

Balancing infrastructure, ecosystem conservation, and community approaches on integrated development planning of Citarum Watershed

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Submitted 15 November 2021; Accepted 10 March 2022

ABSTRACT

The condition of several watersheds in Indonesia at this time has experienced a lot of decline in functions in maintaining water availability and environmental health. The number of critical watersheds in Indonesia continues to grow and is getting worse even though there have been many rehabilitation programmes for several watersheds in Indonesia, including the Citarum Watershed in West Java. Changes in the characteristics of the Citarum Watershed that can be seen include an increase in the overflow point of flood inundation, erosion of agricultural land, and sedimentation in rivers. The method used in this research is a qualitative approach through analysis based on a literature review of planning documents, regulations, books, journals, and expert judgment analysis. This study aims to assess the extent to which cross-sectoral, cross-regional and inter-disciplinary problems affect regional development and analyze problems that occur at the watershed scale. The Citarum Watershed Strategic Plan is a set of activities with steps to implement the planned strategies. The Strategic Plan reveals some activities, involvement of stakeholders, and also goals for the future which are to be achieved through the identified implementation steps. All of the activities have a main vision: "All stakeholders working together to enhance the quality of watershed carrying capacity by balancing infrastructure, ecosystem conservation, and community approaches".

ABSTRAK

Kondisi beberapa Daerah Aliran Sungai (DAS) di Indonesia saat ini banyak mengalami penurunan fungsi dalam menjaga ketersediaan air dan kesehatan lingkungan. Jumlah DAS kritis di Indonesia terus bertambah dan kondisinya semakin parah meski telah banyak dilakukan program rehabilitasi, termasuk di DAS Citarum, Jawa Barat. Perubahan karakteristik DAS Citarum yang terlihat antara lain peningkatan titik luapan genangan banjir, erosi lahan pertanian, dan sedimentasi di sungai. Metode yang digunakan dalam penelitian ini adalah pendekatan kualitatif melalui analisis berdasarkan tinjauan pustaka terhadap dokumen perencanaan, peraturan, buku, jurnal, dan analisis expert judgment. Penelitian ini bertujuan untuk mengkaji sejauh mana permasalahan lintas sektor, lintas wilayah dan antar disiplin ilmu mempengaruhi pembangunan wilayah dan menganalisis permasalahan yang terjadi pada skala DAS. Renstra DAS Citarum merupakan rangkaian kegiatan dengan langkah-langkah untuk mengimplementasikan strategi yang telah direncanakan. Rencana Strategis mengungkapkan beberapa kegiatan, keterlibatan pemangku kepentingan, dan juga tujuan ke depan yang ingin dicapai melalui langkah-langkah implementasi yang diidentifikasi. Seluruh kegiatan tersebut memiliki visi utama: "Seluruh pemangku kepentingan bekerja sama untuk meningkatkan kualitas daya dukung DAS dengan menyeimbangkan infrastruktur, konservasi ekosistem, dan pendekatan masyarakat".

Keywords: *Citarum, development planning, integrated, watershed*

INTRODUCTION

Increasing population growth and the rate of development often impact land conversion (Soemarwoto, 1999). Area conversion results from population pressure on land, indicating that there is a role for the community, both on a specific scale and in general, that affects the sustainability of natural resources (Watson et al, 2014; Cumming, 2016). In many cases, land conversion increases the frequency and magnitude of flooding in the rainy season and water shortages in the dry season (Pambudi, 2021a, 2021b, 2021c). Water scarcity due to the destruction of watershed ecosystems has the potential to cause tensions both from an economic and social perspective due to conflicts of interest between

users (Pambudi, 2019a).

The success of watershed management is always related to the conservation of water resources through increasing the flow rate and increasing the rate of rainwater infiltration, and at the same time, the conservation of water resources can also improve the quality of river water because a controlled surface water flow rate can reduce the rate of erosion (Calder, 2005; Dixon, 1992; Nakamura 2003). Thus, successful watershed management can play a significant role in managing, developing, and/or increasing the water supply needed to stabilize water-based food and energy availability (Gregersen et al, 2007).

Watershed management, which is part of regional development in Indonesia, is facing various problems

such as the absence of integration among sectors, agencies, and regions (Pambudi, 2019b). The Citarum Watershed (Figure 1) is one of the supercritical watershed in Indonesia related to environmental degradation (Djuaningasih, 1993) and is the most prioritised one in the country. The river of fed irrigation scheme produces 5% of the country's rice production. Located in West Java with a length of 297 km, Citarum is the biggest and the longest river on the island of Java, Indonesia. The Citarum Watershed covers an area of 6,614 km² with a population of around 30 million people.

With the great potential in helping various elements of life, the Citarum river should be a magnet or attraction

for all people. For this reason, the Citarum Watershed should be preserved and maintained as one of the natural resources as much as possible. With the contamination of the Citarum River, the Government as the policy holder, needs to know how much is the loss due to the contamination of the Citarum River. Such a process is complex and takes many years. The smallest damage is in the upstream of Citarum Watershed in Cisanti, followed by the industrial waste pollution in the Bandung basin, especially the Baleendah and Dayeuhkolot areas which are increasingly populated with industrial factories.

The population around the Citarum Watershed has a growth rate of up to 3% every year. Neediness in the

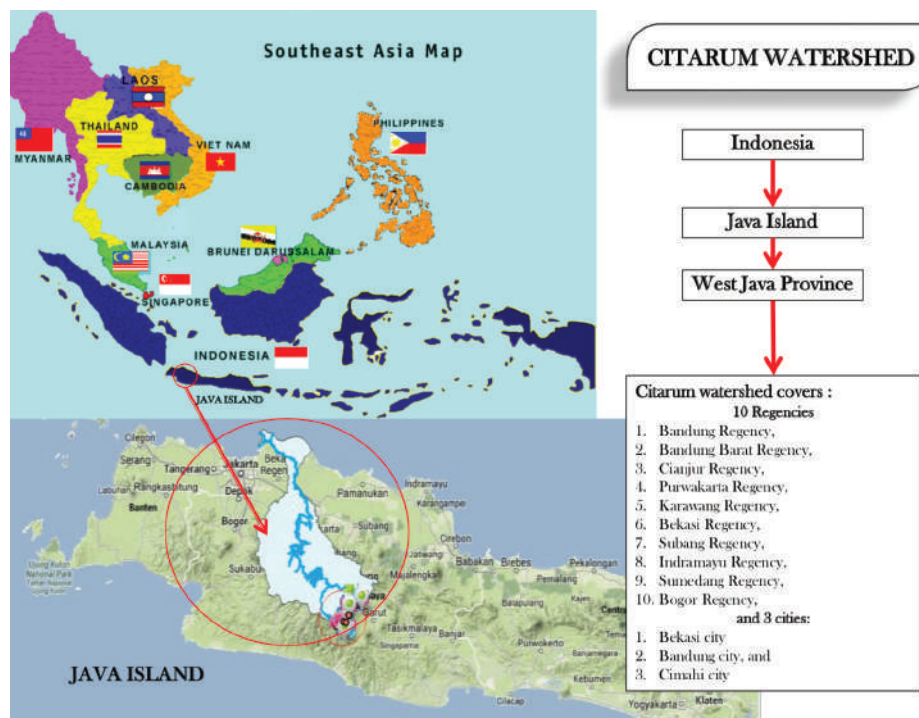


Figure 1. Map of Citarum Watershed, West Java, Indonesia.

bowl is essentially over the public normal, with 8 of 11 areas recording destitution levels of 25% or above in 2019. Situated in the Citarum Watershed are major modern places including Indonesia's fourth-biggest city and the common capital of West Java, Bandung, and satellite modern parks toward the west of Jakarta (Idris et al, 2019). The Citarum stream supplies some 80% of Jakarta's crude water and is the site of three significant dams and three huge multipurpose repositories (GoI, 2010). Potential water accessibility in Citarum Watershed comprises of 7.5 billion m³/year or 57.9% (currently used) and 5.5 billion m³/year or 42.1% (future potential). The water is used as drinking water for Jakarta 6.0%, drinking water for Bandung 0.3%, businesses 2.0%, water system 86.7%, and others 5.0%. Subsequently, the Citarum River and dams along its stream have extremely high potential in terms of financial value and balancing the climate, in which they

can affect community socio-cultural of the community and the environment (Fridayani, 2020).

Citarum is a watershed with heavy rainfall. Even in the driest month, there is a lot of rain. This location is classified as Af by Köppen and Geiger. The temperature here averages 23.2 °C. The rainfall here averages 2,161 mm. The temperatures are highest on average in April, at around 23.8 °C. July is the coldest month. The least amount of rainfall occurs in August, averaging 68 mm. Most of the precipitation here falls in December, averaging 293 mm (GoI, 2014).

Spontaneous land use throughout the most recent 150 years has left just little, dissipated remainders of Java's normal woodland environments and their related organic variety, particularly in the swamps. All low-lying regions continue to endure effects of human activities,

including expulsion of non-lumber backwoods items and trees for development purposes, and contamination

of water and soil from homegrown, modern, and farming endeavours. Presently, there are no satisfactory or viable arrangements to manage land use and to control advancement exercises in the Citarum Watershed.

The GoI (2003) highlighted the following biodiversity assets inside the Citarum Watershed ie. 160 species of plant species, 72 species of birds (10 endemic, 2 rare), 11 species of reptiles, and at least 2 species of fishes. Among the wildlife that occurs in the forests of West Java, endangered species such as Grizzle Leaf Monkey or Javan Surili (*Presbytis comata*) as well as the endemic of Javan Gibbon (*Hylobates moloch*) are still found in Citarum Watershed. Additionally, Javan Leopard (*Panthera pardus*) is also still roaming in the area. The rare bird species of West Java are represented by Javan Tesia (*Tesia superciliaris*), Green Spectacled Pigeon (*Treron oxyurus*), and the Sunda Thrush (*Zoothera andromedae*). The Javan Hawk-eagle (*Nisaetus bartelsi*), which is endemic and one of the most endangered species, can be found in the Citarum Watershed. The Javan Scops owl (*Otus angelinae*) has also been seen on some occasions. The Citarum Watershed is also home to endemic tree species such as Rasamala (*Altingia excelsa*), Jamuju (*Dacrycarpus imbricatus*), etc., as well as the rare trees like Kiputri (*Podocarpus nerifolius*) and Kimerak (*Weinmannia blumei*), which have a high financial value as building materials.

METHODS

The method used in this research is a qualitative one (Moleong, 2010), whereby analysis based on literature review of planning documents, regulations, books, journals, and expert judgment analysis with an emphasis on analysis related to the conditions of the Citarum Watershed, the root causes of the damage to the area, previous programmes/policies and the lead factors that affect the problems of the Citarum Watershed were undertaken. This study aims to assess the extent to which cross-sectoral, cross-regional and inter-disciplinary problems affect regional development and analyze problems that occur at the watershed scale. The consideration for choosing this location is due to its strategic role in national development, particularly related to food, energy and water security. The Citarum River Basin has begun to develop into a national priority because of the complexity of the problems that have a major impact on other areas outside the province of West Java.

RESULTS AND DISCUSSION

Multi-Functional Watershed

Citarum has three multipurpose-fell dams, including Saguling, Cirata, and Jatiluhur supplies (ADB, 2019). The primary dam, Saguling covers 5,340 ha of mountain regions and its principal work is to create

hydroelectric power with a full limit of around 750 MW. The subsequent dam, Cirata covers 6,200 ha and has a capacity to produce hydroelectric power with a full limit of up to 1,000 MW. The third dam, Juanda previously Jatiluhur, covers 8,300 ha of area and its main function is to inundate 240 thousand hectares of rural marsh regions, in addition to providing crude water for drinking in Jakarta. The water is likewise used for hydro- electric force with full limit up to 187.5 MW. About 155 m³/second of water from the Jatiluhur reservoir is distributed through three irrigation canals to irrigate 420,000 ha of fertile land. Three major hydropower plants used the Saguling, Cirata, and Jatiluhur reservoirs with a combined volume of 5,300 million m³ to produce electricity with an output of 1,937.5 MW (GoI, 2014)

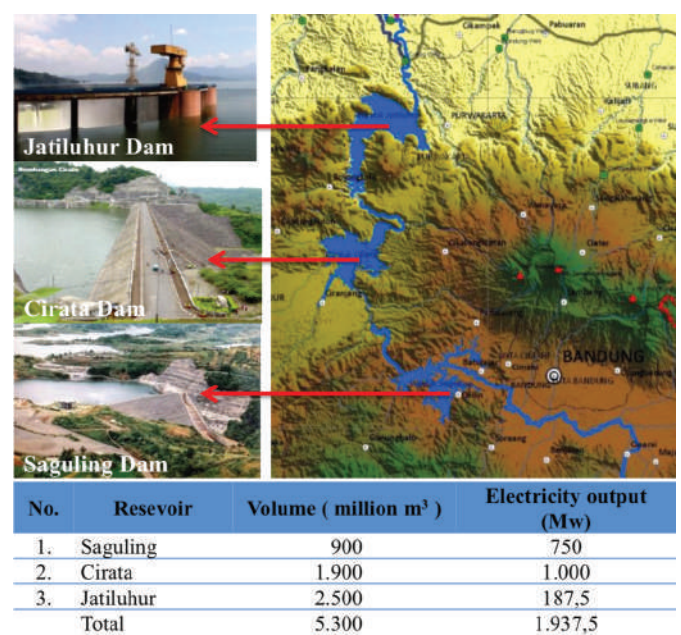


Figure 2. Three major hydropower plants used the Saguling, Cirata and Jatiluhur dams (reservoirs) with a combine volume of 5.300 million m³ to produce electricity with an output of 1.937 Megawatt.

Around 17.6 billion m³/year of water from the Citarum Watershed, 50% provided by surface water, was used for domestic, industrial and irrigation purposes. The rest is supplied by deep groundwater extraction. Furthermore, the Citarum Watershed provides a great potential for eco- tourism and recreation for more than 30 million people who live in the adjacent urban agglomeration of Jakarta and Bandung, due to its environmental assets like rivers, lakes, and waterfalls.

Problems of Citarum Watershed

One of the more critical problem facing the Citarum Watershed is erosion, which has affected about 31,850 ha or 4.4% of the watershed (in state forest). Due to economic pressures, people have been converting the forest since 1995 when no arable lands were left.

Uncontrolled deforestation and unsuitable land cultivation have left the land upstream exposed to severe erosion.

Average annual sedimentation into the three reservoirs is estimated at 8 million m³/year. This has caused flooding in the rainy season and water scarcity in the dry season. Severe environmental degradation in the Citarum River, from upstream to downstream areas, has triggered floods from the Bandung regency to the Karawang Regency, through a distance of 196 km in West Java annually. Within last decade, a flood has occurred in Karawang, the downstream of Citarum Watershed (Kerstens, 2013). Flooding issues in the watershed are managed by the Citarum Flood Control Task. Remediation measures in the watershed are has been implemented such as incorporating re-greening/reforestation schemes as well as the metropolitan city seepage framework.

The upper part of the Citarum Watershed, where the Sanguling Basin is, faces heavy level of chemical and physical pollution, erosion and sedimentation. 190 tons of waste were dumped into the river from farms every day in which 8,000 cows produce 24 kg of waste each. Various activities that take place in the upper part of the Citarum Watershed will certainly affect the performance of hydroelectric power and functions of state and sustainability Saguling Reservoir.

Citarum Previous Programmes

Various programmes have been rolled out, including the “Citarum Bergetar” programme. The “Citarum Bergetar” is a response to concerns in the Citarum River. The plan was implemented to control damage and pollution, and to restore the Citarum Watershed, in hope of improving the process and quality of ecosystem-based spatial planning on the Citarum River. The “Citarum Bergetar” programme serves as a starting ground to inform researchers the extent of its success for future programmes (Andri & Aziz, 2021).

After the Citarum programme, the National Development Planning Agency (Bappenas) proposed the Citarum Integrated Water Resources Management Investment Programme (ICWRMIP) in 2008. The new programme aims to improve the quality of the Citarum River by taking a loan of 50 million US Dollars from the Asian Development Bank (ADB). With this huge amount of money, the programme should ideally be on track to achieving its planned target. However, the results of the programme have been far from promising, with residents of Majalaya, Baleendah and Dayeuhkolot still feeling the impact of the overflowing Citarum River every year.

Another programme that was rolled out in 2013 was the Citarum Bestari (Healthy, Beautiful and Sustainable) movement programme. This programme missed the expected target, which was to ensure that water in the Citarum river can be safe for consumption in 2018. But

the fact is that until now the water from the river has not been suitable for direct consumption because the water quality has not met the specified quality (Pambudi, 2019b). In February 2018 the government as a policy maker issued the latest policy programme namely the “Citarum Harum” programme. “Citarum Harum” encouraged the restoration of the longest river in West Java through concepts and idea like that of the other programmes before. The only exception was that “Citarum Harum” was under direct supervision by the central government coordinated by the Ministry for Maritime Affairs. In this “Citarum Harum” programme, the handling was divided into three stages, namely upstream, middle and downstream. The implementation was carried out in an integrated manner by the central, provincial, district/city governments as well as all relevant ministries, including the Siliwangi Regional Military Command III (Kodam III) and the West Java Regional Police (Polda Jawa Barat).

The Lead Factors

The sustainability of watershed is determined not only from fulfilment status of water supply but also from the quality aspect (Pambudi et al, 2020). Flooding during the rainy season and drought during the dry season are indicators of an unhealthy watershed. It is critical to understand the conditions of the watershed, especially if erosion in the upstream areas resulted in the

reduction of carrying capacity of the water supply (Pambudi, 2021a). The Citarum River, which is located in West Java and is in the Citarum Watershed, has earned the title as one of the most polluted areas in the world. This river has three main problems. In the upstream part of the watershed, there is critical land that often provides input from soil erosion, which then flows along the stream and settles downstream. The accumulated sediment causes a potential flood disaster during the rainy season. The lead factors that influencing the degradation of the Citarum Watershed carrying capacity are:

1. *Lack of coordination and stakeholders' involvement.* The complexity of the issues that expand from its upstream to downstream areas needs to be comprehensively addressed by a variety of related institutions. Lack of community awareness about watershed ecosystem was also a problem in the Citarum Watershed.
2. *Illegal Clearing of Rainforest.* Erosion down the slope occurs when water runoff displaces surface soil during heavy rainfalls. Yet, many farmers still prefer to plant vegetables and crops annually around the slope.

3. *Industrial and Domestic Pollution.* There are 1,500 businesses in Bandung and its periphery, and they deliver 280 tons of compound waste into Citarum consistently as there is an absence of sterilization and wastewater treatment offices. This implies that pollution loads in the waterway framework will be overburdened beyond its capacity limit and its absorption rate. Water quality observed in the last part of the 1990s showed that yearly normal of Body focuses as high as 300 mg/litre.
4. *Biodiversity problems.* The upstream-downstream watershed area can only provide support as a habitat for several species of remaining flora and fauna.
5. *Increasing of Vegetable Land in Upland Area and Decreasing Rice Production.* The horticulture creation of the Upper Citarum Watershed depends as a rule on earthen porches, which are either unprotected or deficiently secured by any disintegration control measures. they are profoundly erodible and helpless against imploding during the wet season. As an effect of expanding vegetable land, a portion of the ranchers change their plants from paddies to vegetables.
6. *Solid Waste.* The yearly uncollected trash that constantly winds up gathering in the waste framework and waterways adds up to 500,000 m³/year.
7. *Groundwater Over Extraction.* Subsidence is severe and basin-wide: From 1988 more than 3-4 meters subsidence; Severe impact on river hydraulics (and flooding); Irreversible aquifer damage starting.

Strategic Plans for Citarum Watershed Management

The Citarum Watershed Strategic Plan is a set of activities with steps to implement the planned strategies. The Strategic Plan includes activities, involvement of stakeholders, and goals for the future to be achieved through the identified implementation steps. All of the activities have a main vision: "All stakeholders [to work] together to enhance the quality of watershed carrying capacity by balancing infrastructure, ecosystem conservation, and community approaches".

The main challenges of implementing the Citarum Watershed management Strategic Plans are related to sectoral coordination (inter sectors) and how to make the plan a priority on national programme supported by adequate funding (national or international). It is additionally challenging to convince local people to be involved/join actively on this plan. One of the first steps to overcoming the increasingly severe watershed damage is to form a community movement that would jointly conserve and protect the watershed ecosystem. To form a community movement, a forum is needed to accommodate aspirations and coordination in managing the watershed.

In principle, watershed institutions are formed based on the awareness and needs of the community around the watershed to carry out better watershed management. Watershed degradation is the result of problems that arise due to conflicts of interest between sectors and between local governments. The establishment of watershed institutions must be based on a shared commitment to achieve the goals of watershed

Table 1. Strategic Plans for Citarum Watershed Management.

Issues / Problems	Proposed Activities	Goal	Key Stakeholders
Lack of coordination and stakeholders' involvement	<ul style="list-style-type: none"> • Map out potential and constraints of Citarum Watershed. • Facilitate stakeholder participation in planning, investment, and implementation. • Prepare integrated development concept for Citarum Watershed 	Institutional Coordination	National Development Planning Agency (Bappenas)
Biodiversity problems	<ul style="list-style-type: none"> • Biodiversity Inventory, Habitat Mapping, GIS Framework • Pilot Project for Forest Restoration/Land 	Biodiversity Conservation	Ministry of Environment and Forestry

	<p>Rehabilitation</p> <ul style="list-style-type: none"> • Mainstreaming Biodiversity <p>Conservation in the Production Landscape</p>		
Illegal Clearing of Rainforest	<ul style="list-style-type: none"> • Conservation and reforestation are balanced with capacity building for farmers to adopt sustainable farming practices. • Campaign to save spring water in the watershed upstream 	Conservation of Upper Watershed	Local Government, Communities, CSO, Private Sector
Community Awareness	<ul style="list-style-type: none"> • Activities in Pilot Demonstration Activities (PDA) is being mobilized to raise the community-driven development and community participatory, including campaign "water and environment for life" to all level communities, man or woman 	Community-Driven Development and Participatory Approaches	Ministry of Social Affairs
Industrial and Domestic Pollution	<ul style="list-style-type: none"> • Improving sanitation and access to clean water in 15 villages along West Tarum Canal in 3 District/City. 	Improvement of Water Supply and Sanitation	Ministry of Health
Increasing of vegetable land in Upland area and decreasing production of rice	<ul style="list-style-type: none"> • System Rice Intensification Method will be implemented in 3.000 Ha rice paddy field in Citarum Watershed (Karawang-Subang and Bandung). SRI Method using organic fertilizer and could save up to 40% water as compared to the conventional method. • Sustainable Financing for Water and Land Conservation in Upland Area through Payment for Environmental Services (PES) 	Improvement of Water and Land Management	Ministry of Agriculture

Solid Waste Flooding	<ul style="list-style-type: none"> • Rehabilitation of Flood Control a long Citarum River (weir, siphon, etc) • Rehabilitation of West Tarum Canal /Diversion Channel 	Improvement of Infrastructure	Ministry of Public Works and People Settlement
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management. With such institutional membership, communication and networking among stakeholders related to watershed management will be built. Each party can obtain benefits, roles, responsibilities and build commitments to achieve common goals in improving community welfare and conserving watershed ecosystems.

CONCLUSION

The Citarum Watershed experiences many problems, both from the physical, institutional, social aspects. It is also affected by previous policy problems that have not been holistic, integrative and integrated. Physical problems that exist are generally influenced by land conversion, heavy rainfall, sedimentation and environmental problems. The lead factors that influenced the degradation of Citarum Watershed carrying capacity are: 1) Lack of coordination and stakeholders involvement; 2) Illegal Clearing of Rainforest; 3) Industrial and Domestic Pollution; 4) Biodiversity problems; 5) Increasing of Vegetable Land in Upland Area and Decreasing Rice Production; 6) Solid Waste; and 7) Groundwater Over Extraction.

Institutions in this area also face the problem of the lack of integration between existing stakeholders, be it government, private, or community in the region. Previous policies tend to solve problems partially and have not placed the social and cultural aspects of the local community as part of the development approach. This has had an impact on the ineffectiveness of the budget disbursed by the government because it does not address the real root cause of the Citarum Watershed problem at the site level.

To solve the problem related to development planning, government agencies and non-government organizations (NGOs) should join and cooperate in a series of dialogues leading to the preparation of the Citarum Watershed strategic plan to improve the management of water resources and restore the environment of the watershed. The planning of the Citarum strategic plan is based on a comprehensive assessment of the development potential and constraints of the watershed, and on multi-sector and integrated solutions for its complex challenges and problems. The National Development Planning Agency (Bappenas) is responsible for the coordination and management of the Citarum Watershed Strategic Plan. Stakeholders should

be involved in all stages from planning and investment of the strategic plan to physical implementation, operation, and maintenance.

REFERENCES

- Andri, Y. & Aziz, Y.M.A. (2021). Environmental policy strategy for Citarum Harum Program in Bandung Regency (Strategi kebijakan lingkungan Program Citarum Harum di Kabupaten Bandung). *Ministrate: Jurnal Birokrasi & Pemerintahan Daerah*, 3(2), 29-39. doi:10.15575/jbpd.v3i2.13561
- Asian Development Bank [ADB]. (2019). *Indonesia: Integrated Citarum Water Resources Management Investment Program (Validation Report 2019)*. Reference Number: PVR-630 Project Numbers: 37049-013 and 37049-023.
- Calder, I.R. (2005). *Blue Revolution: Integrated Land and Water Resource Management*. London, UK: Earthscan Publ.
- Cumming, G.S. (2016). The relevance and resilience of protected areas in the Anthropocene. *Journal Anthropocene*, 13, 46-56.
- Dixon J.A. (1992). Analysis and Management of Watersheds. In P. Dasgupta & K.G, Maler (Eds) *The environment and emerging development issues* (2nd vol.). Oxford, UK: Clarendon Press.
- Djuangsih, N. (1993). Understanding the state of river basin management from an environmental toxicology perspective: an example from water pollution at Citarum river basin, West Java, Indonesia. *Science of the Total Environment*, 134, 283-292. doi:10.1016/s0048-9697(05)80029-4
- Fridayani, H. D. (2020). The Government's role in facing SDGs 2030 Citarum River Clean-up Program, Indonesia: An analysis. *Journal of Governance and Public Policy*, 7(1), 41-50. doi: https://doi.org/10.18196/jgpp.71120
- Government of Indonesia [GoI]. (2003). *The West Java Annual State of the Environment Report*. Bandung, Indonesia: West Java Local Government.
- Government of Indonesia [GoI]. (2010). *West Java Local Government Regulation Number 22/2010: Spatial Planning of West Java Province, Indonesia 2009 -2029*. Bandung: Indonesia: West Java Local Government.
- Government of Indonesia [GoI]. (2014). *Indonesia Minister of Public Works Decree Number 197/KPTS/M/2014: Water Resources Management Planning of Citarum River Basin Territory*. Jakarta, Indonesia: Ministry of Public Works.

- Gregersen, H.M., Ffolliott, P.F. & Brooks, K.N. (2007). *Integrated Watershed Management: Connecting People to their Land and Water*. Cambridge, MA, USA: CABI
- Idris, A.M.S., Permadi, A. S. C., Kamil, A.I., Wananda, B.R. & Taufani, A.R. (2019). Citarum Harum Project: A restoration model of river basin. *Jurnal Perencanaan Pembangunan: The Indonesian Journal of Development Planning*, 3(3), 310-324. <https://doi.org/10.36574/jpp.v3i3.85>
- Kerstens, S. (2013). *Downstream Impacts of Water Pollution in the Upper Citarum River, West Java, Indonesia: Economic Assessment of Interventions to Improve Water Quality (English)*. Water and Sanitation Program Technical Paper, Washington, D.C.: World Bank Group.
- Moleong, L.J. (2010). *Metodologi Penelitian Kualitatif*. Bandung: PT. Remaja Rosdakarya.
- Nakamura, T. (2003). Ecosystem-based river basin management: Its approach and policy-level application. *Hydrological Processes*, 17, 2711-2725.
- Pambudi, A.S. (2019a). Water price calculations in concept of environmental service: A case in Cimanuk Watershed. *The Indonesian Journal of Development Planning*, 3(3), 325-337. <https://doi.org/10.36574/jpp.v3i3.84>
- Pambudi, A.S. (2019b). Watershed management in Indonesia: A regulation, institution, and policy review. *The Indonesian Journal of Development Planning*, 3(2), 185-202. <https://doi.org/10.36574/jpp.v3i2.74>
- Pambudi, A.S. (2021a). *Erosi dan Konservasi Daerah Aliran Sungai dalam Perspektif Ilmu Lingkungan (Erosion and Watershed Conservation in Environmental Science Perspective)*. Banyumas, Jawa Tengah: Amerta Media.
- Pambudi, A.S. (2021b). *A Reflection on The Management of Natural Resources and The Environment in Indonesia*. *Academia Letters, Article 1789*. <https://doi.org/10.20935/AL1789>.
- Pambudi, A.S. (2021c). Overview and evaluation of the Indonesia's water resources management policies for food security. *Indonesian Journal of Applied Environmental Studies (InJAST)*, 2(2), 84-93. doi: 10.33751/injast.v2i2.3586
- Pambudi, A.S., Moersidik, S.S., & Karuniasa, M. (2020). Keterkaitan perilaku masyarakat dengan penggunaan lahan dan erosivitas limpasan permukaan di Sub DAS Lesti, Kab. Malang (Relationship between community behavior with land use and surface runoff erosivity in Lesti Subwatershed, Malang District). *Jurnal Penelitian Pengelolaan Daerah Aliran Sungai (Journal of Watershed Management Research)*, 4(2), 155-172. doi <https://doi.org/10.20886/jppdas.2020.4.2.155-172>
- Soemarwoto, O. (1999). *Environmental Impact Analysis (Analisis Mengenai Dampak Lingkungan)*. Yogyakarta: Gadjah Mada University Press.
- Watson, J.E., Dudley, N., Segan, D.B., & Hockings, M. (2014). The performance and potential of protected areas. *Nature*, 515, 67-73.