ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2521-0912 (Print)
ISSN: 2521-0513 (Online)
CODEN: JCOLBF

Journal CleanWAS (JCleanWAS)

DOI: http://doi.org/10.26480/jcleanwas.02.2022.40.45

RESEARCH ARTICLE

STRENGTHENING POLICY OF *EX-SITU* BIODIVERSITY MANAGEMENT CONSERVATION PREVENTING BIODIVERSITY LOSS IN CIBINONG SCIENCE CENTER BOTANICAL GARDEN

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ARTICLE DETAILS

Article History:

Received 05 May 2022
Accepted 09 June 2022
Available online 14 June 2022

ABSTRACT

The IUCN (International Union for Conservation of Nature) as international system for biodiversity conservation stated that all botanical garden should conserve endangered biodiversity. In this context, the IUCN publish the IUCN's Red List every year; in the year 2021 for example only around 35,765 species or 28% out of 75% conserved in *ex-situ* conservation or botanical garden. Indonesia has been developed further the notion through Presidential Decree No. 93/2011 that accommodated Target 8 of the Global Strategy for Plant Conservation (GSPC). Target 8 stated that at least 75 per cent of threatened plant species in *ex-situ* collections, preferably in the country of origin, and at least 20 percent available for recovery and restoration programs. From previous study, two out of six botanical gardens managed by the Government implemented the Target varied. Therefore, it is necessary to evaluate others including The Cibinong Science Center Botanical Garden (CSCBG). The study used qualitative method combined with policy approach through interview and observation with Miles and Hubermen approach for analysis. The result shows that the Gardens has not accommodated the policy yet, however the Garden has introduced technology with more than 6.000 species equipped with barcode. The collection is mainly Indonesia tropical plants specifically flora at lowland. Therefore, to strengthening policy of *ex-situ* conservation in the CSBG needs further policies: (a) coordination among and within related actors, (b) integration of biodiversity conservation into socio-economic sectors, (c) adequacy and sufficiency of funds, and (d) governance and stakeholder participation.

KEYWORDS

Biodiversity, ex-situ conservation, botanical garden, The Cibinong Science Center Botanical Garden

1. INTRODUCTION

Ex-situ conservation known as conservation outside, off site, or away from the natural location becomes one of plant preservation mechanism that also known as botanical garden. This type of conservation becomes strategic way to prevent biodiversity loss (Hochkirch et al., 2021; Purnomo et al., 2015). The loss of biodiversity all over the world becomes serious concern. The International Union for Conservation of Nature's (IUCN) publish called as Red List. In the year 2020, the IUCN stated there are 35,765 species (28%) categorized as threatened with extinction (IUCN, 2020). This number is considered huge and becomes alarm for humankind (O'Donnell & Sharrock, 2017) since the plant conservation is essential for human kind: without plant there is no life (GSPC, 2011). The conservation means food security; plantation damage and extinction will impacted significantly to the life support system as a whole (Hotimah et al., 2015; Lubis, 2009; Powers, 1993).

Responding to that, some botanical gardens in Indonesia has been accommodated the List including Cibodas Botanical Garden (Kurniawan et al., 2020) which shows that 86 species of the collection stated in the Red List, 13 species Critically Endangered (CR), 39 species Endangered (EN), and 34 species Vulnerable (VU). The number still far from the target. The similar research result shows in Bogor Botanical Garden that only 20% out of 75% of the target in the Red List has been accommodated (Lubis, 2021).

Botanical garden hold an important role in such preventing degradation of biodiversity loss. The Garden commonly function as taxonomic and systematic research centers (Dosmann, 2006; Stevens, 2007). However in this context the Garden can also be functioned as sources of plant ecology, growth, conservation (Coates & Dixon, 2007; Gratani, L. et al., 2008; Wang et al., 2018). Botanical gardens have great abilities to explore plant diversity and plant resource utilization and effective way to counteract for rapidly disappearing of biodiversity (Chen & Sun, 2018; Volis, 2017; Purnomo et al., 2015). Conservation also covered genetic resources which focus on developing protection strategy on target species due to its decreasing condition leads to endangered or extinct. The protection goes side by side with genetic resources utilization and equal benefit sharing (Bean et al., 2007).

IUCN takes a position as watchdog of number of threatened species comprehensively through list named Red List. Red List is a critical indicator of the health of the world's biodiversity. The IUCN Red List is comprehensive information on the global extinction risk status of animal, fungus, and plant species. The List is also a tool to inform and catalyze action for biodiversity conservation and policy change, critical to protecting the natural resources we need to survive (Hochkirch et al., 2021; IUCN, 2020).

Quick Response Code	Access this article online	
	Website: www.jcleanwas.com	**DOI:** 10.26480/jcleanwas.02.2022.40.45

Cite the Article: Efridani Lubis, Fauziah, Mulyono (2022). Strengthening Policy of Ex-Situ Biodiversity Management Conservation Preventing Biodiversity Loss in Cibinong Science Center Botanical Garden. *Journal CleanWas, 6(2): 40-45.*

The degree of biodiversity condition according to IUCN can be classified into eight categories with the extinct the worst one as Table 1. The critical condition when the biodiversity has been classified as endangered. In this stage, strong policy is needed in order to avoid the biodiversity fall in next bad stage.

Table 1: IUCN Red List Biodiversity Classification

Abbreviation	Means
EX	extinct
EW	extinct in the wild
RE	regional extinct
CR	critical extinct
EN	endangered
VU	vulnerable
LR	low risk
NT	near threatened

The IUCN Red List classified biodiversity into four groups, i.e., vertebrate, invertebrate, plants, fungi and protists. In the term of plants and fungi and protists, there is two trends in the last five years; first is worsen by the years and second, stable. Table 2 shows that mosses for example tend to be endangered in years; the same condition goes to forms and allies, flowering plants, lichens, and mushroom. On the other hand, red algae and brown algae are stable that also evidenced that there is no effective strategy to overcome the problem (O'Donnell & Sharrock, 2017)(Butchart et al., 2012).

The authority for managing botanical gardens in Indonesia use the IUCN Red List as an indicator to establish the priority for its *ex-situ* conservation programs. Accommodate the IUCN mandate, the main related policy is Target 8 of the Global Strategy on Plants Conservation (GSPC) that stated at least 75 percent of threatened plant species in *ex-situ* collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programs (BRIN, 2022). The policy is in line with Law No. 05/1990 of Biological Diversity Conservation as national legal framework and Law No. 05/1994 of Ratification of Convention on Biological Diversity. Therefore, the target of *ex-situ* conservation in 2021 is 17.501 plants species should, and 3.500 out of it in recovery and restoration programs (Hidayat et al., 2019).

Table 2: Numbers of plants threatened species

Year	PLANTS							FUNGI & PROTISTS			
	Mosses	Forms & alies	Gymno-sperms	Flowering plants	Green algae	Red algae	Sub total	Lichens	Mushroom	Brown algae	Sub total
2021	165	281	403	22.477	0	9	23.335	56	208	6	270
2020	165	265	403	19.518	0	9	20.360	48	185	6	239
2019	164	261	402	14.938	0	9	15.774	24	140	6	170
2018	76	249	401	12.564	0	9	13.299	20	33	6	59
2017	76	246	401	11.773	0	9	12.505	10	33	6	71

Sources: IUCN Report

The purpose of the research is to evaluate whether the IUCN target has been accommodate in Cibinong Science Center Botanical Garden since the basic policy in the Garden is bioregion that specific to Indonesia. In order to meet the need of biodiversity conservation effectively in order to prevent biodiversity loss, the other study purpose is strengthening the policy in Cibinong Science Center Botanical Garden.

2. Literature Review

Due to continuous biodiversity loss since warned by Rachel Carlson in her book 'Silent Spring' in 1960, many fora discussed, elaborated, and took an action toward it. Carlson's book documented an effect of indiscriminate use of pesticides that caused birds disappeared in spring (Carlson, 1960; Beyl, 1992). Although chemical companies opposed the book fiercely, but on the other hand, it drawn public opinion and drove the United States' made a change in national pesticide policy through ban on DDT for agriculture use (Dunlap, 2008). The increasing awareness triggered the UN to conduct the first environment conference known as UN Conference on the Human Environment in 1972 with the result of Stockholm Declaration (Handl et al., 2012; Shmelev, 1998). However, when the impact of declaration was evaluated twenty years later, environment degradation and biodiversity loss still ongoing (Hoban et al., 2021). Again UN took an initiative to invite all state leaders to discuss the biodiversity loss without trade off to development in the Earth Summit, Brazil in 1992. The Earth Summit was presented by 177 world's leader, used a theme UN Conference on Environment and Sustainable Development (Lubis, 2009). The movement to decrease biodiversity loss spreading across the world since.

The first International Convention as a biodiversity conservation legal framework is the Convention on Biological Diversity (CBD) that was opened for signature in 1992 and entered into forced on 1993. The main issue regarding biodiversity conservation stated in Article 6. According to the article, each country develops measurement to conserve its biodiversity relevant to country concerned and integrated cross-sectoral. To strengthening the measurement, in April 2002, the Conference of the parties by decision VI/9, had adopted Global Strategy for Plant Conservation (GSPC) which provided strategy to slow the rate of plant extinctions around the world by 2010 (CBD, 2011). Plants are universally recognized as a vital component of the world's biodiversity and an essential resources for the planet (Hoban et al., 2021). However, there is the fact that biodiversity is in danger of extinction endangered by human-induced factors such as climate change, environment changes, over-exploitation, alien invasive species, pollution, clearing for agriculture and other development (Laikre et al., 2010; Hoban et al., 2020).

To follow up the GSPC, at CBD's tenth meeting the Conference of the Parties adopted a consolidated update of the Global Strategy for Plant Conservation 2011-2020. There are 5 objectives and 16 targets during that period of time. Target 8 is in Objective II concern with plant diversity is urgently and effectively conserved.

Parallel with the recognition to the biodiversity threatened, various concern parties established International Union for Conservation of Nature's Red List of Threatened Species (IUCN Red List) in 1964. This measurement has evolved to become the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species. The IUCN provides public, private and non-governmental organizations with the knowledge and tools that enable human progress, economic development and nature conservation to take place together (IUCN, 2021).

Red List categories as described in Table 1 based on updated assessments and new knowledge. The IUCN evaluates criteria such as total species census size, reductions in population size and/or geographic range, each of which should theoretically correlate with losses of biodiversity. There is a critic toward Red List data gathering process, said that the Red List thresholds will not meet the census size. For example, to be listed under the RL criterion D (very small or restricted population), the total Nc must be <1000 for Vulnerable, <250 for Endangered, <50 for Critically Endangered (IUCN, 2020). While in some cases the original data used for the assessments of the Red List (e.g. number of populations, size of populations) could help calculate the genetic indicators we propose below, the Red List Index itself does not suffice as a genetic indicator (Hoban et al., 2020; Rout et al., 2021). However, the Red List is still necessary in the sense to avoid biodiversity endangered/extinct. Parallel with the Red List, other measurement is the Global Species Program (GSP) that focus on global fight to save species from extinction. GSP main functions are to generate, curate and disseminate The IUCN Red List of Threatened Species and to advance conservation action and policy.

One strategy of reducing continuous biodiversity loss as a part of global commitment is through *ex-situ* conservation. According to Article 9 of CBD, contracting party shall adopt *ex-situ* conservation of components of biodiversity preferably in the country of origin, recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats. To do so, regulation and management of collecting of biodiversity from natural habitats to *ex-situ* conservation becomes essential, and also include financial and other support necessary in establishing and maintaining *ex-situ* conservation.

Ex-situ conservation is an opposite of *in-situ* conservation which conserve biodiversity within their natural ecosystem where they occur. The implementation of both approaches is mutually reinforcing and complement to each other (Thielges & Sastrapradja, 2001; Chen & Sun, 2018). The difference between the two approaches is *ex-situ* conservation involves sampling, transfer and storage of species away from their original location, whereas *in-situ* conservation involves designation, management and monitoring of species at the location where they are found (J.G. Hawkes, 2000). *Ex-situ* conservation conducted through different techniques including zoos, captive breeding, aquarium, botanical gardens, and gene banks (Dunn, 2017; Sharrock & Oldfield, 2013). *Ex-situ* conservation in botanical garden involves collecting of seed or living material from one location and its transfer and maintenance at a second location in a garden (Hotimah et al., 2015; J.G. Hawkes, 2000).

Ex-situ conservation is necessary for restoring biodiversity erosion in the original location and the need for easy access for exploitation such crops and other species. Other benefit of this conservation is that the genetic material is always available to the plant breeder or for evaluation. This technique can also be as safety back-up to *in-situ* conservation where biodiversity reserve on its natural location cannot guarantee long-term security (J.G. Hawkes, 2000).

Ex-situ conservation in botanical gardens in Indonesia is coordinated by Pusat Penelitian Konservasi Tumbuhan dan Kebun Raya (Research Center of Plant Conservation and Botanical Garden), Lembaga Pengetahuan Indonesia (The Indonesian Academy of Sciences). There are six botanical gardens *ex-situ* conservation around Indonesia: (1) The Bogor Botanical Gardens, (2) The Cibinong Science Center Botanical Garden, (3) The Cibodas Botanical Garden, (4) The Bedugul-Bali Botanical Garden, (5) The Purwodadi Botanical Garden, and (6) The Puspiptek-Serpong Botanical Garden. The botanical garden (1), (2), and (3) located in Bogor (Lubis, 2021). The legal framework as a policy basis of the botanical gardens refer to The Convention on Biological Diversity and Global Strategy for Plant Conservation at international level. The Convention on Biological Diversity has been ratified through Law No. 05/1994. The concept has been initiated before International Convention through Law No. 05/1990 of Biological Diversity Conservation. Responding to international concern of biodiversity threatened with extinction in the IUCN's Red List, several regulations have been passed, including Presidential Degree No. 93/2011 of Botanical Garden, and Ministry of Forestry Decree No. P. 57/Menhut-II/2008 of Strategic Plan for National Species Conservation 2008-2018 for forestry sector and General Director Decree No. P.6/KSDAE/SET.3/REN.0/9/2020 of Strategic Plan for Natural Resources and Environmental Conservation 2020-2024 for environmental sector.

According to Ministry of Forestry Decree, there are 58 species that should be conserved in *ex-situ* method; and the target of Ministry of Environmental, at least 4 species can be restore and rehabilitate each year until 2023.

3. Research Method

The methodology used for study is qualitative method with stressing in evaluation approach combined with policy approach through interview and survey.

The research question of the study is whether the policy of *ex-situ* conservation in The Cibinong Science Center Botanical Garden applied and in line with the Global Strategy for Plant Conservation strategy to decline IUCN's Red List.

In order to answer the research question, this study was conducted with sequential: (1) identify problems and potent; (2) theoretical study; (3) gathering data through observation and interview, (4) qualitative data analysis; (5) hypothesis findings; (6) conclusion and recommendation.

Data collection process begins with (1) study documents for finding relevant theory and key informants; (2) observation in the Cibinong Science Center Botanical Garden as an object of the study and collecting relevant data at the same time; and (3) to complete data obtained, documentation is also conducted ; and (4) interview with relevant and related persons. Using observation, interview, and documentation is also as triangulation to verified data obtained so that credible (Sugiyono, 2020).

Analyzing data used Miles and Huberman Models with sequence: (1) exploration; (2) reduction; (3) data display, and (4) conclusion drawing/verification. At the exploration and data collection, all information, data, and situation have been recorded. In reduction stage, data obtained was divided and classified based on their importance to the study. Data display use narrative text. The fourth step of qualitative data analysis from Miles and Hubermen is conclusion drawing based on data obtained to answer the research question.

4. Findings and Discussion

The Cibinong Science Center Botanical Garden (CSCBG) located in Bogor area covers 32 ha. The collection of the garden more than 6.000 species from around Indonesia. The information of collection has been equipped by barcode that can be scanned by visitor and directly connected to relevant website. This method could give adequate information for public as a part of education. The concept of the garden is bioregion. Main flora that preserved in The CSCBG is Indonesia tropical plants specifically covering flora at lowland or 500 meter above sea level maximum. The garden would become Indonesian forest miniature. The facilities in the CSCBG are completed by supporting infrastructures such as Dora, Walini, and Dori Lake; Convention Hall; Conservation and Exhibition Hall, Mayakasa Playground, and *Ecodome* Greenhouse; a greenhouse for mountain plants with its original temperature.

The main policy of CSCBG is in line with Global Strategy for Plant Conservation (GSPC) under Convention Biological Diversity (CBD) and Presidential Degree No. 93/2011 of Botanical Garden with stressing on Target 8 of the GSPC. Target 8 of the GSPC stated that at least 75 percent of threatened plant species in *ex-situ* collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programs. Further, the Target 8 of the GSPC has been identified and highlighted in technical guideline in Forestry Ministry Decree No. P.

57/Menhut-II/2008 of Strategic Plan for National Species Conservation 2008-2018 for forestry sector and General Director Decree No. P.6/KSDAE/SET.3/REN.0/9/2020 of Strategic Plan for Natural Resources and Environmental Conservation 2020-2024 for environmental sector. In the Appendix of the Forestry Ministry Decree 2008 identified that there are 58 species according to the IUCN's Red List that classified vulnerable to endangered also in Indonesia as describe in Table 4, so these plants need to conserve in *ex-situ* including the CSCBG

Table 3: The IUCN's Red List in Indonesia Threatened Biodiversity

No	Species	Conservation Policy	Desription
1	Pelalar Dipterocapus littoralis	*Ex-situ* development, *in-situ* reintroduction	Familia Dipterocarpaceae. Area distribution is limited to Nusa Kambangan Island, Central Java. Categorized by IUCN as critical (CR). Threatened by illegal logging.
2	Kalapia Kalappia celebica	*Ex-situ* development, *in-situ* reintroduction	Familia Fabaceae. Endemic to Sulawesi and its distribution is limited in Malili. Categorized by IUCN as vulnerable (VU). Threatened by over harvesting.
3	Resak banten Vatica bantamensis	*Ex-situ* development, *in-situ* reintroduction	Endemic to Java and found only in Ujung Kulon. Categorized by IUCN as endangered (EN).
4	Resak bribes Vatica javanica	*Ex-situ* development, *in-situ* reintroduction	Endemic to Java and has been in IUCN Red List since 1971. Categorized by IUCN as endangered (EN).
5	Nothofagus womersleyi	*Ex-situ* development	Familia Fagaceae. Endemic to Papua. Found only in Bukit Irau, Head of Bird, Papua. Categorized by IUCN as endangered (EN). Threatened by environmental damage and harvesting.
6	Kayu hitam, eboni Dyospyros celebica	Sustainable harvesting, wide scale development.	Endemic to Sulawesi. Found only in lowland rain forest. Categorized by IUCN as vulnerable (VU). Threatened by habitat extinction and harvesting.
7	Kayu susu Alstonia beatricis	Local utilization regulation.	Familia Apocynaceae. Found only in Waigeo Island, Papua. Categorized by IUCN as vulnerable (VU).
8	Bintangur Calophyllum insularum	*Ex-situ* development.	Famili Guttiferae. Endemic to Papua. Threatened by habitat extinction and felling. Categorized by IUCN as endangered (EN).
9	Guioa waigeoensis	*Ex-situ* development.	Familia Sapindaceae. Found only in Pulau Waigeo Island. Categorized by IUCN as vulnerable (VU).
10	Kawoli Alloxylon brachycarphus	*Ex-situ* development.	Familia Proteaceae. Area distribution is in PNG, Papua, Maluku, Aru Island. Categorized by IUCN as endangered (EN). Threatened by habitat damage. No conservation effort whatsoever.
11	Bintangur Calohpyllum papuanum	*Ex-situ* development.	Familia Guttiferae. Area distribution is in Papua, Maluku, and PNG. Categorized by IUCN as LR (Lower risk)
12	Bintangur Calophyllum euryphyllum	*Ex-situ* development.	Familia Guttiferae. Area distribution is in PNG, Papua, and Aru Island. Categorized by IUCN as LR (Lower Risk)
13	Nyatoh Manilkara kanosiensi	*Ex-situ* development.	Familia Sapotaceae. Found only in Maluku and Tanimbar Island. Categorized by IUCN as endangered (EN).
14	Tualang Koompasia grandiflora	*Ex-situ* development.	Familia Leguminosae (Fabaceae). Area distribution is PNG. Categorized by IUCN as vulnerable (VU).

In the policy level, the strategy for saving threatened biodiversity clear and focus. However, the CSCBG has not accommodate the list in Table 4, despite the target of the garden is Indonesian forest miniature. Therefore, it is essential for the CSCBG to adopt the list in the future.

Botanical Garden as *ex-situ* conservation considered as important part in conservation strategy in Indonesia. Combine with the research aspect, the management of botanical garden is under coordination of Pusat Penelitian Konservasi Tumbuhan dan Kebun Raya (Research Center of Plant Conservation and Botanical Garden) Indonesian Science Institute (LIPI). Along with other 5 botanical gardens: Bogor Botanical Garden, Bedugul-Bali Botanical Garden, Cibodas Botanical Garden, Purwodadi Botanical Garden, and Puspiptek- Serpong Botanical Garden; and Cibinong Science Center Botanical Garden as the newest garden comply with Presidential Decree No. 93/2011 of Botanical Garden. According to the Law, the botanical gardens have a function as *ex-situ* biodiversity conservation with plant collection documentation which organized by taxonomy, bioregion, thematic classification or combination of them with the purpose of research, education, tourism, and environment services.

Following the guidelines, the Research Center has been divided the role among botanical gardens especially in the term of plant collection as describe Table 5. Therefore, focus of the Law is to conserve Indonesia plant, not specifically toward responding to UICN's Red List.

Table 4: Differentiation and Sharing Position between Botanical Gardens

Elements	Bogor Botanical Garden	Cibodas Botanical Garden	Cibinong Botanical Garden
Area	87 ha	84,99 ha	32 ha has been utilized from 189 ha
Plant collection	12.531 species	5.606 species	6.000 species + 1.147 species
Collection base	Familia (genus, tribe)	Specific to western region	Bioregion
Age	204 years	171 years	2 years

The CSCBG also encounters the difficulties in fulfilling its duty, however. According to Laksana Tri Handoko, the head of Indonesia Science Institute, it's not easy to transfer high land plants to low land plant that needs certain infrastructure and modification. Further, the CSCBG will be place of collection, maintaining, and captivity biodiversity in order to establish and develop new habitat for *ex-situ* Indonesian biodiversity conservation. The visitor can see researcher doing the conservation activities directly in the CSCBG as a part of tourism and education.

In order to enhance the function of botanical gardens around Indonesia in the context of *ex-situ* biodiversity conservation accommodated the IUCN Red List, there are four aspects should be regulated or becomes strategic policy:

1. efficient distribution of the IUCN Red List among Indonesia botanical gardens in accordance with geographical of the biodiversity;
2. provision on back up for certain biodiversity to anticipate endangered species and their recovery (Saparita, 2019);
3. list of biodiversity for development and sustainable use (Saparita, 2019)(Hermoso et al., 2022); and
4. generating adequacy and sufficiency of fund (Hermoso et al., 2022).

The concept needs philosophical, technical, social, and economy approach that elaborate academically under cooperation with universities.

5. Conclusion

The Cibinong Science Center Botanical Garden (CSCBG) as *ex-situ* conservation has been equipped with adequate regulations, including technical regulation such as Ministry Forestry and Directorate General Decree. Since the CSCBG is one of six botanical gardens managed by Indonesia Science Institute, the position and function of the garden is complemented to other gardens. Unlike the Bogor Botanical Garden, where previous study has been conducted, focus on the CSCBG Indonesia tropical plants specifically flora at lowland or 500 meter above sea level maximum from around Indonesia to meet bioregion concept. In this sense, the IUCN' Red List has not became consideration yet, despite some of plants on the list also fall to the CSCBG concept. To maximize its role as *ex-situ* conservation combine with bioregion concept, it is urge to put the IUCN's Red List in consideration in future the CSCBG's policy; so that the Target 8 of the Global Strategy for Plant Conservation strategy could be fulfilled.

To optimize the function of Indonesia botanical gardens as *ex-situ* conservation for endangered and threat to extinct biodiversity, it is urge to establish strategic policy or regulation that covered inter alia efficient and effective distribution for conservation biodiversity according to botanical garden's geographical condition so that 75% of the target in the Red List can be accommodated.

Limitation & Further Research

The study is limited only to the CSCBG as *ex-situ* conservation method in reducing biodiversity loss according to the IUCN's Red List. As explained above; there are six botanical gardens under coordination of Indonesia Science Institute at the moment. The further study in other botanical garden is needed to find similar policy in other four gardens in order to have comprehensive data so that allowing to formulate appropriate policy and regulation. The other phenomenon that should put into consideration is local government also initiated developing and building a botanical gardens out of the six gardens.

References

Bean, R., Burke, M., & Jarvis, A. 2007. The Conservation of Global Crop Genetic Resources In the Face of Climate Change. Assessment, 1–20.

Beyl, C. A. 1992. Rachel Carlson, Silent Spring and the Environmental Movement. HortTechnology, 2(June). https://doi.org/10.21273/HORTTECH.2.2.272

BRIN. 2022. Kebun Raya Cibinong BRIN, Platform Riset dan Konservasi Tumbuhan Berkonsep Ekoregion. Kabar BRIN.

Butchart, S. H. M., Scharlemann, J. P. W., Evans, M. I., Quader, S., Aricò, S., Arinaitwe, J., Balman, M., Bennun, L. A., Bertzky, B., Besançon, C., Boucher, T. M., Brooks, T. M., Burfield, I. J., Burgess, N. D., Chan, S., Clay, R. P., Crosby, M. J., Davidson, N. C., de Silva, N., … Woodley, S. 2012. Protecting important sites for biodiversity contributes to meeting global conservation targets. PLoS ONE, 7(3). https://doi.org/10.1371/JOURNAL.PONE.0032529

Carlson, R. 1960. Silent Spring. Mariner Book, Houghton Mifflin Harcourt.

CBD. 2011. Global Strategy For Plant Conservation - Updated Strategy 2011-2020. CBD.

Chen, G., & Sun, W. 2018. The role of botanical gardens in scienti fi c research , conservation , and citizen science. Plant Diversity, 40(4), 181–188. https://doi.org/10.1016/j.pld.2018.07.006

Coates, D. J., & Dixon, K. W. 2007. Current perspectives in plant conservation biology. Australian Journal of Botany, 55(3), 187–193. https://doi.org/10.1071/BT07037

Dosmann, M. S. 2006. Research in the Garden: Averting the Collections Crisis. The Botanical Review, 72(3), 207–234. https://www.jstor.org/stable/4354520

Dunlap, T. R. 2008. DDT, Silent Spring, and the Rise of Environmentalism: Classic Texts. University of Washington Press. https://www.jstor.org/stable/j.ctvcwnrw5

Dunn, C. P. 2017. Biological and cultural diversity in the context of botanic garden conservation strategies. Plant Diversity, 39(6), 396–401. https://doi.org/10.1016/J.PLD.2017.10.003

Gratani, L., Crescente, M.F., Varone, L., et al. 2008. Growth pattern and photosynthetic activity of different bamboo species growing in the Botanical Garden of Rome. Flora - Morphology, Distribution, Functional Ecology of Plants, 203(1), 77–84.

GSPC. 2011. Updated Global Strategy for Plant Conservation 2011-2020. CBD. https://www.cbd.int/gspc/

Handl, G., Deutsch, E., & Law, I. 2012. Historical Archives - Introductory Note - Declaration of the United Nations Conference on the Human Environment (Stockholm Declaration), 1972 and the Rio Declaration on Environment and Development, 1992 - English. 1–11.

Hermoso, V., Carvalho, S. B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I. N., & Yates, K. L. 2022. The EU Biodiversity Strategy for 2030: Opportunities and challenges on the path towards biodiversity recovery. Environmental Science & Policy, 127, 263–271. https://doi.org/10.1016/J.ENVSCI.2021.10.028

Hidayat, I. W., Kurnita, N. I., & Ardiyanto, D. 2019. the Contribution of Cibodas Botanic Garden As an Ex-Situ Conservation Site for Tropical Mountainous Plants: the Last Decade. Jurnal Biologi Tropis, 19(2), 161–171. https://doi.org/10.29303/jbt.v19i2.1317

Hoban, S., Bruford, M., D'Urban Jackson, J., Lopes-Fernandes, M., Heuertz, M., Hohenlohe, P. A., Paz-Vinas, I., Sjögren-Gulve, P., Segelbacher, G., Vernesi, C., Aitken, S., Bertola, L. D., Bloomer, P., Breed, M., Rodríguez-Correa, H., Funk, W. C., Grueber, C. E., Hunter, M. E., Jaffe, R., … Laikre, L. 2020. Genetic diversity targets and indicators in the CBD post-2020 Global Biodiversity Framework must be improved. Biological Conservation, 248. https://doi.org/10.1016/J.BIOCON.2020.108654

Hoban, S., Campbell, C. D., da Silva, J. M., Ekblom, R., Funk, W. C., Garner, B. A., Godoy, J. A., Kershaw, F., MacDonald, A. J., Mergeay, J., Minter, M., O'Brien, D., Vinas, I. P., Pearson, S. K., Pérez-Espona, S., Potter, K. M., Russo, I. R. M., Segelbacher, G., Vernesi, C., & Hunter, M. E. 2021. Genetic diversity is considered important but interpreted narrowly in country reports to the Convention on Biological Diversity: Current actions and indicators are insufficient. Biological Conservation, 261, 109233. https://doi.org/10.1016/J.BIOCON.2021.109233

Hochkirch, A., Samways, M. J., Gerlach, J., Böhm, M., Williams, P., Cardoso, P., Cumberlidge, N., Stephenson, P. J., Seddon, M. B., Clausnitzer, V., Borges, P. A. V., Mueller, G. M., Pearce-Kelly, P., Raimondo, D. C., Danielczak, A., & Dijkstra, K. D. B. 2021. A strategy for the next decade to address data deficiency in neglected biodiversity. Conservation Biology, 35(2), 502–509. https://doi.org/10.1111/cobi.13589

Hotimah, O., Wirutomo, P., & Alikodra, H. S. 2015. Conservation of World Heritage Botanical Garden in an Environmentally Friendly City. Procedia Environmental Sciences, 28, 453–463. https://doi.org/10.1016/J.PROENV.2015.07.055

IUCN. 2020. Red list report 2017-2020. Https://Www.Iucnredlist.Org. https://www.jstor.org/stable/25461321

IUCN. 2021. Background & History. IUCN.

J.G. Hawkes, N. M. and B. V. F.-L. 2000. The Ex Situ Conservation of Plant Genetic Resources. Springer Science, Business Media Dordrecht.

Kurniawan, V., Putri, D. M., & Surya, M. I. 2020. Current Status of Threatened Plant Collections in Cibodas Botanical Garden Based on IUCN Red List. Jurnal Penelitian Kehutanan Wallacea, 9(1), 31. https://doi.org/10.18330/jwallacea.2020.vol9iss1pp31-42

Laikre, L., Allendorf, F. W., Aroner, L. C., Baker, C. S., Gregovich, D. P., Hansen, M. M., Jackson, J. A., Kendall, K. C., McKelvey, K., Neel, M. C., Olivieri, I., Ryman, N., Schwartz, M. K., Bull, R. S., Stetz, J. B., Tallmon, D. A., Taylor, B. L., Vojta, C. D., Waller, D. M., & Waples, R. S. 2010. Neglect of genetic diversity in implementation of the convention on biological diversity: Conservation in practice and policy. Conservation Biology, 24(1), 86–88. https://doi.org/10.1111/J.1523-1739.2009.01425.X

Lubis, E. 2009. Perlindungan dan Pemanfaatan Sumber Daya Genetik Berdasarkan Penerapan Konsep Sovereign Right dan Hak Kekayaan Intelektual. Alumni Bandung.

Lubis, E. 2021. Reviewing Policy Of Biodiversity Management As Ex-Situ Conservation In Bogor Botanical Garden Supporting Ecoturism. ASAR International Conference. https://repository.uia.ac.id/2021/12/20/reviewing-policy…rting-ecotourism/

O'Donnell, K., & Sharrock, S. 2017. The contribution of botanic gardens to ex situ conservation through seed banking. Plant Diversity, 39(6), 373–378. https://doi.org/10.1016/J.PLD.2017.11.005

Powers, M. A. 1993. The United Nations Framework Convention on Biological Diversity: Will Biodiversity Preservation be Enhanced Through It's Provisions Concerning Biotechnology Intellectual Property Rights? Wisconsin International Law Journal, 103.

Purnomo, D. W., Magandhi, M., Kuswantoro, F., Risna, R. A., & Witono, J. R. 2015. Developing Plant Collections on the Regional Botanic Gardens in Framework of Plant Conservation Strategy in Indonesia. Buletin Kebun Raya, 18(2), 111–124.

Rout, M., Reid, J., Wallace, K. J., Hall, M. M., & Whitehead, J. 2021. Voicing stakeholder visions for biodiversity indicators: A framework using content analysis. Environmental and Sustainability Indicators, 12, 100156. https://doi.org/10.1016/J.INDIC.2021.100156

Saparita, R. E. K. A. S. D. A. A. 2019. Pengelolaan Kebun Raya Daerah Antara Kenyataan dan Harapan (N. D. P (ed.)). LIPI Press. http://penerbit.lipi.go.id/data/naskah1573011618.pdf

Sharrock, S., & Oldfield, S. 2013. Building capacity for plant conservation – the role of botanic gardens. In BG Journal: Journal of Botanic Gardens Conservation International (Vol. 10, Issue 1). https://www.bgci.org/files/Worldwide/BGjournal/BGjournal 10.1.pdf

Shmelev, S. 1998. Whose Knowledge, Whose nature? Biodiversity, Conservation, and the Political Ecology of Social Movements. Journal of Political Ecology, 5(1). https://doi.org/10.2458/V5I1.21397

Stevens, A. 2007. Botanical gardens and their role in ex situ conservation and research. Phyton, 6(2), 211–214. https://www.zobodat.at/pdf/PHY_46_2_0211-0214.pdf

Sugiyono. 2020. Metode Penelitian Kuantitatif, Kualitatif, dan Kombinasi (Mixed Method). Alfabeta Bandung.

Thielges, B. A. (Ed), & Sastrapradja, S. D. 2001. In situ and Ex situ Conservation of Commercial Tropical Trees.

Volis, S. 2017. Conservation utility of botanic garden living collections: Setting a strategy and appropriate methodology. Plant Diversity, 39(6), 365–372. https://doi.org/10.1016/J.PLD.2017.11.006

Wang, B., Phillips, J. S., & Tomlinson, K. W. 2018. Tradeoff between physical and chemical defense in plant seeds is mediated by seed mass. Oikos, 127(3), 440–447. https://doi.org/10.1111/oik.04867