Fisheries technology innovation supports the Citarum Harum program

J Haryadi1*, A S Nastiti1 and Krismono1

1Research Institute For Fisheries Resources Enhancement, Jalan Cilalawi No. 1 Jatiluhur, West Java, Indonesia 41152

*Corresponding author: joniharyadi73@yahoo.co.id

Abstract. Indonesian waters cover about 75% of Indonesian areas and have an abundance of fish resources that must be used carefully and responsibly to maintain its sustainability. Indonesian waters must be considered by authorities and communities to increase fisheries production and habitat quality. One way is by using technological innovation. The Government launched the Citarum Harum Program, as the Government’s attention to the Citarum River. Citarum River has about 11,323 km² large. The length of the river is about 300 km, starts from Mount Wayang until Java sea. Citarum River dammed into three reservoirs developed for fish culture (Saguling Cirata and Juanda) and industries, domestic, agriculture also animal husbandry along the river. The impact of the river is experiencing pollution. The World Bank responded to this condition and has the intention to improve the water quality of the Citarum river. The Research Institute for Fisheries Resources Enhancement under The Ministry of Marine and Fisheries made efforts to control industrial waste pollution through technologies. The technologies are phytoremediation, culture-based fisheries models (blooming Cyanophyceae, and Eichhornia crassipes with herbivorous/planktivorous fish stock), and KJA Smart. Innovation in fisheries technology is one of the bases for the management of water bodies in support of the Citarum Harum program.

Keywords: Technology innovation, sustainable fisheries, Citarum Harum program

1. Introduction
Geographically Indonesia stretches from 6°8′ North Latitude to 11°15′ South Latitude and from 94°45′ to 141°65′ East Longitude, consisting of large and small islands, which number approximately 17,504 islands. About 75% of its territory is the sea (5.9 million km²), with a coastline length of 95,161 km, the second-longest after Canada [1]. The mainland waters of Indonesia have an area of 13.85 million hectares consisting of 12.0 million hectares of rivers and flood plains, 1.8 million hectares of natural lakes, and 0.05 million hectares of artificial lakes (human-made lakes) or reservoirs. In the fisheries sector, Indonesian territorial waters are utilized to capture fisheries and aquaculture activities. The abundance of fish resources in the sea and inland public waters in Indonesia provided catch fisheries about 66-77% in 2014. The potential of capture fisheries in inland public waters is estimated at 3,034,934 tons year⁻¹. Aquaculture, mainly freshwater, develops economically and productively [2]. In the future, Indonesian freshwater aquaculture plays a vital role in donating fish for domestic consumption, yet the potential of aquaculture export has not been used optimally, mostly marginal peatlands [3].
In Indonesia, 52 rivers have been recorded in high polluted status conditions. Of the 450 Watersheds in Indonesia, 118 watersheds are in critical condition [3]. Furthermore, 100 river flows have been recorded in 33 provinces in Indonesia. In the Special Capital Region of Jakarta, the Ciliwung River from 2013-2015 was heavily polluted. In East Java, heavily polluted rivers are the Bengawan Solo River, the Madiun River, and the Surabaya River. Likewise, Yogyakarta, there are features of the Progo River, Krasak River, Sudu, Opak, and Serang, which are also heavily polluted. Whereas in Kalimantan, the Barito River and Martapura River are bearing heavy pollutants for three years in a row. In West Java, there are heavily polluted Citarum, Cisadane, and Citanduy rivers.

The Citarum river as one of the polluted rivers in West Java described in this paper. According to Government Regulation No. 35 of 1991 regarding the river defines a river area is a unit of the irrigation as a result of the development of one or more river drainage areas. In its management, it must cover the entire river area. Citarum River has an essential meaning now and in the future. The benefits are not only for the interests of the people of the Jakarta Special Capital Region but also for the national part. Citarum River is the main river and one of the largest in Java Island, with a length of about 300 Km with a watershed area of 6,080 km². Upstream from the Citarum River in Gunung Wayang, Kertasari District, Bandung Regency at an altitude of 2182 meters above sea level and the end into the Java Sea. Citarum River is the main river and one of the largest in Java, with a length of about 300 km with a watershed area of 6,080 km². Citarum River crosses 7 Regencies and 2 Cities, namely Bandung, Cianjur, Bogor, Purwakarta, Karawang, and Bekasi Regencies and Bandung and Cimahi Cities. Tributary has a length of around 873 km [5].

Pollution of the Citarum River has an impact on decreasing productivity. According to [6], the neglected terrestrial public waters will affect reducing the potential breadth, diversity of fish species, fish production, employment opportunities and opportunities (increasing unemployment), local original income, and aesthetic functions. Proper management of public waters will affect a minimum increase in production of 20% and ecological functions so that inland water fisheries can be used as a foundation for community economic development, mostly fishermen and fish cultivators. Fish cultivation activities are concentrated in the inundated Citarum river, namely the Saguling, Cirata, and Jatiluhur reservoirs in each water body based on the Fisheries Business Permit (SIUP) of the Regency Fisheries Service as follows: 4,550; 98,397 and 36,051 plots. However, based on Landsat imagery, the number of plots in Juanda Reservoir in 2016 was 48,989, and in 2017 there were 49,024 plots. Because of the polluted water, it is almost sure that at the beginning of the rainy season (end of September), there will be a mass death of fish farming. The condition of the Citarum river needs to be revitalized immediately. For its preservation, because the Citarum River socially becomes a place of dependence on the local community and the Jakarta Capital City to carry out a prosperous and healthy life managed by the Government (agricultural irrigation, water sources for industry and electricity generators) and the community. Ecologically the river, a body of water that is inundated into a habitat for fish biodiversity and fish culture containers that require water quality following water quality standards set by the Government.

The Government has made many efforts since 2003 to address the decline in water quality of the Citarum river, but the target of providing clean water has not achieved yet. The peak of the Citarum river revitalization program is announced in Presidential Regulation No. 15 of 2018 concerning: Acceleration of Pollution and Damage Control in the Citarum River Basin, which is popularly known as the “Citarum Harum Program”. In its consideration, it was stated that for the prevention of pollution and damage to the Citarum watershed, integrated acceleration and strategic steps for control and law enforcement must be taken, which integrate authority between government agencies and related stakeholders for the recovery of the Citarum watershed. In accordance with Presidential Regulation No.15 of 2018 Chapter I paragraph 4-7, the Research Institute for Fisheries Resources Enhancement as a technical implementing unit of the Ministry of Marine Affairs and Fisheries of Republic of Indonesia has produced fisheries technology innovation to improve the habitat and population of fish resources. Some of the technologies are KJA Smart to reduce water fertility; Phytoremediation technology to reduce pollution from industrial waste; Control water hyacinth to improve water quality; CBF (Culture Base Fisheries) to control phytoplankton blooms and increase fish catch production; early warning
technology with a fish mortality calendar and the Buoy PLUTO instrument (in collaboration with the Center for Marine Research).

2. Characteristics of Citarum River
The Citarum River Region is geographically located at 106 ° 51’36 “-107 ° 51 ‘E and 7 ° 19’ -6 ° 24’ S, with the following boundaries: North: the Java Sea, east: Cimanuk River-Cisanggarung, southside: Ciwulan-Cilaki River and Cisadea-Cibaren River, westside: Ciliwung-Cisadane River. The Citarum River region has an area of 1,132,334 Km² or 32.01% of the scope of West Java Province (35,374.38 Km²). Based on Government Regulation No. 26/2008 concerning National Spatial Planning, the Citarum River Basin has 2 National Strategic Areas and 3 Mainstay Areas. National Strategic Area covers Urban Area (Jakarta, Bogor, Depok, Tangerang, Bekasi, Puncak, Cianjur) and Bandung Basin (Bandung City, Cimahi City, Bandung Regency, West Bandung Regency, Sumedang Regency). Mainstay Areas cover Bogor-Puncak-Cianjur, Purwakarta-Subang-Karawang, and Bandung Basin [7]. Based on the Minister of Public Works and Public Housing Regulation No.04/PRT/M/2015, the Citarum River Basin is in the administrative area of West Java Province in Tables 1, 2, and Figure 1 [7].

| Table 1. Citarum River Region |
|--------------------------------|
| **River Region** | **West Java Province** | **City** |
| Citarum | 1. Cianjur | 1. Bandung |
| | 2. Bandung | 2. Cimahi |
| | 3. Sumedang | 3. Indramayu |
| | 4. Indramayu | 4. Subang |

| Table 2. List of Citarum River Basin |
|-------------------------------------|
| **No** | **Name of River Basin** | **Area of River Basin (km²)** | **Long River (km)** |
| 1 | Citarum | 6617 | 279 |
| 2 | Sedari | 232.1 | 23.17 |
| 3 | Cisaga | 69.01 | 19.36 |
| 4 | Cibadar Dua | 195.2 | 34.37 |
| 5 | Cibadak | 147.3 | 35.11 |
| 6 | Cikarokroko | 364.5 | 59.46 |
| 7 | Cibanteng | 74.72 | 17.58 |
| 8 | Cimalaya | 522.30 | 91.8 |
| 9 | Cigemari | 127.70 | 18.26 |
| **Total** | | 10,670.53 | 968.16 |

* [7]  
** Spatial analysis
3. Citarum River function and utilization

Inland public waters play an important role as a source of protein and food security, a source of the economic community, a source of employment, a source of genetic and genetic resources, a source of foreign exchange and original local income, as well as a natural tourism object (ecotourism) [6]. There are several places to support the increased productivity of Citarum River (Table 3).

Table 3. Dams in the Citarum River Basin [7]

| No | Dam   | Operation | River  | Catchment Area (km²) | Volume x10³m³ | Function                     | Management |
|----|-------|-----------|--------|----------------------|---------------|------------------------------|------------|
| 1  | Saguling | 1986 | Citarum | 2,283                | 900,000       | Irrigation /Hydropower Plant | Indonesia Power |
| 2  | Cileunca | 1984 | Cileunca | 21                   | 11,000        | Hydropower Plant             | PLN        |
| 3  | Cipanjuang | 1930 | Cipanjuang | 8                   | 18,500       | Hydropower Plant             | PLN        |
| 4  | Cirata  | 1988 | Citarum  | 4,119                | 1,900,000     | Hydropower Plant             | PJB        |
| 5  | Jatilhur | 1967 | Citarum  | 2,283                | 2,500,000     | Irrigation /Hydropower Plant | PJT II     |

Figure 1. Map of the Citarum River Basin [7]
The allocation of the Citarum river and its tributaries based on the Decree of the Governor of West Java Province No.30 of 2001 are drinking water sources; water source for fisheries and animal husbandry; water source for agriculture, business urban, industrial and hydroelectric power plants. All these rations produce several types of waste, such as municipal and urban waste, industry, agriculture, livestock, fisheries, and pollution from the mud. Besides the function that has been mentioned, the Citarum River is also a waste receiving water body (Table 4).

**Table 4. Some Activities that Produce Waste Entering the Citarum River [5, 8]**

| Waste               | Locations                                                                 | Explanation                                                                                                                                 |
|---------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Population and urban areas | Majalaya, Bandung City, and Purwakarta Regency, Karawang, Bekasi         | Domestic waste both directly and from leachate* and solid waste in Figure 2.                                                            |
| Industries          | Upstream of the Citarum River                                             | 600 industries                                                                                                                                 |
|                     | Majalaya, Rancaekek, Cimahi, Banjaran, Cisirung, Batujajar               | Only 10%                                                                                                                                 |
|                     | Lower Citarum River (Taran Barat)                                        | have a Waste Water Treatment Plant                                                                                                       |
| Agricultural        | Upstream of the Citarum river (Kertasari District Lembang, Pangalengan)  | Agricultural fertilizer                                                                                                                   |
| Fisheries           | wasted feed and feces                                                     | Manure from the farm                                                                                                                     |
|                     | Waduk Saguling (Bongas)                                                   | The number of cage culture Saguling: 4550, Cirata: 98397, and Jatiluhur 36051 plots based on Fisheries Business Permit from the Regency Fisheries Service. Based on Landsat imagery the number of plots is higher, in Jatiluhur reservoir in 2017 as many as 49,024 plots |
|                     | Cirata (Cikalong wetan)                                                   |                                                                                                                                              |
|                     | Jatiluhur (Cilalawi)                                                      |                                                                                                                                              |
| Mud                 | Forest without plants                                                    | The level of erosion from very low to very high 0.73-592.11 tons/ha/year [7]                                                               |
|                     | Upstream of the Citarum river                                             |                                                                                                                                              |
|                     | Sand mining                                                               |                                                                                                                                              |

*) Leachate water that comes out of the garbage pile due to its rainwater seepage into the pile of waste then compounded with the components of the decomposition of garbage flowing into the body of water that can pollute river water or seep into the ground.

According to [8], the deteriorating water quality in the Citarum river basin is caused by industrial wastewater that is not appropriately treated and the behavior of people who still throw garbage, household waste, agriculture, and livestock directly into the river.
Observations made by each reservoir operator, namely PT. Indonesia Power (Saguling), PT. Java Bali (Cirata) and PJT II (Jatiluhur), show that the metal content in the three reservoirs has exceeded the threshold for the class of raw water designation. Drinking water (Class I/PP no 82/2001) [9] so that the water in the three reservoirs is not suitable for raw drinking water. The heavy metal parameters which become the limiting are iron, manganese, nickel, copper, zinc, lead, and cadmium, and mercury. Besides being used for raw drinking water, it is also used for fish farming. Therefore it is necessary to handle carefully and responsibly to make efforts to restore water quality. This matter is following the Program Citarum Harum launched through Presidential Regulation No.15 of 2018 concerning Acceleration of Pollution and Damage Control in the Citarum River Basin.

4. The innovation of fish resources technology enhancement

The word “Innovation” in an Indonesian Dictionary means: 1) Importance or introduction of new things; renewal, 2) Recent discoveries that are different from those already exist or have known before. Innovation can be in the form of ideas, methods, or tools. The innovation of fish resources technology enhancement is a new invention in the form of technology that contributes to the process of efforts to restore the condition of fish resources, which were previously degraded/damaged for better and more productive sustainable waters. Research Institute for Fisheries Resources Enhancement has produced innovation technologies including KJA Smart, Capture Fisheries Based on Cultivation/Culture Base Fisheries (CBF), Control/eradication of water weeds, phytoremediation, determination of carrying capacity of water bodies, and early warning system for the mass death of fish culture.

4.1. KJA Smart

KJA Smart is motivated by eutrophic-hypereutrophic water conditions so that the dissolved oxygen concentration is deficient and can even be detected. The research locations were in the Saguling, Cirata, and Jatiluhur reservoirs. The concentration of dissolved oxygen becomes a key parameter for fish life. KJA (Keramba Jaring Apiung) Smart is a floating net cage in the water management system with recirculation and plants. KJA Smart is an aquaponic system that is modified and applied in open water [10]. This technology can reduce the content of P-PO4, N-NO3, and organic matter after passing aquaponic plants are 6.3-84.8%, 4.1-77.7%, and 8.8-90.71 % so that it can be used to manage water quality in fish culture in floating net cages. SMART KJA Smart has become a technology recommendation published by the Agency for Marine and Fisheries Research and Development in 2016 [11].

4.2. Culture-Based Fishery (CBF)

CBF is an effort made to optimize the utilization of natural productivity of waters through the conservation of raw food resources into fish biomass without damaging the environment. The mechanism of regulating some reservoir waters and situ in Java has been carried out through the development of CBF [12]. According to [13], applying CBF technology in waters can increase fish production by adding abundant natural food or utilizing natural food at mesotrophic fertility to hypereutrophic fertility levels.

A negative/detrimental effect for the waters themselves if the excessive abundance of phytoplankton or at the level of eutrophic-hypertrophic is a drastic decrease in the concentration of dissolved oxygen in the water column below the surface if the condition is more than 8 hours will cause mass fish death. According to [14], Industrialization in mainland public waters fisheries, if carried out in a sustainable management concept through a fisheries development approach based on CBF and controlling cultivation activities, will support the national food security program.

4.3. Control/eradication of water hyacinth weeds

The rapid development of water hyacinth weeds has caused various changes in aquatic ecosystems, including a decrease in water quality due to water hyacinth leaf litter. Allelopathy, pressure on fish and plankton populations and siltation due to evaporation on the surface of water covered by water hyacinth weeds has an evaporation speed from a surface covered with water hyacinth three times
faster than open surface waters [15]. Such is the case in three large reservoirs (Jatiluhur, Cirata, and Saguling) in the Citarum River (Figure 3a, b, and c). According to [15], the rate of browsing of koan fish/China Carp (*Ctenopharyngodon idella*) with a density of 100, 200, and 400 fish with 10 kg of water hyacinth biomass affects the increase in aquatic productivity.

![Image of reservoirs](Saguling Reservoir[16] Cirata Reservoir [17] Juanda-Jatiluhur Reservoir June, 2019)

**Figure 3.** Conditions of Saguling, Cirata, and Jatiluhur Reservoir Waters that are covered by Water hyacinth (*Eichhornia crassipes*)

4.4. Calculation of carrying capacity

The carrying capacity of the Jatiluhur Reservoir needs to be calculated as a first step in estimating the maximum amount of KJA so that the negative impacts of KJA activities can be avoided. Based on the results of calculations with the Beveridge method in this study, the number of plots KJA has been excessive. The optimal number of KJA in the Jatiluhur Reservoir is 19,401 plots [18]. In 2012, the carrying capacity of the Jatiluhur reservoir amounted to 5,365 tons of fish, which is equivalent to 2,364 KJA plots based on phosphorus input loads from KJA aquaculture activities while the number of KJA operating reached 21,579 plots. In 2016 the number of KJA was 48,989 plots [19], whereas, in 2017 from the Landsat imagery, there were 49,024 plots.

4.5. Phytoremediation

Phytoremediation is a method for washing waste using plants. The form of this method can be in destruction, inactivation, or immobilization of waste to a harmless way. The ability of plants to absorb waste varies greatly. Only plants that have hyperaccumulator properties on specific heavy metals are used for phytoremediation. In Indonesia, the problem of pollution continues following the progress of the industry so that remediation efforts and prevention of pollution need to be considered. Phytoremediation is expected to make a real and practical contribution to efforts to maintain and improve environmental quality in Indonesia. Plants that can be used as phytoremediation are plants that have several characteristics such as being able to consume large amounts of water in a short time, being able to remediate more than one pollutant, tolerant of contaminants and have fast growth.

The types of plants that can be used are spinach, kale, weeds (*Mimosa pudica* /shameplant, some types of grass, aquatic weeds), sunflowers, and azolla. Heavy metals that can be accumulated by these plants are cadmium (Cd), zinc (Zn), cobalt (Co), copper (Cu), lead (Pb), mercury (Hg), manganese (Mn), nickel (Ni), petroleum and radioactive material. Some examples of other phytoremediation applications are carried out by the wetland or wastewater garden method. Waste is channeled into a storage pond planted with aquatic plants, which are hyperaccumulators (for example, water hyacinth, apu wood) (Figure 4). This system has been used in several areas such as Bali and an explosives factory in Tennessee, United States. Sunflower is used as phytoremediation to overcome nuclear radiation contamination on the ground after the nuclear leak disaster in Chernobyl, Hiroshima, and Fukushima.
According to [21] that *Pistia stratiotes* aquatic plants were able to reduce heavy metal Cu at a concentration of 2 mg.L\(^{-1}\) by 94\% and 5 mg/L by 90\%. Still, the *Pistia stratiotes* plant suffered damage in the form of chlorosis and necrosis at both concentrations. In comparison, in aquatic plants, *Salvinia molesta* can reduce heavy metal Cu by 96\% at a concentration of 2 mg.L\(^{-1}\) and 95\% at 5 mg.L\(^{-1}\) without damage. Pakcoy plants are also able to accumulate heavy metals Cu in the roots and canopy of plants. The value of heavy metal Cu content in the roots and canopy of the Pakcoy plant is above the threshold of Cu metal in vegetables. According to [22], *Pistia* sp. (water lettuce) can reduce BOT and P-PO\(_4\) by 55.52\%, and 60.62\% and *Eichhornia crassipes* reduce BOT and P-PO\(_4\) by 23.38\% and 92.68\%.

4.6. Early warning system

The early warning system is a technology to provide early warnings before the death of mass aquaculture to fish farmers.

Fish Death Calendar is a guide for fish farmers to be aware of fish deaths in Figure 5. Cases of mass fish deaths in floating net cages occur every year in the Juanda-Jatiluhur reservoir. The calendar is also published; the target is policymakers. The function of the fish death calendar is to provide preparedness to farmers and managers, that there will be mass fish deaths [23]. Fish farmers take several steps so as not to suffer losses, including harvesting, reducing the amount of feed, reducing the number of fish, preparing a cooler or salt to preserve fish so that it is suitable for human consumption.

Buoy PLUTO (Perairan selaLU termoniTor) is a device that floats in waters and connected to the internet so that active android applications can monitor the condition of lake waters and reservoirs in real-time, some of the parameters detected are temperature, turbidity, and dissolved oxygen. This tool
was engineered by researchers from the Center for Marine Research - Ministry of Maritime Affairs. Buoy PLUTO has been applied in the Jatiluhur Reservoir, Cirata, Saguling, Kedung Ombo, and Lake Maninjau in Figure 6 [24]. Fish farmers, through mobile phones, can find out the concentration of dissolved oxygen at that time. The results of the interviews with fish farmers in Lake Maninjau is the information is beneficial and useful. By reading the information from the mobile phones, the farmers take precautionary measures if dissolved oxygen is low (below 5 mg.L$^{-1}$), then reducing the amount of feed. Despite mass fish deaths, farmers said they had not suffered losses due to harvesting fish before or reducing the amount of feed.

**Table 5.** Some activities that produce waste entering the Citarum River and innovations technology.

| No  | Waste                      | Locations                                      | Explanation                                                                 | Innovation Technology               |
|-----|----------------------------|------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------|
| 1.  | Population and urban areas| Majalaya, Bandung City, and Purwakarta Regency, Karawang, Bekasi | Domestic waste both directly and from leachate * and solid waste (Figure 3). | Phytoremediation                    |
| 2.  | Industries                 | Upstream of the Citarum River                  | 600 industries                                                            | Phytoremediation                    |
|     |                            | Majalaya, Rancaekek, Cimahi, Banjaran, Cisirung, Batujajar                     | Only 10%                                                                  | Have a Waste Water Treatment Plant  |
|     |                            | Lower Citarum River (Tarum Barat)               | have a Waste Water Treatment Plant                                         |                                     |
| 3.  | Agricultural               | Upstream of the Citarum river                  | Agricultural fertilizer                                                   | Phytoremediation                    |
|     |                            | (Kertasari District Lembang, Pangalengan)        | Manure from the farm                                                      | Control/Erradicating Water Hyacinth |
| 4.  | Fisheries                  | Waduk Saguling (Bongas) Cirata (Cikalong wetan) Jatiluhur(Cilalawi)             | The number of cage culture in Saguling 4,550, Cirata 98,397, and Jatiluhur 36,051 plots based on Fisheries Business Permit from the Regency of Fisheries Service. Based on Landsat imagery, there were 49,024 plots in Jatiluhur reservoir in 2017 | KJA Smart, CBF, Control/Erradicating Water Hyacinth, Carrying Capacity, Fish Death Calendar, Buoy PLUTO |
| 5.  | Mud                        | Forest without plants Upstream of the Citarum river | The level of erosion from very low to very high 0.73-592.11 tons.ha$^{-1}$.year$^{-1}$ [7] | Reforestation                       |
|     |                            | Sand mining                                    |                                                                            |                                     |
5. Management

These policy options must be followed by the application of ecosystem-based co-management (Ecosystem Approach for Fisheries Management/EAFM and Ecosystem Approach for Aquaculture/EAA). EAFM and EAA are in the framework of integrated water body management (Integrated Reservoir Management), so the sustainable resource is achieved in ecosystem power and health [19].

Stages in management organized by the Government:

1. Involving the components directly involved in integrated management for the target of improving the quality of Citarum river water from upstream to downstream (Figure 7) based on Government rule No.82 of 2001, including:
   a. Water Management Agency (Indonesia Power, PJB, PJT II)
   b. West Java Province Environment and Forestry Office and Technical Implementation Unit
   c. BBWSC (Balai Besar Wilayah Sungai Citarum)
   d. Fisheries and Agriculture Agencies along the Citarum River
   e. 600 industries along the Citarum river
   f. Districts and villages along the Citarum river
   g. Community Groups (POKMASWAS) along the Citarum river

2. Appoint a program coordinator and subprogram in each program implementing unit.
3. Arrange an Integrated Water Quality Improvement Efforts Program (Table 5).
4. Set an Implementation Schedule for Integrated Water Quality Efforts.
5. Conduct FGD meetings in discussing results or output and compiling reports.
6. Arrange spatial planning, regulations following the carrying capacity, and licensing.
7. Hold FGD meetings to develop regulations and sanctions for violators who dump trash into the Citarum river
8. Integrate monitoring and surveillance of the Citarum river, which is taken every semester.
9. Follow up monitoring and surveillance.
10. Propose regulations and sanctions to maintain the sustainability of the Citarum river in an integrated manner.
6. Review
The adoption and implementation of technological innovations in the recovery of fish resources will be carried out immediately to revitalize the Citarum river.

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