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Status and efforts of conservation on biodiversity of inland waters in Indonesia: A review

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Abstract

Based on the distribution of the world biodiversity, Indonesia is often called mega-biodiversity region, i.e. a region with the highest biodiversity in the world. Constituting just 13 percent of the world's total land area, Indonesia is home to 17 percent of all species on the planet, comprising at least 35,000-40,000 plant species (11-15 percent), 707 mammal species (12 percent), 350 amphibian and reptile species (15 percent), 1,602 bird species (17 percent) and 2,184 freshwater fish species (37 percent).However, Indonesia is also recognized as a biodiversity hotspot, referring to its high endemism but with high rate of biodiversity lost as well. In context of inland freshwater, threats to biodiversity include: habitat degradation and fragmentation, consumption/over-exploitation, pollution, invasive alien species, and climate change. The Government of Indonesia has set policies, laws, and programs, to address the issues of biodiversity. This paper aims to evaluate the protrection efforts in order to see the recent state of the freshwater biodiversity.The authors find that the freshwater biodiversity loss seems to continue unabated indicating that the efforts of national biodiversity protection are not effectively implemented.

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Introduction

Global biodiversity and its loss have been receiving a strong attention from international parties since decades back. Such concern was driven by the awareness that biodiversity underpins the functioning of the ecosystems on which we depend for food and fresh water, health and recreation, and protection from natural disasters (CBD, 2010). Its loss also affects us culturally and spiritually. Through international convention, the parties pointed out the importance of (i) consciousness of the intrinsic value of biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components, (ii) affirmation that the conservation of biological diversity is a common concern of humankind, and (iii) reaffirmation that States are responsible for conserving their biological diversity and for using their biological resources in a sustainable manner (CBD, 1992).

Indonesia is one of the "megadiverse" countries but unfortunately also listed as one of the biodiversity hotspots, i.e. regions that have at least 1,500 endemic plant species and which have lost at least 70 percent of their natural habitat. Hotspots situated in tropical countries struggle not only with biodiversity conservation issues(Kottelat and Whitten,1996), but also with the poverty and human development of the populations; local conservation efforts suffer from a shortage of funds and support (CEPF, 2014). Such complexity of problems in biodiversity protection has driven the Government of Indonesia to actively participate in international biodiversity convention, as well as set the national measures for biodiversity conservation. The inland water biodiversity is also a part of the Government of Indonesia's concern. Therefore, an evaluation on how the national policies and programs on biodiversity be down earthed and seeing the recent status of the inland water biodiversity is valuable.

Indonesia's Freshwater Biodiversity, Richness, and Values

People depend on freshwater biodiversity for a variety of resources. Various habitats provide a wide range of resources, as well as services such as transportation, supply of clean water, and energy (Kottelatand Whitten, 1996). Freshwater biodiversity provides a broad variety of valuable goods and services for human societies – some of which are irreplaceable (Covich *et al*., 2004a). The value of this biodiversity has several components (Fig. 1): its direct contribution to economy productivity (e.g. fisheries); its 'insurance' value in light of unexpected events; its value as a storehouse of genetic information; and its value in supporting the provision of ecosystem services (e.g. cleaning water) (Pearce, 1998; Heal, 2000; Covich *et al*., 2004b). The value of inland waters is bound to increase as ecosystems become more stressed and their goods and service scarcer (Dudgeon *et al*., 2005).

Indonesia is often called mega-biodiversity region, i.e. one with the highest biodiversity in the world (IBSAP, 2003). The term of biodiversity generally refers to abundance and the variety within and among fauna and flora, as well as the ecosystems and ecological processes to which they belong, and is thus usually considered at ecosystem, species, and genetic levels.

Such wealth of biodiversity was resulted from its geographical position as tropical region which is located between two continents (Asia and Australia) and two oceans (Pacific and Indian). Indonesia possesses a very rich and unique biodiversity with its complex interactions as result of the upheaval of Asian and Australian plates (Metcalfe *et al*., 2001). Indonesia alone supports about 15% of the world's species and has more amphibians and dragonflies than any other country (Braatz *et al*., 1992). Indonesia constitutes just 1,3% of the world's total land area; home to 17% of all species on the planet, comprises 35.000 – 40.000 plant species (11-15%), 707 mammal species (12%), 350 amphibian and reptile species (15%), 1602 bird species (17%), and

2.184 freshwater fish species (37%) (LIPI, 2012). The number of freshwater fish species (1,300) is second largest after Brazil (3,000 species) (Kottelatand Whitten, 1996). Indonesia is listed as one of the ten countries with the richest freshwater fauna world-wide.

Freshwater biodiversity is a component of 'wetlands' in the sense of the Ramsar convention in which 'wetlands' is defined broadly as areas of marsh, fen, peatland, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters. The wide areas of fresh water make it habitats for wide variety of fauna and flora. Animal species are considerably more diverse and numerous in inland waters than plants (WCMC, 1998).

More than half of all freshwater vertebrate species are fish, and more than 8,500 species (40 percent) of the 2,500 known fish species exist in freshwater. Unfortunately, their distribution and systematic are still poorly understood (WCMC, 1998). Being highly localized, however, lakes, rivers, or streams harbor unique, evolved forms of life. Some of the ancient lakes can have extremely high levels of endemism and spectacular species diversity.

Freshwater systems inhabited by different animal and plant communities can be classified into different ways, e.g based on their gross geomorphological features, such as: spring, hill streams, headwaters, rapids; freshwater swamp forest and small streams in lowlands and foothills; large rivers, riverine lakes, and flood plains; estuaries; and lakes (as example see Table 1).

Table 1. Ecosystem Diversity: Asian Lakes with exceptional freshwater biodiversity interest(See Kottelat and Whitten, 1996).

Ecosystem	Country	Biodiversity features
Lakea in Yunnan	China	Large numbers of endemic fishes and invertebrate
Malili Lakes (Matano, Towuti, Wawantoa)	Sulawesi, Indonesia	2 endemic fish genera, 26 endemic fish species (including 15 of the 17 known species of Telmatherinidae), in addition to 1 snake, 3 crabs, about 10 shrimps, some 60 molluscs, 1 macrophyte, possibly sponges and water mites
Lake Poso	Sulawesi, Indonesia	1 endemic fish genus, 7 endemic fish species, numerous endemic invertebrates
Lake Lindu	Sulawesi, Indonesia	1 endemic fish species
Lake Tondano	Sulawesi, Indonesia	1 endemic fish genus
Lake Sentani	Irian Jaya, Indonesia	2 endemic fish species
Lake Biwa	Japan	3 endemic fish species, as well as endemic snails, molluscs, and plankton
Lake Inle	Burma	9 endemic species and 3 endemic genera of fishes
Lake Rara	Nepal	3 endemic fish species
Lake Kutubu	Papua New Guinea	11 endemic fish species
Lake Lanao	Mindanao, Philippines	2 endemic fish genera, 18 endemic fish species

The general types of organisms found in each habitat will be similar among the different areas of Asia but the faunal assemblages will be distinct. But, unlike the ephemeral riverine lakes, ancient lakes are often of tectonic or volcanic origin, and are geographically isolated.

Several lakes host particular fish communities with species specialized to occupy the pelagic habitat (Kottelatand Whitten, 1996).

Freshwater in Indonesia classified into: natural swamp, lake, and river. The Directorate of Management of Water Resources,

Ministry of Public Works (MoPW) (2007) mentioned that swamp area in Indonesia reached 33.4 million ha or 20.56% of the total area of land. The island of Papua has the largest swamp in Indonesia that reaches almost 5 million ha with only 84 swamps. Indonesia also has peat swamp. Tropical peat swamp forest is a unique ecosystem that is most extensive in Southeast Asia, mainly Indonesia. These swamps were formed from the accumulation of peat moss material derived from organic remains of plants or natural vegetation from the past. It harbors significant and highly specialized biodiversity, but this has yet to be comprehensively assessed. Peat swamp provides shelter to many rare species such as Sumatran tiger, Orangutan, Arowana fish, and Sinyulong crocodile, also as sources of life for the people. In the swamp, there are different types of timber species such as Ramin (*Gonystylus* spp), Cajuputi (*Melaleuca* spp.), Jelutung (*Dyera costulata*), and Swamp Meranti (*Shorea*spp.) that have high economic values and can be used by communities to support their income. In Kalimantan landscape, peat swamp forest is a unique feature where they cover from 8% to 11% of the area lowlands (McKinnon and Artha, 1981). They are most abundant along the lower reaches of the Barito River and other south flowing rivers around the lakes of the Kapuas and Mahakam Rivers (Re PProt, 1990). These swamps support a distinctive forest formation but are rather depauperate in flora and fauna (Anderson, 1972). Unfortunately, there is still no consensus on the precise extent and condition of tropical peat lands, as accurate delineation of peat soils without ground-truthing is difficult, and many areas have already been lost or degraded (Joosten, 2004).

Table 2. Summarizes species diversity and endemism in Wallace.

Taxonomic Group	Total # od Species	# of Endemic Species (%)	# of Threatened Species (%)
Dragonflies			7
Amphibians	48	33 (68)	8 (17)
Freshwater Fishes	250	50 (20)	37 (15)
Decapods			32
Calanoida (Copepods)			1
Molluscs			2
Coral	450	few	176 (39)
Marine Bivalves			2
Marine Fishes	2,112	110 (5)	54 (2)
Sea Cucumber			10

Indonesian freshwater threats

Freshwater ecosystems may be the most endangered ecosystems in the world. Declines in biodiversity are far greater in fresh waters than in the most affected terrestrial ecosystem (Sala *et al*., 2000). The main reason is the disproportionate richness of inland waters as a habitat for plants and animals. Over 10.000 fish species live in freshwater (Lundberg *et al*., 2000); approximately 40% of global fish diversity and one quarter of global vertebrate diversity. Yet surface freshwater habitats contain only around 0.01% of the world's water and cover only about 0.8% of the Earth's surface (Gleick, 1996).

Freshwater systems offer fewer chances for biodiversity to adjust to environmental change, since they are relatively discontinuous and offer less opportunity for species to disperse when conditions become unfavorable. Consequently, freshwater biodiversity is extremely sensitive to environmental disturbance. As consequence, the importance of protecting freshwater habitats is correspondingly high. Even in wide-ranging reviews of biodiversity, freshwater biodiversity is often largely ignored.

The threats to global freshwater biodiversity can be grouped under five interacting categories: overexploitation; water pollution, flow modification; destruction or degradation of habitat; and invasion by exotic species (e.g. Allan and Flecker, 1993; Posteland Richter, 2003; Revenga *et al*., 2005). Environmental changes occurring at the global scale, such as nitrogen deposition, warming, and shifts in precipitation and run off patterns (e.g. Poff *et al*., 2002; Galloway *et al*., 2004), are superimposed upon all of these threat categories. The combined and interacting influences of the five major threats categories have resulted in population declines and range reduction of freshwater biodiversity worldwide (Fig. 2).

The threats faced by freshwater biodiversity in Asia are manifold and pervasive. There are cumulative and synergistic effects, and tolerance to one factored may be lowered by a stress resulting from the presence of another factor. A major problem in managing freshwater ecosystems in the region is the lack of knowledge of how the various human-induced changes affect aquatic life (Kottelat and Whitten, 1996).

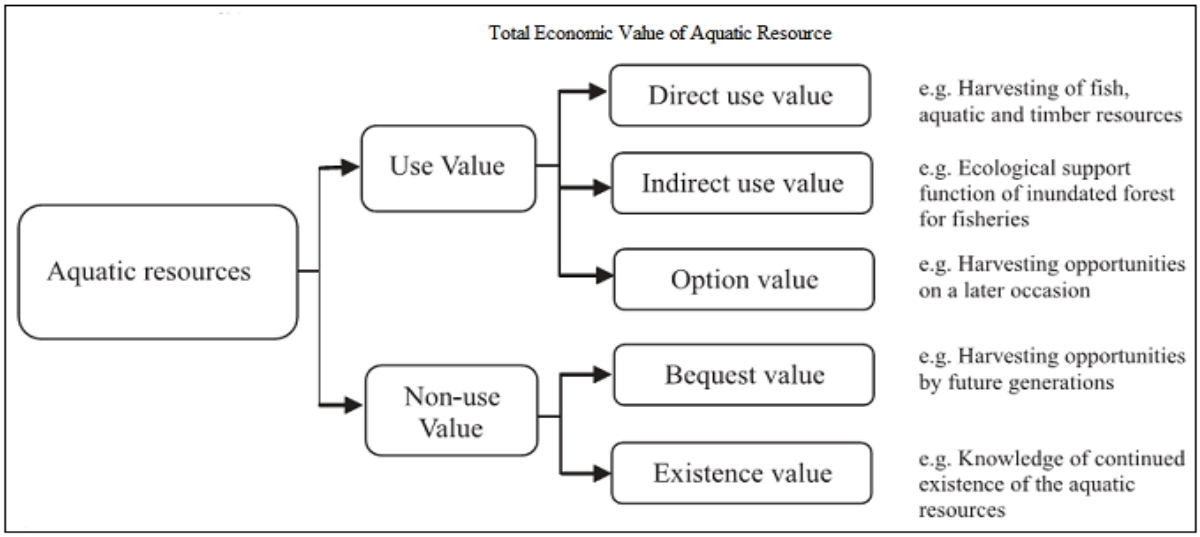

Fig. 1. Value of freshwater biodiversity.

Indonesia is one of the hotspot regions, i.e. a region with high concentration of endemic species experiencing unusually rapid rate of habitat modification or loss. Hotspots situated in tropical countries (Fig. 3) struggle not only with biodiversity conservation issues, but also with the poverty and human development of the populations (Kottelatand Whitten, 1996); local conservation efforts suffer from a shortage of funds and support. Some threats to freshwater biodiversity in Indonesia include: habitat degradation and fragmentation, consumption/over-exploitation, pollution, invasive alien species, and climate change (e.g. Partasasmita *et al*., 2015). In 2013, the Wallacea hotspot in Indonesia and Timor Leste was selected by the CEPF Donor Council as eligible for funding.

CEPF defined the Wallace hotspot as the islands in the Indonesian archipelago and Timor-Leste between the Sunda and Sahul continental shelves. This region covers an area of 33.8 million hectares and comprises three biogeographic sub-regions: Maluku, Lesser Sundas and Sulawesi (CEPF, 2014).

The northern part of Wallace has a double-peaked wet season while the southern part is more monsoonal with a single rainy season and a long dry season.

There is, however, a local variation, especially on small islands with steep topography. El Nino Southern Oscillation (ENSO) cycles also affect the region, creating differences in the timing and quantity of the rainfall.

Although the effects of ENSO vary depending on local climatic patterns, all areas experience a delay in getting the rains, which has implications for food security and health (see CEPF, 2014).

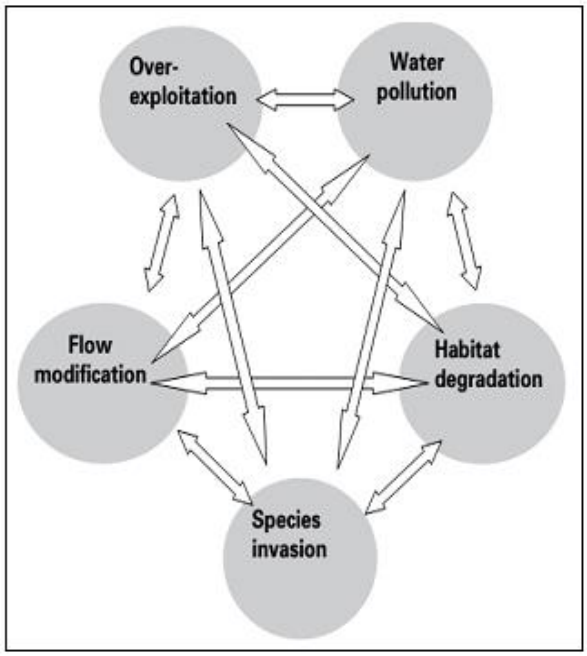

Fig. 2. The five major threat categories and their established or potential interactive impacts on freshwater biodiversity (Dudgeon *et al*., 2005).

Moreover, rivers in the region are typically short, steep and prone to extreme fluctuations in flow over the years. This situation can become severe in the Lesser Sundas where lakes are relatively few; most of them are of volcanic origin. Thus, water supply and the management of water catchment areas in small islands are critical factors for livelihoods and economic development. While there are not many lakes in Maluku, Sulawesi has 13 lakes covering more than 500 hectares, including the second and third largest in Indonesia (Towuti and Poso) and the deepest in Southeast Asia (Matano). These deep and isolated lakes support endemic fishes, shrimps and other fauna as a result of subduction and volcanic activity, the land area in Wallacea. Wallacea is home to 560 globally threatened species, 50 percent of all threatened species recorded from Indonesia (Table 2) (see CEPF, 2014).

Conservation outcomes as defined by CEPF are the entire set of conservation targets in a hotspot that need to be achieved to prevent species extinctions and biodiversity loss. The first step to identifying conservation outcomes is through the compilation of globally threatened species lists that are assessed by IUCN taxonomic specialist groups. IUCN classifies these species as critically endangered, endangered, or vulnerable. Species outcomes are the complete list of globally threatened species found in the hotspot.

Based on globally threatened species data compiled up to November 1, 2013, 560 species in Wallace were classified as threatened with extinction by IUCN in the critically endangered, endangered, or vulnerable categories. Thirty-five of which is classified as critically endangered by IUCN, twenty-six of them are endemic to the hotspot, and of these 13 are only known from one site. Of these threatened species, 308 are terrestrial or freshwater (Birdlife International, 2013).

CPEF (2014) has identified the threats to inland biodiversity. The direct driver of the main threats in Indonesia Wallace is grouped into two main categories. The first is over-exploitation of natural resources and the second category is habitat degradation, fragmentation, and conversion. Other additional categories that act as direct drivers are pollution, erosion, and sedimentation; invasive species, and climate change. Pollution and sedimentation are particular problems of aquatic ecosystems. Indirect drivers of biodiversity loss for both terrestrial and marine habitats include a set of regulatory issues (absent, inappropriate and poorly enforced regulation), capital-intensive economic development (plantation, industrial forestry and mining, supported in some cases by subsidies and global demand for commodities), and increased intensity of small-scale resource use (driven by increased population pressure, changing technology, monetization of traditional economies, and weakening of the customary regulation of resources).

Effort for freshwater biodiversity conservation in Indonesia

A mixture of strategies will be essential to preserve freshwater biodiversity in the long term. It must include reserves that protect key, biodiversity-rich water-bodies and their catchments, as well as species- or habitat-centered plans that reconcile the protection of biodiversity and societal use of water resources in the text human modified ecosystem. In parallel, appreciating the value of freshwater biodiversity is essential to ensure its well-being. It is certain that if scientists are unwilling or unable to place a value on 'free' ecosystem goods and services, then politicians and policy-makers will interpret this as 'zero value'. The resources apt to be protected are those that are appreciated. Water must no longer be a free or cheap resource- as it is still treated in most countries (Kingsford, 2000; Clark and King, 2004). Realistic economic valuations of water as a habitat for freshwater biodiversity, and the services that such biodiversity provides will be an essential driver of any change in societal attitudes (Posteland Carpenter, 1997; Clark and King, 2004). The effectiveness communication between scientist-stakeholders-policy makers on the importance and value of freshwater biodiversity would make certain that all available information on freshwater biodiversity is applied effectively to ensure its conservation.

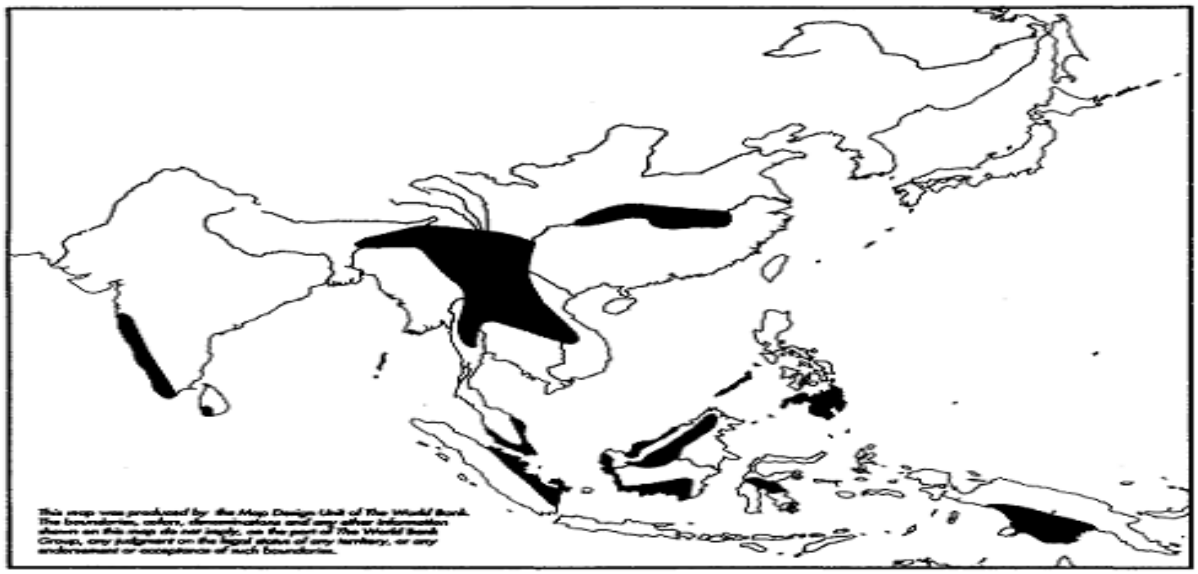

Fig. 3. Hotspots' for freshwater biodiversity in Asia, based mainly on fishes.

Indonesia has many policies and programs to conserve freshwater biodiversity in Indonesia. One of policy is to protect native biodiversity; the government issued Minister of Agriculture Degree No. 179/Kpts/Um/3/1982 which prohibited the import of 37 and the export of 10 fish species. The fish species banned from entering Indonesia were generally deemed dangerous because of their invasive nature, whereas the majority of fish species prohibited from export was classified in the genus *Anguilla* spp.

The Indonesia government also has shown a strong commitment to biodiversity conservation through the ratification of international agreements, such as the Convention on Biological Diversity, the United Nations Forum on Forests, the Convention on International Trade in Endangered Species (CITES), and UNESCO's Man and the Biosphere (MAB) Program. There are four conservation areas in Indonesia designated under multilateral agreements in Nusa Tenggara and Sulawesi. Indonesia committed to two regional agreements that significantly support the biodiversity conservation in the hotspot: The Coral Triangle Initiative and the Association of Southeast Asia Nations (ASEAN).

Biodiversity action plan for Indonesia (BAPI)

In 1993 the Government of Indonesia through the National Development Planning Agency (BAPPENAS) produced the Biodiversity Action Plan for Indonesia (BAPI) (BAPPENAS, 1993). The document was published prior to the ratification of the UN Convention on Biodiversity (CBD) on August 1st 1994. BAPI (1993) prioritized in-situ conservation measures, both inside and outside protected areas, and ex-situ conservation, with four main activities as follow: 1) In-situ conservation in national parks and terrestrial areas; 2) In-situ conservation outside protected areas, including forest, wetland and cultivated areas; 3) Conservation of coastal and marine resources.

Indonesia biodiversity strategy and action plan (IBSAP)

A new national biodiversity strategy and action plan named in 2003 and renewed in 2015 (BAPPENAS, 2003, 2016). There are five important things in IBSAP: 1) To encourage changes in attitude and behavior of the Indonesian individuals and society, as well as, the existing institutions and legal instruments, to be more concerned with conservation and utilization of biodiversity for the welfare of the community, in harmony with national laws and international conventions; 2) To apply scientific and technological inputs, and local wisdom; 3) To implement a balanced conservation & sustainable use of biodiversity; 4) To strengthen institutions and law enforcement; 5) To resolve conflicts over natural resources.

Integrated lake basin management (ILBM)

The ILBM in Indonesia has started and announced on the first National Conference of Indonesia lakes, in Bali 13th August 2009. The Minister of Environment, Home Affairs, Public Works, Agriculture, Energy and Mineral Resources, Research and Technology, Maritime and Fisheries Affairs, Culture and Tourism, and Forestry committed on Lake Sustainable Management, which then called Bali Agreement. This Agreement consisted of 7 programs for 15 lakes priority: 1) The use of lake resource has to be based on deeply scientific and technological analysis their impacts; 2) The development of lake monitoring, evaluation and information systems; 3) Preparation of adaptation and mitigation steps the impact of environmental changes to the lakes; 4) The development of capacity; 5) Regulation and coordination; 6) Improvement of community involvement; and 7) Sustainable funded (Soeprobowati, 2012).

Indonesia has a long history of impressive official policy statements on biodiversity conservation; the protection of biodiversity was first mentioned in the Protection of Wild Animals Ordinance in 1931. With all the efforts such as policies, strategies, and actions to conserve biodiversity freshwater in Indonesia, it is still not make Indonesia out from the crisis. There are few factors that have frustrated the effectiveness implementation of those policies such as inconsistency between policies and biodiversity conservation and lack of adequate funds. Indonesia's biodiversity conservation where freshwater biodiversity is part of this needs one big funding and strong institutional collaboration.

Conclusion

In conclusion, the inland water biodiversity protection in Indonesia is struggling to cope with the challenges. The effective implementation of policies, strategies, and programs of conservation will need a stronger commitment from the parties, concistencey, and adequate fund.

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