A case study on the appraisal of Cupressaceae collection in the Cibodas Botanical Garden

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Abstract. The collection of trees in the Cibodas Botanical Garden is regarded as a biological resources (SDH) asset. Appraisal as an SDH asset in the Cibodas Botanical Garden had been done by the Directorate General of State Finance in 2014, however the calculation of its value does not consider and value the existing condition of the trees. STEM and revised-Burnley are among those scientific methods applied in many countries as non-market appraisal techniques. The assessment of trees of the Cupressaceae collection at Cibodas Botanical Garden applying the STEM and revised-Burnley methods had been conducted in 2015 until 2016. This assessment aims to obtain the most appropriate method to appraise the SDH assets so that it can be recommended to DJKN as a refinement of its current asset appraisal method of tree collection that illustrates the actual condition. The appraisal of Cupressaceae tree collection with STEM method shows the range value of Rp. 88,305,390.86 - Rp. 160,527,847.47; the revised Burnley method of Rp. 5,139.67 - Rp. 4,069,041.21; while DJKN method of Rp. 10,810,863.99 - Rp. 27,211,345.07. Additional attributes may be considered to improve the DJKN method. These include maintenance costs, base value, volume, tree conditions, tree effect on the environment, and notability.

1. Introduction

Biological resources (SDH) is an asset that is crucial for humans to be used a direct of indirect manner. The plant are biological resources owned by the Cibodas Botanical Garden (KRC) as The Plant Conservation Institution of the Indonesian Institute of Sciences (LIPI), mentions that it has a considerable biodiversity. There are 162 families of species currently planted as collections which are native, endemic, and are the result of plant exploration inside and also outside Indonesia [1]. Biological resources in KRC have provided many benefits for humans and has been an asset. In fact, those assets in the form of a collection of plants have been registered as State Property (BMN) since 2010 as fixed assets [2]. The appraisal method of plant collection asset conducted by Directorate General of State Finance (DJKN) uses the multiple approach of tree age, scarcity index and acquisition cost [3]. This is clearly different from the assessment of the tree based on scientific methods which consider the value of uniqueness of the tree.

An appraisal is the determination of the value of the benefit of a good or service for human beings or the society. The existence of the value possessed by a good and service (natural and environmental resources) will, in turn, direct the decision-making behavior performed by individuals, communities or organizations. If the value of ecosystems resources, or more specifically the goods and services of an ecosystem, is already available, the ecosystem manager can use it for various purposes such as the management of decision-making, planning and others [4].
Fundamentally, biological assessment can be done with the non-market approach. A non-market biological appraisal can be undertaken using methods of valuation of indirect benefits such as environmental services, ecological functions, as well as conservation benefits [5]. Non-market appraisal techniques for trees have been developed in many countries, such as The 8th edition Guide for Plant Appraisal in the United States [6,7], Burnley in Australia [8], Helliwell in the United Kingdom [9,10], Norma Granada in Spain [11,12], and STEM in New Zealand [13]. These techniques use formulas related to local market conditions and maintenance costs.

Comparing some of those techniques or methods with the DJKN method is indeed required. The objective of this study is to compare the STEM, The revised Burnley, and DJKN method applied on the Cupressaceae collection of KRC. The expected result of this study is a recommendation for improving the DJKN method.

2. Method

2.1 Measurement techniques in the field

A census of Cupressaceae collection older than 50 years old was conducted from 2015 to 2016 in KRC. Appraisers (5-7 persons) was provided with a form that specifies which attribute to record according to each method. To avoid inconsistency among appraisers, the obtained results were averaged prior analysis. Tree height and diameter at breast height (DBH, measured at 1.3 m) were recorded. Tree age is obtained from the registration collection unit of KRC. Acquisition, pre-collection, and maintenance and costs were obtained by interviewing the staff of nursery and administration of KRC. The wholesale price of Cupressaceae wood is obtained from HTI index of the Forestry Department [14]. The formula for each method is described below. The costs and indexes used in each of them are displayed in table 1.

2.2. A description of the STEM formula, revised Burnley, and DJKN methods

STEM method [13] estimates tree value based on tree performance significance and monetary cost. This method consists of 20 valuation attributes by assigning 3-27 points for each attribute. Attributes used were categorized into condition, amenity, and notability. The formula shown in equation (1).

\[
\text{Appraised value (STEM)} = [(T \times W) + P + M] \times 2 \text{ (suggested retail conversion factor)....(1)}
\]

Where T is the total amount of points, W is the wholesale cost, P is the planting cost, and M is the maintenance cost.

The revised Burnley method [8] estimates the tree value based on the tree volume and a unit monetary budget. Appraisal also considers categories of tree life expectancy (score 0.5-1), form and strength (0-1), and location (0.4-1). The formula is shown in equation (2).

\[
\text{Appraised value (Revised Burnley method)} = V \times BV \times LE \times FG \times L \text{..................(2)}
\]

Where V is the tree volume (m$^3$), BV is the base value, LE is the life expectancy, FG is the tree form & vigour, and L is the location.

DJKN method [3] estimates tree value based on the cost approach. The fair value of the tree is calculated by summing the cost incurred for acquisitions multiplied by the index of the tree age (1-25) and the index tree scarcity (1.080-1.699). The formula shown in equation (3).

\[
\text{Appraised value (DJKN)} = NRC \times IUn \times IK \text{..............................................(3)}
\]
NRC : acquisition cost  
IUn : index of tree age  
IK : index of tree scarcity

**Table 1.** Costs (in Rupiah) and indexes used in the formula.

| No.  | Method                                              | Cost       | STEM | Revised Burnley | DJKN |
|------|-----------------------------------------------------|------------|------|-----------------|------|
| 1    | Wholesale cost (5 years old plant)                 | 250,000    |      |                 |      |
| 2    | Base value (1 m³ tree retail price)                | 483,000    |      |                 |      |
| 3    | Acquisition cost (plant acquiring by exploration)  | 800,804.7  |      |                 |      |
| 4    | Planting cost (pre-collection maintenance + planting cost) | 1,319,008  |      |                 |      |
| 5    | Maintenance cost (per year after planted)          | 221,733    |      |                 |      |
| 6    | Age index (years)                                  |            |      |                 |      |
|      | a. 50 < x ≤ 60                                      | a. 12.5    |      |                 |      |
|      | b. 60 < x ≤ 70                                      | b. 15      |      |                 |      |
|      | c. 70 < x ≤ 80                                      | c. 17.5    |      |                 |      |
|      | d. 80 < x ≤ 90                                      | d. 20      |      |                 |      |
|      | e. 90 < x ≤ 100                                     | e. 22.5    |      |                 |      |
|      | f. 100                                              | f. 25      |      |                 |      |
| 7    | Scarcity index                                      |            |      |                 |      |
|      | a. rare                                             | a. 1.699   |      |                 |      |
|      | b. quite rare                                       | b. 1.171   |      |                 |      |
|      | c. common                                           | c. 1.080   |      |                 |      |

3. Result and discussion

As many as 122 collection of the Cupressaceae consists of 9 genera and 26 species which were measured and appraised, displayed in table 2. Each method has its own species with the highest and lowest value, although STEM and DJKN method shares the species with the highest value (*Tetraclinis articulata* Mast.). Appraisal using the STEM method has a result of a value range of Rp. 88,305,390.86 (*Callitris columellaris* F.Muell.) - Rp. 160,527,847.47 (*T. articulata* Mast.); The revised Burnley method estimated Rp. 5,139.67 (*Chamaecyparis lawsoniana* 'Filiformis') - Rp. 4,069,041.21 (*Calocedrus macrolepis* Kurz); and the DJKN method Rp. 10,810,863.99 (*Widdringtonia whytei* Rendle and *C. formosensis* Matsum.) - Rp. 27,211,345.07 (*Cupressus macrocarpa* Hartw. ex Gordon and *T. articulata* Mast.).The STEM appraised value range is the highest among the methods tested, without any overlapping to the others.

The highest and lowest value of each method is influenced by one or more categories in the formula itself. In the STEM method the average point is included in that category. The highest value of Rp. 160,527,847.47 (*T. articulata, 179.64*) was not related to the highest average points (*C. formosensis; 235.17 points*) in the formula. The value is also influenced by the age of the tree, which add more maintenance cost. In comparison to the *C. formosensis*, the age of the *T. articulata* is older (52 vs. 85 years old). The same case occurs to the *Callitriscomullularis* (52 years old) with its lowest value (Rp. 88,305,390.86). Its average point was not the lowest, however, because the plant with lowest average point (*C. lawsoniana* 'Filiformis') is older (72 years old), the maintenance cost contributes more to the final value.

The Revised Burnley method is influenced by the volume, as shown clearly by the *Calocedrus macrolepis* Kurz which has the highest value (Rp. 4,069,041.21) and volume (14.62 m³). The tree with the lowest volume is not the one with the lowest value due to better conditions. The *C. lawsoniana* 'Filiformis' (2nd lowest volume) has the lowest value because the tree condition is worse than the *Thujopsis dolabrata*. The factors that affect the DJKN method are age and the scarcity index. Both the
C. macrocarpa and T. articulata were 85 years old and ‘rare’, while the C. formosensis and Widdringtonia whytei were 52 years old and ‘common’.

Table 2. Appraisal result of Cupressaceae using the STEM, revised Burnley and DJKN methods.

| Species | Points (avg.) | Appraised value (avg.) | Volume (avg.) | Appraised value (avg.) | Age (avg.) | Scarcity index | Appraised value (avg.) |
|---------|---------------|------------------------|---------------|------------------------|------------|----------------|------------------------|
| Callitris columellaris F.Muell. | 125.21 | 88,305,390.86 | 0.52 | 102,221.02 | 52.00 | 1.699 | 17,007,090.67 |
| Callitris maclayana (F.Muell.) F.Muell. | 134.70 | 111,629,862.48 | 6.01 | 1,335,031.30 | 52.00 | 1.699 | 17,007,090.67 |
| Calocedrus macrolepis Kurz | 177.75 | 114,402,545.25 | **14.62** | **4,069,041.21** | 56.13 | 1.699 | 18,282,622.47 |
| Calocedrus macrolepis var. formosana (Florin) W.C.Cheng&L.K.Fu | 162.43 | 106,912,533.71 | 2.64 | 951,798.63 | 52.00 | 1.699 | 17,007,090.67 |
| Chamaecyparis lawsoniana 'Filiformis' Florin | **235.17** | 143,281,581.33 | 6.41 | 1,732,581.69 | 52.00 | 1.08 | *10,810,863.99 |
| Cupressus benthami Endl. | 175.27 | 118,877,287.29 | 6.92 | 2,719,709.68 | 64.50 | 1.699 | 20,408,508.80 |
| Cupressus sempervirens var. pyramidalis (Targ.Tozz.) Royee ex Carriere | 155.45 | 103,421,462.29 | 12.85 | 3,171,280.87 | 52.00 | 1.699 | 17,007,090.67 |
| Cupressus sempervirens Gordon | 144.68 | 109,632,419.23 | 4.70 | 1,012,009.87 | 78.14 | 1.699 | 24,943,732.98 |
| Cupressus goveniana | 217.90 | 137,419,910.50 | 3.72 | 951,675.06 | 57.27 | 1.699 | 18,707,799.73 |
| Cupressus lusitanica Mill. | 152.06 | 103,818,465.27 | 1.87 | 386,464.74 | 56.71 | 1.699 | 18,464,841.29 |
| Cupressus macrocarpa Hort. ex Gordon | 140.21 | 114,387,005.34 | 4.46 | 646,513.99 | 52.00 | 1.699 | 17,007,090.67 |
| Cupressus sempervirens var. pyramidalis (Targ.Tozz.) Nyman | 162.17 | 151,789,752.23 | 3.61 | 427,597.75 | *85.00* | 1.699 | **27,211,345.07** |
| Cupressus sempervirens subsp. indica (Royle ex Parl.) Sila | 139.90 | 95,648,248.00 | 2.09 | 339,977.14 | 52.00 | 1.699 | 17,007,090.67 |
| Cupressus sempervirens L. | 136.50 | 102,374,102.00 | 2.82 | 397,969.56 | 71.00 | 1.699 | 23,809,926.93 |
| Cupressus sempervirens L. | 154.47 | 104,151,112.83 | 4.42 | 1,262,896.02 | 54.75 | 1.699 | 17,857,445.20 |
| Cupressus torulosa D. Don | 154.06 | 111,092,042.07 | 3.51 | 981,214.38 | 70.86 | 1.699 | 22,838,093.18 |
| Juniperus chinensis L. | 156.74 | 115,488,926.07 | 1.39 | 356,264.37 | 77.75 | 1.699 | 24,660,281.47 |
| Juniperus depeana Steud | 140.64 | 96,019,676.57 | 0.71 | 172,223.70 | 52.00 | 1.699 | 17,007,090.67 |
| Juniperus procera Hochst.ex Endl. | 151.70 | 106,869,840.00 | 2.75 | 678,944.67 | 64.00 | 1.699 | 21,088,792.43 |
| Juniperus virginiana L. | 124.00 | 95,015,437.00 | 0.21 | 29,443.87 | 68.50 | 1.699 | 22,109,217.87 |
| Tetraclinis articulata Mast. | 179.64 | **160,527,847.4** | 1.50 | 341,991.52 | **85.0** | 1.699 | **27,211,345.07** |
| Thuja japonica Maxim. | 123.07 | 105,815,576.77 | 0.34 | 49,386.49 | 52.00 | 1.699 | 17,007,090.67 |
| Thuja orientalis L. | 146.47 | 109,355,413.29 | 0.95 | 245,616.20 | 75.50 | 1.699 | 24,150,068.75 |
| Thuja plicata dambrotrea (Thunb.ex Lf.) Siebold &Zucc. | 125.81 | 88,605,390.86 | *0.03* | 7,162.87 | 52.00 | 1.699 | 17,007,090.67 |
| Widdringtonia whytei Rendle | 145.36 | 98,376,819.43 | 0.83 | 192,100.49 | 52.00 | 1.08 | *10,810,863.99 |

* lowest value;  
** highest value

The detailed comparison between the methods is displayed in table 3. As described above, the Revised Burnley method produced the lowest appraised value, as low as Rp. 5,139.67. The tree condition and its effect on the environment categories act as ‘reducing factor’ should they not be perfect. This method relies profoundly on the volume of the tree. It can be expected that a short, small
diameter and a good tree condition might have a lower value in comparison to a tall, large diameter, but a poor tree condition. A similar result with the low appraised value of small trees was also shown for Eucalyptus a tree appraisal in KRC [15]. The appraised value of the tree was Rp. 486 only because its volume was 0.01 m$^3$.

The DJKN method, on the other hand, does not consider the tree condition, size, and maintenance cost. The older the tree, the more valuable the tree, regardless of its condition. Any given tree with the same age and scarcity index will have the same value. As a living organism, the form, vigour and tree health will be affected by its age, and also influenced by environmental conditions. Thus, performing an appraisal without considering the tree performance and environmental categories seems incomplete. Adding those two categories will generate a value that will closely describe the condition of the asset, in this case, tree asset. They can be used also as depreciation factors of the asset.

The STEM method seems to consider other factors in the appraisal process, but older trees will be more likely to be valued higher due to the ‘notability’ category. Since the scope of this study is that the Cupressaceae collection is older than 50 years old, the resulted value would be affected by the ‘notability’ category. This method is considered unsuitable for small trees [15]. Nevertheless, the appraisal using the STEM method is the more prioritized objective due to its many attributes under considerations. This is in line with Nadhifah [16] which states that the calculation of more detailed costs and more parameters make the STEM method achieve more desired objective.

| Category                  | STEM | Revised Burnley | DJKN |
|---------------------------|------|-----------------|------|
| Age                       | √    | -               | √    |
| Acquisition cost          | -    | -               | √    |
| Maintenance cost          | √    | -               | -    |
| Wholesale cost            | √    | -               | -    |
| Value base                | -    | √               | -    |
| Volume                    | -    | √               | -    |
| Tree condition            | √    | √               | -    |
| Tree effect on the environment | √    | √               | -    |
| Scarcity                  | √    | -               | √    |

4. Conclusion
The differences of the appraisal method will influence in resulting different values. The appraisal of the Cupressaceae by the STEM method resulted in the highest value compared to the revised Burnley and the DJKN methods, with a range of value from Rp 4,440,337.64 - Rp 1,258,173,646.47. However, this method is considered appropriate for aging trees. On the other hand, the Revised Burnley method profoundly depends on the volume of the trees. It is considered that a short, small diameter and good tree condition might have lower value in comparison to unhealthy tall trees and large-diameter. Meanwhile, indexing the scarcity of the DJKN method on the local level which has the potential to produce the bias value of the trees collection in KRC on non-native assets and IUCN endangered status. Furthermore, appraisal by the DJKN method on the same species in the future will result in an ever-increasing value as the asset age index increases. Additional attributes may be considered to improve DJKN method, these include maintenance cost, base value, volume, tree conditions, tree effect on the environment, and notability.

Acknowledgments
This study was done thoroughly through a grain from The KRC DIPA TEMATIK 2015 to 2016.
Reference

[1] Kebun Raya Cibodas 2017 Daftar Kekayaan Koleksi Kebun Raya Cibodas, Unit Registrasi Kebun Raya Cibodas [List of Cibodas Botanical Garden Collection, Registration Unit] (http://siregist.krcibodas.lipi.go.id/Cibodas-Botanic-Gardens.Record) (accessed 11 September 2017).

[2] Republik Indonesia 2010 Peraturan Menteri Keuangan No 29/PMK.06/2010 tentang Penggolongan dan Kodeifikasi Barang Milik Negara, Berita Negara RI Tahun 2010, No 71 (Jakarta: Biro Umum Kementerian Keuangan Republik Indonesia) (In Indonesian).

[3] Republik Indonesia 2014 Buletin Teknis Penilaian Barang Milik Negara berupa Aset Koleksi Hewan, Biota Perairan, Tanaman, Mikroba, Batuan dan Fosil dalam Rangka Penyusunan Laporan Keuangan Pemerintah Pusat, Buletin Teknis Penelitian, Nomor BTP-02/KN.6/2014 (Jakarta: Direktorat Jenderal Kekayaan Negara) (In Indonesian).

[4] Bahruni 2004 Diktat Penilaian Sumberdaya Hutan dan Lingkungan [Assessment of forest and environmental resources] (Bogor: Faculty of Forestry, Bogor Agricultural University).

[5] Fauzi A 2004 Ekonomi Sumberdaya Alam dan Lingkungan [The economy of natural resources and the environment] (Jakarta: Gramedia Pustaka Utama) (In Indonesian).

[6] Council of Tree & Landscape Appraisers 1992 Guide for Plant Appraisal (8th edition) (Champaign Illinois USA: International Society of Arboriculture).

[7] Council of Tree & Landscape Appraisers 2000 Guide for Plant Appraisal (9th edition) (Champaign Illinois USA: International Society of Arboriculture).

[8] Moore G M 1991 Amenity tree evaluation: A revised method in the Scientific Management Plants in the Urban Environment Proc. of the Burnley Centenary Conference Centre of Urban Horticulture Melbourne Australia pp 166-171.

[9] Helliwell D R 1967 The amenity value of trees and woodlands Arboricultural Association Journal I 128–131.

[10] Helliwell D R 2000 Amenity Valuation of Trees and Woodlands (rev. ed.) (Romsey, Hants, United Kingdom: Arboricultural Association).

[11] Asociación Española de Parques y Jardines Públicos 1990 Método para valoración de árboles y arbustos ornamentales (Madrid, Spain: Norma Granada Asociación Española de Parques y Jardines Públicos) [In Spanish].

[12] Asociación Española de Parques y Jardines Públicos 1999 Método para valoración de árboles y arbustos ornamentales: Norma Granada: revisión 1999 Asociación Española de Parques y Jardines Públicos Madrid Spain [In Spanish].

[13] Flook R 1996 A Standard Tree Evaluation Method (STEM) (New Zealand: Tahunanui, Nelson).

[14] Republik Indonesia 2012 Peraturan Menteri Perdagangan Republik Indonesia No. 12/M-DAG/PER/3/2012 tentang Penetapan Harga Patokan Hasil Hutan untuk Perhitungan Provisi Sumber Daya Hutan (Jakarta: Sekteratiat Jendral Kementrian Perdagangan Republik Indonesia) [In Indonesian].

[15] Aldila D and Zuhri M 2014 Penaksiran Nilai Eucalyptus Koleksi Kebun Raya Cibodas [Eucalyptus tree appraisal of Cibodas Botanical Garden Collection]. Proc. of Ekspose dan Seminar Pembangunan Kebun Raya Daerah “Membangun Kebun Raya untuk Penyelamatan Keanekaragaman Hayati dan Lingkungan Menuju Ekonomi Hijau” Kebun Raya Indonesia pp 645-653.

[16] Nadhifah A, Zuhri M, Iskandar E A P and Kurniawati F 2015 Nilai Ekonomi Koleksi Pohon Famili Araucariaceae di Kebun Raya Cibodas [The economic value of Araucariaceae collection in Cibodas Botanical Garden]. Proc. of Seminar Nasional Manajemen Sumber Daya Alam dan Lingkungan Universitas Diponegoro pp 629-633.