E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2020; 8(1): 122-128

www.fisheriesjournal.com
Received: 22-11-2019
Accepted: 24-12-2019

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Factor confronting the resilience of cirata reservoir social ecological systems (Case study cirata reservoir district Cianjur, West Java Indonesia)

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Abstract
Water resources of Cirata Reservoir have a very important ecological, economic and social functions. A number of economic and industrial activities develop with supports of these resources, among them are capture fisheries, floating net cage system and tourism. This situation challenges the social ecological system's resilience, the capacity of an ecosystem to survive an interruption and then restore its essential basic functions. The development of derivative functions in capture fisheries and floating net cage aquaculture at this time has reached a stage of overcapacity and caused degradation in ecological, economic and social functions of the resources. This research was conducted to formulate a strategy to strengthen the resilience of Cirata Reservoir social ecological system by means of socio-economic approach. The data used collected the survey method which 40 respondents representing main actors of fisheries, aquaculture and aquatic tourism. Through resilience analysis, a general analysis was conducted to further develop a dynamic model directed toward a small-scale fisheries management policy scenario to strengthen its resilience with SWOT analysis.. Based on the analysis, it was found that SWOT analysis posision in qudrant 1 the value is 1.05; 0.215 included the Strength-Opportunity Strategy (SO) and the resilience of Cirata reservoir social ecological system(SES) was highly confronted by several attributes, namely weather conditions, availability of fish resources as related to high intensity of utilization, production input prices, transaction costs and social capital assets.

Keywords: Fisheries**,** social ecologicsl system, resilience, reservoir, floating net cages

1. Introduction
The general environmental condition of waters, including the Cirata reservoir, is one of the reservoirs built in the Citarum River Basin (DAS) in 1987. Cirata reservoir has the main function as a hydroelectric power plant for Java - Bali region. The other functions of this reservoir is as a tourism area and aquaculture. Fish cultivation activities are widely developed is aquaculture fish Floating Net Cage system [1].
The nature of reservoir waters is regarded as common property and open access cause floating net cage growth in various places is growing very rapidly and tends to be uncontrolled and uncontrollable [2]. If the restriction floating net cage 12,000 units in Cirata is based on the carrying capacity of the waters, it is suspected that there has been an excess of floating net cages in Cirata Reservoir [3].
The biophysical changes as well as the socio-economic impacts on communities are major challenges in aquaculture and fisheries sectors under climate change scenarios [4]. Require institutional resilience to handle the stresses of the water environment is technically and non technically. Resilience social ecological systems such common water environment pollution bio-physical degradation of ecosystems, over exploitation of fisheries resources, the conversion of protected areas, and conflict resources [5]. Water environment management approach aims to coordinate the development and management of water in order to maximize economic and social welfare for the community [6].
Cirata reservoir conditions must be managed properly so as not to cause socio-economic conflicts that occur in the community especially affected by the construction of Cirata reservoirs, all stakeholder involved in the use of Cirata reservoir have been the same goal that the utilization of Cirata reservoir optimally and sustainable without sacrificing one of the functions main and derivative functions of the Cirata reservoir [5].

Several processes related to community and public water is water vegetation, land use, social activity, and regional economy. In this case there is a pattern of interactions that can contribute to an understanding of the interaction between community and the public waters. The public water system has undergone changes in ecological components such as the development of algae and aquatic plants such as water hyacinth in public waters, which is an indication of changes in ecological conditions that are considered to be ecological crises [7]. Ecological crisis with indicator of primary production, species, carrying capacity, aquatic ecosystem, productivity, turn over, coevision of variability and water quality have happened change which cause decrease of ecological value. The ecological decline of ecology causes the economic parameters of the benefits of using the general distribution for freshwater aquaculture to change with the profitability indicator of floating net cages business and fishery investment, fish farmer's income. Ecological and economic conditions will have implications for social conditions with conflict social indicators [5-7].

Water resource management should be able to scope with environmental stress (resilience) because it has many stakeholders. The aquatic environment has undergone many changes that are relatively rapid compared to the land environment. Utilization of water resources to pressure on the environment public water and thus potentially threatening general resilience of social ecological systems contained therein [8]. Rapid changes occurring in the world in which we live today has given rise to various environmental impacts ecosystems including aquatic resources, so the demand for the immediate rehabilitation. Management of the ecological system of aquatic resources in which there is a social system that plays an important role as a factor driving change, one of the main constituent elements is the idea of the resilience of ecological social systems that see resilience as key to sustainable development.

Resilience is the ability of a particular social ecological system to be able to withstand interference by absorbing and directing it so that the variable state in the system does not change [9]. Social resilience can be reflected in how a community group acquires, controls and maintains access to critical resources for their survival [10].

The resilience of social ecological system of the environment public waters (reservoirs, lakes and rivers) such as pollution of wastes into exponentially rising waters that threaten human health, ecosystems and biodiversity, the growth of invasive species, the occurrence of turnover resulting in mass mortality in reservoir areas and lakes that resulted in the sustainability of water resources [11].

Social ecology system is defined as an integrated system of natural and human resouces with a reciprocal relationship [12]. The social ecological system of an interconnected ecosystem system between social systems, in the sense of establishing mutual cooperation and relationships with others [13]. Resilence is the main framework in different sectors and contexts, on different scales [14]. Perspective resilience of ecological science in the decade of the 60s and 70s of the study populations such interactions between predators and prey and functional response in terms of the theory of ecological stability. Resilience and stability illustrate the existence of multiple stability domains in natural systems, as well as those associated with ecological processes, random events, and heterogeneity based on temporal and spatial scales.

Resilience as the capacity to survive in a domain in the face of change, and propose the theory that resilience determines the persistence of relationships within a system and is a measure of the ability of the system to absorb state change, direct, and maintain its variable state [15]. There are two mainstreams about the definition of resilience: (1) technical aspects such as inertia or inertia and plasticity; (2) aspects of the ecosystem, resilience is essentially defined as the capacity of an ecosystem to survive an interruption and then restore its essential basic functions. Ecosystem resilience is the capacity of an ecosystem to tolerate an interference without changing its main structure and function [16]. Resilience is the dynamics of an economic-environmental system. In conventional economic systems, the environment is often not taken into account in the production and consumption process. The exclusion of the environment as a component of the economic system is ironic because both production activities and consumption activities always interact with the environment [17].

The linkage between human systems with natural resources and their artificial resources is known as the social ecological system. Social ecological resilience needs to be better understood on a wider scale and actively managed and maintained. Social ecological resilience includes a variety of mechanisms for survival and learning from suddenly changing conditions. Social ecological resilience is the capacity of interrelated social ecological systems to absorb disturbance and change. The development of social ecological system resilience is key to sustainable development.

2. Method

2.1 Description of the research location.

The research method used a case study on the resilience of aquaculture floating net cages in public waters Cirata Cianjur district West Java Province. The case study is intended to study intensively about the background of the problem, the state and the status of resilience aquaculture of floating net cagas system, as well as its interaction with the environment or the ecosystems that influence.

Research location in Cirata reservoir Cianjur district West Java Province. The research was conducted in September 2017 until May 2018. The data used in this research consisted of primary and secondary data. Primary data obtained from the interview with respondents by using questionnaires and in-depth interviews with community leaders. While the secondary data obtained from the recording done on the location of research and statistical data collected by local agencies such as Department of Marine and Fisheries West Java Province, Central Statistics Agency of district Cianjur. In addition, data and information from several studies on research reports and results of activities in the same location, scientific publications, regional regulations, data from other government agencies, private and non-governmental organizations and universities were also obtained.

2.2 Data analysis

The data collection method applied is a survey method. In the survey method, data collection was conducted on a part of the population or by sampling that was considered to represent the entire population in this reserach [18]. In accordance with the problem approach framework, the data collected includes data relating to factors affecting the resilience of aquaculture floating net cages in Cirata reservoir.

Primary data were collected by direct observation in the field and interviews using questionnaires containing a list of questions related to the observed variables. Direct observation at the research site is aimed to obtain a description of the area, the situation and condition of the research location, and to verify the data obtained from the interview with the reality. Secondary data was collected by means of a literature research in institutions or agencies, which include information about the general description of the area of research and other information that can support this research. Data analysis used SWOT matriks for combination internal and external factor with scoring value. SWOT analysis is the systematic identification of various factors to formulate strategy. This analysis is based on logic that maximizes strength and opportunities, but simultaneously can minimize weaknesses and threats [19].

$$Quadrant\ SWOT = \frac{S-W}{2}; \frac{O-T}{2}$$

The socio-ecological system approach is used as a framework for resilience analysis, where the concept of resilience is generally defined as the ability of the system to maintain or absorb shocking consequences while maintaining the function and shape of the system [20]. The SES approach takes a nonlinear view of system development, by the adaptive cycle of the four stages of exploitation, conservation, release, and reorganization-through which the system can return to its original state, or have formed a new cycle [21].

3. Results and Discussion

3.1 General condition of research location

Cirata reservoir built in 1982-1987 is located at an altitude of 221 m above sea level. The extent of 6,200 hectares (ha) with a water catchment area of 603,200 ha, an average depth of 34.9 m and a volume of 2300,000 m^2 [1]. The puddle areas include Cianjur, Purwakarta and Bandung districts. The largest area of puddle is in Cianjur district. The development of freshwater aquaculture in Cirata an initiation of the International Center for Living Aquatic Resources Management (ICLARM) in collaboration with the Research Center for Natural Resources and the environment Padjadjaran University which aims to substitutem settlements affected by the Cirata reservoir project.

In the final report of Cirata and Saguling environmental studies and training the aquaculture system applied is floating net cages in one floating net cage unit there are layered net four ponds with 7 x 7 meter net size for 3,000 family heads or as many as 1,600 units. Furthermore, based on West Java Governor Decree number 41 of 2002 on Public Water Utilization Development, Agriculture and Land Reservoir Region Cirata.yang them aim to improve the functioning and optimally useful reservoir through the provision of opportunity for local people to strive in the field of fish farming and agricultural land use as well as tourism development within the limits and technical requirements determined by the management agency, with no consequence to interfere with the preservation and main function of the reservoir [6].

Cirata reservoir management is inseparable from the local government policy as the arbitration institution of various stakeholder that play a role in the use of reservoir cirata. The consistency of West Java Province government in the use of Cirata reservoir as public waters that can be used for aquaculture fishery, must be able to do mapping (specific location) of aquaculture fisheries as part in supporting the sustainability of aquaculture fishery in reservoir cirata. Cirata reservoir management is inseparable from the local government policy as the arbitration institution of various stakeholder that play a role in the use of Cirata reservoir [5].

Ecosystem-based fisheries management is an approach that uses the main components of aquatic environments. Various changes in the biosphere is often preceded by human intervention as a form of interaction with the system environment. The human ecological viewed that the relationship of ecological systems interacts with the social system. The flow of mass, energy, and information connecting the ecosystem and social system, causing the quality of ecosystems may be affected by the social system or social system was influenced by ecological conditions. Utilization of the reservoir function is inseparable from the economic value of profit for utilizing of Cirata stakeholders [7].

3.2 Characteristics of Respondents

Characteristics of respondents is the age structure of fish farmers floating net cages is the range 20 until 30 years of 34.14% are at productive age, to conduct a business activity. Productive age in this case means the phase in which a person has been able to carry out production activities in economic terms to meet the needs of his own life as well as others. The level of formal education of fish farmers floating net cages for 48.78% is primary School graduates, 36.58% of graduates of Junior High School and 12.19%. is senior high school.

3.3 General condition of research location

Cirata reservoir built in 1982-1987 is located at an altitude of 221 m above sea level. The extent of 6,200 hectares (ha) with a water catchment area of 603,200 ha, an average depth of 34.9 m and a volume of 2300,000 m^2 [1]. The puddle areas include Cianjur, Purwakarta and Bandung districts. The largest area of puddle is in Cianjur district. The development of freshwater aquaculture in Cirata an initiation of the International Center for Living Aquatic Resources Management (ICLARM) in collaboration with the Center for Natural Resources and Environmental Research Padjadjaran University, which aims to replace settlements affected by the Cirata reservoir project.

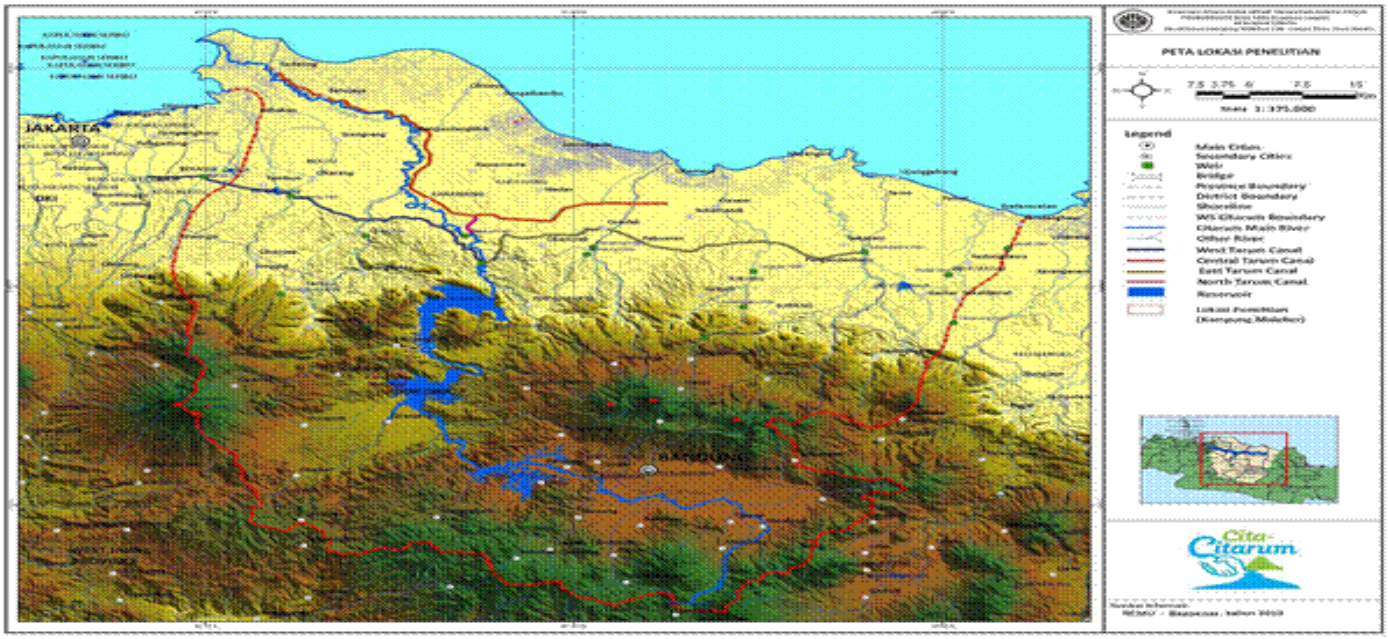

Fig 1: Research Location Cirata Reservoir, West Java Province, Indonesia

In fig 1 can be seen reserach location Cirata reservoir in west java province, Indonesia. Cirata Reservoir with an area of 6,200 Ha, consisting of three districts namely West Bandung, Purwakarta and Cianjur Cianjur district has an area of 2,976 Ha. Utilization of reservoirs as public waters for aquaculture with a floating net cages system is in principle allowed provided that they do not exceed the reservoir threshold and do not interfere with the reservoir's main function as a hydroelectric power plant. Based on this reserach limiting the number of floating net units in Cirata is based on the carrying capacity of the waters, there is an excess of floating net cages in the Cirata Reservoir, so it is necessary to restructure through a controlled management system both ecologically and economically. Internal strategies carried out by fish farmers can be seen in Tabel 1.

Table 1: Results of Respondents' Assessment of Internal Strategy Factors

No.	Internal Strategy Factors	Weight	Rating	Score
	Strengthness			
1	Social capital states that the network of relationships is a fishery resource that can be used for community economic resources.	0.20	4	0.80
2	Providing economic value to the local community.	0.15	3	0.45
3	Can be used for aquaculture of floating net cage systems.	0.15	4	0.60
4	Potential to be used for capture fisheries.	0.10	3	0.30
5	Potential of aquatic and fisheries tourism	0.05	3	0.15
	Total Strengthness	0.65		2.30
	Weakness			
1	Over capasity Floating net cages	0.12	4	0.48
2	Turn over which causes mass death of fish	0.08	4	0.32
3	Social conflicts in the use of water resources that are common accesses.	0.05	3	0.15
4	Regional government policy that is not firm in managing water resources in the Cirata reservoir.	0.05	3	0.15
5	Water resources that are considered public property.	0.05	3	0.15
	Total Weakness	0.35		1.25
		1		

In tabel 1 respondents' assessment of internal strategy factors, including strengthness and weakness. Factor social capital states that the network of relationships is a fishery resource that can be used for community economic resources have highest value than the other strengthness factors. Factor over capasity floating net cages is highest value than the other weaknes factors.

Based on this reserach in the final report of Cirata and Saguling environmental studies and training the aquaculture system applied is floating net cages in one floating net cage unit there are layered net four ponds with 7 x 7 meter net size for 3,000 family heads or as many as 1,600 units. Furthermore, based on West Java Governor Decree number 41 of 2002 on Public Water Utilization Development, Agriculture and Land Reservoir Cirata district them aim to improve the functioning and optimally useful reservoir through the provision of opportunity for local people to strive in the field of fish farming and agricultural land use as well as tourism development within the limits and technical requirements determined by the management agency, with no consequence to interfere with the preservation and main function of the reservoir.

Based on the results of research using swot analysis, there are several factors that determine the social ecological systems conditions, can be seen in table 2 assessment of external strategy factors, including opportunities and threatness. Factor

opening jobs in the fisheries sector is highest value than the other opportunities factors. Factor overcapasity floating net cages is highest value than the other threatness factors.

Table 2: Results of Respondents' Assessment of External Strategy Factors

No.	External Strategy Factors	Weight	Rating	Score
	Opportunities			
1.	Opening Jobs in the Fisheries Sector	0.20	4	0.80
2.	Opening jobs in the tourism sector	0.08	3	0.24
3.	Increasing aquaculture production in West Java	0.12	4	0.48
4.	The demand for fishery products is increasing.	0.10	3	0.30
5.	Opening demand for fish feed	0.07	3	0.21
	Total Opportunities	0.57		2.03
	Threatness			
1.	Social conflicts over land water resource use	0.10	4	0.40
2.	Overcapasity floating net cages	0.11	4	0.44
3.	Unpredictable weather change conditions	0.06	3	0.18
4.	Turnover that causes mass fish death	0.10	4	0.40
5.	Algae blooms that cause the quality of the water decreases	0.06	3	0.18
	Total Threatness	0.43		1.60

The linkage between the human system and natural resources and artificial resources is an indicator of the strategy that must be carried out for the management of water resources in the Cirata reservoir, Cianjur district, West Java Province. Intermal factor had value
maximum is social capital states that the network of relationships is a fishery resource that can be used for community economic resources. External factors had value maximum is opening jobs in the fisheries sector.

Table 3: Weighting of the results of the SWOT questionnaire

IFAS / EFAS	S: 0.65	W: 0.35
O: 0.57	SO : 1.22	WO : 0.92
T : 0.43	ST : 1.08	WT :0.78

Based on table 3, Weighting of the results of the SWOT questionnaire, can be found value is Opportunities (O) 0.57, Threatness (T) 0.43, Strengthness (S) 0.65 and Weakness (W) 0.35.

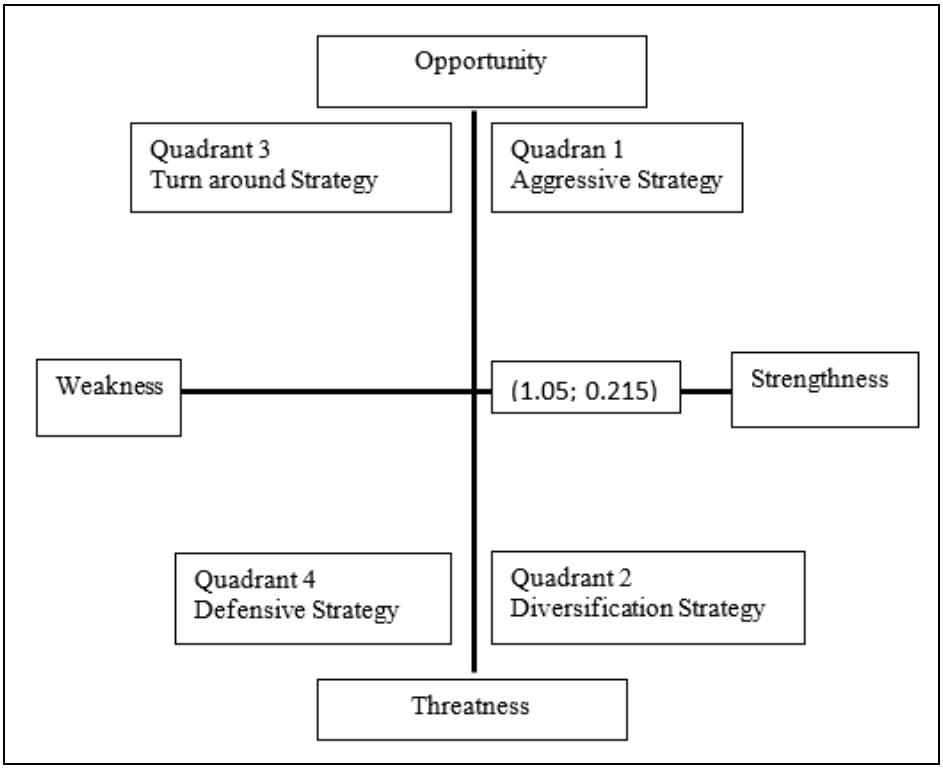

Fig 2: SWOT Analysis Grand Strategy Matrix

Based on this reserach is in quadrant 1 have the opportunities and strengths that can be utilized. The strategy that must be applied in this condition is to support an aggressive growth policy. Then, quadrant I is included in the Strength-Opportunity Strategy (SO). This strategy utilizes the strength of the fish farmers to take advantage of as many opportunities as possible. Strengthness which is owned is social capital states that the network of relationships is a fishery resource that can be used for community economic resources, can be used for aquaculture of floating net cage systems, but should be done capasity floating net cages in Cirata reservoir, and improved potential of aquatic and fisheries tourism in Cirata reservoir.

3.4. Factor Confronting The Resilience of Cirata Reservoir Social Ecological Systems

Based on this reserach ecosystem-based fisheries management is an approach that uses the main components of aquatic environments. Various changes in the biosphere is often preceded by human intervention as a form of interaction with the system environment. The human ecological view sees that the relationship of ecological systems interacts with the social system. The flow of mass, energy, and information connecting the ecosystem and social system, causing the quality of ecosystems may be affected by the social system or social system was influenced by ecological conditions.

Utilization of the reservoir function is inseparable from the economic value of profit for utilizing of Cirata stakeholders.

In table 4 can be seen the ecological social system that includes (1) environmental water resources including water quality of physics, chemistry and biology status is particularly vulnerable, function of public water status is vulnerable and climate change conditions status is particularly vulnerable; (2) ecological vulnerability including turn over, carrying capacity floating net cages, productivity of floating net cages, aquatic ecosystem status is particularly vulnerable and fish endemic of Species status is vulnerable; (3) economic vulnerability including profitability of fisheries, characteristics and handling of fish landing status is particularly vulnerable and sector employment of fisheries, other income of another sector, market prospectif of fisheries status is vulnerable; (4) social vulnerability including a new entry into fisheries, social capital status is particularly vulnerable dan ownership of floating net cages, level of education, environmental knowledge status is vulnerable.

Adaptive capacity in ecological societal systems is linked to genetic diversity in the general waters of the Cirata reservoir, especially for capture fisheries, where it is subject to locally specific endemic stresses due to changes in water quality and other environmental stresses.

Table 4: Factor Confronting The Resilience of Cirata Reservoir Social Ecological Systems

No	Variable	Sub Variable	Level of Vulnerability
1	Environmental Water Resources	Water Quality of physics	3
		Water Quality of chemistry	3
		Water Quality of Biology	3
		Function of the public water	2
		Climate changes	3
2	Ecological Vulnerability	Turn Over	3
		Carrying Capacity Floating Net Cages	3
		Productivity of Floating Net Cages	3
		Aquatic Ecosystem	3
		Fish Endemic of Species	2
3	Economic Vulnerability	Sector employment of fisheries	2
		Profitability of fisheries	3
		Other Income, of Another Sector	2
		Market Prospectif of Fisheries	2
		Characteristics and handling of fish landing	3
4	Social Vulnerability	Ownership of Floating Net Cages	2
		Conflict of Status Derivatif Functions	3
		Level of Education	2
		Environmental Knowledge	2
		A New entry into fisheries	3
		Social Capital	3

Description: 3 : Particularly Vulnerable; 2: Vulnerable; 1: Not Vulnerable

The reservoir water system has changing conditions on ecological components such as the development of algae in reservoirs and some changes in wetland vegetation communities are indicative of changes in ecological conditions that lead to ecological crises. From the results of identification in the ecological social system there are several critical points that determine the level of resilience:

1. Social conflicts of water resource utilization based on main function and derivative function which have economic value but ignore the ecological value so that acceleration of governance and regulation of water resources in Cirata reservoir sustainable.
2. Aquaculture fishery floating net cages system has happened overcasity causing lower level of productivity of water resources and fishery, so must be done arrangement of zonation for aquaculture fishery floating net cages system
3. Ecosystem and environment conditions are susceptible to damage, pollution and degradation of the quality of the aquatic environment in the Cirata reservoir, so it is necessary to do environmental management.
4. The occurrence of climate changes often result in the occurrence of turn over which resulted in mass mortality of fish on aquaculture with floating net cages system.
5. A strong Patron-Client relationship exists between all stakeholders involved in utilizing water resources that have economic value.
6. High level of dependence on the market for fishery resources. This is because the characteristics of fishery commodities that are perisable, volumis produced must be sold in fresh conditions and to meet the needs of everyday life in order to avoid the rotten fish before the sale. The slightest price changes greatly affect the social condition of fish farmers. This condition also helped shape the pattern of patron-client relationship between farmers and traders.
7. The cost and availability of inputs for aquaculture production factors floating net cages system, such as the high price of feed production factors, construction floating net cages and the availability of labor.

Based on the results of research conducted in the general waters of Cirata reservoir that the action of local and regional scale in the context of increasing the resilience of social ecological system in Cirata reservoir. that is : (1) returns the function and role of the ecosystem through the utilization of water resources in a sustainable manner; (2) the application process of action through the decision-making process to respond to the influence of aquatic environments and socio-economic relations; (3) biodiversity of aquatic resources in the context of ecological systems; social capital and institutional societies that have legitimacy In the social system, (4) the existence of institutions and learning networks that have knowledge, experience in problem solving, and balance of forces among interest groups have an important role in adapting capacity.

4. Conclusion

Based on research results factor confronting the resilience of Cirata reservoir social ecological systems (Case Study Cirata Reservoir District Cianjur, West Java Indonesia) showed the condition has decreased from ecological aspects that do not support the activities of floating net cages, because the capacity exceeds the carrying capacity of floating net cages. Social aspects of conflict between floating net cage fish farmers and local governments in managing cirata reservoirs. Economic aspects of the decline in fish farmers' income due to production results continue to decline, due to unfavorable ecological conditions and conflicts of interest from social aspects. Based on the results of this research it is suggested that there is collaboration between stakeholders to create a conducive environment in utilizing public water resources without compromising the social and economic ecological value of the local community.

5. Acknowledgments

We are grateful for the close collaboration between faculty of fisheries and marine science, Padjdajaran University and Public waters fishery conservation centers in Cianjur district, West Java Province, Indonesia for providing facilities and support. This research funded by Unpad internal funded.

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