process more meaningful [7] [21] [24]. Through learning based on local potential students could be invited to make observations in the environment directly so that they were able to connect between concepts with real conditions [8] [9]. Besides learning by using local potential had a variety of benefits such as increasing attitudes to care for the environment, conservation attitudes, and environmental literacy of students [9][21]. Therefore, learning by using local potential could be one of the choices of teachers as learning resources.

4. Conclusion

Based on the research data, it can be concluded that the local potential of freshwater swamp ecosystem in Tasik Serai Timur village can be used as a source of learning for high school students on ecosystem class by including biotic components, abiotic components, types of interactions, and adaptation of biotic components found according to KD. 3.10 and KD. 4.10. The results of research data can be suggested by teachers to use local potential as learning resources.

5. References

[1] Juana S 1985 Air Tawar dan Air Laut *Oseana* 2 85-92
[2] Anwar J Damanik S & Hisyam N 1984 *Ekologi Ekosistem Sumatera* Yogjakarta: Gajah Mada University Press
[3] Doumlele D D Fowler B K & Silberhorn G M 1985 Vegetative Community Structure of a Tidal Freshwater Swamp in Virginia *Wetlands* 4 129-145
[4] Peter K L & Kelvin K P 1992 The conservation status of the Nee Soon freshwater swamp forest of Singapore *Aquatic Conservation: Marine and Freshwater Ecosystems* 2 255-266
[5] Titisari P W Syamsudin T S Sjarmidi A Elfis Zen I S & Hendrayani Y 2019 Potential of Sustainable Fishery Resources at Giam Siak Kecil-Bukit Batu Biosphere Reserve Riau Province Indonesia *Earth and Environmental Science* 1 1-18
[6] Kahar AP & Fadhillah 2018 Penerapan Bahan Ajar Ekosistem Mangrove Berbasis Potensi Lokal untuk Meningkatkan Sikap Peduli Lingkungan Siswa *Didaktika Biologi* 2 1-8
[7] Huda FN Feri N & Nani Y 2018 Pengaruh Bahan Ajar Muatan Lokal Konservasi Pesisir Pantai Bengkulu Terhadap Sikap Peduli ingkungan Siswa Kelas IV Sekolah Dasar *Jurnal Riset Pendidikan Dasar* 3 189-198
[8] Lamasai Muzria S dkk 2014 Pemanfaatan Lingkungan Alam Sekitar Sebagai Sumber Belajar Dalam Meningkatkan Hasil Belajar IPA Siswa Kelas III SDN 10 Gadung *Jurnal Kreatif Tadulako* 5 1-9
[9] Situmorang Risya Pramana 2016 Analisis Potensi Lokal Untuk Mengembangkan Bahan Ajar Biologi di SMA Negeri 2 Wonosari *Jurnal Pendidikan Sains* 4 1-17
[10] Ardan S A 2016 The Development of Biology Teaching Material Based on the Local Community’s Experiences to Improve Students Knowledge and Attitude of Environment In Caring the Persevation of Environment *International Journal of Higher Education* 5 190-200
[11] Millah E S Budipramana L S & Isnawati 2013 Pengembangan Buku Ajar Materi Bioteknologi di Kelas XII SMA IPIEMS Surabaya Berorientasi Sains Teknologi Lingkungan Dan Masyarakat SETS *Jurnal Bio Edu* 1 20-24
[12] Lestari 2013 *Pengembangan Bahan Ajar Berbasis Kompetensi* Jakarta: Akademia Permata

[13] Yara P O & Otieno K O 2010 Teaching/Learning Resources and Academic Performance in Mathematics in Secondary Schools in Bondo District of Kenya *Asian Social Science* 6 127-132

[14] UU RI No 19 Tahun 2004 & P P RI Tahun 2010 tentang Kehutanan Dan Illegal Logging Bandung: Citra Umbara

[15] Mansur M 2012 Laju Penyerapan CO2 pada Kantong Semar Nepenthes Gymnamphora Nees Di Taman Nasional Gunung Halimun-Salak Jawa Barat Jurnal Teknologi Lingkungan 1 59-65

[16] Handayani T & Astuti I P 2005 Perilaku Tumbuh Kantong Semar *Nepenthes mirabilis* di Habitat Alaminya Taman Nasional Kutai Kalimantan Timur Junal Kebun Raya Bogor 6 122-128

[17] Yusuf R & Purwaningsih 2009 Studi vegetasi hutan rawa air tawar di Cagar Alam Rimbo Panti Sumatera Barat *Berita Biologi* 9 491-508

[18] Lisdayanti Hikmat A & Istomo Floristic Composition and Vegetation Diversity of Seasonal Swamp Forest Rimbo Tujuh Danau Riau 2016 *Jurnal Pendidikan Hutan dan Konservasi Alam* 3 15-38

[19] Achyani 2010 Pengembangan Model Penulisan Buku Pelajaran Biologi SMA Berwawasan Ekologi dan Berbasis Realitas Lokal Disertasi Sekolah Pasca Sarjana Universitas Pendidikan Indonesia Bandung Bandung: Tidak diterbitkan

[20] Clews E et al 2018 The biological ecological and conservation significance of freshwater swamp forest in Singapore Gardens’ Bulletin Singapore 70 1 9-31

[21] Bahri H 2016 Pengelolaan Pendidikan dan Pembelajaran Berbasis Potensi Lokal *Nuansa* 9 41-46

[22] Dodds w K 2002 Freshwater Ecology; Concepts and Environmental Applications California: Academic Press

[23] Carpenter S R Stanley E H & Vander Zanden M J 2011 State of the World’s Freshwater Ecosystems: Physical Chemical and Biological Changes *Annual Review of Environment and Resources* 36 75–99

[24] Jayanti Susilo H Suarsini E 2017 Analisis Kebutuhan Sumber Belajar dan Media Pembelajaran Biologi Berbasis Potensi Lokal untuk Kelas X SMA di Provinsi Lampung *Jurnal IPA UM* 2 591-599