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Review

Challenges of Integrated Water Resources Management in Indonesia

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Abstract: The increased demands for water and land in Indonesia as a consequence of the population growth and economic development has reportedly have been accelerated from the year to year. The spatial and temporal variability of human induced hydrological changes in a river basin could affect quality and quantity of water. The challenge is that integrated water resources management (IWRM) should cope with complex issues of water in order to maximize the resultant economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems. Even though the government of Indonesia has adopted new paradigm for water resources management by the enactment of Law No. 7/2004 on water resources, the implementation of IWRM may face the technical and managerial challenges. This paper briefly reviews the implementation of IWRM and related principles and provides an overview of potential water-related issues and progress towards implementation of IWRM in Indonesia. The availability of water and a broader range of water-related issues are identified. The recommended actions for improving the future IWRM are suggested. Challenges to improve the capacity buildings of IWRM related to enabling environment, institutional frameworks and management instruments are verified to contribute to the future directions for efficient problem-solving ability.

Keywords: capacity building; Indonesia; integrated water resources management; sustainable development; water resources management authority

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1. Introduction

Population growth, urbanization, intensive agricultural development, industrial growth and environmental requirements are all increasing demands for water and land. The conversion of forest and agricultural lands to commercial and residential uses is leading to rapid transformation in agricultural production, spatial structure, social structure, land ownership and land market in the rural-urban fringe [1]. Many negative consequences of unbalanced environment such as water quality degradation, flood and drought, groundwater depletion, land subsidence, erosion and sedimentation as well as seawater intrusion are more likely to be generated from manmade objects. The negative impacts due to water pollution and its accompanied maladies are continuously jeopardizing the human health [2]. Integrated water resources management (IWRM) is now the dominant paradigm for water management in many developing countries, including Indonesia. The IWRM paradigm urges the government to involve stakeholders in each level of water management. The involvement of stakeholders to restore and maintain the natural stream flow regime of a river is a key part of building a sustainable water management initiative. The level of restored environment may also play a role in its future improvement [3].

The rationale for the IWRM approach has been accepted by many countries as the way forward for efficient, equitable and sustainable development and management of the limited water resources and for coping with conflicting demands. For example, the lessons learned from the French experience include the following: (1) IWRM at the level of river basins; (2) decentralization of water management; (3) participative management, involving all the stakeholders and the public; (4) application of the polluter-pays principle and the Water Agencies' role of economic mutualization; (5) local public responsibility for water supply and sanitation utilities; (6) experience feedback from the various methods used for managing water utilities, either managed by a public authority or by a delegated private company; and (7) transparency in the operation of services and information to the users [4]. The French experience illustrates the strengths of basin-level management and application of IWRM tools and concepts such as stakeholder consultation, economic instruments and appropriate regulation. A typical form of the participatory approaches should be effective in promoting the comprehensive plans for utilization, conservation, development and improvement of water resources. The integrated approach to water resources management advocates creating and empowering basin-level organizations (Water Agencies) to direct water management efforts in a hydrological boundary. In France, the six Water Agencies are public institutions of the Ministry for sustainable development and can have significant underlying financial requirements and challenges of coordinating among divergent water users. The private sector can play a role in providing water services and should be allowed to bring its technical expertise and efficient management practices into areas where central government has struggled to provide sustainable service. The appropriate level of decentralization depends on the nature of the specific water management problems in question, but the IWRM seeks to strike a balance between top-down and bottom-up management. Since the 1995 Mekong Agreement, the concept of IWRM to involve the participation of four lower Mekong countries (*i.e.*, Cambodia, Lao PDR, Thailand and Vietnam) has been promoted for Southeast Asia. The goal behind this agreement was to introduce a systematic process for sustainable development, allocation and monitoring of water resource use in the context of social, economic and environmental goals. Guided by this sustainable development paradigm, the Lower Mekong River Basin states attempt to balance the maintenance of water quantity

with protection of water quality, and agree to cooperate and use the Mekong's water resources in a manner in which the river system's environmental conditions and ecological balance are conserved and maintained [5].

The Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy has been enacted since 2000 [6]. The implementations of IWRM according to such a water framework directive have been communicated for first stage towards sustainable water management in the European Union on March 2007 and then regarding programs for monitoring of water status in April 2009 [7]. Water law in the United States, which varies by region for both historical and geographic reasons, encompasses a broad array of subjects or categories designed to provide a framework to resolve disputes and policy issues relating to water [8]. In Indonesia, the implementation of IWRM needs for a participatory approach and is binding on a paradigm change, which obligates the government to reform the water resources policy (see Table 1). The most important milestone in implementing the IWRM principles and processes occurred by the politics of administrative reform is the enactment of Law No. 7/2004 on water resources [9,10]. Efforts such as the regulations, guidelines as well as short- and long-term plans issued by local and central governments could have been attempted to implement the IWRM as prescribed by the law [11,12]. Still, the procedural integration where an agreed set of protocols is used for all the aspects of IWRM must be verified to try and make all the information accessible in a standard or known format [13]. Commitment of stakeholders, from grassroots to top decision making executives and political leaders, is important in order to ensure successful implementation of IWRM approaches [2,14]. Given such the problems of drought, flood, water pollution, lands subsidence, erosion and sedimentation are unavoidable to put a special scrutiny in the first place and to launch a national movement campaign particularly for developing a sense of crises to the entire community. Therefore, capacity building in IWRM accounting for enabling environment, institutional frameworks and management instruments should be given a profound attention in Indonesia and seems like a good reason to start strategic planning implementation to IWRM [10].

The objectives of this study are as follows: (1) to briefly overview the water availability and water-related issues in Indonesia; (2) to evaluate the progress in implementing the IWRM plans including the biases and problems being inherent inefficiency of government bureaucracy; and (3) to describe and propose the recommended actions for capacity building in IWRM related to enabling environment, institutional frameworks and management instruments.

Table 1. Changing paradigms in water resources management in Indonesia.

Elements	**Old (1971–1998) and new (1998–present) paradigms and their implications in water resources management**			
	Old Paradigms	**Implication**	**New Paradigms**	**Implication**
Governance regime	Autocracy	Strong leadership character	Democracy	Participative leadership
Administrative rule	Centralization	Concentration on national administration	Decentralization	Domination by district and provincial administrations
Decision-making process	Top down	All decisions made based on administrator interests	Bottom up	All decisions made based on stakeholders aspiration
Budgetary system	Government allocation	Financial sources from debts offering by international institutions funding and government budget	Water users sharing participation	Financial sources from water users and water polluters pay principles and government budget
Role of water in regional development	Supporting factor	Risks to environmental imbalance	Limiting factor	Priority on water balance consideration
Management responsibility	Regional authority	Regionally economic development interests	River basin and regional authority	Sustainable development interests
Role of government in construction	Provider	Risks of corruption due to power authority	Enabler	Capacity building needs for strengthening government administration
Project setting up orientation	Partial approach	Regionally (or personally) economic development interests basis	Integrated approach	Environmental sustainability interests basis
Project interest	Supremacy instruction	To increase personal popularity	People aspiration	To solve water-related problems
Project preparation	Based on short term planning	Approved based on personal/local interests	Based on master plan	Approved based on comprehensive study

2. Water Availability and Seasonality of Indonesia's Climate

Despite the abundance of water resources, Indonesia has already experienced water shortages due to the variety of climates, geographical conditions and dry season. Total water demands to support population and economic growth for irrigation, domestic, municipal and industrial uses are currently at a flow rate of approximately 1074 m^3 s^{-1} while the availability of surface water during low-flow conditions at normal climate of years is at a flow rate of approximately 790 m^3 s^{-1}. The pattern of variations in climate from the year to year may affect water availability to an unequal extent hence it might be predicted that the water use is already highly constrained by unbalanced conditions of demands and the potential availability, particularly during dry season [15]. Competition for water during periods of low natural availability might be suggested that users may not have access to their full water supply requirements at all the time [16]. Growing the attention on the issues of economic and population growth development strategy is a result of the worsening environmental conditions in Indonesia today, due to the pace and pattern of growth in the past and the increasing awareness of the costs and risks of continued environmental degradation in the future [10].

3. Water-Related Issues

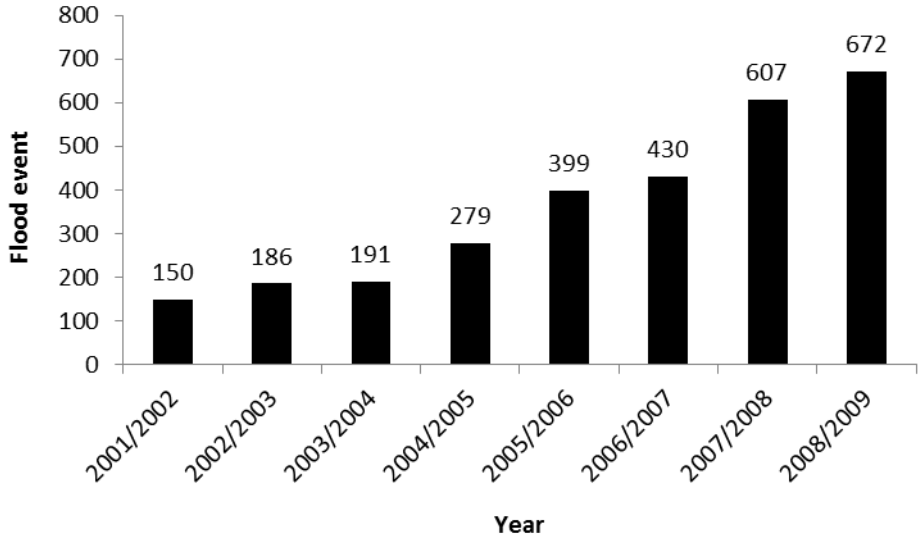
3.1. Floods

In Indonesia, earlier flood management plans mainly focused on the improvement of infrastructure, to address inadequacies for flood prevention. As has been identified, Indonesia has about 5,590 main rivers; among them, 600 rivers have the worst impact on social and economic conditions [17]. To structurally mitigate flood hazard impact on these 600 rivers are required for about 30,000 km river training and 15,000 km dike. However, the capacity of the government in term of budget availability to develop the river trainings and dikes is about 300 km and 150 km, respectively; therefore, it needs to be approximately 100 years of flood hazard mitigation [10]. The remarkable fact is that the importance of these structures seems to have been addressing the only part of the problems, which makes the result ineffective, or they are too ambitious, where socioeconomic feasibility is usually not sufficient. Moreover, even though the flood risk impact factor has been introduced as an index to evaluate the impact of various sources of increased or reduced flood risk to society [18], if the plans are implemented they frequently do not deliver the results expected because of insufficient analysis of what causes the problems or because institutional capacity to support the measures is insufficient.

Flood events as shown in Figure 1 are continuing to increase from the year to year. Therefore, the government of Indonesia must take urgent actions in response to the causes of the flooding problems being encountered to recommend sustainable management solutions to them and needs to promote a more promising approach, which would be to concentrate on flood management. Floods and inundations cannot be prevented totally but preventive measures for minimizing loss and waste to be taken [19]. This implies having to live with flood risk because there is no reason how the engineers, the politicians and the public want to make sure flood never happens. Flood hazard mitigation efforts of non-structural measures are the important tools in preventing the potential damages. Whereas, structural mitigation includes physical measures and standards such as building codes, materials specifications and performance standards for construction must be provided only in the appropriate locations. Cost

effective investments to reduce damages could make use of natural retention capacity [20]. By compensating for redirected flooding from the potential high damages of industry, settlement and society towards flooding of agricultural lands and natural wetlands can withstand a limited flooding without harm. The feasible investments to reduce floods should start with soil conservation in upper watershed for reducing natural or man-made bottlenecks in flood ways. In a non-structural approach, the resilience of community to live in harmony with flood is the most important component; therefore, it needs the provisions of such as early flood warning systems and flood risk mapping as well as flood-resistant building constructions [21].

Figure 1. Flood events during the period of 2001–2009.



3.2. Droughts

Drought can change its characteristics through time [22] and mainly affects the second crop of irrigated and rain-fed rice fields, normally these rice fields have two rice cropping seasons, the first is a period from November to February and the second is that from March to June for each year [23]. Annually about a total of 0.250 million hectares, approximately 3% of the total planted rice fields, of the second crop of rice fields is affected by drought. An example of the drought impacts on society including anxiety or depression about economic losses that during the 10-year period (1993–2003), among a total number of 2.453 million hectares of crops affected by the drought, of which 0.462 million hectares were totally lost. El-Nino phenomena are the main caused of drought in the years of 1994, 1997 and 2003, which caused a total number of 1.5 million hectares, approximately 60% of the total area affected by the 10 years of drought, of rice fields were affected. The average annual loss of rice production due to the drought was estimated to be about 300,000 tonnes or equal to IDR 550 billion or equivalent to USD 61 million [10]. Furthermore, annually these droughts have caused about 250,000 farming families that depend on rice production suffer from a decrease in rice farming.

3.3. Soil Erosion and Sludge Production

Dispose of sludge overdose into the receiving environments is an example of the negative impacts generated from misleading of such as IWRM implementation, forest land conversion and agricultural

land occupation. Major sources of sludge in the country resulted from soil erosion and sedimentation are due to agricultural land occupation does not ensure that the soil conservation principles are quite well understood and implemented by farmers. Solid waste disposals and night soils as well as chemical and activated sludge produced from water and wastewater treatment plant (WWWTP) markedly contribute to an increase in quantity for sludge released into the environments [2,24–26]. Still the major sludge from soil erosion might eventually induce a huge accumulation of sediment in lakes and reservoirs hence the impact of decreased storage capacity may reduce water potential gradients in the stem [27–29]. For example, the upper Citarum river basin area in West Java with an average flow rate of 92.3 m^3 s^{-1} brought about 1.05 million tonnes of suspended matter per year during the 11-year period (1981–1982). The figure has increased to about 1.47 million tonnes per year in 2004, or about 40% increase within a period of 20 years [2,30]. In another case, the garbage productions require a good practice of the solid waste management. For example, during the year 2002, three biggest cities (*i.e.*, Jakarta, Surabaya and Bandung) have produced respectively about 25.0, 9.0 and 6.5 thousands m^3 garbage per day. But, the capabilities of Jakarta, Surabaya and Bandung to handle the garbage productions of about 96%, 77% and 70%, respectively, were still not quite enough [31]. Another potential source of sludge is associated with latrines or toilets referred as night-soil, having collected during the night in the past [32]. The problems with fecal sludge management is that the collected night-soil of such as for Bogor city is discharged untreated into the receiving environments due to excessive distance of disposal sites, traffic congestion and lack of suitable night-soil treatment options. Chemical and activated sludge as by-products of the WWWTP operation have reportedly have been increased from the year to year yet programming this matter as high priority considers, there is due to limited knowledge, technology and facility, as well as lack of the initiative to be implemented the regulation on economic instruments basis [2]. Sludge overdose may affect the discharge regime of rivers, which in turn reduces the inland water availability and worsens the quality of waters.

3.4. Lack of Adequate Water Storage

Although water resources in Indonesia are abundant, yet spatial and temporal variations in rainfall patterns and lack of adequate storage might create competition and conflicts amongst users [33]. The annual renewal water resources are estimated to be about 3085 km^3 of blue water while the estimated freshwater demands in 1990 were of the order of 50.5 km^3. In spite of the abundance in water resources estimated about 13,000 m^3 per capita per year, the water resources potential (WRP) per capita varies from the island to island. In the major parts of Java Island there are the available water less than 2000 m^3 while for Papua it is greater than 282,000 m^3 per capita per year. The large variation in WRP poses challenges for the nation development and requires a sound planning and management system in water resources. The estimated surface water demand by the years of 1990, 2000, 2015, 2020 for major islands in Indonesia shows the increasing demand for all water users [10]. The figure shows that two islands *i.e.*, Java and Bali, which have a 62% country's population, could have the biggest water demands for domestic, municipality and industry. Groundwater potential in Indonesia would be a limited resource that could support only part of the urban and rural needs for water supply and provides irrigation water for very limited areas. In some regions of the country, the river basins exhibit tremendous variability in available water resources, which are inadequate to meet current and future demand more effectively. The status of surface water resources in the year 1990 showed that Java has

faced water shortage during the dry season. The ongoing industrialization and urbanization have put further strain on the nation's water resources due to water quality degradation. As a consequence of the condition of scarcity, the government of Indonesia should place great emphasis on holistic water resources planning by channeling effort toward the mission driven program approaches to meet the challenges of the 21st century.

3.5. Watersheds Degradation

Many river basins have reportedly have been downgraded by illegal logging and intense land use change in these areas. Critical land areas and deforestation scattered across the country were noted to increase from approximately 13 million hectares in 1992 to 21 million hectares in 2001 and yield up to 45 million hectares in 2005 [2,10]. The population growth could affect the future changes in nature and intensity of economic activity; therefore, the issues of land and water use have become increasingly important due to the number of degraded watersheds, which have increased rapidly. The number of the critical river basin (CRB) indicating that high runoff coefficients are responsible for high flood return periods [34] were only 22 CRBs mostly in Java in 1984 and become 39 and 59 CRBs in the years of 1992 and 1998, respectively, and about 458 CRBs need to be rehabilitated since 2006 [10]. Economic and social impacts of desertification and land degradation might have caused the loss of certain spring waters [12]. The degradation of the Sengguruh Dam watershed, which covers a catchment area of 1659 km^2 in the upper Brantas River Basin, might be a good illustration of the critical land area caused by soil erosion (see Figure 2a). The Sengguruh Dam, with an initial storage of 21.5 million $m^{3,}$ was built in 1988, as this construction of sediment traps on watercourse can benefit the protection of Sutami Dam in the downstream. The Sutami Dam of the multifunction water control facility would be protected for ensuring the sustainability of electrical hydropower energy from a power generation of 29,000 kW and the important source of water supply to Surabaya city. By considering the average erosion rate of 0.58 mm per year, the design lifetime of Sengguruh Dam should be 20 years. Due to uncontrollable deforestation, land degradation and land-use change, as well as the effects of bed land-use and land-treatment for agricultural purposes, the Sengguruh Dam was completely full of sediment after 12 years (1988–2000). At a specific erosion rate of 869.8 m^3 per km^2 per year, about 1.44 million m^3 per year of the average annual volume of sediment was monitored during the 15-year period (1988–2003) [29].

3.6. Threats on Water Availability and Sustainability

Issues of water quality include surface water and groundwater contamination while issues of water quantity include the growing problem of increasing competition among water users and the declines in groundwater for urban areas of Java caused by withdrawal rates that are greater than recharge rates [35–37]. Even if in the aggregate, Java is well endowed with rainfall; the problem is one of seasonal and annual variations, with dry season flow in the main rivers only 20% of annual flows—and as little as 10% in a dry year. This is compounded by the fact that river basins in Java are relatively short, resulting in most of the wet season running unused water flows into the sea. A number of dams have been built in major river basins such as Citarum, Brantas, Bengawan Solo, Serayu-Bogowonto and others, and all the dams can hold a total capacity of less than approximately 5% of river flows. Several additional sites have been identified for possible future dams, but the implementation of accessibility to the built of them

is likely to be constrained by high population densities and the social and economic costs of resettlement. At the current time, agricultural water use accounts for more than 90% of water use in the country, while industrial and municipal water requirements together account for less than 10%. It is suggested that the consumption of water by households and business will grow rapidly over the next decades to support continued rapid population growth and improvements in human health and economic; however, the available water supplies will have met. Public water services currently provide at a range of 40%–60% of water supply in major cities of Java such as Jakarta, Bandung, Semarang and Surabaya while the remaining is met from groundwater extraction. The heavy reliance on groundwater to serve industrial and domestic needs for Java's large urban areas cannot continue indefinitely. This is particularly true for the northern coastal cities of Java where groundwater is being abstracted at greater than replenishment rates, leading to saltwater intrusion and land subsidence with attendant increases in floods and water logging, which in turn aggravates groundwater pollution from septic tanks and leaching pits [38].

Figure 2. Environmental conditions in the river watersheds; (**a**) critical land area in the upper part of the Brantas River Basin in East Java and (**b**) dirty part of the Citarum River in West Java.

(**a**)

(**b**)

3.7. Water Quality Problems

Unsafe water is one of the major sources of disease in Indonesia, and the lack of adequate sanitation facilities is a primary cause of fecal contamination of urban water supplies. An important indication of the threat this poses to the urban is the fact that water, with exception of bottled water, is not safe to drink. High levels of chemical contamination were detected in most well especially in the special capital region of Jakarta. Tap water samples in Jakarta in 1992 reveal a 73% rate of coliforms contamination, with a 55% rate in drinking water from wells. The 2010 National Basic Health Research found that a high proportion of Indonesian households (32.5%) rely on low-quality drinking water. Surprisingly, approximately 83% of good-quality drinking water in urban areas, and 62% in rural areas, comes from commercial packaged water. This commercialization of drinking water adds to household spending and worsens conditions for the poor, who already spend two-thirds of their income on food [39].

A major reason for the poor quality of water supply in urban areas is that about two thirds of public water supplies are derived from increasingly polluted surface waters [39]. A 2008 water quality survey conducted by the Ministry of Environment found that the majority of main rivers in Indonesia would fall into the heavily polluted category, including iconic rivers such as the Musi River in Sumatera, Mahakam River in Kalimantan and Citarum River in Java (see Figure 2b). Since groundwater are already being over-extracted in many large coastal cities, surface water may be the only source of incremental supply for expanding public water systems. Although demand from municipal and industrial users will remain relatively small compared with the total resource base, the supply of surface water must have very high security and be used more effectively. Unfortunately, the lower reaches of most rivers are already polluted beyond the capacity of existing treatment plants. A technically feasible option would be to upgrade the plants to handle more polluted inflows, but this would be an expensive solution and would only address the problem until pollution levels again exceed treatment capacity. The only sustainable solution, therefore, is to clean up pollution at the sources *i.e.*, to address the growing challenge of urban and industrial pollution [10].

4. A Brief Description of the Major Tasks Involved in the Implementation of IWRM

4.1. Coordinating Perspectives in Water Management

The government of Indonesia has made special efforts on IWRM since the enactment of Law No. 7/2004 on water resources [11]. Guided by this law, the decision makers, managers and operators will always strive to do the right things to implement the strategies, programs and activities to support water management. The law and policies governing the implementation of IWRM are the legal provision for managing water resources in the river basin perspective but have not yet been synchronized effectively. Each ministry in pursuit of its mission has a mandate with responsibility for promoting social, economic, environmental and cultural well-being of communities in the present and for the future. Challenging the IWRM perspective may be the pilot projects need to be done together in order to solve a problem. This perspective seeks inter-ministerial cooperation and coordination to expedite clearances for water management activities. The goal of involvement different ministries is to help identify and implement mechanisms that encourage members to find ways to become involved in analyzing the complexity of implementation projects. Multi-criteria decision analysis is an umbrella

approach that has been applied to a wide range of water management situations and helps to frame a group process that made stakeholder preferences explicit and substantive discussions about long-term river management possible [40,41]. The need for coordinated data collection has been proposed as salient features of a coordinated observation program for water resources management [42]. This paper reviews a novel purpose-oriented access control model which takes into account the purpose for which all government-related institutions involved in inter-ministerial cooperation access the IWRM perspective by operations of the pilot projects in accordance with their mandate tasks. In order to provide more detailed guidance for each water-related institution under the administration and supervision of a ministry, the sectoral ministry has developed a set of operational guidelines that are appropriate to the activities of that sector. The operational guidelines may be reviewed and updated from time to time. The accuracy of factual information can help judge the credibility of the ministry in implementing the IWRM concepts. Accuracy of information can provide clues to possible bias in the implementation of IWRM for all institutions involved in the pilot projects.

4.2. The IWRM Pilot Projects and Reasons behind Program Delays

Strengthening inter-ministerial coordination mechanisms for the IWRM implementation needs financial sustainability, such as promotion of cost recovery, and must consider long-term management. At a ministerial meeting, the decision as to the content of the IWRM cooperation was made to select four projects to be implemented at four river basins in West Java [2,12], such that: (1) the project for capacity development of Jakarta comprehensive flood management has as its target area the upper Ciliwung River Basin in order to reduce rate of surface runoff and soil erosion. Among the initiatives and measures to be supported are the spatial planning for special region of Bogor-Puncak-Cianjur, improved knowledge of river basin environment and development of water resources management structures; (2) the pilot pollution prevention project's goal is to prevent water pollution for the Citarum River from industrial and domestic wastewater, because three large reservoirs have been built on the Citarum River over the last five decades *i.e.*, Jatiluhur (1967; 8300 Ha), Saguling (1985; 5607 Ha) and Cirata (1987; 6210 Ha). Operation principles of these three multipurpose reservoirs are to keep a stable water supply for the uses of hydropower, industry, irrigation, aquaculture, leisure, aquatic sport, domestic and municipality; (3) dynamic optimization of water flooding using optimal control of water release from reservoir has a significant potential to increase ultimate goal of water distribution service. The maximum volume of water likely needs to be stored in the Jatigede Reservoir; therefore, reducing erosion and runoff of the upper Cimanuk River Basin is the important project to increase efficiency and extend the service life of Jatigede Dam; and (4) an overlooked effect of river withdrawal from sediment laden the Sagara Anakan Lagoon is the long-term aggradation and degradation [43] that can occur in the Citanduy River Basin. The life of the Sagara Anakan Lagoon may be extended through the project for comprehensive erosion and sediment control management practices by reducing the upstream sediment loads. The fact is that quasi-totality of the proposed projects today still has not been realized: Many program delays, cancellations and stretchouts have combined through the years to reduce effective collaborative IWRM projects. In all cases, a delay is usually a costly situation; random interviews with various types of administrative staff of water resources organizations and non-governmental organizations (NGOs) revealed preference arguments that consolidation of contingency variables, such as the institutional role, personal character of high level managers, manager's moral worst, unreliability

of subordinates as well as the government bureaucracy and budgetary process are common risk factors that enable and hinder the implementation of the projects.

The economic analysis of an IWRM project helps select and design projects. The analysis should compare costs with benefits and determines which among alternative projects have an acceptable return. The costs and benefits such as for the Citarum River Basin (CitRB) projects can be identified, evidence that the Integrated Citarum Water Resources Management Investment Program funds a range of interventions across the water sector that relates to water and land management necessary to pursue the introduction of IWRM in the CitRB. A road map has been developed setting out the agreed interventions that address the IWRM key issues under the Investment Program (IP). The estimated cost of implementing the projects of the road map could be about USD 3.5 billion over 15 years, of which the IP accounts for USD 921 million. The expected impacts of the IP are to reduce poverty and to improve health and living standards in the CitRB, and the expected outcome is to improve IWRM in the CitRB [44]. With the present condition in mind, this paper proposes one suggested implementation that integrating the issues of watershed and water resources into one management system might encourage active learning, which is widely seen as an appropriate way for capacity building of IWRM. Thus, one of the important considerations for the future IWRM in Indonesia is to improve capability of the government-related institutions, which act within the capacity building for enabling environment, institutional frameworks and management instruments.

4.3. Coordination Instruments and Water Coordinating Agency

In 2003, the government of Indonesia under coordination of Coordinating Ministry of Social Affairs has launched the National Movement for Forest and Land Rehabilitation (GERHAN). The GERHAN program focused on the efforts to decrease frequency and severity of droughts and floods and to reduce erosion and sedimentation. Even the achievement GERHAN program was not yet enough to meet the targets, about 3 million hectares of critical land have reportedly tried to rehabilitate during the 5-year period (2003–2008) [45]. The significance of this program has restored in several parts of the CRBs to reduce runoff coefficient after it was downgraded by illegal logging and intense land use. In 2005, President of the Republic of Indonesia has launched the National Movement for Water Resources Management Partnership (GNKPA). The award caps a yearlong debate program based on the value of courage and dedicated to strengthening institutional capacity building and coordination among the government agencies. The GNKPA focuses to integrate the programs and actions related to water resources, agricultural lands and forestry in order to realize sustainable development in the country [10].

The recognition of an obligation to obey the Law No. 7/2004 must as stakeholders' representative body to establish the Water Council at national level. In 2009, a presidential decree has been issued to establish the National Water Resources Council (DSDAN), where picture of representative is the concept of equal opportunity by fifty-fifty percent chance composition members of government agencies and NGOs. The DSDAN plays an important role in effective implementation of the IWRM programs to discuss the water-related issues during the council meeting and can influence the decision-making process on the national policy and strategy. Active participations in public policy-making processes that attempt to influence the implementation of regulatory mechanisms address to reduce the environmental impacts of implementing the IWRM at the river basin level [46]. A long-term perspective needs to be reinforced in decision making and planning to encourage research and

development both for technology and organizational structure to be better able to meet the challenges of sustainability in IWRM [47].

4.4. Constraints and Weaknesses

Because the implementation of IWRM in Indonesia remains theoretical and prescriptive [48], some limitations play out in practice, such that: (1) regulatory functions and service provision functions of water resources may still intermingle; (2) law enforcement is not functional as well the frameworks for water management have not yet been legalized; (3) most human resources in the water resources sector, especially those in the fields are not professionals; (4) conflicts of interest among stakeholders, sectors, administration authority and geographical area (*i.e.*, downstream *versus* upstream); (5) strong sectoral and local ego in water resources and other sector related to water; and (6) process of formulation of framework for water management is considered by some participants as lacking adequate participation and inputs from stakeholders [10]. As a consequence, even though three large multipurpose reservoirs *i.e.*, Cirata, Saguling and Jatiluhur have been built on the Citarum River in West Java for the use of water for hydropower, recreational purpose and supply water for domestic use, industrial use, livestock watering, irrigation, fisheries and other beneficial uses, the river is suggested as one of the most polluted river in the world due to effort of the governments is still ineffective in reducing pollution loads from domestic effluents, industrial wastewaters and solid wastes.

The Law No. 7/2004 meets the most important elements of two aspects of IWRM *i.e.*, enabling environment and institutional roles. However, management instruments, especially with respect to resource assessment, economic instruments and demand management need to be broadened. The implementing regulations may take care of some of missing IWRM elements. It is suggested that almost all stakeholders (governments, NGOs and academics) should involve in formulating the law and its related regulations [49]. As part of the democratization of public policy making, the draft bill and its regulations need to be widely discussed at public consultation meetings held at different locations throughout the major islands of Indonesia. By eliciting opinions from the widest possible range of stakeholders in an organized and professional way, this process could significantly shorten what in the Indonesia case was a repetitive and lengthy series of discussions and a long lag time between drafting and passing the bill. In addition, there is a need to build awareness of the principles of IWRM among decision-makers and stakeholders, including NGOs to ensure that all parties are arguing from a common base.

5. Challenges of Developing the Future IWRM

5.1. Enabling Environment

It can be argued that IWRM might be considered as the means to resolve complex environmental problems caused by anthropogenic sources. The underlying causes of deforestation, critical watershed and land mismanagement are those factors which may create an environment where further imbalance between water supply and demand, water pollution, flood and drought as well as erosion and sedimentation can occur. Moreover, a number of different water-related problems caused by human activities, such as land subsidence due to groundwater withdrawal, sludge production (*i.e.*, biological

and chemical sludge), solid waste and seawater intrusion, may widely affect all aspects of society, yielding some of the most systemic and most complicated feedbacks that frustrate human progress and sustainable development [50]. The fact that IWRM is a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. Challenges of reforming enabling environment for water resources management in Indonesia can be categorized according to the eleven pillars (see Figure 3) of critical managerial elements that must be highly scrutinized by local and central governments in order to develop best practice. These pillars are grouped into two management approaches, such that: (1) an integrated approach consisting of watershed and forestry, agricultural land, flood and drought, water quality and pollution control, soil erosion and sedimentation as well as seawater intrusion should be put under authority of river basin agency supervision; and (2) a partial approach consisting of water and wastewater treatment, biological and chemical sludge, solid waste, groundwater withdrawal and land subsidence as well as night-soil should be put under responsibility of district/municipal authority. All of these pillars must be implemented by the local and central governments as well as by the private institutions and NGOs. The first step to starting IWRM is developing a river basin integrated water resources management plan (RBIWRMP) and then enacting it into official plan as the legal document. This document might guide all stakeholders corresponding program activities to the whole-of-government framework makes it possible to meet the IWRM targets.

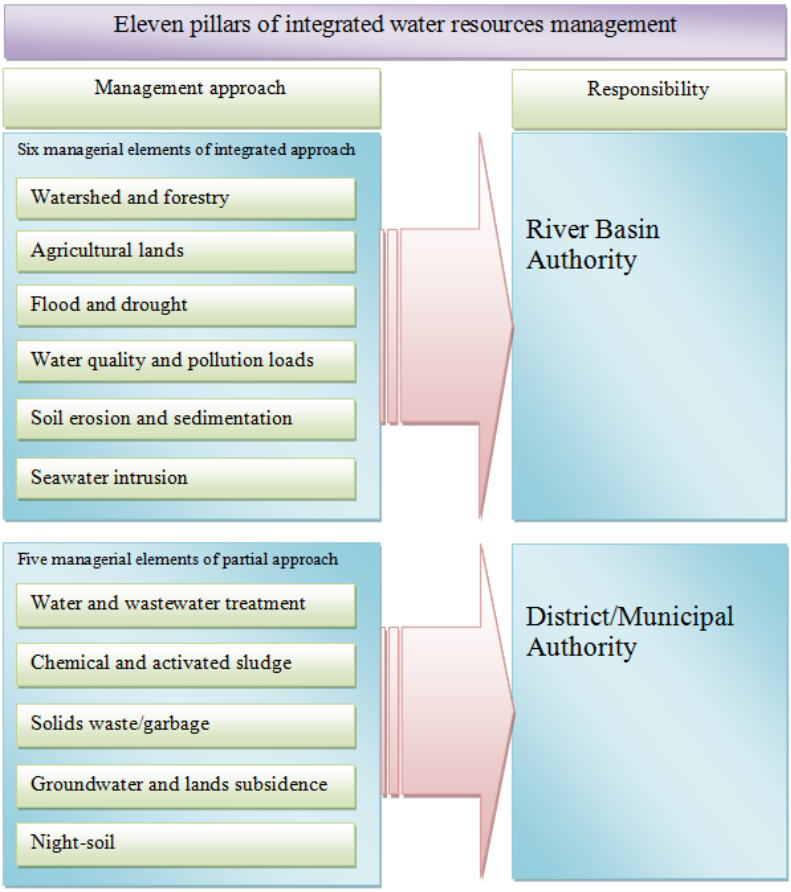
Indonesia has undertaken a step forward the implementation of IWRM approach that is the concept of such a comprehensive approach to improve water resources management towards achieving sustainable prosperity. Since 1969, the water infrastructures have been continuously developed due to the needs to build, operate and maintain water infrastructures are usually driven by the necessity to meet the water needs for irrigations and the water supplies for domestic, municipal, industrial and other purposes from the year to year. The government of Indonesia under coordination of the appropriate regulatory agencies has issued the regulations on water supply system, irrigation, water resources management, ground water, dam, water council, water quality management and pollution control as well as water resources corporatization and financing necessary to implement the IWRM approach in accordance with the Law No. 7/2004. Though examples of attempts at government regulation are widespread, there are four stands out from the rest, *i.e.*, river and lake, swamp, watershed management as well as water use and rights.

5.2. Institutional Frameworks

Indonesia is a unitary state, which is divided into three levels of executive-administrative authority of government *i.e.*, national (central), provincial and city/district. The Law No. 7/2004 stipulates that basin water resources should be managed in an integrated and sustainable way. With all the existing problems and constraints, new institutional arrangement must consider ways of trading-off between the river basin management authority and the public administration authority. However, in many cases the programs do not synchronize with each other. The RBIWRMP should provide the acquisition planning guidance and procedures for government, river basin manager and other personnel assigned to participate in water resources management. Acquisition planning means the process by which the efforts of all personnel responsible for an acquisition are coordinated and integrated through a comprehensive plan for fulfilling the IWRM need in a timely manner and at a reasonable cost. In Indonesia, a river basin territory called

"Wilayah Sungai (WS)" bordering on outer boundary of drainage basin of closed rivers might facilitate efficient water resources management. According to the ministerial regulation No. 11a/PRT/M/2006 issued by Minister of Public Works, the country is divided into 133 WS. Of these, 13 WS which are fully located in a district are termed as district WS, 51 WS which are fully located in a province are termed as provincial WS. For the remaining 69 WS, 5 WS are located crossing boundary of two countries, 27 WS in two or more provinces and 37 WS are of strategic importance are termed as national WS to be under the management authority of central government [10]. The water council at the provincial level, called "Provincial Water Council (PWC)", has been established in 13 province,s and that at river basin level called "River Basin Water Council (RBWC)" has been established for 12 WS, as required by the law. Nevertheless, there are still significant gaps in managing of water resources for rural areas of the country and analysis of matter on both water and land management necessary to pursue the introduction of IWRM. Many water councils need to be established in the future (*i.e.*, 20 PWCs at 20 other provinces and 121 RBWCs at 121 other WS). The proposed scheme to ensure the IWRM practices is zero delta policy that must maintain status of the environment before and after the development of regional land-use plans should be in the same conditions. Therefore, three basic policies must be to set up by the district, provincial and central governments, such that: (1) zero ΔQ policy to maintain run-offs; (2) zero ΔS policy to preserve erosion rate; and (3) zero ΔP policy to safeguard the pollutant loads resulting from human activities [10]. The essential elements of enforcement to implement these policies effectively are to involve the related government agencies, private institutions and other stakeholders particularly for high intensity land-use of river basin.

Figure 3. Elements of the future integrated water resources management.



In implementing Law No. 7/2004, the central government has long debated the introduction of water pays for water principles in the new regulations [11]. This imposes self-financing scheme in the future IWRM perspective, specifying that water management must generate economic and financial resources to carry out its inherent tasks. The implementation of prevention, user and polluter paid principles is a recommended way of doing deep financial development, as all details for the implementation of framework legislation would otherwise need to be adopted under the lengthy ordinary legislative procedure [51]. The principle of prevention paid focuses on preventing unwanted impacts regardless of who should pay. It is closely related to precautionary principle which aims at risk reduction and pollution prevention, where investment in central wastewater treatment facility is an example. The principle of user pays focuses on overuse of water resources. For example, it can be controlled by water user fee. The principle of polluter pays emphasizes on water pollution. By adopting the environmental fee can contribute to the reduction of pollutant load discharged into the receiving waters [4,52].

5.3. Management Instruments

Water flows from the upstream to downstream areas of a river basin adhere the interests of multiparty and regions. To facilitate the implementation of IWRM needs to have a legal document of RBIWRMP, and all stakeholders should be made aware of their river basin planning framework. It is necessary to involve stakeholders at all stages in the IWRM process because the participatory approach to develop a framework will enable local authorities to implement the RBIWRMP to achieve sustainable development goals. Challenges to IWRM and good water governance should allow all stakeholders to participate directly in all aspects of policy making. Significant connections exist between the elements of social capital and the perceptions of stakeholders towards water allocation policies [53]. It is recognized that response indicator relates to the actions taken to mitigate loss or protect water resources. The causal links between the upstream-downstream communities in a river basin need to be established whereby the corrective actions might be implemented in response to the interests of water users and water savers. The need for a cooperative agreement included compensation to upstream communities for protecting and conserving water resources for benefit of the communities living downstream areas must be approved by the RBWC. Because the Law No. 7/2004 stipulates the representative institutions by representing the river basin diversity, it has definitely help pave the way for participatory IWRM. The need to establish a RBWC as coordinating board could provide synchronization in support of water resources program activities [11]. The specific problems to be addressed are highly diverse and vary from one basin to another.

The economic tool can be designed as priority the internalization of external impacts of pollution to make polluters use a new standard for IWRM practices. Polluter and user pay principles give a good illustration of the stakeholders' participation to the future IWRM framework. Based on the studies of farmer participation on operation and maintenance of irrigation networks system conducted in Central Java, Yogyakarta and West Nusa Tenggara [54], it seems that farmers agree with concept of volumetric pricing for irrigation water. Therefore, the implementation of water pays for water principles can be an instrument of fiscal policy for financing the IWRM activities. This is a challenge that can be recommended for avoiding the snare of debt from donor countries and/or international agencies. The recommended policy scenario has been proposed by Bryan and Kandulu [55] involved targeted information, followed by an incentive program and a proposed mandatory code of practice for IWRM.

One of the perspectives in managing of water resources is to promote the instruments and mechanisms for enacting the participation concepts to share benefits and costs resulting from land-water interactions by upstream and downstream resource users. Therefore, it needs to have much greater sensitivity to relative materiality in order to safeguard adequate quantity and safe quality of water. In recent years, most concern around erosion and sedimentation has focused on the impact of continuing sedimentation on the environmental quality that would be tolerable for all stakeholders. A starting set of concepts can be created by selecting the ideas based on seller-buyer approach to consolidate the interactions of multiparty entire the river basin [56]. Community group has proved to be the most appropriate in terms of manageability and positive impact with respect to conservations of forest, land and water in the upper parts of a river basin; they should be recognized as a community of sellers. Public suppliers provide water for a variety of applications such as domestic, commercial, industrial, thermoelectric power and public water use; they should be recognized as a buyers group. It can be seen that the seller-buyer approach offers a win-win solution that must continually face severe water-related problems. Challenges to establishing markets for watershed protection services and improved livelihood opportunities for poor rural households have been studied for three river basins (*i.e.*, Brantas, Cidanau and Segara) [57]. Yet, managing water resources at a river basin level can be unrealistic, particularly when Indonesia has weak regulating institutions and limited technical and financial capacity.

The RBIWRMP lays out strategies for overcoming the water environment related problems. It sets short, medium and long term goals for IWRM, agreed by all the major stakeholders. Consequently, public consultation is a very important element in the planning process particularly in the light of future concerns about water allocation and the need for sustainable development. Guided by the RBIWRMP to assist decision makers monitor and evaluate the progress made for all proposed projects. Accurate basin-wide accounting of water use including equitable distribution based on existing legal entitlements would significantly contribute to water conservation efforts [58]. The use of water varies somewhat according to both stakeholders concerned over water rights and nature of lands. Need to establishing RBWC would be to avoid the conflicts of interest and to synchronize the access to a shared resource of water for multipurpose. Therefore, even if some manuals of standard operating procedures have been provided to support the implementation of IWRM, and web-based information systems (WBIS) have been established at national and certain WS levels, a network of the WBIS should be also established across the country to bring together different parts of the regions where water resources data and information may temporally change along the year. Consistent implementation of RBIWRMP brings success to contribute to IWRM and all key stakeholders must work toward the same compelling visions.

6. Conclusions

This paper presented a brief review on water availability and water-related issues in Indonesia reveals challenges of the future IWRM to support sustainable development. The most apparent measure toward resolving the present problems and constraints of implementing the IWRM approach is by means of the RBIWRMP, which first of all must start with massive campaigning programs to develop the public's sense of belonging, so that the communities as a whole are willing to participate in IWRM practices. Capacity buildings of enabling environment, institutional frameworks and management instruments were highlighted to contribute to pertinent policy proposals that strive for an effective implementation of the future IWRM. Picking the right policy to help stakeholders depends on accurate justification of

current water conditions. The recommended actions for improving the future IWRM related to the important pillars of management approach, integrated planning, water pays for water principles, coordinating model and stakeholders' interaction on the basis of seller-buyer approach were presented to contribute to the future IWRM in Indonesia.

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Conflicts of Interest

The author declares no conflict of interest.

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