MADURESE FISHERMEN'S ADAPTATION TO MARINE ENVIRONMENT-BASED APPROACH IN FISHERIES RESOURCES MANAGEMENT BY EMPOWERING THE LOCAL WISDOM OF "*ONJEM*"

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***Abstract*—Nowadays, the number of coastal areas which are rich in natural resources has declined. Such condition affects the economic status of the society in the coastal area. It is necessary for the society to be willing to explore the local wisdom in managing the natural resources. This research aimed to identify the local wisdom upheld by the Madurese fishermen in managing the fish resources and purposed to analyze the society adaptation to the sea condition when fishing. This study utilized descriptive qualitative approach through an in-depth interview with the fishermen, observation, and documentation of the local wisdom upheld by fishers in managing the fisheries resources. The results of the study showed that the Madurese fishermen uphold the local wisdom of "*onjem*" to manage fisheries resources. The fishermen used "*onjem*" to adapt to the high sea water temperature and strong waves. The fishermen utilized "*onjem*" to gather fish. "*Onjem*" is made from a rope, coconut leaf stalks, and buoys, and attach to the sea bottom using a weight. "*Onjem*" could lower the surrounding temperature. Thus, it attracts fish to gather around, even in a dry season or famine.**

Keywords—"onjem", climate change adaptation, fishermen

I. INTRODUCTION

The coastal area is most likely to be affected by the climate change. Climate change results in eroded coastal areas, high frequency of coastal flood, high level of water salinity, stronger ocean waves, higher ocean temperature, overflow, and so on. Such conditions influence the coastal area which has a role as a natural and social subsystem. Due to such conditions, fishermen are unable to support their basic needs sufficiently [1]; [2].

There were also economic issues faced by the society, namely illegal fishing, degradation of coastal resources and small islands, mangrove, coral reefs, sea sand miners, beach reclamation, oil contaminated sea water, abrasion, sedimentation, and global climate change. Such problems are affecting the coastal area and marine resources [3]; [4]; [5].

There are many signs of global warming in the last twenty years. Therefore, it is important to identify how the society regards the natural resources in their environment. Either the sustainable environment or coastal resources are declining from time to time because of the uncontrollable human acts to the environment [6]. The society in the coastal area should maintain the environment sustainability so that there will be enough quality resources for the future [7].

The current environmental issues are greatly caused by human acts and the global climate. The present condition of global climate damages the environment, including the coastal environment in Tlanakan, Madura, Indonesia. Therefore, the fishermen have to adapt to the sea environment affected by the global warming to be able to support their needs. The society adapt to the condition by empowering the local wisdom of Madurese culture [8].

Local wisdom could be understood as a human effort to use cognition to act upon and to form an attitude towards something, an object, or event happening in the particular area [9]. The above definition is made etymologically, in which wisdom is understood as someone's capability to use cognition in acting upon or forming an attitude towards something, an object, or the happening event. The term local specifically refers to limited interaction space with limited value systems, while wisdom is frequently understood as the ability to use knowledge and experience to make good decisions. The interaction space is designed in such a way that involves patterns of interaction among humans or between human and his or her physical environment.

The concept of adaptation is a part of the process of culture evolution, namely a process engaging a set of human efforts to fit or respond to temporary changes on physical or social environments [10]. It is supported by a statement 11] which regards adaptation as a conscious act of human towards the environmental changes. Such responsive act allows humans to set certain systems of actions or attitude to cope with the happening situation and condition. The actions relate to their needs, after going through particular situations and to subsequently form a certain strategy or decision to overcome future situations, including to make decisions of adapting to the climate change [12]; [13].

One ethnic group in Indonesia which still strongly upholds its local wisdom is the fishermen in Madura. They

hold to local wisdom in managing the fisheries resources, marine environment utilization and conservation, which include the knowledge of natural symptoms, physical marine environment and biota. They also have knowledge of reading the water for signs of fish, types of fish and exportable and edible fish, fishing technology and traditional ceremonies in managing, utilizing and conserving the marine environment [14].

The fishermen partiality towards environment can be approached by various models, one of which is ecological behavior model introduced by [15]. This model consists of five components which directly or indirectly contribute to the fishermen partiality towards the environment. Such five components including environmental knowledge, attitudes and values; supporting factors of ecological behavior namely external factor, infrastructure and economic factors which allow or prevent someone's ecological behavior; the incentive theory of behavior which acts as an internal factor strengthening and supporting the ecological behavior; feedback about the ecological behavior, someone would continue a certain ecological behavior if he or she obtains good feedback about it, either intrinsically (e.g. satisfaction from doing something good or right), and extrinsically.

The strategies the fishermen took in facing the climate change can be seen in economic aspect namely a change in livelihood and professional diversification [16];[17]. There is also a strategy of fishing equipment and fishing ground variations in technical and technological aspects. Also, there is a strategy in sociocultural aspect, i.e. utilizing social relationship and mobilizing family members.

Based on the various kinds of fishermen adaption to such marine environmental changes, this research aimed to identify the local wisdom empowered by the Madurese to manage the fisheries resources and to analyze the Madurese fishermen adaptation to fishing based on marine conditions. The uncertain situations of sea and coast make fishermen in Tlanakan, Pamekasan, Madura must adapt to marine conditions to keep getting fishes. "*Onjem*" is one of the ways for Madurese fishermen to increase their fish catches.

II. METHOD

This research used the qualitative ethnographic approach. This qualitative research purposed to identify the local wisdom empowered by the fishermen in Tlanakan, Pamekasan Regency, Madura, i.e. "*onjem*" in fisheries resources management to adapt to the sea condition. The data collection was done through observation to identify the ecological and cultural conditions of the studied society and the fishing process by using "*onjem*," participative in-depth interview, and documentation to gather essential information related to the research subject and object.

Key informant named Mr. Abas, as a skipper who is on the Song Asong beach everyday. Overall, there were six skippers at the research locations. Each of them has five subordinates (fishermen). In this research, I interviewed only 15 fishermen and all the 6 skippers.

The primary data of this research are gathered from fishermen with small boats. The research data were analyzed via interactive analysis model [18]. The analysis included three steps. The first stage is data reduction in which the processes of data selection, simplification abstraction, and transformation were performed to the raw data gathered from the field. Second, the reduced data were presented by the topics and key issues to ease the researcher in interpreting the data. The third step was conclusion withdrawal. In this stage, the researchers verified or rechecked the accuracy of the successfully gathered data. Therefore, an accurate conclusion could be taken based on the focus or problem of research.

There were some criteria utilized to ensure the validity of the data collected during the research. The first criterion was the degree of confidence. In-depth observation, triangulation, and member-check were done to fulfill such criterion. The second criterion was transferability. The researchers tried to explain the studied problem in detail, diligently, accurately, and deeply so that the researchers could distinguish the data collected and their interpretation. The next criterion was a dependency. The researchers accurately rechecked the research components, process, and findings. The last criterion was a certainty. In order to meet such criterion, the researchers were assisted by some colleagues in performing peer discussion related to the issue of "*onjem*".

III. FINDING AND DISCUSSION

A global warming effect can be seen from the occurrence of a tornado which greatly damaged fishermen's houses, caused coastal abrasion, tidal flooding, and reduced the fishermen's catch. The coastal society whose professions are fishermen were the most damaged by the tornado, including the coastal society in Tlanakan, Pamekasan, Madura.

The unpredictable marine and coastal situations forced fishers in Tlanakan, Madura to adapt to the environmental condition if they want to catch fish. "*Onjem*" is a way of fishing taken by the Madurese to increase their catch. The society empowered the local wisdom of "*onjem*" to sustain the fisheries resources so that they could have a good catch. The society implemented "*onjem*" to adapt to the condition of the marine environment. "*Onjem*" prevented the sunlight so that it lowered the temperature of the sea water around it. The fishermen preferred to put the "*Onjem*," which means a fish-aggregating device in English, near with or on top of coral with the assumption that fish usually gather on coral.

The results of an interview with respondent (Ikram) (17 and 25 October 2016), a small-scale fisherman who owned a boat originated from Branta village, Tlanakan district related to the empowerment of "*onjem*" in fisheries resources management are presented in Table 1.

TABLE I. INTERVIEW WITH RESPONDENT (IKRAM)

1.	*Researcher: de'remah caranah nyabek rumpon ka tengah tasek? (*How do you place the FAD in the middle of the ocean?*)*
2.	*Fisherman: onjem/rumpon se egebey nelayan e sabe' e tengga tase', male benyya' juko' sedetheng. (*The FADs made by the fishermen are located in the middle of the ocean to gather numerous fish*)*
3.	*Researcher: apa pemerintah berik bantuan ka nelayan? (Does the government support the fishermen?)*
4.	*Fisherman: pamerinta aberi' benthuan bhubuh male hasel tangkepan nelayan tambeh benya', (*The government gives money to improve the fishermen's catch.)

5.	*Researcher: berempak meter mon nyabek onjem ka tengah tasek? (*What is the distance between one "*onjem*" and another?*)*
6.	*Fisherman: jarak onjem maso onjem nelayan selaen paleng semmak 100 M. (*the closest distance between one "*onjem*" and another is 100 meters*)*
7.	*Researcher: se biasanah nyabek onjem katengah laut nelayan se dekremah?(*What kind of fishermen who utilize "*onjem*" and place it in the middle of the ocean?*)*
8.	*Fisherman: biasanah se andhi' onjem panekah nelayan se andhi' praho kenek. (*Usually, fishermen who place "*onjem*" in the middle of the ocean are the fishermen who have small boats.*)*
9.	*Researcher: arapa rumpon anyar gempang benyak juko'nah? (*How could a new FAD attract much fish?*)*
10.	*Fisherman: onjem(rumpon) se daunah anyar benya' juko'nah, polanah beunah ro'om.* (a new FAD made with a fresh coconut leaf stalk is scented so it attracts more fish*)*
11.	*Researcher: bulen berempa kera-kera be'na nyabek rumpon ka tengah tasek?* (In what month of the year do you place the "*onjem*"?*)*
12.	*Fisherman: mosem nemor bhulan Juni nelayan nganyareh onjemmah. (*the fishermen usually replace or fix their "*onjem*" at the beginning of the dry season in June.*)*
13.	*Researcher: Apa saben areh oleh onjem? Apa ye oleh jukok kia! (*Does having an "*onjem*" can guarantee that the fisherman will catch fish every day?)
14.	*Fisherman: Sajen bennya' onjem seepasang sajen bennya' ollenah juko'. (*More "*onjem*" can gather more fish.*)*
15.	*Researcher: Ontong nganggui onjem apa enjek? (*Does the use of "*onjem*" give more benefits?)
16.	*Fisherman: Onjem benya' ontongah dha' nelayan etimbang se ta' ngayguy onjem . (*The fishermen who use "*onjem*" collect more fish than those who do not use "*onjem*"*)*
17.	*Researcher: Jukokna jenis apa bei mon nganggui onjem? Berempa kilo! (*What kinds of fish usually gathered around the "*onjem*" and how many kilos of them?*)*
18.	*Fisherman: Hasel dhari onjem juko'nah jerajah, chontonah juko' kerapoh ben cakalan. Berra'nah juko' kerapoh kerah-kerah 12-15 kg. (*Big fish gather around an "*onjem*," such as groupers and tunas. They weigh approximately 12-15 kg.*)*
19.	*Researcher: Nelayan a panen rumpon rua berempa minggu sakale?(*How many times a week do fishermen collect the fish from the "*onjem*"?)
20.	*Fisherman: Nelayan mighe' juko' dhari onjem saminggu sakalian. (*They usually catch the fish once in a week.*)*

Onjem" or fish aggregating devices made by fishermen were located in the middle of the ocean. They preferred to use "*onjem*" since it can attract fish with its shade. There is at least 100 M distance between one "*onjem*" and another. In general, "*onjem*" is used by small-scale fishermen. On the other hand, large-scale fishing depended on large ships and rods to catch fish. There were also some rented "*onjem*" for the fishermen who need them. The making process of "*onjem*" is depicted in Figure 1.

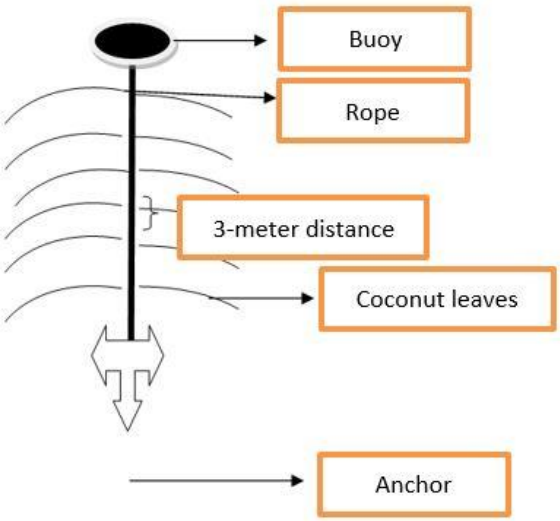

Fig. 1. Sketch of "*Onjem*"/Rumpon

The required materials for making "*onjem*" are particularly simple. The weight situated on the ocean floor is made of bamboo, the float utilizes water barrels made of plastic or cork, and a rope made from an "ompai" (coconut leaf stack) at the price of Rp. 3000. Usually, there is a distance of 3 meters between one "ompai" and another. However, some fishermen set the "ompai" every 2 meters. The average height of an "*onjem*" is 35 meters from the ocean floor to the water surface. Figure 2-7 present the required equipment to make an "*onjem.*"

Fig. 2. Weight

Fig. 3. A medium used to tie the concrete

Fig. 4. Float

Fig. 5. Rope for the "ompai" (coconut leaf stalk)

Fig. 6. The position of "*onjem*" (fish-aggregating device) in the middle of the ocean

Fig. 7. The rope positioned next to the concrete

In every dry season around June, the fishermen will add one more "*onjem*" by tying it next to the old one using the old float. When the float drowns, they will put a new float beside the old float. Most of the fishermen have hundreds of "*onjem*" situated in the ocean. They assume that a fresh scented new "*onjem*" would attract fish to gather around. The "*onjem*" they set, the more fish they can catch. The old "*onjem*" will drown as it wilts or dries. Fishers who can afford small boats would put them next to the weight to trap fish after being equipped by the fish bait (shaped as spoons). Big fish are usually trapped in those boats.

The fish gathered around the "*onjem*" would be caught by using hooks and small nets. The fish collected by the fishermen by "*onjem*" are more than those caught without "*onjem*". The types of fish captured by the fishermen commonly consist of kerapu fish (Epinephelus) weigh approximately 12 – 15 kg. The fishermen collect the fish caught by the "*onjem*" on a weekly basis.

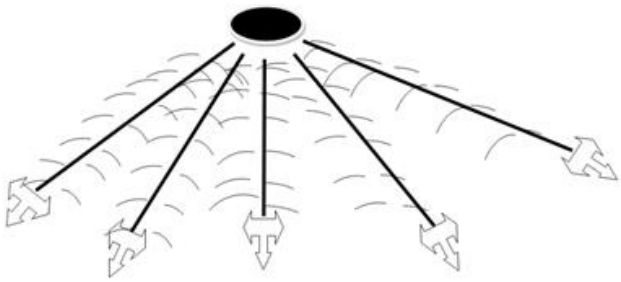

Fig. 8. Installing New "*Onjem*"

Figure 8 illustrates the new "*onjem*" positioning in the middle of the ocean.

A. The Condition of Fishermen in Tlanakan Madura

Madura Island is known as a Salt-producing Island located in the northeast of Java Island with the coordinates of approximately seven degrees south latitude and between 112 and 114 east longitude consisting of large and small islands. Madura is the largest island surrounded by smaller islands. The Madura Island is divided into four Second-level regions (municipalities), from west to east: Bangkalan, Sampang, Pamekasan, and Sumenep.

Compared to other islands in Indonesia, Madura is a dry, infertile area. It results from the soil structures which are not suitable for plants. Also, there are limited water techniques. Therefore, the majority of farming lands are in the form of moor, and it results in non-land farming livelihoods, such as being fish traders or fishermen. The same goes with the society of Tlanakan, Pamekasan Regency. The society lives in the suburban area of Pamekasan with infertile and calcareous soil which becomes worse during dry seasons. There are only certain plants which can grow in such condition, namely acacia and bamboo. There are some existing social rules applied for the fishermen coordinated through a fisherman association. The rules prohibit the use of potassium cyanide or dynamite in fishing and prohibit the fishermen to damage the mangrove forests [19].

The coastal and marine environments provide economic potential which needs to be developed. [20] stated that it is because the coastal and marine areas comprise of 63 % of Indonesia territory. It provides rich and various natural resources and environment, such as fisheries, coral reefs, mangrove forests, oil and gas, minerals, and as tourism areas. Nowadays, Indonesia depends on the development of marine resources to economically heal from the multidimensional crisis suffered continuously by the nation.

The effects of climate change result from global warming keep getting worse from year to year, especially in the coastal areas. The effects of climate change which are needed to be dealt with immediately include a change in the rainfall pattern. It may lead to drought, flood and sea water surface. Such impacts significantly influence the social, economic, cultural and political systems. The real influence can be seen in people's social lives, especially people in the coastal area, and on the narrowing coastal areas, hydrological cycle, and water management system due to flood or drought. Generally, the sea level rise will increase the frequency and intensity of floods, change the ocean current and damage the mangrove forests, expand the sea water intrusion, threaten the socio-economic activities of the society by the narrowing area of land, or disappearing small islands, and discoloring coral reefs [21]. Such conditions also affect the sea and coastal areas around Madura Island.

The coastal area vulnerability to climate change results from three factors, including the characteristic and size of variability and climate change, human capital, and the capacity of the coastal society to adapt and overcome the climate change. The adaptation program implemented in the coastal area aimed to optimize healthy and optimally functioned coastal ecosystem, reduce the exposure and vulnerability of artificial environment, strengthen the government program regarding coastal adaption, maintain the potential and diversification, and reduce human safety and health threatening risks [22]; [23].

The coastal and marine area management and conservation are performed by the Government of the Republic of Indonesia, i.e. the Ministry of Marine and Fisheries for the last 4 years. 2014 was the last implementation year of National Medium-Term Development Plan (RPJMN) of 2010-2014. The Ministry of Marine and Fisheries (2015) performed five out of eleven priority agendas of national development. Marine and fisheries development was implemented to promote the four developmental foundations, namely pro-poor (eradication of poverty), pro-job (employment of workforce), pro-growth (development) and pro-environment (environmental relief and preservation).

The coastal environment or area comprises one or more ecosystems and coastal resources which create the need of innovative ideas in conservation. A coastal ecosystem can be in the form of the natural or human-made ecosystem. The natural ecosystems of the coastal area include coral reefs, mangrove forests, seagrass, sandy beach, pes-caprae, barringtonia, estuary, and lagoon and delta formations. The artificial ecosystems consist of, among others, pond, tidal rice field, tourism area, industrial area, agro-industrial area, and residential area [24], [25]. The various coastal ecosystems and resources function as a life support of the dwelling animals, plants, and the fishermen. The innovative ideas of conserving natural resources, especially fisheries resource are represented by fishers in Madura through the utilization of "*onjem*".

B. "Onjem" for the Fish to Gather as aa Form of Adaptation to Climate Change

In the interview with Ikram, a fisherman originated from Branta village, Tlanakan District, Pamekasan Regency; he explained that a fisherman then put an "*Onjem*"/fish-aggregating device in the middle of the ocean. The fishermen are choosing "*onjem*" as it can attract fish to gather around with its shade. Fish usually gather around coral reefs so that the fishermen commonly put their "*onjem*" on or around them. "*Onjem*" is extremely beneficial to maintain the amount of fish catch or even improve it, even in a famine.

It is only the small-scale fishermen having small boats that use "*onjem*," while large-scale fishermen who have ships and large nets depend on their ships and nets only. It shows that "*onjem*" can attract fish to gather around without requiring the fishermen to go too far to the ocean which may put them in danger. The condition of the ocean becomes

dangerous after it is affected by the global climate change, leading to unpredictable sea wave. A high wave complemented by a hurricane could emerge at any time [26].

The Madurese are known as strong people with their motto of "Abhantal omba'asapo' angen" (sea wave is our pillow and wind is our blanket). Becoming fishermen is the most important livelihood for the Madurese coastal society [27]. It is supported by the findings of research which state that the Madurese fishermen possess some local wisdom regarded as the society principles in managing the environment. There are seven cultures of "*Onjem*, Petik Laut, Nyabis, Kontrak Kerja, Pengambek, Telasan, and Andun". However, it is only two of them regarded as local wisdom, namely "Petik Laut" and "*Onjem*". The Petik Laut ceremony (a ceremony to express gratitude and ask for blessing performed by fishermen) is held annually based on the society agreement. The utilization of an "*Onjem*" or a fish-aggregating device is a device used by the Madurese fishermen to increase their catch.

The results of a study conducted by [28]; [29] presented that there are 4 factors of production which make 95 % influence on the level of trust, namely the experience of being a fisherman, the number of fishing trips, the length of the seine fishing, and the utilization of FAD (Fish-Aggregating Device)/*Onjem*. Such 4 factors of production could improve the fish catch gathered by the seine fishing. The FAD utilization has increased the effectiveness, efficiency, and regularity of the fishing activities. Unmanaged fisheries using FAD will result in overcapacity, overfishing, and unsustainable fisheries. - Fisheries using FADs have to be optimally managed to assure its sustainability through research, consultation, planning, resource allocation, and law enforcement [30]; [31]).

Research findings [32] pointed out that "*onjem*" gives a more significant impact on the fishermen's catch than other factors. The influence values of the variables are -0.127-0.87 NS of education/experience of the worker, 0.30 of education/experience of the employer, 0.10 of the fish price, 0.30 of the worker household, and 2665.133 of *onjem*. Thus, the "*onjem*" utilized by the fishermen in marine biota management is evidenced to give the most significant impact on the fishermen's catch compared with other variables.

The productivity of seine fishing device operated around the FAD when the west monsoon blows more strongly. The short-term CPUE (1-3 month of installation) experienced an improvement, but it declined drastically after 4-7 month of installation. However, the productivity of a FAD situated in a different location did not show any significant difference. Hence, the fishermen utilizing seine fishing method are suggested not to install the FAD when the west monsoon blows or to manage the method further to prevent over-exploitation. The installation of FAD when the west monsoon blew in a period of 4 months, namely from January – April 2012 had increased the fish catch of up to 24 %. Nevertheless, the FAD installation on a 5-7 month period of May – July 2012 had declined the fish catch of 100 %. The FAD installation when the west monsoon blew in different locations showed the equal/similar amount of fish catch [33].

The use of FAD aimed to increase the effectiveness of the fishing operation. The operation becomes easier since the fish are already gathering around the FAD (Sondita, 2011; Primyastanto et al., 2013). However, Nahib, 2007 reminded that the biomass increase around the FAD is temporary and will not increase the entire biomass. As pointed by Nahib, 2007, a FAD acts as an ecological trap for small-sized yellowfin tuna until they reach gonadal maturity level. Therefore, the FAD needs to be carefully utilized.

The bamboo FADs equipped with attractive objects are more effective in attracting fish than the FAD made of plastic barrels with less attractive objects. A purse seine boat is more effective than gillnet and trolling lines to be operated near with the FAD location. According to Simbolon et al., 2011, the climate change also affects the social, cultural and economic conditions of the fishermen.

According to [34]; [35]; [36], the indicators and impacts of climate change on social, cultural and economic conditions of the fishermen include the different knowledge of fishermen regarding the season or wind patterns leading to their inability to predict the sea condition, the disturbance of fishing activities and the fishermen's safety. The indicators of the disappearance of animals that used to indicate the season change, the shifting seasonal starting and ending time, the unpredictable wind and wave which are used to be the signs of a season starting and ending time, the changing wind speed on certain seasons, and the period of wind blowing and wave on particular seasons influence the uncertainty of the fishermen to go fishing.

The fishermen have performed several strategies to adapt to the climate change. There are livelihood shifting and diversification relating to the economic aspect. In fishing techniques and technologies, there are some variations of fishing devices and fishing grounds. In the socio-cultural aspect, there are strategies for utilizing social relationship and mobilizing family members. Based on such findings, this study concluded that adaptation needs to be pursued as a multidimensional process. The temperature increase tended to give bigger impacts on commercial fisheries through the continuous shifting of the community interaction distribution.

The bamboo FAD is more efficient than the plastic barrel FAD, and a Purse seine boat is more effective compared with gillnet and trolling lines to be operated near with the FAD location [37]. FAD is one fishing device which has been known for an extended period in Indonesia. An important factor which influences the success of fisheries is the chosen area. The installation of FAD supporting the fishing activities allows the fishermen to fish without having to look for the proper area. It is possible since the fishing area is already clear and certain [38]; 39]. It is suggested to the fishermen who utilize purse seine boats not to install the FADs when the west monsoon blows or to have further management when the west monsoon blows to prevent over-exploitation.

It is found that the effective distance between one unjam to another is 180 m (Ibrahim et al., 1990). Fish tend to gather very massively near with blue and green-colored FADs, massively around black and white-colored FADs, and quite massively near with yellow and red-colored FADs. Therefore, fish are attracted by the blue and green-colored FADs than the contrasting colors [40]. The adaptation can be

negatively affected by the climate change [41]. The solutions that have been given for reducing such adverse effects especially in coastal areas have not yet covered marine and traditional coastal management [42]; [43]; [44].

Research conducted by [45] in Pulau Panjang Village, Subi District, Natura Regency, Riau Islands, showed that in facing the climate change, the fishermen in those areas used some adaptation strategies, one of which is by economic diversification. Such economic diversification includes fishing device diversification,

fishing site diversification, social network utilization, and family member mobilization. Such strategies were not taken solely based on the rapid climate change, but the fishermen assumed that they need more than one strategy since the environmental condition in Pulau Panjang village had started to change. Direct contact with the environment and weather anomalies which were likely to occur when the north wind (strong wind) blew and when the weather pattern was unpredictable since the fishermen consider the need to adapt to such famine. In a socio-cultural aspect, the fishermen utilized their social networks and mobilized their family members to work.

Based on the above circumstances, fishers in Tlanakan, Madura are regarded as having an environmental conscience if they have biosphere altruism orientation. It can be seen from the way of adaptation of fishers by utilizing "*onjem*" to create a dark and cool environment in attracting fish to gather around. Biosphere altruism can be developed in a society that upholds a local wisdom in environmental management. The values of ecological wisdom empowered by the Madurese have benefits for the people; one of which is a satisfying catch since the fish are attracted to gather by the "*onjem.*" The wise management results from the society ecological behavior.

Besides utilizing "*onjem*", the society also improves their economic conditions by selling their catch in various final products. Additionally, the economic situation of Madurese people was also increased by the construction of Suramadu Bridge since it connects Surabaya and Madura. Such easy access also benefits the fishermen and improves their economic conditions. Such increased income gathered from the sale of raw fish and fish products produced by the fishermen and their families.

IV. CONCLUSION

Climate change has affected the global temperature. It results in a water crisis, and it threatens food and coastal ecosystem security. In order to minimize such coastal ecosystem vulnerability in Madura Island, people adapt to the new conditions by empowering a local wisdom of using "*onjem*" (Fish Aggregating Device). Madurese fishermen upholding the positive values they inherited from their predecessors highly support fish sustainability in their environment.

REFERENCES

[1] Kusnanto, H. 2011. Adaptasi perubahan iklim. Yogjakarta. BPFE.

[2] Kekenusa, J.S. 2006. Analisis penentuan musim penangkapan ikan cakalang (Katsuwonus pelamis) di perairan sekitar Bitung Sulawesi Utara. J. Protein, 13.

[3] Apridar, M. & Karim, S. 2011. Ekonomi Kelautan dan Pesisir. Yogjakarta, Graha Ilmu.

[4] Nahib, I. 2007. Analisis bioekonomi dampak keberadaan rumpon terhadap kelestarian sumberdaya perikanan tuna kecil (Studi kasus di Perairan Teluk Palabuhanratu Kabupaten Sukabumi).

[5] Hoegh-Guldberg, O. 1999. Climate change, coral bleaching and the future of the world's coral reefs. Mar. Freshw. Res, 50, 839–866.

[6] Priyadi, H. & Suprajaka. 2015. Paradigma Geomaritim strategi Mewujudkan Indonesia sebagai Poros Maritim Dunia dalam Perspektif Geografi. Annual Meeting of IGI. Badan Informasi Geospasial (BIG) didukung oleh Ikatan Geograf Indonesia (IGI). Jakarta.

[7] Sumarmi. 2012. Pengembangan Wilayah Berkelanjutan. Yogjakarta: Aditya Media ISBN 978-602-9461-75-6.

[8] Primyastanto, M. & Purwanti, P. 2013. Fisheries Resource Management through Local institutions in Empowering Community Based on Local Wisdom in Coastal Madura Strait. International Review of Social Sciences, Vol. 2 Issue 5.

[9] Suhartini. 2009. Kajian Kearifan Lokal Masyarakat dalam Pengelolaan Sumberdaya Alam dan lingkungan. Jurusan Pedidikan Biologi FMIPA Universitas Negeri Yogyakarta. Proceeding for National Seminar.

[10] Adger, W.N., Arnell, N.W., Tompkins, E.L., 2005. Successful adaptation to climate change across scales. Glob. Environ. Change, 15, 77–86.

[11] Sovacool, B.K., Linnér, B.-O., Klein, R.J. 2017. Climate change adaptation and the Least Developed Countries Fund (LDCF): Qualitative insights from policy implementation in the Asia-Pacific. Clim. Change 140, 209–226.

[12] Primyastanto, M., Muhammad, S., Soemarno, Efani, A., 2013. Fisheries Resources Management by Empowering the Local Wisdom in Madura Straits. Research on Humanities and Social Sciences, Vol.3, No.6.

[13] Yasa, A. 2012. Pengkajian Fasilitas dan Pelayanan Kepelabuhanan Terkait Usaha Perikanan Pancing Rumpon di PPN Palabuhanratu. Unpublished Undergraduate Thesis. Retrieved from http://repository.ipb.ac.id.

[14] Sumintarsih & Budi, N.S. 2005. Kearifan Lokal di lingkungan Masyarakat Nelayan Madura. Yogyakarta: Balai Kajian Sejarah dan Nilai Tradisional Yogyakarta.

[15] Kollmuss, A. & Julia, N.A. 2002. Mind the Gap : why do people act environmentally and what are the barriers to pro-e nvironmental behavior?. Environmental Education Research, Vol . 8, No . 3, 2002

[16] Hidayati, D. 2011. Adaptasi & Mitigasi Masyarakat Pesisir Terhadap Perubahan Iklim dan

[17] Helmi, A. & Satria, A. 2012. Strategi Adaptasi Nelayan Terhadap Perubahan Ekologis. Journal UI – Makara, 16(1) : 68-78.

[18] Mils, M.B. & Huberman. A.M. 2002. Analisis Data Kualitatif. Jakarta: UI Press.

[19] Sumarmi. 2014. Pengelolaan Lingkungan Berbasis kearifan lokal. Yogjakarta: Aditya Media. ISBN 978-602.7957-50-3

[20] Dahuri, R. 2001. Pendayagunaan Sumberdaya Kelautan Untuk Kesejahteraan Rakyat. Kumpulan Pemikiran. Lembaga Informasi dan Studi Pembangunan Indonesia. Jakarta

[21] Hughes, T.P., Baird, A.H., Bellwood, D.R., Card, M., Connolly, S.R., Folke, C., Grosberg, R., Hoegh-Guldberg, O., Jackson, J.B.C., Kleypas, J., others. 2003. Climate change, human impacts, and the resilience of coral reefs. science 301, 929–933.

[22] Lobell, D.B., Burke, M.B., Tebaldi, C., Mastrandrea, M.D., Falcon, W.P., Naylor, R.L. 2008. Prioritizing climate change adaptation needs for food security in 2030. Science 319, 607–610.

[23] Georgios, T. & Nikolaos, R. 2017. Maritime spatial planning and spatial planning: Synergy issues and incompatibilities. Evidence from Crete island, Greece. Ocean Coast. Manag. 1,39, 33–41. doi:10.1016/j.ocecoaman.2017.02.001

[24] Change, I.P. on C. 2014. Climate Change 2014–Impacts, Adaptation and Vulnerability: Regional Aspects. Cambridge University Press.

[25] Dahuri, R., Rais Y., Putra S.,G., Sitepu, M.J. 2008. Pengelolaan Sumber daya Wilayah Pesisir dan Lautan Secara Terpadu. Jakarta: PT. Pradnya Pramita.

[26] Lloyd, S.J., Kovats, R.S., Chalabi, Z., Brown, S., Nicholls, R.J. 2016. Modelling the influences of climate change-associated sea-level rise and socioeconomic development on future storm surge mortality. Clim. Change, 134, 441–455.

[27] Haryanto, R. 2008. Rehabilitasi Hutan Mangrove: Pelestarian Ekosistem Pesisir Pantai dan Pemberdayaan Masyarakat Pesisir. KARSA, Vol. XIV No. 2 Oktober 2008. Diunduh 2 Juli 2016.

[28] Primyastanto, Mimit. 2016. Analisis pengaruh faktor produksi terhadap produksi dan Efektivitas fad onjhem pada alat tangkap payang di selat Madura. Seminar Nasional Perikanan dan Kelautan VI, Fakultas Perikanan dan Ilmu Kelautan, Universitas Brawijaya Malang

[29] Sondita, M.F.A. 2011. Sebuah perspektif: rumpon sebagai alat pengelolaan sumberdaya ikan.

[30] Yusfiandayani, R. 2013. Fish Aggregating Devices in Indonesia: Past and Present Status on Sustainable Capture Fisheries. Galaxea, journal of coral reef studies (special issue): 260-268.

[31] Rönnbäck, P. 1999. The ecological basis for economic value of seafood production supported by mangrove ecosystems. Ecol. Econ. 29, 235–252.

[32] Primyastanto, Mimit, Sahri Muhammad, Soemarno, Anthon Efani1, Zainal Abidin. Study on Entrepreneurship Spirit And Production Factors Affecting Sail Income of Madura Strait Fishermen. International Journal of Civil & Environmental Engineering IJCEE-IJENS Vol:14 No: 01 February 2014

[33] Kurniawan, M.R., Setyohadi, D.D., Bintoro, G.G. 2013. Pengaruh Pemasangan rumpon pada Musim Barat Terhadap Hasil Tangkapan Alat Tangkap Payang di Perairan Tuban Jawa Timur. J. Mhs. Pemanfaat. Sumberd. Perikan. Dan Kelaut, 1, 16–20.

[34] Reid, H., Alam, M., Berger, R., Cannon, T., Huq, S. and Milligan, A. 2009. Community-based adaptation to climate change: an overview. In Participatory Learning and Action. Community-based Adaptation to Climate Change, International Institute for Environment and Development, London.

[35] Smit, B. & Wandel, J. 2006. Adaptation, adaptive capacity and vulnerability. Global Environmental Change.

[36] Pareek, A. & Trivedi, P.C. 2011. Cultural values and indigenous knowledge of climate change and disaster prediction in Rajasthan, India.

[37] Simbolon, D., Jeujanan, B., Wiyono, E.S. 2011. Efektivitas pemanfaatan rumpon pada operasi penangkapan ikan di Perairan Kei Kecil, Maluku Tenggara. J. Mar. Fish. 2, 19–28.

[38] Wahyudin, E.N. 2007. Konstruksi rumpon laut dangkal dengan pelampung utama jenis ponton di perairan Kabupaten Pandeglang, Provinsi Banten. Unpublished Undergraduate Thesis. Retrieved from http://repository.ipb.ac.id.

[39] Martasuganda, S. 2008. Rumpon: Rumah Pondokan Ikan (fish aggregation device). Dept. Penanfaatan Sumberdaya Perikanan IPB.

[40] Kawamura, G., Matsushita, T., Nishitai, M., Matsuoka, T. 1996. Blue and green fish aggregation devices are more attractive to fish. Fish. Res. 28, 99–108. doi:10.1016/0165-7836(96)00478-X

[41] Georgopoulou, E., Mirasgedis, S., Sarafidis, Y., Vitaliotou, M., Lalas, D.P., Theloudis, I., Giannoulaki, K.-D., Dimopoulos, D., Zavras, V. 2017. Climate change impacts and adaptation options for the Greek agriculture in 2021-2050: A monetary assessment. Clim. Risk Manag, doi:10.1016/j.crm.2017.02.002

[42] Glaser, M., Baitoningsih, W., Ferse, S.C.A., Neil, M., Deswandi, R. 2010. Whose sustainability? Top–down participation and emergent rules in marine protected area management in Indonesia. Mar. Policy, 34, 1215–1225. doi:10.1016/j.marpol.2010.04.006

[43] Sudirman, Halide, H., Jompa, J., Zulfikar, Iswahyudin, McKinnon, A.D. 2009. Wild fish associated with tropical sea cage aquaculture in South Sulawesi, Indonesia. Aquaculture 286, 233–239. doi:10.1016/j.aquaculture.2008.09.020

[44] Glaser, M., Breckwoldt, A., Deswandi, R., Radjawali, I., Baitoningsih, W., Ferse, S.C.A. 2015. Of exploited reefs and fishers – A holistic view on participatory coastal and marine

[45] Wibowo, A. & Satria, A. 2015. Strategi Adaptasi Nelayan di Pulau-Pulau Kecil terhadap Dampak Perubahan Iklim (Kasus: Desa Pulau Panjang, Kecamatan Subi, Kabupaten Natuna, Kepulauan Riau). Jurnal Sosiologi Pedesaan, August, p.107-124.