FOREST RESOURCES BALANCE AND IT'S ECONOMIC VALUATION AT BUOL REGENCY, CENTRAL SULAWESI PROVINCE, INDONESIA BY USING GEOGRAPHICAL INFORMATION SYSTEM AND BENEFITS TRANSFER METHOD

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ABSTRACT: Some problems that occur in the developing countries like Indonesia for assessing the condition of natural resources and environmental are the limited data availability as well as budget for conducting comprehensive research. The materials used in this study are : Land Use Spatial Data (2000 – 2011), Director General of Forestry Planning. Forest balance map derived from the geographic information systems analysis. Calculations of the economic valuation based on the benefit transfer method conducted based on economic valuations in the reference region, a map of the quality of the forest study sites, and socioeconomic characteristics of communities in the study area. Based on re-calibration, economic valuations reference area to be transferred can be estimated to the study site. Based on balance analysis of forest, deforestation happed in Buol Regency were 8,406,00 ha during the period 2000-2011 or about 764 ha year $^{-1}$. Dryland forest primary experiencing a reduction of 3,957 ha year $^{-1}$, and lead to the addition of secondary dry forest of 35,135 ha or about 3,914 ha year^{-1}. The impact of deforestation is causing the loss of 2,420,032 tonnes of carbon deposits equal 8,881,517 tonnes carbon dioksida to emissions. The economic losses caused by the carbon emissions, referring to Pirard D (2005) is a US $ 374,669,400. Economic valuation of forest in the study area is U.S. $ 28,638.45 ha^{-1} year $^{-1}$ or 204 % of the reference value.

I. INTRODUCTION

1.1 Background

Forest is natural resources that are very important and useful for life and living either directly or indirectly. Direct benefits from the existence of the forest are timber, non-timber products and wildlife. While the indirect benefits are environmental services, such as watersheds, aesthetic function, an oxygen supplier and carbon sink.

Forest functions as a provider of environmental services landscape and global level, including the balance of the hydrological function, reduce emissions of greenhouse gases (GHGs) and maintaining the amount of carbon stored mainland (carbon stocks) as well as maintaining biodiversity (Hairiah et al., 2001).

Forest destruction, climate change and global warming reduce the indirect benefit of forest because forest is the largest carbon sink and play a very important role in global carbon cycle and can hold carbon at least 10 times greater than other vegetations prairie grass, crops and tundra (Adiriono, 2009). The disorder can affect the functions of other ecosystems and ultimately lead to the declining of the forest resources economic value. As Bengen (2002)said that the issue of sustainable forest management is how to combine the interests of ecology (forest conservation) with the socio-economic importance.

One of the methods in monitoring the forest resources is the forest resource balance method and calculating its economic value. Forest balance map derived from geographic information systems analysis. Calculations of the economic valuation based on the benefit transfer method based on economic valuations conducted in the reference region, a map of the quality of the forest study sites, and socioeconomic characteristics of communities in the study area.

The location of this research is Buol Regency, Central Sulawesi Province, Indonesia.

1.2 Objective

This study aims to determine the potency of forest resource, the level of resources deforestation in 2000-2011 and its economic value.

II. METHOD

2.1 Data Used:

- Indonesian Topographic Map, Scale 1: 50,000, Geospatial Information Agency (BIG)
- Forest Area, Inland Water, Coastal and Marine Ecosystem Map of Buol Regency, Scale 1: 250,000 Directorate General of Forestry Planning Ministry of Forestry.
- Closure and Land Use Map of Buol Regency , Scale 1: 250,000, Directorate General of Forestry Planning Ministry of Forestry
- Buol Regency Administrative Area Map, planning and regional development agencies of Buol Regency

2.2 The Change of Forest Land Analysis Method

The determination of widespread closures and land use the spatial analysis which is done by overlaying process of the closing map and the land use of Buol Regency in 2000 and 2011. Flowchart stage research activities are presented Figure 1.

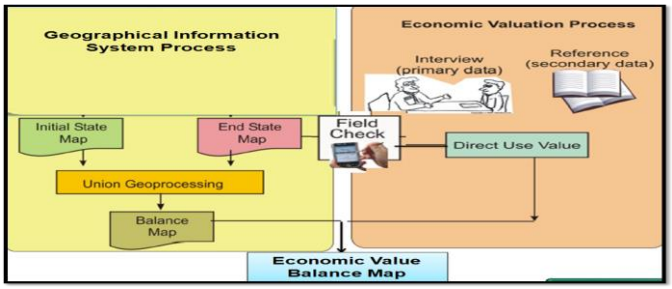


Figure 1. Flowchart Stage Research Activities

2.3 Economic Valuation Based on Benefit Transfer Method

Benefit of data transfers is the transfer and application of estimates of the economic benefits of particular resources from previous studies to a site for the which no such benefit values are available. The transfer of benefits assumes that the value of the resources in question is the same or a similar values across the different sites (Pearce and Moran, 1994). Each location has differeent characteristics of resources and socio-economic conditions ,so there must be an adjustment to be able to use the economic valuation of a region.

The results of the study of forest economic valuation in Central Kalimantan (Faculty of Forestry, 1999) is the recommended data . The data was adjusted as follow:
• The base year of study is 2000.
• The economic valuation presented in American dollars (USD).
• After an economic valuation was standardized, minimum, average and maximum values were calculated.
• The economic valuation in 2000 was converted to 2014 values by $V = (1 + i)\ t\ P$,

where :
V = the value in 2014
P = value in 2000
t = the period of 2000 - 2014 = 14 years
i = the average rate of inflation in 2000 - 2013 = 8.00%
http://www.bi.go.id/id/moneter/inflasi/data/Default.aspx, downloaded on June 11, 2014)

Resource factors : Referring to Eade and Moran (1996), the environmental characteristics was approached by the natural resource management parameters. The correction factor of the natural resource management are : rate of forest change, critical areas, environmental quality index, environment budget percent.

Society Characteristics Factors : Estimating the value based on the characteristics of socio-economic conditions (level of social welfare) of the natural resources was approximated by population density, agricultural gdp and gdp. labor income, workers expenditure, minimum necessities of life, minimum labourage, human development index.

2.4 Carbon Reserve Calculation Method, Carbon Reserving Changes and Carbon Emissions

Calculation of emissions using the stock changes approach (stock difference) which was measured at two different time points using two factors, namely: activity data and emission factors. The main data of carbon stocks changes was

derived from the data of the land cover change. The emissions and carbon sequestration were calculated by carbon stock extrapolation activity (the change of land area) through GIS analysis. The calculation of C carbon stock of each land cover for each year, refer to table of emission factor for various forms of land cover, Central Sulawesi Province (Omfo, R. 2012; Nahardi, et al. 2012). Annual emissions is obtained by calculating the difference between the carbon stocks and multiplied by a conversion factor of C into CO_2 equivalent; with the formula $E_{t-t+1} = [(C_{t-t+1}) \times 3.67]$. The amount of loss caused by the emissions of C carbon = $E_{tn-tn+1} \times P_C$ (USD)

III. RESULTS AND DISCUSSION

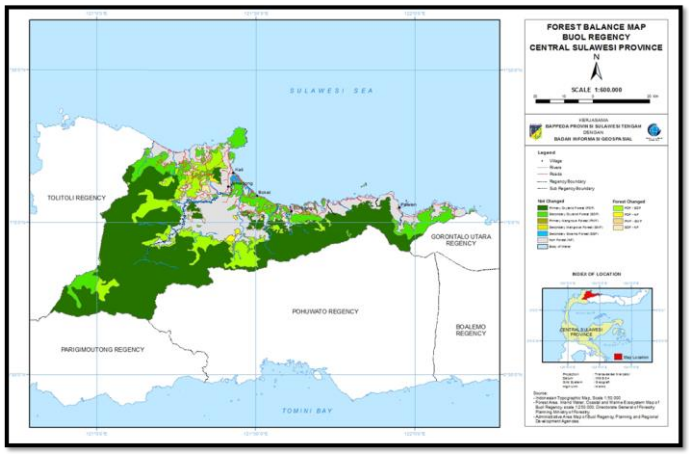
4.1 Balance of Forest Resources

The changes of land use in forest areas in two periods can be determined by the forest resources balance sheet approach . The map of forest balance in Buol Regency, was obtained from the overlaying between map forest assets in 2000 (initial state map) to map of forest liabilities in 2011 (end state map). the map provides information about the condition of the initial state map, utilization and damage as well as the end state map in 2011 (Table 1 and Figure 2).

Table 1. Forests Resources Balance of Buol Regency in 2000-2011

No.	Type of Land Use	Initial State Map (2000)		End State Map (2011)		Changed in 2000 - 2011	
		Ha	Persent	Ha	Persent	Ha	Persent
1	Primary dryland forest	234.200	61,18	190.676	49,81	43.524	18,58
2	Secondary dryland forest	51.579	13,47	86.714	22,65	(35.135)	(68,12)
3	Primary mangrove forest	768	0,20	751	0,20	17	2,21
4	Secondary mangrove forest	24	0,01	24	0,01	-	-
5	Secondary swamp forest	642	0,17	642	0,17	-	-
6	Non Forest	95.609	24,97	104.015	27,17	(8.406)	(8,79)
	TOTAL	382.822	100,00	382.822	100,00	-	

Source : Result of Analysis of Land Use Map in 2000 - 2011



Ficture 2. Forest Resources Balance Map of Buol Regency

Primary dryland forest conditions in Buol Regency in 2000 covered 234.200 ha and in 2011 reduced into 190. 676 ha. A reduction was 43. 524 ha, or approximately 18.58% over the 11 years. The average deforestation of primary dryland forest occurred in Buol Regency was 1.69% per year, or about 3,957 ha per year. The reduction was caused by deforestation which has changed primary dryland forest into a secondary dryland forest.

The reduction of primary dryland forest caused an additional extensive secondary dry forest directly, because deforestation in Indonesia is the selective cutting of trees which had 50 cm and up diameter of the tress . In 2000 the secondary dry forest area in Buol Regency was 51 579 ha and in 2011 increased to 86 714 ha. The addition of secondary dryland forest area was 35. 135 ha, or approximately 68.12% over the 11 years. The increasing average of secondary dryland forest was 6.19% per year, or about 3,194 ha per year. The reduction of primary dryland forest was caused by the deforestation of primary dryland forest which has changed the primary dryland forest into a secondary dryland forest.

Moreover, beside the forest degradation due to a concession, there was also a reduction of primary dryland forest into non-forest areas (forest conversion). Over the 11 years the reduction of dry forest areas into non-forest area was 28. 497 ha or (11.63). The average of increasing rate of non-forest areas in Buol Regency was 2,591 ha per year, or about 1.06%.

Over the 11 years (2000-2011) the increase of non-forest area was 8406 ha or 8.79 % compared to the condition of the land cover in 2000. The rate of change was 764 ha per year or the reduction was 0.80% per year compared to non-forest areas condition in 2000. The increase of non-forest areas was caused by the activity of forest land conversion into non-forest areas (other uses).

The changes of forest cover was caused by the deforestation, either planned or not, or by the forest degradation. Planned deforestation is usually in the form of changes planned by the government for the benefit of forest land for plantations, agricultural or residential development, which is carried out lawfully in accordance with the legislation. unplanned deforestation is a deforestation through illegal activities. The forest degradation can be caused by illegal or unauthorized activities, such as harvesting and illegal logging. Degradation due to illegal logging caused the vulnerable land of deforestation since the damaged forest is easier tobe opened.

3.3 Economic Valuation of Forest

Referring to the research results of Faculty of Forestry (1999), and Kusuma, ID (2005), the economic valuation of forest in Central Kalimantan are presented in Table 2. The total value of economic valuation of forest in Central Kalimantan has a various value and significant difference between the minimum and maximum values.

Table 2. Summary of Total Economic Valuation in Central Kalimantan in 2000 (US $ / Ha)

	Type of Values	Minimum [1)]		Maximum [2)]		Average [3)]	
		(US $)	Persent	(US $)	Persent	(US $)	Persent
1	Direct Use Value	0.028	0.00	377.16	2.64	188.59	1.85
2	Indirect Use Value	3155.85	52.37	5758.85	40.24	4,457.35	43.83
	a. Erosion Prevention	287	4.76	523.72	3.66	405.36	3.99
	b. Carbon Sequestration	2868.85	47.61	5,235.13	36.58	4,051.99	39.85
3	Non Use Value	2869.99	47.63	8176.34	57.13	**5,523.17**	54.31
	a. Optional	3.86	0.06	0.37	0.00	2.12	0.02
	b.Bequest Value	392.61	6.52	8175.97	57.13	4,284.29	42.13
	c. Existence Value	2473.52	41.05			1,236.76	12.16
Total Economic Valuation		6,025.87	100.00	14,312.35	100.00	10,169.11	100.00

Source : 1) Kusuma, I.D (2005), 2) Faculty of Forestry - Bogor Agricultural Institute. 1999
3) Average from Minimum and Maximum

Referring to Krupnick (1993) the benefit transfer method could be used if the resources have the same ecosystem both in terms of place and the characteristics of the market. Recommended area is not the same as the assessed location,therefore adjustments are made, the correction factor : inflation was 2.04, the natural resources was 2.51 and 0.55 Socioeconomics. The correction factor correction is a reference value of 2.55. Economic valuation based benefit transfer method for Buol Regencys are presented in Table 3.

By using the average value, the estimated total economic value of Buol Regency is US$ 28,638.45 ha^{-1} $year^{-1}$. Was calculated by summing the direct use value (US$ 531.12 ha^{-1} $year^{-1}$), indirect use value (US$ 12,552.88 ha^{-1} $year^{-1}$ and non use value (US$ 15,554.45 ha^{-1} $year^{-1}$. The economic value reaches 204 % of the reference value. The economic valuation of forest is a rough estimation of the value (global) which can be used as references. For a more detailed value, research must be conducted (economic valuation calculation) with the appropriate method. Economic valuation of forest can be used as a basis for decision making, when forests are converted to another use. It can be used as a basis for granting use of forest resources, which can be expected to improve the welfare of the community (maximizing social well-being).

3.3 The Changes of Carbon Stocks and Emissions

Natural forest is the highest carbon storage (C) compared to non-forest (agricultural land). The change of forest usage into non-forest areas (agricultural land) reduced the environmental services, this is due to the low vegetation density and diversity of vegetation.

Tabel 3. Summary of Total Economic Valuation in Buol Regency in 2014 (Based on Benefit Transfer Method)

No	Type of Values	Minimum		Maximum		Average	
		(US $)	Persent	(US $)	Persent	(US $)	Persent
1	Direct Use Value	0.08	0.00	1,062.17	2.64	531.12	1.85
2	Indirect Use Value	8,887.57	52.37	16,218.19	40.24	12,552.88	43.83
	a. Erosion Prevention	808.26	4.76	1,474.92	3.66	1,141.59	3.99
	b. Carbon Sequestration	8,079.31	47.61	14,743.27	36.58	11,411.29	39.85
3	Non Use Value	8,082.52	47.63	23,026.37	57.13	15,554.45	54.31
	a. Optional	10.87	0.06	1.04	0.00	5.96	0.02
	b.Bequest Value	1,105.68	6.52	23,025.33	57.13	12,065.50	42.13
	c. Existence Value	6,965.98	41.05	-	-	3,482.99	12.16
	Total Economic Value	16,970.17	100.00	40,306.73	100.00	28,638.45	100.00

The reduction of CO_2 in the air by the plants was called sequestration process (C sequestration). ThisC sequestration process occurs for the survival of plants which need sunlight, carbon dioxide gas (CO_2) is absorbed from the air and water as well as nutrients absorbed from the soil. Through the photosynthesis process , the CO2 in the air is absorbed by plants and converted into carbohydrates, afterwards they are distributed throughout the body of the plants and eventually are dumped throughout the plant body. Thus, measuring the amount of C stored in the body of living plants (biomass) in a field can describe the amount of CO2 in the atmosphere absorbed by plants. (Hairiah et al., 2001).

By measuring the amount of C stored in the bodies of living plants (biomass) in the landscape, can calculate the amount of CO_2 in the atmosphere is absorbed by plants. In a 11-year period (2000-2011 years) a reduction in the primary dry forest area of 43,524 ha, or approximately 18.58%. This condition leads to reduced carbon stocks 8,504.59 Gton for 11 years. Reduction of carbon stocks by 99.97% due to the reduction in primary dryland forest area and carbon stock reduction of 0.03% due to the reduction of primary mangrove forest area. This reduction of carbon stocks caused carbon emissions in Table 4.

Table 4. Carbon Stocks in Buol Regency in 2000 and 2011

No		**Initial State Map 2000**		**End State Map 2011**		**Changed in 2000-011**		**Average per year**	
	Type of Land Use	**(GTon C)**	**(%)**	**(GTon C)**	**(%)**	**(GTon C)**	**(%)**	**(GTon C)**	**(%)**
1	Primary dryland forest	45.762,68	80,12	37.258,09	68,12	8.504,59	18,58	773,14	1,69
2	Secondary dryland forest	8.752,96	15,32	14.715,37	26,90	(5.962,41)	(68,12)	(542,04)	(6,19)
3	Primary mangrove forest	130,56	0,23	127,67	0,23	2,89	2,21	0,26	0,20
4	Secondary mangrove forest	2,88	0,01	2,88	0,01	-	-	-	-
5	Secondary swamp forest	99,51	0,17	99,51	0,18	-	-	-	-
6	Non Forest	2.370,32	4,15	2.492,80	4,56	(122,49)	(5,17)	(11,14)	(0,47)
	Jumlah	57.118,90	100,00	54.696,32	100,00	2.422,58	4,24	220,23	0,39

Sumber : Calculation Result : Area x Carbon Factor

Table 4 showed the total carbon stocks (excluding soil carbon stocks) throughout the land cover in Buol Regency in 2011 reached 54,696.32 Gton C, where the contribution of dry forest and mangrove forest about 95, 44%, and the closing of non-forest land was 4.56%. Carbon stocks has been reduced by 24,22.58 Gton or the average was 220.23 Gt C $year^{-1}$, compared to the carbon stocks in 2000.

Beside the reduction of carbon stocks, there was also the increase of carbon stocks in closing the area in the forms of : a) Secondary dryland forest, the increase of carbon stocks was 5,962.41 Gton or 68.12% compared to the condition in 2000. The increasing average of carbon stocks was 542.04 Gton $year^{-1}$ or 6.19% $year^{-1}$; . b). Non-Forest, the increase of carbon stocks was 122.49 Gton or 5.17% compared to non-forest condition in 2000. The increasing average of carbon stocks was 11.14 Gton $year^{-1}$ or 0.47% $year^{-1}$. The increase of carbon stocks mainly happened in

the closing of non-forest land in form of shrub swamp.

The carbon emission was caused by the reduction of primary dryland forest, if the economic value was using the approach that each hectar of dryland is able to store or absorb the carbon for 195.4 ton or equivalent to 716.5 12 t CO_2 e ha^{-1}. Referring to Pirard (2005) price of carbon (hypothetical price) is $ 12 ton CO2 e / ha, then the emissions occured caused the economic loss of US $ 374,669,400. Referring total economic valuation in Buol Regency in 2014 (US $ 28,638.45 ha^{-1}), this condition is equivalent to forest damage was 13,082.74 ha.

CONCLUSION

1. The area of forest cover in Buol Regency in 2011 was 287 213 ha, or approximately 75.03% of the total area . It has been reduced by 8406 ha (2.93%) compared to forest cover reduction in 2000. The forest reduction was 764.18 ha $year^{-1}$ or 0.27% $year^{-1}$.
2. Total carbon stocks (not including soil carbon reserves) throughout the land cover in Buol Regency in 2011 reached 54,696.32 Gton C. The carbon stocks has been reduced by 24,22.58 Gton C or the average was 220.23 Gt C $year^{-1}$, compared to the carbon stocks in 2000.
3. The estimated total economic value of Buol Regency of US $ 28,638.45 per hectare per year was calculated by summing the direct use value (USD $ 531.12 per hectare per year), indirect use value (USD $ 12,552.88 per hectare per year), and non--use value (USD $ 15,554.45 per hectare per year). The economic value reaches 204% of the reference value.
4. The economic losses caused by the carbon emissions, referring to Pirard D (2005) is a US $ 374,669,400.

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