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Conservation and Utilization of Natural Orchids using a Collaborative Action Model in the Lore Lindu Biosphere Reserve, Sulawesi, Indonesia

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Abstract

Lore Lindu National Park (LLNP) as the core zone of the Lore Lindu Biosphere Reserve in Central Sulawesi is home to a unique biodiversity. In the last decade, over exploitation of orchids and illegal timber logging caused a reduction of more than 50% of the orchid population and about 10% of orchids diversity in their natural habitat. Nowadays, there are 31 species remaining and 3 of them are endemic to Sulawesi.

In 2015, the LLNP authority (BBTNLL) began conducting research on orchid gardens growing in the National Park. Based on the research results the NP authority has built a conservation model for orchids through the education of pupils by combining ex-situ and in-situ conservation efforts through collaborative action methods to increase public awareness and restocking/restoration of orchids to their natural habitat.

The NP authority used the model for conserving orchids for an educational program in cooperation with one local senior high school (SMA). The conservation-based education is carried out in four stages; (i) scoping areas and target locations, (ii) preparation of local content education materials, (iii) orchid conservation education and restocking by taking at least 3 samples per species in pure lines), (iv) replicating the results of conservation education as lessons-learned.

The result of the implementation of this model is the establishment of an orchid education project based on a conservation agreement between the *NP authority* and the SMA. Today, students, but also spontaneously formed women's groups cooperate in protecting, breeding and restocking of orchids. In total, students and women groups have already successfully restored 465 orchid plants. Thus, the local population has made an important contribution to the conservation of the remaining 31 orchid species. Of this amount at least 25% was restored in the natural forest to increase the populations in-situ. Further, two other schools adopted this project as best practice for ecological education.

Beside all this, some women gain income by selling breed orchids. Thus, beside a high ecological and conservation value, this initiative of the NP auhority also has an economic value.

Key words. Forest, Biodiversity, Restoration, Endemic Species, Participatory, Education

Background

Lore Lindu National Park (LLNP) is the core zone of the Lore Lindu Biosphere Reserve (LLCB) established by UNCESCO in 1977. LLNP is an important tropical forest area on the Wallacea shelf (Rosydi et al, 2019). The NP authority manages the NP in five zones (core, jungle, utilization, traditional, special) . Hereby, the NP authority takes participatory management into account (Kosmaryandi et al, 2012). The core zone is important for the habitat of numerous fauna and flore. The biodiversity of this region is extremely rich. The jungle zones of the LLNP are also predominantly undisturbed. Only minor parts are used by communities for cultural purpose and for local wisdom. In the contrary, in the utilization zone and in the traditional zone many community activities are carried out (Massiri et al, 2015). In the last 20 years, local populations have increasingly converted NP land to cocoa, coffee, maize and rice fields (Nasrun et al, 2019). This change in use has had a negative impact on biodiversity and thus also on the diversity and population of orchids.

As Sadili (2013) emphasizes, orchids are a good indicator of forest health During the last decade, there has been a decline in the population and species of orchids in Lore Lindu National Park due to 5 major problems:

1. Rationalization the national park zones that accommodate the traditional areas
2. Increment of the encroachment activities by communities,
3. illegal logging,
4. lack of coordination, the Dongi-Dongi indigenous movement (Mappatoba et al, 2017).
5. The increasing demand of the local and global market has triggered the extraction of natural orchids from the NP.

Moreover, the natural conditions of Lore Lindu National Park which are vulnerable to natural disasters such as floods and landslides in the rainy season (Massiri et al, 2015) and forest fires in the dry season. In recent years, the Indonesian government has made a paradigm shift regarding the management of national parks. This shift is away from a top-down and prohibitive culture towards a participatory and partnership culture (Widodo et al, 2018). This study focuses on the problem of the high loss of orchid biodiversity in the Lore Lindu National Park as a result of the analysis of the above-listed problems. The research objective is to elaborate how a simple conservation-education model contributes to the harmonization of conservation efforts and economic improvement.

Study Area

The research was carried out for 6 months in 2020 in two locations in the Lore Lindu National Park buffer zone, namely: Desa Karunia at coordinates 120^{o} 3 '51 "East Longitude and 1^{o} 11' 46" LS as the location for sampling orchids and SMU 6 Sigi (Senior High School) at coordinates 120^{o} 3 '51 "East Longitude and 1^{o} 8' 8" LS for the study treatment location. The two locations are in Palolo District, Sigi Regency, Central Sulawesi. The study area is located at an altitude between 500 - 800 masl . The average rainfall is about 958 mm / year with an average of 79.83 mm / month (Somba, 2006).

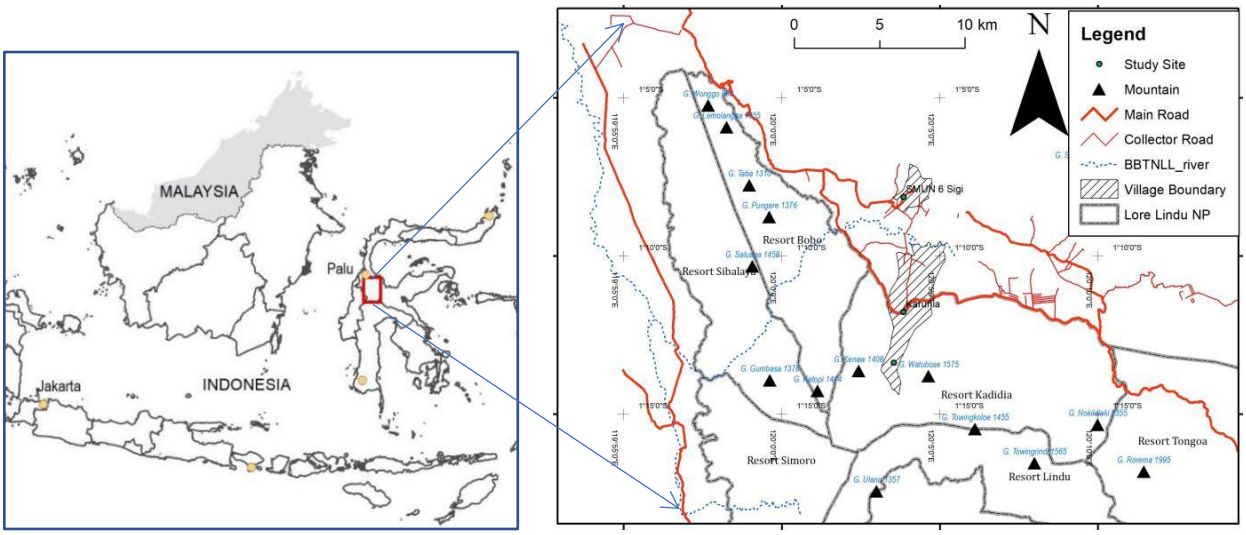

Figure 1. Educational Research Locations for Orchid Conservation in Lore Lindu National Park Buffer

Research methodology

The method used in this research is descriptive quantitative using a collaborative action research approach (Maanesi et al, 2013) by dividing the research stages into 4 processes, namely: (i) joint planning to determine the subject and object of the study, (ii) preparation of the material basic education, (iii) adaptation of management with participatory action research, (iv) collaboration of action.

This paper focuses on stage 3. The discussion is further divided into two topics, namely: (1) research treatment with samples and repetition of the types of orchids used as research objects and (2) assessment of observations of type variables. orchids to prepare recommendations for conservation-education education modules.

To address the first topic, the team approached a randomized block design method of 31 orchid species. Samples were taken from three orchid broods taken from natural habitat (insitu) and carried out with vegetative propagation.

The second topic was carried out by creating criteria for fixed variables from 31 identified orchid species (Fandani et al, 2018) combined with four variables, namely; endemicity status, protection status, economic valuation, cultivation valuation. This correlation is made to determine the average value of the model of chance of success which will be a recommendation for developing an education-conservation model and an action plan as a form of adaptive management of habitat restoration or education-conservation replication to other groups.

Table 1. Variables and assessments in the preparation of the education module

No	Variable	Key Question	Bolean
1	Origin Value	Is this an endemic species in Sulawesi?	Yes (1) /No (0)
2	Protection Value	Is the species protected by the IUCN or by GoI?	Yes (1) /No (0)
3	Economic Value	What is the local/national/international market prize for this species?	Yes (1) /No (0)
4	Cultural Value	Has the species any cultural value?	Yes (1) /No (0)

An assessment of the suitability of the conservation-education model of 31 orchid species was made by converting Boolean qualitative data to quantitative ones. The four data variables are changed to a value of 1 (one) if YES and 0 (zero) if NO. Then a linear balance formulation between conservation and economy is made to see the model resulting from this analysis as a total result in the form of a percentage value (%). These results indicate the value of the chance of success to be developed into replication of activities and restoration to natural habitats (in-situ). The chances of success are divided into 4 (four) classes, namely: very low (0 - 25%), low (25-50%),

moderate (50% - 75%) and high (> 75%). This yield percentage class is the basis for the consideration of the conservation-education module

Results

The results of the analysis of the development of this conservation-education model with four variables for 31 orchid species showed quantitative data.

Table 2. Results of analysis of 31 orchid species for an education-conservation model

Orchid Species	Endemic Value	Conservation Value	Economic Value	Cultural Value	Success (in %)
Appendicula anceps	0	0	0	1	25 ***)
Appendicula congenera	0	0	0	1	25 ***)
Arundina graminifolia	0	0	0	1	25 ***)
Bulbophyllum echinolabium	0	0	0	1	25 ***)
Bulbophyllum lobbi	0	0	1	1	50 ****b)
Bulbophyllum sp 1	0	0	1	1	50 ****b)
Calanthe tripiculata	0	0	0	0	0 *)
Coelogyne asperata	0	0	0	1	25 ***)
Calanthe sp 1	0	0	0	0	0 *)
Coelogyne celebensis	1	0	1	1	75 **)
Coelogyne rochuaenii	0	0	0	1	25 ***)
Coelogyne sp 1	0	0	1	1	50 ****b)
Cymbidium ensifolium	0	0	1	1	50 ****b)
Cymbidium finlaysonianum	0	0	1	1	50 ****b)
Dendrobium discolor	0	0	1	1	50 ****b)
Dendrobium indivisum	0	0	1	1	50 ****b)
Dendrobium merpati	0	0	0	1	25 ***)
Dendrobium machophyllum	0	1	1	1	75 **)
Dendrobium sp 1	0	0	1	1	50 ****b)
Dendrobium sp 2	0	0	1	1	50 ****b)

Eria multiflora	0	0	0	1	25 ***)
Gramatophyllum stapelliflorum	0	0	1	1	50 ****b)
Luisia javanica	0	0	0	1	25 ***)
Phalaenopsis amabilis	0	0	1	1	50 ****b)
Phalaenopsis celebensis	1	0	1	1	75 **)
Phalaenopsis vennosa	1	0	1	1	75 **)
Phalaenopsis sp 1	0	0	1	1	50 ****b)
Spathoglogtis plicata	0	0	0	1	25 ***)
Spathoglogtis sp 1	0	0	0	1	25 ***)
Vanda jennae	1	0	1	1	75 **)
Vandopsis fissochiloedes	0	0	0	1	25 ***)

Source: Results of research analysis for the preparation of a conservation education module

*) need further research with micro-population

**) Types of orchids are developed, but genetic plasma needs to be considered

***) easy to cultivate but the conservation has not been identified

**** a) It is necessary to consider endemism with cultivation

**** b) is not protected, but has economic value and is easy to cultivate

Discussion

The discussion of the results of this study is divided into two themes: a) the results of research experiments in terms of quantitative data sampling methods, and b) qualitatively identified 31 species which are used as recommendations in developing a more specific conservation-education module.

Results of research experiments

A total of 31 orchid species (table 1) were used as treatments and a total of 465 data samples were developed vegetatively by considering genetic quality. 100% of this treatment can grow well for at least 4 (four) months. This is of particular concern in this study, because it provides an increase in a high level of trust in the role of SMA 6 Sigi students with the guidance of a trainer. This approach is an important asset for the Action Management built on creating consensus between SMA 6 Sigi and BBTNLL on orchid restoration purposes. 25% of the orchids used for this study have been returned to their natural habitat (insitu) inside the TNLL area. Meanwhile, 75% of the treatment samples are kept in the research location. With these orchids, staff of BBTNLL in collaboration with the women group have started to develop material for future material used for orchid conservation education.

The data are used as input by students, teachers and BBTNLL staff to build recommendations for the preparation of orchid conservation modules. Details of the discussion on the preparation of this orchid conservation module are explained in the presentation of the results of the participatory action research below.

Results of Participatory Action Research

This research was conducted by a companion team of community representatives, SMA 6 teachers and BBTNLL staff with focused discussions to obtain recommendations for module forms that can balance the conservation and economic needs of orchids. The output is a recommendation regarding an eco-education module that can be used for other groups with minimal risk.

Based o the result of the study, the following five recommendations how to prepare an eco-education module for orchid species in the Lore Lindu National Park can be provided:

a) Very low success rate (<25%): Two types of orchids; Calanthe tripiculata and Calanthe sp1 which should receive special attention for module preparation because there is no need for market and cultivation value and no protection value.
b) Low success rates (25-50%): as many as twelve types of orchids are Appendicula anceps, Appendicula congenera, Arundina graminifolia, Bulbophyllum echinolabium, Coelogyne asperata, Coelogyne rochuaenii, Dendrobium pigeon, Eria multiflora, Luisia javanica, Spathoglogtis plicata and Vandopsis fissochiloedes. The advantages of these twelve types of orchids are that these orchids are relatively easy to cultivate. This can be a recommendation for developing modules that can be developed more broadly with low risk because these tweve orchids neither do have a protected status or are endemic to Sulawesi. This model can be developed for education and research groups because there is no high market demand.
d) Medium success rate (50 - 75%): are fulfilled by twelve types of orchids, such as Bulbophyllum lobbi, Bulbophyllum sp1, Coelogyne sp1, Cymbidium ensifolium, Cymbidium finlaysonianum, Dendrobium discolor, Dendrobium indivisum, Dendrobium sp1, Dendrobium sp. Sp. 1. The group with medium success has characteristics that are easy to cultivate and have a promising market value. This model is appropriate to be developed in the segment of the women group. High success rate (> 75%): there are five types, namely Dendrobium machophyllum and Vanda jennae which are recommended to be the top priority for the preparation of the eco-education module because these species have endemic / protection status and they are easy to cultivate. The market demand Is high. However, there is one aspect which needs to be considered in the preparation of the module. This is that business management is reducing genetic quality to F2 and making propagation for restoration in natural habitats.
    i. One type of the dendrobium genus, Dendrobium machophyllum, has a protected status, but also high economic value and is relatively easy to cultivate.

ii. Four types of the 31 orchids have endemicity value, a high economic value and they are easy to cultivate: These orchids are: Coelogyne celebensis, Phalaenopsis celebensis, Phalaenopsis vennosa, Vanda jennae.

These five types of orchids are modules for eco-education considered to maintain a balance between species that have high conservation value on the one hand and high economic value on the other hand.

Research implications

The concrete collaborative action phase which is a follow-up to this research has been carried out with the following 2 (two) activities:

a) Orchid species restoration and activity module recommendations. In accordance with the agreement, 25% of the multiplication of treatment results from 29 species of orchids has been taken to be returned to their natural habitat (insitu) as a tangible result of conservation education.
b) Extrapolating the results of research in the medium success class as a training of trainers (ToT) module for a group of women in Karunia Village. Here, orchids have been selected which have economic value and are relatively easy to cultivate. This is considered as an extra effort to mitigate the risk of damage to orchids in natural habitats due to exploitation.

Conclusion

The most important lessons learned from this research is that knowledge about the What, the How and the Why creates a better understanding about the need and benefit of conservation efforts. The second lessons learned is that participation and bottom-up planning, implementation and analyses creates trust motivates people to contribute. In this research case, the knowledge transfer and the consequent participation of teachers and students has significantly improved the results (learning by doing). This conservation awareness is manifested in participatory action research and it is jointly agreed that 25% of the 31 types of research results were returned to their natural habitat (restoration) and 75% were used as media to extrapolate the results.

The results of the analysis of the typology of the conservation education model through the recommendations for the preparation of the eco-education module state that 94% of orchids are easy to cultivate and only 6% or two types of orchids, namely: Calanthe tripiculata and Calanthe sp1 which need further research to determine cultivation problems and opportunities for market demand. A total of 24 species with low to moderate success classes were recommended to be used by public groups because of the low risk to conservation values. As many as five types of orchids, such as: Dendrobium machophyllum, Coelogyne celebensis, Phalaenopsis celebensis, Phalaenopsis vennosa, Vanda jennae must receive special attention by compiling a model that balances conservation and economic values. This is of particular risk of species loss if exploited in natural habitats.

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