Watershed and Water Resources Management in Indonesia

An Overview of Forest Degradation and Present Situation of Water Resources Supply and Efficient Utilization for Human Survival and Bioproduction[1)]

Hendrayanto[2)]

INTRODUCTION

The total area of Indonesia is estimated about 5,193,250 km^2 and the sea territory is about 3,166,163 km^2. Indonesia is an archipelago nation consisted of about 17,508 islands with five main islands and some 30 smaller islands.

The climate of Indonesia mostly is tropical humid climate characterized by two seasons, the dry and rainy season. The monsoon type climate changes approximately every six months, where the dry season is from June to September and the rainy season from December to March, although in recent years weather patterns have been somewhat disrupted [11].

Indonesia is blessed with abundant rainfall and has approximately 6 percent of the world's fresh water resources equivalent to about 2,500 km^3 of annual renewable water resources. However the rainfall transformation into run-off become increasing by time due the decreasing function of land system to regulate the appropriate water balance. Recent situation figures about 60% of the rainfalls become run-off water [17].

In the past, the landscape of Indonesia mostly is covered by natural rain forest as the climatic climax forest which is characterized by high vegetation density, multi canopy stories, high organic matter decomposition, high bio diversity, high economic and ecology values, but actually high risk for environment when it is utilized. In the climax stage, natural rain forest regulates the water balance optimally in term of economic utilized water. Water is available appropriately in quantity and quality within the years for many purposes.

Population growth with the annual rate (1990-2000) of 1,49% reach up the Indonesia population of about 206,264,595 people in 2000 [1] causes increasing the needs of water,

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[2] Laboratory of Forest Influence, Department of Forest Management, Faculty of Forestry, Bogor Agricultural University (IPB) Bogor, Indonesia.

but this increasing needs ironically followed by the decreasing of water availability especially in term of quality and timing which are caused by the individuals and in grouped human behaviors and accelerated by the behavior of government policies which is actually hoped to regulate the individuals and groups behavior to create the appropriate water supply-demand balance, but in facts many cases reversibly toward decreasing water supply.

Population growth also increases the need of land which push the forested lands are converted into other land uses. Conversion of natural rain forest into monoculture forest plantation, settlement, annual crop fields, etc. without considering the land capability reduces the function of land system for water balance regulation which shift water balance component, where the number of run-off water increasing while the infiltrated water decreasing. This causes the frequent severe flood and drought, that mean, the amount of available or utilized water is decreasing. In other hand the available water is utilized inappropriately. Water is utilized without control, limited waste (used) water treatment, and polluted by liquid and solid waste disposal.

This paper presents the forest degradation in relation to present situation of water resources supply, and water utilization for human survival and bioproduction in Indonesia and the role of agro–environmental education.

FOREST DEGRADATION

Indonesia as recently as 1950 was still densely forested (Table 1). Forty percent of the forests existing in 1950 were cleared in the following 50 years. In round numbers, forest cover fell from 162 million ha to 98 million ha. The rate of forest loss is accelerating. On average, about 1 million ha per year were cleared in the 1980s, rising to about 1.7 million ha per year in the first part of the 1990s. Since 1996, deforestation appears to have increased to an average of 2 million ha per year (Table 2). Forests have been almost entirely cleared in Sulawesi and are predicted to disappear in Sumatra by 2005 and Kalimantan by 2010 if current trends continue [3].

Table 1. Forest Cover in 1950 (thousand ha)

Island	PRF, PF, SWF, P	Tidal Forest	Secondary Forest	Total Forest	Savana, Grassland & Non-irrigated Rice Fields	Irrigated Rice Fields	Total Land Area
Sumatera	33,400.0	570.0	3,400.0	37,370.0	8,600.0	900.0	46,900.0
Kalimantan	47,500.0	700.0	3,200.0	51,400.0	3,500.0	—	54,900.0
Sulawesi	14,700.0	50.0	2,300.0	17,050.0	2,600.0	—	19,700.0
Maluku	6,9000.0	—	400.0	7,300.0	1,300.0	—	8,600.0
Irian Jaya	38,400.0	2,300.0	—	40,700.0	300.0	—	41,000.0
Jawa	4,400.0	70.0	600.0	5,070.0	4,100.0	4,100.0	13,300.0
Bali/Nusa Tenggara	3,000.0	—	400.0	3,400.0	5,600.0	300.0	9,300.0
Total	148,300.0	3,000.6	10,300.0	162,290.0	26,000.0	5,300.0	193,700.0
% of Total land Area	77%	2%	3.5 %	84%	13%	3%	100%

Source: Base on L.W.Hannibal, 1950, Vegetation Map of Indonesia, Planning Department, Forest Service, Jakarta, in: *Forest Policies in Indonesia. The Sustainable Development of Forest Lands* (Jakarta, Indonesia: International Institute for Environment and Development and Government of Indonesia, 1985). Vol. 3, Ch.4. (in: (FWI/GFW. 2002)

Notes: Numbers may not add due to rounding. - = zero or no data.

PRF: Primary Rainforest, PF : Protected Forest, SWF : Swamp and Wilderness Forest, P: Plantations

Table 2. Forest Area and Degradation, 1985-1997 (GFW estimates)

Island	1985			1997			Forest Change 1985-1997 (Ha)	Forest Change (%)
	Land Area (Ha)	Forest Cover (Ha)	Forest as % Land Area	Land Area (Ha)	Forest Cover (Ha)	Forest as % Land Area		
Sumatera	47,581,650	22,938,825	48	47,574,550	16,430,300	35	- 6,508,525	- 28
Jawa	13,319,975	1,274,600	10	13,315,550	1,869,675	14	595,075	47
Bali	563,750	96,450	17	563,150	76,700	14	- 19,750	- 20
Nusa Tenggara	6,645,625	686,775	10	6,639,925	450,450	7	- 236,325	- 34
East Timor	1,498,500	374,400	25	1,497,525	9,850	1	- 364,550	- 97
Kalimantan	53,721,675	39,644,025	74	53,721,225	29,637,475	55	- 10,006,550	- 25
Sulawesi	18,757,575	11,192,950	60	18,753,025	7,950,900	42	- 3,242,050	- 29
Maluku	7,848,175	5,790,800	74	7,846,600	5,820,975	74	30,175	1
Irian Jaya	41,405,500	35,192,725	85	41,403,850	33,382,475	81	- 1,810,250	- 5
Total	191,342,425	117,191,550	61	191,315,400	95,682,800	50	- 21,562,750	- 18

Source: 1985 forest area are GFW estimates based on UNEP-WCMC, "Tropical Moist Forest and Protected Areas: The Digital Files Version 1." (Cambridge: World Conservation Monitoring Centre, Center for International Forestry Research, and Overseas Development Administration of the Unitied Kingdom, 1996), 1997 forest area are GFW estimates based on the digital dataset developed by the Ministry of Forestry, Government of Indonesia and the World Bank (Jakarta, Indonesia: GOI and World Bank, 200). CD-ROM.

Notes: The apparent increase in forest area in Java between 1985-1997 is probably owing plantation establishment. The poor quality of the spatial data for plantation in Java did not allow verification of this assumption. For further information on calculation of forest area and problem associated with "no data" areas, see Annex 3: Technical Notes, Table 2.3. (In: (FWI/GFW. 2002).

Decreasing forest coverage was pushed by government policies and forest management practices that neglected or less considered the sustainability of land production and functions. It has been occurring rapidly since the implementation of forestry policy to exploit the natural forest resources in the seventies. In this era, Indonesia with the assistance from foreign companies (the involvement of the companies was possible due to Foreign Investment Law in 1967) has become the biggest log exporter in the world. In 1983, 560 private companies held the Forest Concession for about 65.14 million ha of the forest area, exceed the total area of production forest as allocated in the Forest Land Use Allocation. Forest degradation in Jawa

was occurred long time before that policy implemented, that was begun in 19-century when the colonial government opened the forest to be converted into large estate.

Log export restriction policy introduced by government in 1980 to promote plywood industry development was successful and Indonesia become the biggest producer in the world for plywood and fulfills 75% of the world market demands at the time. However, forest resources overestimate, weaknesses in the management and law system, and the plywood industries overcapacity caused even higher acceleration rate of primary forest exploitation [6].

The policy to establish the industrial timber plantations (HTI) as a means of supplying Indonesia's booming demand for pulp and taking pressure off natural forests. Nearly 9 million ha of land, much of it natural forest has been allocated for HTI. This land has already been cleared or will be cleared soon. Yet only about 2 million ha have actually been planted with fast-growing species, mostly *Acacia mangium* to produce pulpwood. The implication: 7 million ha of former forest land are lying idle [3].

By the end of 1997, nearly 7 million ha of forest had been approved for conversion to estate crop plantations, and this land has almost certainly been cleared. But the area actually converted to oil palm plantations since 1985 is about 2.6 million hectares, while new plantations of other estate crops probably account for another 1-1.5 million ha. The implication: 3 million ha of former forest land are lying idle [3].

The transmigration program that relocated people from densely populated Jawa to the outer islands was responsible for about 2 million ha of forest clearance between the 1960s and the program's end in 1999. In addition, illegal migration and settlement by pioneer farmers at the margins of logging concessions, along roads, and even in national parks has greatly accelerated since 1997. Small-scale farmers through shifting cultivation practices are estimated be responsible for about 20 percent of forest loss about 4 million ha between 1985 and 1997 [3].

Large-scale plantation owners have turned to the use of fire as a cheap and easy means of clearing forest for further planting. Deliberate fire-setting, in combination with unusually dry conditions caused by El Niño events, has led to uncontrolled wildfires of unprecedented extent and intensity. More than 5 million ha of forest burned in 1994 and another 4.6 million

ha burned in 1997-98. Some of this land is regenerating as scrubby forest, some has been colonized by small-scale farmers, but there has been little systematic effort to restore forest cover or establish productive agriculture.

Numerous forest-dependent communities, sensing the weakening of central power, have erupted violently against logging and plantation operations that they consider to be plundering their local resources. Longstanding problems of unclear land tenure rights are the root cause of many such conflicts. The government is no longer willing to protect corporate interests as it once did, but neither does it appear to have any coordinated plan for dealing with the problem.

Indonesia is moving rapidly toward a new system of "regional autonomy," but the provincial and district governments that will benefit from decentralization are largely without the capacities or funds needed to govern effectively. Raising short-term revenue will be a top priority and, as a result, intensified exploitation of forest resources is already occurring in many regions.

WATER SUPPLY

Water supply in a region (watershed) for a certain purpose is determined by the amount of water input (precipitation) and the watershed function to transform precipitation into utilized water that fulfill the requirement of that utilization purpose, quantity, quality and timing of availability.

The watershed function in precipitation transformation is strongly influenced by the land use and management. Many researches show forest degradation, and inappropriate soil conservation practices to influence directly on the water supply decreasing. To figure the effects of the deforestation explained above on water supply quantitatively in Indonesia is hard, due the lack of climatic and hydrological data.

A figure of decreasing water supply analyzed from long-term rainfall and river discharge (1896-1994) of the Upper Citarum Watershed (6,000 km^2) indicated the decline of the annual rainfall at a rate of 10 mm/yr, accompanied by 3 mm/yr reduction in basin run-off and increased fluctuation of extreme events [13]. Present condition of watershed hydrology in

Indonesia is characterized by frequent occurrence of extreme flood and drought, high sediment/pollutant loads in the water bodies. The changes of land covers and its management of watersheds affect not only the long-term hydrologic regime but also the precipitation amount and pattern [14, 15].

Ministry of Settlement and Regional Infrastructure figures the availability of water in Indonesia as the total amount of river water discharge of about 1,957 million m3 which is distributed unequally spatially and temporally. More than 83% is concentrated in Kalimantan, Papua, and Sumatera islands, and about 17% in Jawa, Sulawesi and Nusa Tenggara where densely populated. About 80% available in wet season (5 months) and 20% in dry season (7 months) [10].

Based on that water availability, the national water needs for domestic utilization, industrial, and agriculture could be fulfilled, even for the year 2020 (constant water supply with increasing water needs based on population growth) but actually there are some regions deficit (Jawa, Bali, and Nusa Tenggara) and the other surplus [10].

The figure of the global quantitative water availability actually does not figure the accurate situation of water supply without considering the water quality, and management especially in water distribution. Recent facts from the news, the deficit of water frequently occurs almost in the whole country. Every year, the draught is often followed by flood. In some cities the people often difficult to get the health water even in the wet season. Jawa island in 1995 and 2000 deficit water of about 32.347 and 52.809 million m^3 respectively, and in 2015 the deficit is predicted of about 134.102 million m^3 [12].

Number of reservoirs (lakes) in Jakarta-Bogor-Depok areas is decreasing from about 218 in 1970 to less than 100 in 2003. Sedimentation rate in the big lakes are very high reducing the storage capacity. Sentani Lake in Papua since 1999 silting up of about 5 m/yr, Tondano Lake in Sulawesi, the deepest level in 1970 was 50 m, now only 10 m [2].

Big cities experienced severe ground water level decreasing. In Bandung city, intermediate ground water level (< 150 m) decreases 0.12-8.76/yr, while deep ground water level (> 150m) decrease 1.44-12.48 m/yr. In Jakarta (the areas around Cengakareng, Grogol, Cempaka Putih, and Cakung), ground water level decrease of about 17 meter. In other

regions of Jakarta, decreasing ground water level forms a cone, where the deepest point reach 40-50 m below sea level. The area of cone increase by time. The land subsidence almost occur in whole area of Jakarta of about 10-100 m. In Semarang, Middle Jawa, and Nganjuk, East Jawa the gorund water level decreasing is about 2 m/yr and 1-5 m respectively especially in dry season [2].

Spring discharge is also decrease. Spring discharge utilized by PDAM (Municipal Water Supply Enterprises) Bogor up to 2001, decrease 4–15% [16].

WATER UTILIZATION

Water utilizations are categorized as agricultural, domestic, and industrial uses. Water used for irrigaton in 1990 was about 74.9 $x10^9$ m^3/yr and increase by year of about 6.7%. For domestic and industrial uses were 3.1 $x10^9$, and 0.7 x 10^9 m^3/yr respectively and increasing need per year estimated of 6.7%, and 12.5%. [2].

Irrigation

Total area of irrigated paddy fields in Indonesia is 4.14 million ha. That is about 91% of total developed tersiery areas (4.529.292 ha). Comparing to potential irrigated areas (7.59 million ha), ratio of irrigated area and its potential is about 54%, but if it is compared to irrigated command areas (12.335.823 ha), the percentage of irrigated area is only 34% (Ministry of Agriculture, 2003 [9]). Those data shows the efficiency of water utilization of developed irrigation infrastrcture/network is low.

Domestic

Most of households utilize water for domestic uses originated from shallow ground water(74%), the rest are from river (3,4%) and other (1,4%). The percentage of households in water utilization for domestic use based on water sources is presented in Tabel 3. Those figure is excluded the housholds supplied by piped water from PDAM (Municipal Water Supply Enterprises). At the end of 1994, only 36 percent of Indonesia's urban population of about 67 million had access to piped water. Water supply of PDAM is derived from surface water sources (60%), springs (25%), and ground water (15%) [8].

Tabel 3. Household percentage in Water Utilization for Domestic Uses 2002

No.	Region	Water Source			
		Ground *)	River	Rainfall	Other
1.	Sumatera**)	70,24	5,28	7,20	1,04
2.	Jawa	80,52	0,67	0,40	1,69
3.	Bali	47,84	2,06	2,06	2,45
4.	Nusa Tenggara	75,63	3,35	3,35	0,54
5.	Kalimantan	27,87	27,89	27,89	0,67
6.	Sulawesi	71,73	2,43	2,43	0,94
7.	Maluku	-	-	-	-
8.	Papua	55,70	18,44	18,44	0,00
TOTAL		74,21	3,42	2,78	1,42

Source: BPS-Statistic Indonesia, 2000 *in* Kementerian LH, 2003
Notes: *) Shallow ground water and spring **) Nangroe Aceh Darussalam Province excluded

Industry

Industries mostly utilize the ground water. This is due low quality of surface water to fullfill the industrial water quality requirement. Water use for Indistries is relatively small compare to agricultural and domestic use, but the increasing and uncontroll ground water use for industrial causes the decreasing of ground water level and land subsidence [2].

BIOPRODUCTION

Indonesia experienced as a food/rice self sufficience country in 1984. Although in arround that years, Indonesia was being lossing other bio-production through abundant timber harvesting. In the following years of the food/rice self sufficience year, Indonesia's bioproduction decreasing and now become the big agricultural products importer country. Land use changes regionally and globally caused anomally regional and global climate changes. Anomally climate occured in 1991 and 1994 forced Indonesia to import rice of 600.000 ton and more than 1 million ton respectvely [4]. Tabel 4 shows the paddy field areas influenced by climatic and hydrologic behavior which is believed correlated to the regional and global land use changes.

WATERSHED AND WATER MANAGEMENT

Watershed resources management requires an integrated and comprehensive approaches. Top down policy without involved the stakeholders in watershed resources management often results less comprehensive and partial approaches, further result less effective (failure) and inefficient works.

Table 4. Paddy Field Areas Influenced by Flood and Drough, and Idle area in 1988-1997 [7, 18]

Year	Flooding	Drought	Idle	Notes
1987	***	430.170	***	El-Nino
1988	130.375	87.373	44.049	La-Nina
1989	96.540	36.143	15.290	Normal
1990	66.901	54.125	19.163	Normal
1991	38.006	867.997	198.054	El-Nino
1992	50.360	42.409	16.882	Normal
1993	78.480	66.992	47.259	Normal
1994	132.975	544.422	194.025	El-Nino
1995	218.144	28.580	51.571	La-Nina
1996	107.385	59.560	50.649	Normal
1997	58.974	504.021	102.254	El-Nino

The degraded land rehabilitation programs that was actually initiated since 1930 in Jawa, and more intensive since 1976 when FAO supported loan for Upper Solo Watershed Management and Upland Development project, and the availability of Aforestation and Reforestation Grant through Presidential Instruction No. 8/76, 1976 are more focused on direct reduction of surface run-off and erosion through physical measures approaches such as trees planting, terraces, check dams and other constructions development, but less attention to find and solve the root problems causes the deforestation and inappropriate land uses itself. Top down policy, where government deliver a package of a project without or less consider the needs of people resulted the grant dependency of people to rehabilitate the land, in many cases, the success story was only during the project period; during the post project periods people conducted the usual practices even destroyed the results of the project, due to the project content actually out of their interest. This approach also required abundant government fund, therefore the capacity to rehabilitate degraded land is much less than the degradation rate, and low success story of projects result the rate of land degradation is still increasing, even accelerated.

The weakness or unavailable incentive system that provides reward for the success agents and punishment or disincentive for the fail, or attractiveness scheme to practice agricultural conservation are needed more attention to create the initiatives to protect/maintain productive land and rehabilitate the degraded land.

The development of water supply infrastructures and water (bodies) management also often run in partial way without considering the sustainable programs for maintenance and

rehabilitate the upland that hard influence the water and its infrastructure to store and distributions of water. Considering the fiscal constraints, GoI has initiated to set up water service fee based on the economic good principle rather than the currently active socio-political concept that treats water as a public good [5]. Potential fees generated from water uses are not schemed clearly yet to possibly cross administrative boundaries funding system in the watershed management framework.

THE ROLE OF AGRO-ENVIRONMENTAL EDUCATION

Agro-environmental education is necessary and important to understand the ecosystem behavior in relation to resources utilization to produce bio-products. Agro-environmental education is necessary and important to be delivered to everyone since beginning, formally in school or informal delivery through extra curricular activities. Formal education in elementary school till senior high school is still limited to Basic Natural Science, less focus on agricultural practices related to human life, and less practical education to introduce or identify the “real world” through for example out door activities. In the higher education, especially in the undergraduate levels and master degree where the graduates are prepared to be a middle manager or to share in decision making, fragmentation among natural processes approaches in one side and social (economy, policy) approaches cause less comprehension in understanding the underlying factors of a natural phenomena. This situation is easy to identify the policy content on a natural phenomena. A technocrat with less background in social knowledge will simply decide to solve the natural phenomena by introducing the technical approach. In the situation where the specialists are coordinated well, then the understanding of a phenomena and solving the problems could be better.

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