A comprehensive assessment of the role of stakeholders in the management of Wanamina Island in Sidoarjo, East Java Province, Indonesia

[1,2]Rudianto, [1]Ayu P. Larasati, [1]Faizah R. Yusuf, [1]Wasis Parawiranata

[1] Department of Marine Science, Faculty of Fisheries and Marine Science, Brawijaya University, Malang, East Java, Indonesia; [2] Laboratory of Fisheries and Marine Resources Exploration, Brawijaya University, Malang, East Java, Indonesia. Corresponding author: Rudianto, rudiantoita@gmail.com

Abstract. Wanamina Island is an island formed by Sidoarjo mudflow which began to occur on May 29, 2006. The mudflow management by the Government resulted in mud deposits on the downstream of Porong river. Then in 2016, after approximately 11 years, Lapindo mud deposits became an island that is currently designated as an ecotourism area. It is called the Island of Wanamina. However, the mangrove forests of the island are damaged due to illegal logging and conversion of land into aquaculture area. Wanamina Island which has a total area of 94 ha, is very unique. The island is directly managed by the Indonesian Ministry of Marine Affairs and Fisheries. The purpose of this research is to synergize the roles of stakeholders, including the communities, Government and private sector in managing Wanamina Island as a sustainable ecotourism area based on the fish stock, the condition of water physico-chemical parameters and mangrove density. The method used is Data analysis with Generalized Structured Component Analysis (GSCA). GSCA is one of component analysis based on Structural Equation Modeling (SEM). The results show that the management of Wanamina Island area will not be successful if it is only done by the government. Therefore, collaboration between community stakeholders, government and private parties is needed.
Key Words: mudflow, ecotourism area, stakeholders, GSCA.

Introduction. According to Chamdalah et al (2016) the Island of Sarinah (today known as the Island Wanamina) is an island formed by the flow of Sidoarjo mud. The Lapindo mudflow emerged because of a mistake in drilling activity by a gas exploration company owned by Lapindo Brantas Inc. Thick black mud with little water and crude oil came out from the center of the burst. The temperature of the mud from center of bursts was about 100^{o}C (Satrio et al 2012).

Mudflow has impacted on 109 ha of land. The flooded land consists of 71.7 ha of agricultural land (rice field), 16.3 ha of industrial land, 7.9 ha of settlement land, 8 ha of public facilities, 1.1 ha of vacant land, and about 1 ha of other land. Economically, the existence of hot mud has disrupted the socio-economic life of the people and damaged agricultural land and settlements. So most of the population fled and evacuated to the evacuation post. The mud volume was estimated at about 5,000 to 50,000 cubic meters per day. As a result, this mudflow brought tremendous impact to the surrounding community as well as to economic activities in East Java (Hanafi 2006; Rumpopoy 2012)

The height of the mud in the settlement reached 6 meters. The total number of citizens evacuated is 8,200 inhabitants. The number of damaged houses is 1,683 unit. The agricultural and plantation areas damaged are almost 200 ha; more than 15 flooded factories stopped production activities and housed more than 1,873 people. Most educational facilities did not operate. The mud also damaged the environment facilities and infrastructures in the area (Malia & Anjasmara 2013).

Despite the negative impacts, the mudflow had a positive effect, that is the formation of a new island. Sidoarjo Mud Island is an artificial island formed as a solution of sediment management in the Estuary of Porong River due to the blast of hot mud flowing into the sea through the Porong River. Currently, Wanamina Island is used as a land to increase the area of mangrove ecosystem in estuary and aquaculture fishery with Wanamina system (silvofishery). Tourism economy is one of the programs based on the utilization of mangrove ecosystem and Wanamina pond with educational and economic approach to achieve community prosperity (Prasenja et al 2017). Wanamina Island has been established as an ecotourism area by the central government. However, the island has not been optimized as an ecotourism area because it still lacks of infrastructure and the condition of the environment is decreasing. Based on this background, it is necessary to conduct some research on the re-functioning of the island as an ecotourism area. The purpose of this study is to synergize the roles of various stakeholders, including the communities, Government and private sector to manage Wanamina island as a sustainable ecotourism area based on the existence of fish stock, the condition of water physico-chemical parameters and mangrove density.

Material and Method

Description of the study sites. This study was conducted on May, 2016 at the location of the Sidoarjo mud disaster. In 2006, the Government stated that Porong river, which is part of Brantas river, to be used as a mud and drainage dump to drain the sludge into the sea. The mud dumped at the downstream of the Porong River causes sedimentation forming a mud island. By the Sidoarjo Mud Disaster Mitigation Agency (BPLS) and the Ministry of Marine Affairs, the island is called Wanamina Island, but the local community often calls it Sarinah Island. Wanamina Island has an area of 94 ha (Central Bureau of Statistics and Government of Sidoarjo Regency, 2015) located just east or upstream of Porong River estuary.

Wanamina Island is an estuary and is heavily influenced by activities of the Porong River and the waters of the Madura Strait. The estuary area is a meeting area of salt waters and fresh waters. The area is characterized by extreme salinity, tidal, turbulence, turbidity and unstable water parameter characteristics. The center of the mudflow and its drainage are connected into the Porong river (Figure 1). The red square in the picture shows the location of the study area.

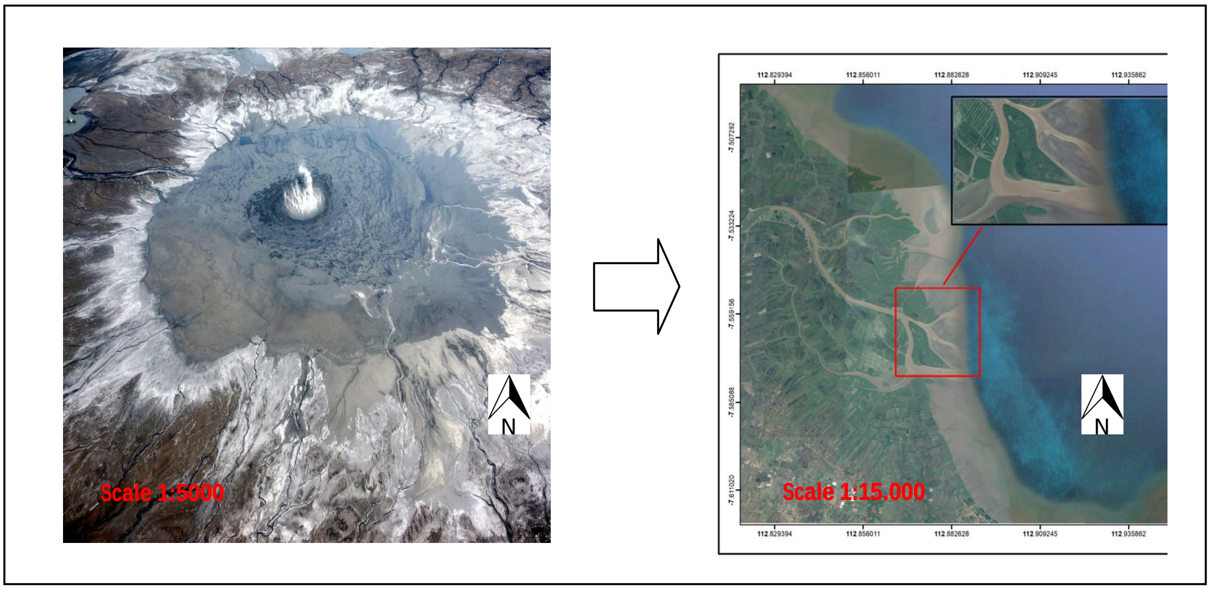

Figure 1. The location of picture center of the mudflow and stream to the Porong river.

Interviews and generalized structured component analysis (GeSCA models). GeSCA models followed (Ghozali & Kusumadewi 2013). To analyze the optimal management of Wanamina Island area requires the analysis of the stakeholders responsible for the management of the island. Until now, the management of the Wanamina Island area has not been established, so that each party is hesitant to manage the island. Therefore, an interview was conducted first to investigate the roles of the parties. Table 1 shows the types and number of respondents

Table 1

The types and number of respondents

The types of respondents	*The number of respondents*
Local planning development board	4
Community monitoring group	5
Shrimp factory	4
PT. Cigarette factory Candi Baru Sidoarjo	4
PT. Japfa Comfeed Indonesia Tbk	4
Social and workers agency	4
Department of Marine and Fisheries	4
Community empowerment agency	4

It is necessary to construct a diagram to find out to what extent the roles and responsibilities of each stakeholder as shown in Figure 2.

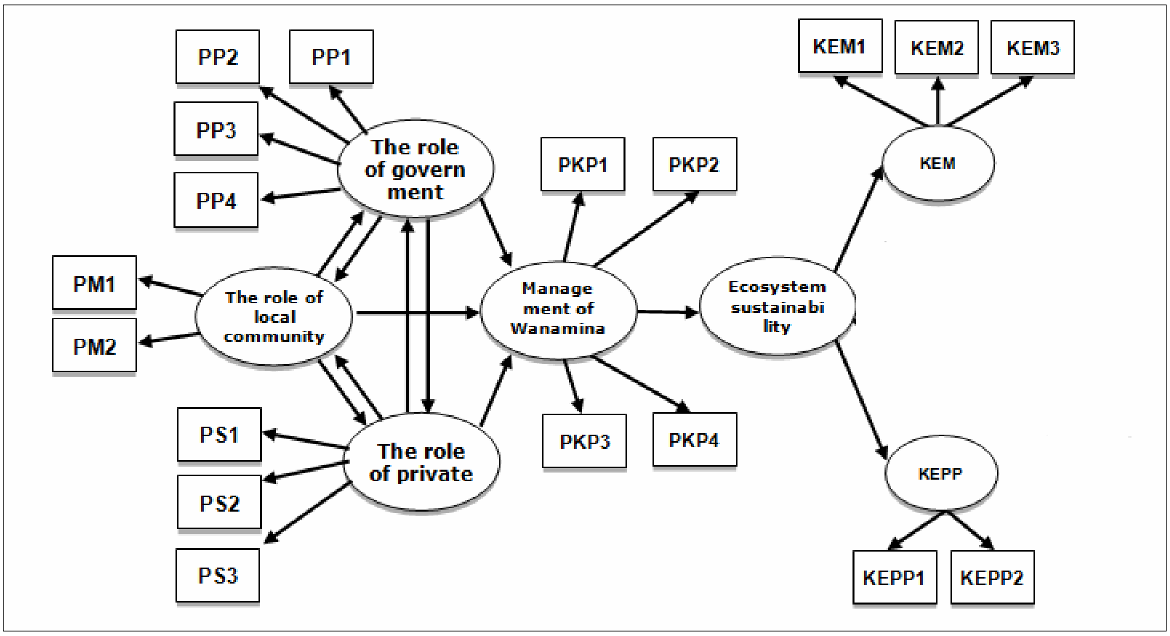

Figure 2. Diagram of path.

Figure 2 stated the abbreviation as follows: the role of government (PP) is affected by; PP1 (implementation of government policy), PP2 (supervision of Government policy), PP3 (evaluation of government policy), and PP4 (development planning of government policy). The role of community (PM) is affected by PM1 (implementation of local community), and PM2 (supervision of local community). Whereas, PS (the role of private parties) is affected by PS1 (conservation by private sector), PS2 (implementation by private sector), and PS3 (evaluation by private sector). PKP (management of Wanamina Island) is affected by PKP1 (involvement of stakeholders), PKP2 (availibility of funds), PKP3 (synergy among stakeholders) and PKP4 (supervision and evaluation). Ecosystem sustainability is consisted of KEM (sustainability of mangrove ecosystem) and KEPP (Coastal ecosystem sustainability). KEM is affected by KEM1 (mangrove damage is reduced), KEM2 (small fish seeds increased), and KEM3 (wise and responsible). Whereas KEPP (coastal ecosystem sustainability) is affected by KEPP1 (a little trash scattered on the beach) and KEPP2 (sand beach clean).

The management of the Wanamina Island requires information about on (1) the types of fish present; (2) whether the water quality physically and chemically is still feasible to be developed as an ecotourism area; (3) the ecosystem condition, especially mangrove forest.

To understand the condition of Wanamina Island about fish potential and the physical and chemical conditions of the waters and the condition of the mangrove forests on Wanamina Island, research was carried out as shown in the picture as follows: Figure 3 relates to the research on the existence of fish by using gill-net fishing gear to determine the potential of fish on Wanamina Island. Figure 3 also conducts research on the physical and chemical quality of the waters on Wanamina Island, performs a transect of mangrove forests on Wanamina Island.

Figure 3. Research on Wanamina island.

Results

***Analysis of fish existence using gill-net*.** According to Fischer & Bianchi (1984), there are several species of fish that can live in estuary (brackish) areas, such as Ariidae tribe species, Mugil, *Lutjanus kasmira*.

The results of catches using gill-net were obtained by various types of fish caught at stations 1, 2, 3 and 4. The giant prawn is also included in the catch (Table 2).

Table 2

Estimated results of capture fisheries in Wanamina Island waters on May 24, 2017

Fish species	*Local name*	*Fishing capture (Kg)*				
		St. 1	*St. 2*	*St. 3*	*St. 4*	*Σ Fish/days (kg)*
Hexanematichtys sagor	Dukang fish	14.7	7.7	14.0	10.6	47.2
Mugil spp	Gerih fish	7.5	2.0	3.3	12.8	25.5
Lates calcalifer	Kakap putih fish	0.2	0.3	2.6	2.1	5.2
Dermogenys sp.	Julung-julung fish	-	-	0.3	3.0	3.3
Mystus nigriceps	Keting fish	4.2	5.9	11.4	7.7	29.2
Chana striata	Gabus fish	3.0	2.0	0.3	-	5.3
Macrobrachium rosenbergii	Udang galah	0.3	2.0	0.7	6.4	9.3
Total		30	19.75	32.5	42.5	124.8

Source: Larasati (2017).

Analysis of physical and chemical water quality parameters. Physical and chemical factors in the water have a great influence on fish. Fish and shrimp are influenced by their habitat both by the physical and chemical properties of their aquatic environment. These two factors interact and influence the behavior, movement, and survival of the fish. The intensity and frequency of the interaction over time has an effect on the distribution and abundance of fish in a region (Brotowidjoyo et al 1999). Table 3 shows the measurement of physical and chemical parameter in Wanamina waters.

Table 3

The average of physical and chemical waters parameters in Wanamina

Parameters	*Units*	*Average value in each station*				*Average*	*Standard deviation*	*Quality standards*
		St. 1	*St. 2*	*St. 3*	*St. 4*			
Physical parameters								
Temperature	^oC	31.00	31.47	31.34	31.62	31.36	0.26	28-32[1)]
Current velocity	cm s^{-1}	0.060	0.046	0.054	0.058	0.055	0.006	-
Depth	M	2.03	1.41	1.87	1.35	1.66	33.66	-
Brightness	cm	42.44	29.25	33.22	20.56	31.37	9.08	-
Waves	cm	1.61	1.50	2.22	2.33	1.92	0.42	-
Chemical parameters								
pH		7.7	7.8	8.1	8.6*)	8.08	0.38	7.6-8.3[4)]
Salinity	‰	6.89	10.00	10.67	13.89	10.36	2.87	5-35[2)]
Dissolved oxygent	mg L^{-1}	6.27	6.36	6.27	6.12	6.25	0.1	5-6[2)]
Phosphate	mg L^{-1}	1.27*)	0.30*)	0.50*)	0.37*)	0.47	0.18	0.015[3)]
Nitrate	mg L^{-1}	10.80*)	10.00*)	11.00*)	10.83*)	9.7	1.92	0.008[3)]

Source: Larasati (2017); [1)] Tataningdatu et al (2013); [2)] Nybakken (1992); [3)] Ministerial Decree Number 51, year 2004; [4)] Apridayanti (2008); *) above the quality standard.

Based on the measurements of ten physical and chemical water parameters, there are seven parameters in accordance with the water quality standard. However, three obtained parameters exceeded the quality standard, namely pH, phosphate and nitrate content. Station 4 has a high pH value because it is directly facing the sea off Madura strait. So its influence on the nature of alkaline sea bases is greater than other stations, meanwhile, high phosphate levels in the waters can be caused by antrophogenic activities such as aquaculture activities. This activity produces residues that will affect the quality of the waters on Wanamina Island.High phosphate levels caused the high production of organic matter in the waters and low absorption (Romimohtarto & Sri 2005). According to Piranti & Christiani (2005), an increase in phosphate levels results in the occurrence of hypernutrification due to the process of overhauling of the organic material from waste. The cause of high nitrate is the same as the cause of high phosphate.

Based on the measurement both physical and chemical parameters have an influence on the fishery results in the waters of Wanamina Island. They affect metabolic processes, respiration, food chains, behavior, and fish migration. However, the most dominant influencing parameter is brightness. This parameter is calculated by loading factor. According to Brotowidjoyo et al (1999), light affects the fish migration associated with fish diurnal behavior with sunlight. The current parameter is an important factor affecting the number of net catch traps. Increasing the current velocity from weak to medium currents can reduce the number of catches (Putra et al 2013).

Based on the Bplot results in Figure 6, it is known that station 1 is strongly influenced by wave, depth, current velocity and brightness while at station 3 the pH, salinity, temperature and nitrate are dominating. Whereas at station 2 the phosphate and DO (dissolved oxygen) parameters have dominant influence.

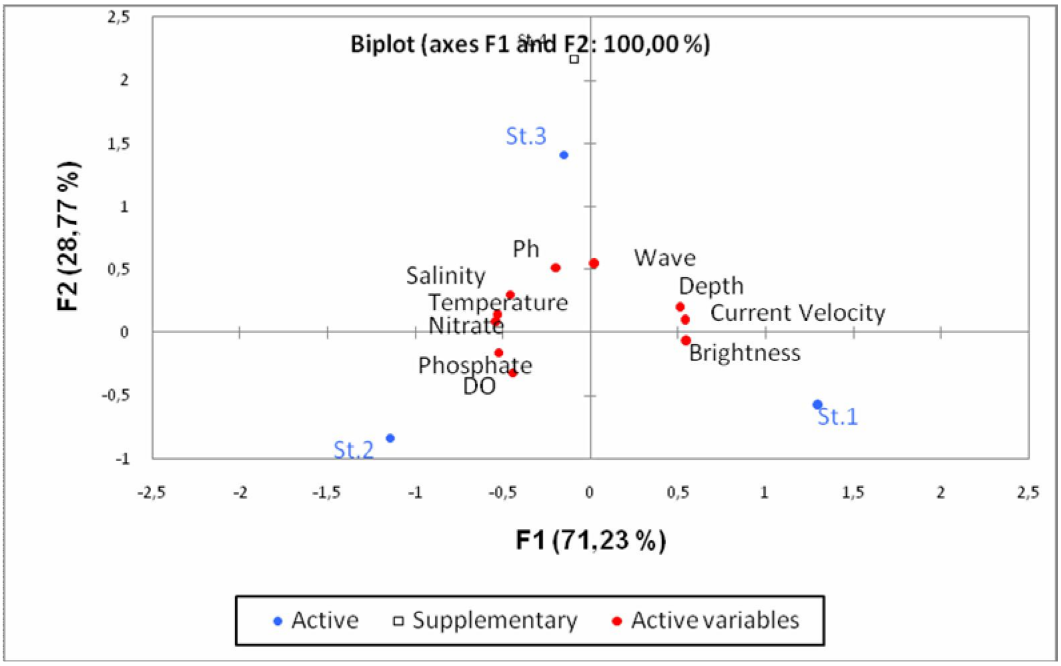

Figure 6. Biplot (Source: Larasati (2017)).

Mangrove conditions on Wanamina Island. There are 3 species of mangrove trees in Wanamina Island which can be seen in Table 4 below.

Table 4

Type of mangrove vegetation

Station	*Number of trees*	*Mangrove species*
1	22	*Avicennia marina*
	1	*Avicennia alba*
	5	*Sonneratia alba*
2	23	*Sonneratia alba*
3	16	*Avicenia marina*
	1	*Avicennia alba*

Source: Prawiranata (2017).

Table 4 presents the mangrove species found in Wanamina Island. Mangrove trees in this island were planted by the local community together with the local government. The density of mangrove species refers to the number of individual trees of mangrove species in a certain area. Based on the calculation of the mangrove density on Wanamina Island, the density value at station 1 is 933 trees ha^{-1}. Station 2 has a mangrove density of 767 trees ha^{-1}. Station 3 has a mangrove density of 566 trees ha^{-1}. Based on data at stations 1, 2 and 3, the overall density of mangrove on the island can be categorized as low. The low density of mangrove in the area is due to illegal logging.

Discussion. Based on the physical and chemical parameters of the waters which directly influence the availability of fish and the existence of mangrove forest, it can be concluded that Wanamina Island can be developed as an ecotourism area. However, it is necessary to conduct conservation efforts through sustainable management of mangrove ecosystems. Based on the path diagram model in Figure 2, the model measurement shown in Table 5 is performed. The results of the analysis are known for all indicators to produce the loading factor value > 0.5. It means that the AVE value of all variables > 0.5, and the value of Cronbach's alpha > 0.6. The Table 5 below indicates that the obtained AVE value is 0.745 and Cronbach's 0.771 alpha and the value has met the measurement model test criteria. Thus indicators that measure the role of Government, the role of society, the role of the private sector, coastal management, and ecosystem sustainability are valid and reliable.

Table 5

The measurement model

Variable	*Item*	*Loading item*	*AVE*	*Alpha*
The role of Government	PP1	0.854	0.616	0.742
	PP2	0.828		
	PP3	0.946		
	PP4	0.79		
The role of local community	PM1	0.869	0.745	0.854
	PM2	0.857		
The role of private sector	PS1	0.866	0.697	0.873
	PS2	0.834		
	PS3	0.803		
The role of Wanamina management	PKP1	0.752	0.566	0.633
	PKP2	0.732		
	PKP3	0.756		
	PKP4	0.768		
Ecosystem sustainablity	KEM1	0.799	0.602	0.819
	KEM2	0.758		
	KEM3	0.77		

With regard to the Government role variables, the evaluation indicator (PP3) has the largest loading factor value and the planning indicator (PP4) has the lowest loading value. This suggests that the evaluation indicator (PP3) has the greatest contribution in measuring the role variables of the government. Meanwhile, planning indicators (PP4) have the lowest contribution in measuring Government role variables.

In the community role variable, the implementation indicator (PM1) has the largest loading factor value and the monitoring indicator (PM2) has the lowest loading value. This indicates that the implementation indicators (PM1) have the greatest contribution in measuring the role variables of society. Meanwhile the monitoring indicator (PM2) has the lowest contribution in measuring the role variables of the community.

In private role variables, the preservation indicator (PS1) has the largest loading factor value and the evaluation indicator (PS3) has the lowest loading value. This indicates that conservation indicators (PS1) have the greatest contribution in measuring private role variables, while evaluation indicators (PS3) have the lowest contribution in measuring private role variables.

In the coastal management variable, the monitoring and evaluation (PKP4) indicator has the largest loading factor value. The fund availability indicator (PKP2) has the lowest loading value. This indicates that monitoring and evaluation (PKP4) indicators have the greatest contribution in measuring coastal area manager variables, while indicator of fund availability (PKP2) has the lowest contribution in measuring coastal area manager variables. The reduced dimensional dimension (KEM1), has the largest loading factor value and an improved small fish seed indicator (KEM2) has the lowest loading value. This indicates that the small fish seed indicator increased. The reduced damage (KEM1) has the largest contribution in measuring the dimension of preservation of mangrove ecosystem, while the indicator of small fish increased (KEM2) has the lowest contribution in measuring the dimension of preservation of mangrove ecosystem.

In the dimensions of coastal ecosystem sustainability, the slightly scattered waste indicators on the beach (KEPP1) have the greatest loading factor values. The cleanest sand beach indicator (KEPP2) has the lowest loading value. This indicates that the slightly scattered rubbish indicators on the beach (KEPP1) have the greatest contribution in measuring the dimensions of coastal ecosystem sustainability. Meanwhile the cleanest sand beach indicator (KEPP2) has the lowest contribution in measuring the dimensions of coastal ecosystem sustainability.

In the ecosystem sustainability variable, the dimension of coral reef ecosystem has the largest loading factor value and the dimension of coastal sand ecosystem has the lowest loading value. This shows that the dimensions of coral reef ecosystems have the greatest contribution in measuring the ecosystem sustainability variable. Meanwhile the dimensions of coastal sand ecosystem sustainability have the lowest contribution in measuring ecosystem sustainability variables.

Evaluation of structural model. Table 6 shows the results of analysis with goodness fit of index (GFI) value of 0.955. This shows that the GFI value > 0.9 which states that the GSCA model formed is feasible to use to predict a value. FIT value of 0.675 shows the diversity of data which can be explained by the model of 67.5%, while the rest 32.5% is explained by other variables outside this study.

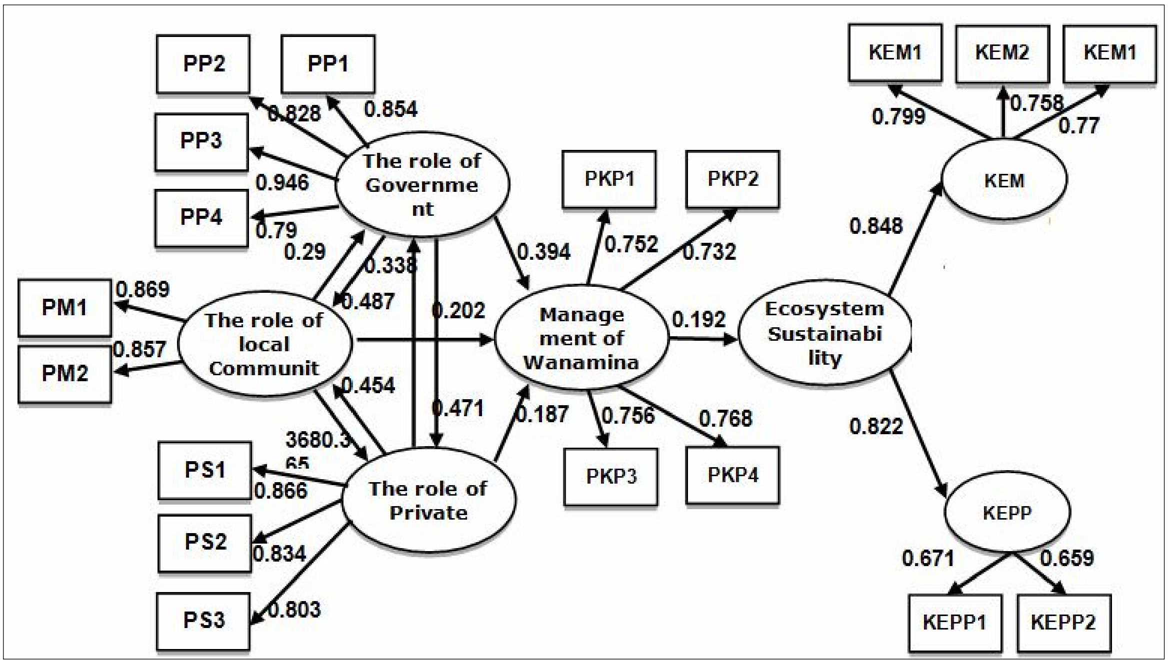

Figure 7. Diagram path for the role of Government, private and the local community.

Evaluation of structural model is aimed at knowing the feasibility of the model and to test the hypothesis of the effect of exogenous variables on the endogenous variables. The results of the analysis in Table 6 below indicate at the influence of the Government's role on the role of the community generated coefficient of 0.679 with critical ratio value (CR) of 7.49 * (starred or CR > 2.00). This means that there is a significant influence of the government policy on the community resulted in the conclusion that the greater the role of the government in preserving Wanamina Island, the better the role of the community in preserving the island.

Table 6

Goodness of fit model and structural model

Exogen	*Endogen*	*Estimate*	*CR*	*FIT*	*GFI*
PP	PM	0.679	7.49*	0.675	0.956
PP	PS	0.471	4.94*	0.675	0.956
PP	PKP	0.394	4.31*	0.675	0.956
PM	PP	0.29	3.25*	0.675	0.956
PM	PS	0.368	4.11*	0.675	0.956
PM	PKP	0.202	2.15*	0.675	0.956
PS	PP	0.338	6.89*	0.675	0.956
PS	PM	0.454	7.83*	0.675	0.956
PS	PKP	0.187	2.23*	0.675	0.956
PKP	KE	0.192	2.23*	0.675	0.956

The influence of government role on the role of private generated coefficient of 0.471 with the critical ratio value (CR) of 4.94 * (starred or CR > 2.00). This means that there is a significant influence on the role of government on the role of the private sector. The better the Government's role in preserving the Wanamina Island, the bigger the role of the private sector in preserving the Wanamina Island. The influence of the Government's role on coastal area management generated coefficient of 0.394 with a critical ratio value (CR) of 4.31 * (star or CR > 2.00). This means that there is a significant influence of the Government's role on the management of Wanamina Island. The better the role of the Government, the better the management of Wanamina Island is.

The influence of public role on the role of Government produced a coefficient of 0.29 with a critical ratio value (CR) of 3.25 * (starred or CR > 2.00). This means that there is a significant influence of the role of the community in the role of Government. The better the role of the community in preserving the Wanamina Island the bigger the the role of Government in preserving the Wanamina Island. The intervention of the Government becomes very dominant in managing Wanamina Island with the active participation of local and private communities.

The influence of the role of the public on the role of private sector generated a coefficient value of 0.368 with a critical ratio (CR) value of 4.11 * (starred or CR > 2.00). This means that there is a significant influence of the role of the public on the role of the private sector. The better the role of the community in preserving the coastal area of Wanamina Island, the bigger the role of the private role in preserving the management of Wanamina Island.

The influence of community role on coastal area management generated a coefficient value of 0.202 with a critical ratio value (CR) of 2.15 * (starred or CR > 2.00). This means that there is a significant influence of the role of the community on the management of Wanamina Island area. The better the role of the community, the better the management of the Wanamina Island.

The influence of the role of private policy on the role of the government produces a coefficient value of 0.338 with a critical ratio value (CR) of 6.89* (starred or CR > 2.00). This means that there is a significant influence on the role of the private sector, the better the role of the private in preserving the Wanamina Island, the bigger the role of the Government in preserving the coastal Wanamina Island.

While the influence of the role of private policy on the role of society produces a coefficient value of 0.454 with a critical ratio value (CR) of 7.83* (starred or CR > 2.00). This means that there is a significant influence of the role of the private sector. The better the the role of the private in preserving the Wanamina Island, the bigger the role of the community in preserving the Wanamina Island.

The influence of private role on Wanamina island area management generated coefficient value of 0.187 with a critical ratio value (CR) of 2.23 * (star or CR > 2.00). This means that there is a significant influence of the role of the private sector of the management of the coastal areas. The better role of the private sector will increase the management of the Wanamina Island.

The effect of Wanamina Island area management of the ecosystem sustainability generated as coefficient value of 0.192 with a critical ratio value (CR) of 2.23 * (starred or CR > 2.00). This means that there is a significant influence of Wanamina Island area management on the ecosystem sustainability. Better management of Wanamina Island will increase the ecosystem sustainability.

The role of government is known to be the most influential variable on the role of the society, private sector, and Wanamina Island management. On the other hand, the role of the private sector becomes the most influential variable onto the role of Government.

Conclusions. The results of this study indicate that the synergy among stakeholders is necessary for the successful management of Wanamina Island area. Water quality improvement is done by (a) involving the community to participate in preventing and monitoring water pollution; (b) enforcing environmental laws against business actors violating the established environmental quality standards. The balance of growth and fishing requires management of biological resources by considering: (a) protection of the source of fish eggs, as well as fish; (b) the tools used to catch fish and which areas are allowed for fishing activities. Meanwhile, increasing the mangrove density can be done by improving institutional management of ecotourism area.

Acknowledgements. We would like to thank the Lapindo mud handling agency and the local government of Sidoarjo regency. We also thank Professor Happy Nursyam for giving us opportunity to conduct this study.

References

Apridayanti E., 2008 [Evaluation of waters environment management of Lahor reservoir in Malang regency, East Java]. MSc thesis, Semarang: Diponegoro University, 64 pp. [in Indonesian]

Brotowidjoyo M. D., Tribawono D., Mulbyantoro E., 1999 [Introduction to environment and water cultivation]. Liberty, Yogyakarta, 258 pp. [in Indonesian]

Central Bureau of Statistics and Government of Sidoarjo Regency, 2015 [Regency Sidoarjo in Figures 2015]. Sidoarjo: Office of the central Statistics Agency Sidoaarjo Regency Government, 135 pp. [in Indonesian]

Chamdalah S., Ikhwani H., Wahyudi, 2016 [Study development of Sarinah muddy island of Sidoarjo regency as geo-ecotourism]. Jurnal Teknik ITS 5(2):408-412. [in Indonesian]

Fischer W., Bianchi G., 1984 Western Indian Ocean: Fishing Area 51. Marine Resources Service. FAO Fisheries Department, Rome, Italy, pp. 3-29.

Ghozali I., Kusumadewi K. A., 2013 [Generalized structure component analysis (GeSCA): component-based structural equation model]. Agency publisher Diponegoro University, ISBN: 978.979.704.669.6, 210 pp. [in Indonesian]

Hanafi F., 2006 [Assessment of mud and gas disaster in Sidoarjo District, East Java Province and its impact on the health of the surrounding population]. Buletin Penelitian Sistem Kesehatan 9(3):164-169. [in Indonesian]

Larasati A. P., 2017 [Relationship of physics and chemical parameters to fishery result at Kedung Pandan Village, Jabon Sub-district, Sidoarjo Regency]. BSc thesis. Marine Science Study Program, Department of Fishery Resources Utilization, Faculty of Fisheries and Marine Sciences, Brawijaya University, 64 pp. [in Indonesian]

Malia A. N., Anjasmara I. M., 2013 [Analysis of land coverage of lower Brantas river basin using multitemporal satellite imagery (case study: kali Porong kabupaten Sidoarjo)]. Jurnal Teknik Pomits 10(10):1-6. [in Indonesian]

Ministerial Decree Number 51, year 2004, 2004 [About sea water standards]. 5 pp. [in Indonesian]

Nyabakken J. W., 1992 [Biology of the sea - ecological approach]. PT. Gramedia, Jakarta, 459 pp. [in Indonesian]

Piranti A. S., Christiani, 2005 [Influence of existence of fish cultivation system in floating net to trophic level of waters of Mrica Banjarnegara reservoir]. Purwokerto: Faculty of biology Unsoed. Biosfera 22(2):82-85. [in Indonesian]
Prasenja Y., Alamsyah A. T., Bengen D. G., 2017 [Sustainability analysis of mangrove ecosystem for ecofishery tourism in Sidoarjo Lumpur island]. Jurnal Ilmu dan Teknologi Kelautan Tropis 9(1):255-264. [in Indonesian]
Prawiranata W., 2017 [Analysis of land suitability of Wanamina island as mangrove ecotourism in Kedungpandan village, Jabon sub-district, Sidoarjo regency]. BSc thesis, Marine Science Study Program, Department of Fishery Resources Utilization, Faculty of Fisheries and Marine Sciences, Brawijaya University, 52 pp. [in Indonesian]
Putra A. E., Najamuddin, Hajar M. A. I., 2013 [Effect of direction and speed of flow on the passive trapping net (set net) at Mallasoro bay, Jeneponto]. Jurnal Sains dan Teknologi 13(3):257-263. [in Indonesian]
Romimohtarto, Kasijan, Juwana S., 2005 [Marine biology]. Djambatan, Jakarta, 540 pp. [in Indonesian]
Rumpopoy A. T., 2012 [Implementation of government policy in handling Lapindo mudflow]. Jurnal Politic Muda 2(1):226-234. [in Indonesian]
Satrio B. P., Sidauruk P., 2016 [Study of the Lapindo mud burst origin in the 2007-2012 period using environmental isotopes]. Application Center for Isotopes and Radiation Technology, BATAN, ISSN 1907-0322, pp. 89-99. [in Indonesian]
Tatangindatu F., Kalesaran O., Rompas R., 2013 [Study on water physical-chemical parameters around fish culture areas in Lake Tondano, Paleloan Village, Minahasa Regency]. Budidaya Perairan 1(2):8-19. [in Indonesian]

Received: 30 August 2018. Accepted: 06 January 2018. Published online: 19 February 2019.
Authors:
Rudianto, Department of Marine Science, Faculty of Fisheries and Marine Science, Laboratory of Fisheries and Marine Resources Exploration, Brawijaya University, 65145 Malang, East Java, Indonesia, e-mail: rudiantoita@gmail.com
Ayu Puji Larasati, Laboratory of Fisheries and Marine Resources Exploration, Brawijaya University, Malang, East Java, Indonesia, e-mail: ayupuji.larasati@gmail.com
Faizah Rahmayadi Yusuf, Laboratory of Fisheries and Marine Resources Exploration, Brawijaya University, Malang, East Java, Indonesia, e-mail: faizahrahmayadi@gmail.com
Wasis Parawiranata, Laboratory of Fisheries and Marine Resources Exploration, Brawijaya University, Malang, East Java, Indonesia, e-mail: wasisgkjw@gmail.com

How to cite this article:
Rudianto, Larasati A. P., Yusuf F. R., Parawiranata W., 2019 A comprehensive assessment of the role of stakeholders in the management of Wanamina Island in Sidoarjo, East Java Province, Indonesia. AACL Bioflux 12(1):250-260.