Short Communication:

Plant diversity utilization and land cover composition in the Subak Jatiluwih, Bali, Indonesia

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Abstract. Sutomo, Iryadi R, Darma ID, Wibawa IPAH, Rahayu A, Hanum SF, Rizal S, Novamizanti L, Raharjo J. 2021. Short Communication: Plant diversity utilization, and land cover composition in the Subak Jatiluwih, Bali, Indonesia. Biodiversitas 22: 1424-1432. Subak is water management or irrigation system for paddy fields in Bali Island and it has been assigned as a UNESCO’s World Heritage Site. At a landscape level, it comprises several components which are forests, terraced paddy landscape, rice fields, villages and temples. Subak in Jatiluwih Village, Tabanan Regency depicts an area characterized by its natural appearance in the form of a vast rice valley with a dike in stratum following its natural contours (frequent terraces). This paper aimed to explore plant diversity in various vegetations around Subak Jatiluwih as well as their usage in the daily living of the local community. We also explore the potential application of drone for classifying the landscape patterns of the Subak. Vegetation sampling to record plant diversity was done using purposive sampling, and drone or Unmanned Aerial Vehicle (UAV) was used to map the Subak Jatiluwih landscape. The potential usage of each species was obtained through interview with key respondents, and the level of usage of each species was analyzed by the BIV (Benefit Index Value). Tegalan area shows the highest number plant diversity in Subak Jatiluwih area. Furthermore, there are four species of plants that have the highest BIV namely: Cocos nucifera L., Psidium guajava L., Areca catechu L., and Musa × paradisiaca L.. Various plant uses by the locals include for animal feed, building, ceremony, craft, and food and medicinal purposes. The landscape in Subak Jatiluwih is dominated the vast valley of rice fields which has strata following its natural contours. These conditions provide opportunities to applied the conservation strategy based on cultural and custom values.

Keywords: Rice field, species diversity, culture, conservation

INTRODUCTION

The water management or irrigation system for paddy fields in Bali Island is known as Subak. Subak is characterized by ecologically sustainable system-managed under strong Balinese culture. It connects Balinese agricultural management together within the village's Bale Banjar community center and Balinese temples. Management of the water is under the leadership of a chosen farmer, a priest that practices the Tri Hita Karana Philosophy, which is a self-described relationship between humans, the earth, and the Gods (Lansing 1987; Wardana 2020). Sutawan (2004) states that the elements of Tri Hita Karana are represented in the subak temple hierarchy and the rituals performed (parahyangan), the irrigation network, and paddy fields, including fauna and flora (palemahan), and the subak organization and rules (pawongan).

The word ‘subak’ is considered as the modern form of the word ‘suwak’. Suwak is found in the Pandak Badung Inscription (1071) and Klungkung inscription (1072). Suwak comes from two words, namely ‘su’ which means good and ‘wak’ which means watering. Thus, suwak can be interpreted as a good irrigation system (Mulyati, 2019). Etymologically, ‘Subak’ refers to a unique social and religious institution, has its own arrangements, associations democracy of farmers in determining the use of irrigation water for rice growing agriculture. In practice, however, Subak for the people of Bali is not just an irrigation system, but also a concept of life for the people of Bali itself. In the view of the Balinese, Subak is a direct illustration of the Tri Hita Karana philosophy (Wardana 2020). As a method of structuring life together, Subak has been able to survive for more than a century because its people are obedient to ancestral traditions (Chong and Lai 2018) and The Subak has particular interest because of their sustainability in managing nature, human, and culture for more than a millennium (Surata and Vipriyanti 2018).

Subak comprises several landscape components, namely: forests, terraced paddy landscape, rice fields, villages, and temples. The forest protects the water supply, the terraced rice field landscape is connected by a system of canals, tunnels, and dams while the existence of temples of various sizes indicates the importance of water sources or the passage of water through the temples downhill to irrigate Subak lands. Bali has about 1,200 subaks (Salamanca et al., 2015). Until 2016, the total area of rice fields managed by the Subak community throughout Bali was 78,000 hectares (Bappeda Provinsi Bali 2015). The
area of the subak area is very dependent on the ability of a water source to irrigate a certain land. The number of springs in Bali is recorded at 547 with a total water discharge of 13.4 m³/second or 422.59 million m³/year. Other sources of water come from rainfall, which is 7,465.83 million m³/year, as well as from rivers, groundwater, and others. In terms of number (percentage), the water demand in Bali is sufficient to irrigate the rice fields in Bali. The main infrastructure component in Subak is the irrigation network. The main facilities for subak irrigation (palemahan) for each subak member are pengalapan (water dam), jelinjing (ditch), and cakangan (a place/tool to enter water into processed rice fields/fields) (Windia, 2010). The water from springs and canals flows through the temples that have been managing water resource by a group of Subak (Rahmi and Setiawan 2020).

Because of its ecological and socio-cultural uniqueness, Subak system was then internationally recognized as a world heritage site by UNESCO on 6 July, 2012 (Chapman 2017). One of the most popular Subak systems in Bali is located in Jatiluwih Village, Tabanan Regency where becomes a magnet for tourists in Bali to visit it, especially foreign tourists (Rahmi and Setiawan 2020). Landscape in Subak Jatiluwih depicts an area characterized by its natural appearance in the form of a vast rice valley with a dike in stratum following its natural contours (frequent terraces). On the paddy field, there are six patches of landscape in the form of vegetation cover, namely paddy fields, Pur a Bedugul (A special temple built by farmers and landowners intended for Dewi Sri as the goddess of prosperity and fertility), huts, dry fields, footpaths and river basins (DAS).

Subak system has attracted studies from various fields; one of them is spatial ecology. Taking benefits from the advancing technology, monitoring and study of vegetation can now be conducted in a spatially explicit manner using aerial photographic data and satellite imagery. Some monitoring studies in their development at this time require a technology that is fast and accurate in which periodical data can be acquired. One of the tools that can currently be relied upon is the use of drone technology in which we are able to use this tool without having to wait until daily or weekly. Currently, researchers are exploring the uses of drone technology and satellite imagery data for monitoring landscape and agricultural land, for example monitoring the growth development of rice to estimate its productivity, and other agricultural purposes ( Dharmiasih and Arbi, 2018; Marsujitullah and Kaligis 2019; Inoue 2020).

In this paper, we elaborate on plant diversity in various vegetations around Subak Jatiluwih as well as their usage in the daily living of the local community. We also explore the potential application of drones for classifying the landscape patterns of the Subak. This information is expected to be a reference in the management of Subak Jatiluwih.

**MATERIALS AND METHODS**

**Study area and period**

The study was conducted in Subak Jatiluwih in March 2020 (Figure 1). Jatiluwih Subak is located at the foot of Batukaru Mountain, Jatiluwih Village, Penebel District, Tabanan Regency, Bali, Indonesia. Jatiluwih Village is ± 26 km to the north of Tabanan Regency or ± 13 km to the north of Penebel District and 49 km to the capital of the Bali Province. Jatiluwih village lies at an altitude of approximately 685 m above sea level, with an average temperature of 26-29°C with humidity of 75-90%. Jatiluwih Village has a tropical climate with the rainy season from October to March and the dry season from April to September (Artanegara 2019). Village boundary area of Jatiluwih is as follows: the north side is bordered with protected forest, the east side is Senganan village while on the south side is Babahan Village and on the west side is bordered with Wongaya Gede Village.

Overall, the size area of Subak Jatiluwih is 348 ha. Jatiluwih Subak is divided into seven sub-subaks or tempek, with the length of the irrigation channel from the water source to the rice fields per farmer reaching 33,383 m. These tempek include the Telede Gede Subak Tempek, Besikalung Subak Tempek, Kendamean Subak Tempek, Uma Duwi Subak Tempek, Kesambi Subak Tempek, Gunung Sari Subak Tempek, and Gunung Uma Subak Tempek. Irrigation water sources in Jatiluwih Subak are obtained from springs, waterfalls, and several rivers that cross Jatiluwih Subak such as the Yeh Ho River, the Yeh Baat River, the Munduk Abangan River, and the Yeh Pusat River (Wardana 2020). Then, Artanegara (2019) proposes that the four rivers of the Ho Ho River irrigate the Umakayu subak, the Yeh Baat River irrigate the Jatiluwih subak, Kendamean and Kalungbesi, the Munduk Abangan River irrigate the Gunung Sari subak and the Yeh Pusat River irrigate the Kesambi subak.

**Data collection**

Vegetation sampling was done with purposive sampling, which was carried out on six areas includes tegalan (land fields), daerah aliran sungai/DAS (river flow areas), papag an sawah (rice fields), pura (temples), jalan setapak (walkways) and pondok (huts). Papagan rice field is an area on the edge of a paddy field that cannot be planted with rice. Pondok is a place for raising livestock. Roads are corridors of subak members.

Herbarium voucher was collected and then identified at the Hortus Botanicus Baliensis. Potential usage of each species by the community was obtained by interviewing key persons such as banten handymen (banten is an offering made to God), pandita, and housewifes.

**Data analysis**

Data were analyzed using the BIV (Benefit Index Value) with the equation as follow(Hoffman and Gallaher 2007; Phillips and Gentry 1993):

\[
BIV = \frac{RF_{sj}}{RFT_{sj}} \times 100 \%
\]

Where:

- BIV : Usage and abundance Index of A species
- RF sj : Relative Frequency of a species
- RFT sj : Total relative frequency of a species
In addition, Unmanned Aerial Vehicle (UAV) or drone (Mavic 2 Pro) was used to capture the aerial view of landscape of the Subak Jatiluwih. Mapping data were recorded using drones in parts of Jatiluwih’s rice fields to see the detail the proportion of land cover/use classes in an area of 3.8 ha.

RESULTS AND DISCUSSION

The diversity of plants in several types of vegetation cover in Subak Jatiluwih area can be seen in Table 1. Tegalan area has the highest number of species with 33 species, followed by daerah aliran sungai/ DAS with 24 species, and also there are 21 species at papagan sawah, 15 species at temple areas, 12 species at jalan setapak, and 10 species at pondok areas. Ten plant species have high abundance index values, which are Cocos nucifera L./ Kelapa (5.22) followed by Psidium guajava L./ Solong (4.35), Areca catechu L./ Buah (4.35), Musa × paradisiaca L./ Banana (3.48), Artocarpus integer (Thum.) Merr./ Jackfruit (3.48), Antidesma bunius (L.) Spreng./ Boni (3.48), Cordyline terminalis (L.) Kunth Andong gadang (2.61) Plumeria acuminata Jepun (2.61), Gliricidia sepium/ Gamal (2.61) and Persea americana/ Apokar (2.61).

There are 107 species of plants utilized by the communities around the Jatiluwih Subak area. From these, 70 species are used for ceremonies, 49 species for food, 26 species for medicinal purposes, 11 species for building materials, 9 species for animal feed and for crafts there are 5 species (Table 2).

In this study, ten plant species that have the highest benefit index are Musa × paradisiaca L./ Pisang (2.94), followed by Cocos nucifera L./ Kelapa (2.94), Arenga pinnata (Wurmb) Merr./ Joke (2.35), Artocarpus integer (Thumb) Merr./ Nangka (2.35), Schizostachyum brachyckadum (Kurz) Kurz/ Ting tali (1.76) and Zea mays L./ Jagung (1.76). Dendrocalamus asper (Schult.f.) Backer ex Heyne/ Petung (1.76), Aleurites moluccana (L.) Willd./ Tingkih (1.76) and Moringa oleifera Moringa (1.18). Balinese culture and plants seem inseparable, as their ceremonies and traditions are always made use of a variety of plants as well as for their traditional medication known as the Usada Bali. The local people in Jatiluwih know 26 plant species that are used for medicinal purposes. This figure is lower than in Bedugul, Bali in which the local people use 69 species (Oktavia et al. 2019), but higher than average indigenous groups in Bali which generally have more than 10 species of medicinal plants that are planted in the area of the yard (Sujarwo and Caneva 2015). Some traditional villages in Bali have experienced cultural erosion, one of which is marked by a decline in ethnobotanical knowledge. One important factor causing cultural erosion is the influence of foreign cultures from developed countries in ecotourism areas (Sujarwo et al. 2014).
Table 1. Plant diversity in various vegetation covers in Subak Jatiluwih, Bali, Indonesia

| Species name/local name | Papagan sawah | Pura | Pondok | Tegalan | Jalan setapak | DAS |
|-------------------------|---------------|------|--------|---------|---------------|-----|
| Acalypha sp/ Plawa      | 1             | 1    |        |         | 2             | 1.74 |
| Albizia sp/ Belalau     |               | 1    |        |         | 2             | 1.74 |
| Anomomum sp Bongkot     | 1             | 1    |        |         | 2             | 1.74 |
| Antidesma bunius (L.) Spreng./Boni | 1 | 1 | 1 | 1 | 4 | 3.48 |
| Areca catechu L./ Buah  | 2             | 2    | 1      | 5       | 4.35          |     |
| Arenga pinnata (Wurmb) Merr./ Jake | 1 | 1 | 2 | 1.74 |
| Artocarpus integer (Thunb.) Merr./ Nangka | 1 | 1 | 1 | 4 | 3.48 |
| Bambusa vulgaris Ness/ Tiang apek | 1 | 1 | 2.35 |
| Kaempferia galanga L./ Cekuh | 1 | 1 | 2.35 |
| Cajanus cajan (L.) Huth./ Undis | 1 | 1 | 2.35 |
| Capsicum annuum L./ Tabia | 1 | 1 | 2.35 |
| Citrus sp./ Jeruk        | 1             | 1    |        |         | 2             | 1.74 |
| Caladium sp./ Keladi     | 1             | 1    |        |         | 2             | 1.74 |
| Cocos nucifera (L.) Kelapa | 1 | 1 | 1 | 1 | 6 | 5.22 |
| Codiaeum variegatum (L.) Rumph.ex A.Juss./ Puring | 1 | 1 | 2.35 |
| Cordyline terminalis Kunth/ Andong gadang | 1 | 1 | 1 | 3 | 2.61 |
| Cordyline fruticosa (L). A. Chev./ Adong | 1 | 1 | 2.35 |
| Curcuma longa L./ Kunyit | 1             | 1    |        |         | 2             | 1.74 |
| Cymbopogon nardus (L.) Rendle/ Sere | 1 | 1 | 2.35 |
| Debregeasia longifolia (Burm.f.) Wedd./ Sia-sia | 1 | 1 | 2.35 |
| Dendrocalamus asper (Schult.f.) Backer/ Tiing petung | 1 | 1 | 2.35 |
| Dario zibethinus L./ Doren | 1             | 1    |        |         | 2             | 1.74 |
| Erythrina cristagalli L./ Cangling | 1 | 1 | 2.35 |
| Ficus benjamina L./ Beringin | 1 | 1 | 2.35 |
| Ficus drupacea Thunb./ Banua | 1             | 1    |        |         | 2             | 1.74 |
| Gardenia jasminoides J.Ellis/ Jempiring | 1 | 1 | 2.35 |
| Gigantochloa nigriciliata (Buse) Kurz/ Tiing Tabah | 1 | 1 | 2.35 |
| Gliciridia sepium (Jacq.) Steud/ Gamal | 1             | 1    |        |         | 3             | 2.61 |
| Graptophyllum pictum (L.) Griff./ Temen | 1             | 1    |        |         | 2             | 1.74 |
| Hibiscus rosa-sinensis L./ Pucuk | 1 | 1 | 3 | 2.61 |
| Hibiscus tiliae L./ Waru | 1 | 1 | 2.61 |
| Languas galanga (L.) Wild./ Isen | 1 | 1 | 2.61 |
| Leucaena leucocephala (Lam.) de Wit./ Lamtoro | 1 | 1 | 2.61 |
| Malvaviscus sp./ Waru | 1             | 1    |        |         | 2             | 1.74 |
| Mangifera indicaL./ Mangga | 1 | 1 | 2.61 |
| Michelia campaca L./ Cempaka kuning | 1 | 1 | 2.61 |
| Melia azedarach L./ Gempinis | 1 | 1 | 2.61 |
| Morinda citrifolia L./ Tibah | 1 | 1 | 2.61 |
| Muntingia calabura L./ Singepur | 1 | 1 | 2.61 |
| Musa × paradisiaca L./ Pisang | 1 | 1 | 1 | 4 | 3.48 |
| Musa brachycarpa Backet/ Bbu Batu | 1 | 1 | 1 | 2 | 1.74 |
| Nephelium lappaceum L./ Buluan | 1 | 1 | 2.61 |
| Persea americana Mill./ Apokat | 1 | 1 | 1 | 3 | 2.61 |
| Phyllanthus buxifolius (Blume) Mull.Arg./ Sisih | 1 | 1 | 2.61 |
| Plocomele angustifolia (Medik.) N.E.Br. / Kaya sugih | 1 | 1 | 2.61 |
| Plumeria acuminata W.T.Aiton/ Jepun | 1 | 1 | 1 | 3 | 2.61 |
| Psidium guajava L./ Seong | 1 | 1 | 5 | 4.35 |
| Punica granatum L./ Delima | 1 | 1 | 2.61 |
| Saccharum officinarum L./ Tebu | 1 | 1 | 2 | 1.74 |
| Salacca edulis Reinw./ Salak | 1 | 1 | 2.61 |
| Scheflera elliptica (Blume) Harms/ K. Tulak | 1 | 1 | 2.61 |
| Schizostachyum brachycladum (Kurz)Kurz/ Tiing tali | 1 | 1 | 2 | 1.74 |
| Schizostachyum brachycladum (Kurz)ex Munro Kurz/ Tiing buluh | 1 | 1 | 2 | 1.74 |
| Sesbania grandiflora (L.) Poir./ Tuvi | 1 | 1 | 2.61 |
| Syzygium aromaticum (L.) Merr.& L.M.Perry/ Cengkeh | 1 | 1 | 2.61 |
| Vitis trifolia L./ Liligundi | 1 | 1 | 2 | 1.74 |
| Zingiber officinale Roscoee/ Jahe | 1 | 1 | 2 | 1.74 |

Total 21 15 10 33 12 24 115 100
| Species name / local name | Usage | FR | BIV |
|---------------------------|-------|----|-----|
| Acorus calamus L./ Janggu* | A 1 B 1 Ce 1 Cr 2 F 1 M 1 | 1.18 |
| Albizia chinensis (Osbeck) Merr./ Sengon* | 1 | 1 | 0.59 |
| Aleurites ambinux Pers./ Tingkiah* | 1 | 1 | 1 | 3 | 1.76 |
| Allium cepa L./ Kesuna* | 1 | 1 | 2 | 1.18 |
| Allium sativum L./ Bawang* | 1 | 1 | 2 | 1.18 |
| Ananas comosus (L.) Merr./ Nanas* | 1 | 1 | 2 | 1.18 |
| Annona muricata L./ Sirsak* | 1 | 1 | 2 | 1.18 |
| Arenga pinnata (Wurmb) Merr./ Jake* | 1 | 1 | 1 | 4 | 2.35 |
| Artocarpus altilis (Parkinson) Fosberg/ Sukun* | 1 | 1 | 2 | 1.18 |
| Artocarpus integer (Thunb.) Merr./ Nangka* | 1 | 1 | 1 | 4 | 2.35 |
| Baccaraea racemosa (Reinw.) Mull.Arg./ Kepundung* | 1 | 1 | 2 | 1.18 |
| Bougainvillea spectabilis Wild./ Kembang kertas* | 1 | 1 | 0.59 |
| Caesalpinia pulcherrima (L.) Sw./ Kemerakan* | 1 | 1 | 0.59 |
| Cajanus cajan (L.) Huth./ Kacang undis* | 1 | 1 | 2 | 1.18 |
| Calamus sp./ Penyalin* | 1 | 1 | 2 | 1.18 |
| Caltha sp./ Kaliandra* | 1 | 1 | 0.59 |
| Calliandra sp./ Kaliandra* | 1 | 1 | 0.59 |
| Calotropis gigantea (L.) W.T.Aiton/ Maduri* | 1 | 1 | 0.59 |
| Cananga odorata (Lam.) Hook.f. & Thomson/ Sandat* | 1 | 1 | 0.59 |
| Capsicum annuum L./ Tabia* | 1 | 1 | 0.59 |
| Caryota mitis Lour./ Udah* | 1 | 1 | 0.59 |
| Centella asiatica (L.) Urb./ Kepiduh* | 1 | 1 | 0.59 |
| Citrus × aurantifolia (Christm.) Swingle/ Jeruk lengis* | 1 | 1 | 2 | 1.18 |
| Citrus limon (L.) Osbeck/ Lemo* | 1 | 1 | 0.59 |
| Clitoria ternatea L./ Teleng putih* | 1 | 1 | 0.59 |
| Cocos nucifera L./ Kelapa* | 1 | 1 | 1 | 5 | 2.94 |
| Cordyline fruticosa (L.) A. Chev./ Kayu sugih* | 1 | 1 | 2 | 1.18 |
| Cordyline terminalis-bicolor/ Andong bang* | 1 | 1 | 0.59 |
| Croscophalum crepidioides (Benth.) S. Moore/ Kejelengotan* | 1 | 1 | 0.59 |
| Curcuma aeruginosa Roxb./ Temu ireng* | 1 | 1 | 2 | 1.18 |
| Curcuma longa L./ Jake* | 1 | 1 | 0.59 |
| Curcuma sp./ Temu konci* | 1 | 1 | 0.59 |
| Curcuma sp./ Temu tis* | 1 | 1 | 2 | 1.18 |
| Curcuma sp./ Temu gonggeng* | 1 | 1 | 0.59 |
| Curcuma sp./ Temu poh* | 1 | 1 | 0.59 |
| Curcuma sp./ Temu agung* | 1 | 1 | 0.59 |
| Cymbopogon citratus (DC.) Stapf/ Sere* | 1 | 1 | 0.59 |
| Cyndodon dactylon (L.) Pers./ Padang lepas* | 1 | 1 | 0.59 |
| Dendrocalamus asper (Schult.f.) Backer/ Tieng petung* | 1 | 1 | 1 | 3 | 1.76 |
| Dioscorea hispida Dennis./ Sekape* | 1 | 1 | 2 | 1.18 |
| Diplazium esculentum (Retz.) Sw./ Paku jukat* | 1 | 1 | 0.59 |
| Diplazium polyiodioide Blume/ Paku kedis* | 1 | 1 | 0.59 |
| Dolichos lablab L./ Kare* | 1 | 1 | 2 | 1.18 |
| Durio zibethinus L./ Duren* | 1 | 1 | 2 | 1.18 |
| Elaeocarpus grandiflorus Sm./ Rijasa* | 1 | 1 | 0.59 |
| Erythrina subambrans (Hassk.) Merr./ Dapad* | 1 | 1 | 2 | 1.18 |
| Euchresta horsfieldii (Lesch.) Benn./ Purnajiwa* | 1 | 1 | 0.59 |
| Ficus benjamina L./ Beringin* | 1 | 1 | 0.59 |
| Foeniculum vulgare Mill./ Adas* | 1 | 1 | 2 | 1.18 |
| Garcinia mangostana Linn./ Mangis* | 1 | 1 | 2 | 1.18 |
| Gardenia jasminoides J.Ellis/ Jempiring* | 1 | 1 | 0.59 |
| Gigantochloa sp. Tiang tamplang kuning* | 1 | 1 | 0.59 |
| Gossypium herbaceum L./ Kaps* | 1 | 1 | 0.59 |
| Graptophyllum pictum (L.) Griff./ Temen* | 1 | 1 | 0.59 |
| Hibiscus rosa-sinensis L./ Pucuk* | 1 | 1 | 0.59 |
| Hoya macrophylla Blume/ Don tebel tebel* | 1 | 1 | 0.59 |
| Hydrangea macrocarpa Hand.-Mazz./ Panca warna* | 1 | 1 | 0.59 |
| Jasminum sambac (L.) Aiton/ Meneh* | 1 | 1 | 0.59 |
| Kaempferia galanga L./ Cekuh* | 1 | 1 | 2 | 1.18 |
| Languas galanga (L.) Stuntz/ Isen* | 1 | 1 | 2 | 1.18 |
| Lansium domesticum Correa/ Croring* | 1 | 1 | 2 | 1.18 |
| Leucaena leucocephala (Lam.) de Wit/ Lamtoro* | 1 | 1 | 0.59 |
| Lindera polyantha (Blume) Boerl./ Adis* | 1 | 1 | 0.59 |
Macropanax dispermus (Blume) Kuntze/ Jembrok jaran* 1 1 1 0.59
Mangifera casia Jackl. Wani* 1 1 2 1.18
Mangifera indica L. Poh* 1 1 2 1.18
Manglietia glauca Blume/ Kepelan* 1 1 1 0.59
Manilkara zapota (L.) P.Royen/ Sabo* 1 1 2 1.18
Michelia × alba DC./ Cempaka putih* 1 1 0.59
Michelia champaca L/ Cempaka kuning* 1 1 0.59
Momordica charantia L./ Paye* 1 1 2 1.18
Moringa oleifera Lam./ Kelor* 1 1 2 1.18
Musa × paradisiaca L./ Pisang* 1 1 1 1 5 2.94
Myristica fragrans Hout./ Jembaguran* 1 1 2 1.18
Nephelium lappaceum L./ Buluran* 1 1 2 1.18
Nerium oleander L./ Kenyeri* 1 1 0.59
Nymphaeas sp./ Tujuang* 1 1 0.59
Oryza sativa L./ Padi* 1 1 2 1.18
Paederia foetida L./ Kesimbukan* 1 1 0.59
Pandanus amaryllifolius Roxb./ Pandan arum* 1 1 2 1.18
Pandanus sp./ Pandan mediwi* 1 1 0.59
Phaseolus radiatus L./ Kacang hijau* 1 1 2 1.18
Phaseolus vulgaris L./ Kacang merah* 1 1 2 1.18
Phyllanthus baxifolius (Blume) Müll.Arg./ Kayu sisih* 1 1 0.59
Piper betle L./ Base* 1 1 2 1.18
Piper nigrum L./ Mica* 1 1 2 1.18
Piper sp./ Tabia bun* 1 1 2 1.18
Piper sp./ Don sabo* 1 1 0.59
Panica granatum L./ Delina* 1 1 2 1.18
Rosa sp./ Mawar* 1 1 0.59
Saccharum officinarum L./ Tebu* 1 1 0.59
Salacca edulis Reinw./ Salak* 1 1 2 1.18
Sanchezia nobilis Hook./ Temen poleng* 1 1 0.59
Saurauia bracteosa DC./ Yeh-yeh* 1 1 0.59
Saurupas androgynus (L.) Merr./ Kayu mani* 1 1 2 1.18
Schizostachyum brachycladum (Kurz) Kurz/ Tiing tali* 1 1 1 3 1.76
Selaginella sp./ Cakar ayam* 1 1 0.59
Sida rhombifolia L./ Siligui* 1 1 0.59
Solamum torvum Sw./ Tuang kokak* 1 1 0.59
Syzygium polyanthum (Wight) Walp./ Jangar ulam* 1 1 2 1.18
Tagetes erecta L./ Gumtitir* 1 1 0.59
Tephrisos sp./ Sudamala* 1 1 0.59
Toona saturei (Blume) Merr./ Suren* 1 1 0.59
Trevesia sudaica Miq./ Pelendo* 1 1 0.59
Zea mays L./ Jagung* 1 1 1 3 1.76
Zingiber officinale Roscoe/ Jahe* 1 1 2 1.18
Total: 9 11 70 5 49 26 170 100

Note: *: Local name, A: Animal feed, B: building, Ce: Ceremony, Cr: Craft, F: Food, M: Medicine

Mapping data using drones in Jatiluwih's rice fields aimed to see the proportion of land cover or land uses in a sampling area of 3.8 ha. From landscape ecology perspective, Subak Jatiluwih landscape consists of fragments, matrix and corridors. Fragment is a homogenous area that can be differentiated from the surrounding area, while matrix is the dominant fragment in landscape, and corridor is a long fragment (Forman and Godron 1986). The fragments in Subak Jatiluwih are mixed gardens, bare fields (papagan), palawija, herb field, temple, house; while the matrix is rice fields; and the corridors are road and talun along riverside (Figure 3). Papagan paddy field is an area on the edge of a rice field that cannot be planted with paddy (Figure 4). This land indicates conditions that were originally agricultural land and then considered less productive. Papagan can be distinguished based on land patterns close to rice fields and conditions in the form of empty land, grass and shrubs scrub or a combination of these covers.

Jatiluwih rice fields use irrigation water following Subak system (Komin and Sedana 2019). In the design of the rice fields, it pays close attention to the irrigation system with a combination of terracing concepts because this area has less flat topography. Similar to rice farming in most Indonesia, the community in Jatiluwih limits ownership of their rice fields, making the area of each rice field of each farmer is not uniform (Macrae 2011).
Figure 3. Morphological feature of landscape of Subak Jatiluwih in Bali obtained from Mavic 2 Pro drone at 100-meter height

Figure 4. Map of land cover/land use in the sampling site in Subak Jatiluwih, Bali
The Jatiluwih rice field complex which has been designed as an ecotourism area also shows the building area that has been made for the needs of both farmers and tourists. However, the appearance of the built-in land is very limited and is more about building concrete roads for tourist access. As a UNESCO world heritage site, the rapid development of tourism is a threat to the sustainability of subak, as well as in subak Jatiluwih. The results of research by Sriaqtha et al. (2015) reveal that 87.8% of the sustainability of a subak is determined by regional development factors, such as the distance of the subak area into the center of tourism, roads, economic facilities, population density, and percentage of non-agriculture family. Apart from paddy fields, other land use classes, both natural land cover and human activity, include riparian zone vegetation, mixed gardens, and mixed agriculture. Several types of plants found in the area include *Cymbopogon citratus*, *Musa paradisiaca*, *Cocos nucifera*, *Syzygium polyanthum*, and other species of woody plants. The vegetation riparian zone consists of ferns, *Arenig pinnata*, other woody plants, and various types of shrubs.

In the sampling site photographed using the drone, the landscape is composed of rice fields (53.8%), dike/pematang (15.5%), mixed gardens (6.5%), vegetation riparian zone (5%), and others (Table 3). Roads and pathways are corridors for the mobilities of farmers, while other land uses with small size include area for buildings, such as house and pondok (a place for raising livestock).

The rice farming system in Subak Jatiluwih is semi-organic because the farmers use urea fertilizer at the beginning of planting season. The research results of Salamanca et al. (2015) note that farmers’ outlook has changed. They want quick fixes, such as using chemical fertilizers and chemicals to kill pests and weeds. The cropping pattern consists of white rice twice and red rice once a year.

| Land cover type          | Area (m²) | Percentage |
|--------------------------|-----------|------------|
| Building                 | 177.45    | 0.9%       |
| Rice fields              | 20,389.92 | 53.8%      |
| Grass                    | 599,331.4 | 1.6%       |
| Herb (Cymbopogon)        | 593.44    | 1.6%       |
| Irrigation               | 386.78    | 1.0%       |
| Mixed crop               | 1,691.32  | 4.5%       |
| Mixed gardens            | 2,451.35  | 6.5%       |
| Open field               | 84.30     | 0.2%       |
| Papagan                  | 1,663.02  | 4.4%       |
| Pathway                  | 204.13    | 0.5%       |
| Dike/pematang            | 5,891.34  | 15.5%      |
| Holy place               | 16.96     | 0.05%      |
| River                    | 1,009.162 | 2.9%       |
| Riverside/ Riparian zone| 1,876.96  | 5.0%       |
| Road                     | 563.42    | 1.5%       |
| Shrub                    | 217.68    | 0.6%       |

In conclusion, there are a large number of plant species found in Subak Jatiluwih, Bali with some species have high benefit values, especially in term of cultural perspective. This condition strengthens the position of Subak Jatiluwih, not only as a UNESCO’s World Heritage site but also as a place with ethnobotanical information which warrants conservation based on culture. The assignment of Subak Jatiluwih as a world cultural heritage will ensure the protection of the diversity of vegetation cover in the area. We recommend that conservation efforts in Subak Jatiluwih should be prioritized on rare plants or plants and those with the highest utilization index value.

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