Indian J. Fish., 63(1) : 102-106, 2016
DOI:10.21077/ijf.2016.63.1.37784-14

Note

Characterisation of small scale fisheries in southern coast of Java, Indonesia

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ABSTRACT

This study was undertaken with the objectives to identify, classify and map the characteristics as well as practices of small scale fisheries in the waters of Gunungkidul region along the southern coast of Java. Data were collected by a purposive sampling method during the period from September 2012 to January 2013. In order to map the characteristics in the utilisation of fishery resources, hierarchical cluster analysis (HCA) was employed. Characteristics of small scale fisheries identified based on ecological, technological, social, economic and institutional aspects were found to have 15 indicators. Based on HCA, fish landing in Gunungkidul were divided into 4 groups *viz.,* group I: PPP (*Pelabuhan Perikanan Pantai i.e.,* coastal fishing port) of Sadeng; group II : PPI (*Pusat Pendaratan Ikan i.e.,* fish landing centre) of Nampu, Siung and Ngandong; group III (PPI of Drini, Baron and Gesing) and group IV (PPI of Ngrenehan). Strategies for development of management measures for the fisheries resources were identified to be implemented for two clusters namely, PPP of Sadeng and the other PPIs.

Keywords: Fisheries management, Hierarchical cluster analysis, Indonesia, Small scale capture fisheries

Small scale fisheries forms an integral part of the fishing sector in Indonesia (Wiyono, 2007). According to Balagia *et al.* (2010), small scale fishing uses vessels of low gross tonnage (GT). Indonesian fisheries statistics show that more than 70% of the fishing boats are classified under small scale fisheries (Sularso, 2008). The sea off Gunungkidul along the southern coast of Java, is also dominated by small scale fisheries. Fishing in this area is done by traditional fishermen using outboard or inboard powered boats and statistics shows that 94% of fishermen do not use boats (DKP GK, 2012).

Generally, small scale fishery varies greatly from one area to another and is dependent on the biological and environmental conditions as well as on the social, economic and historical contexts in which the fishermen live (Farrugioin Bataglia *et al.,* 2010). As per the code of conduct for responsible fisheries, the management and utilisation of fishery resources in a sustainable manner should consider all ecological, technological, economic, social, environmental and commercial aspects relevant to the resource management (Himelda, 2013). Tzanatos *et al.* (2005) reported that small scale fisheries have a characteristic variation in space and time in terms of the diverse types of fishing gear and catches. In addition, characteristics of small scale fisheries sector determine variation in complexity of management.

Tzanatos *et al.* (2005) found that the main characteristics of small scale fisheries are the high diversification of fishing gear and techniques, changing patterns of time and place that they use and the different levels of dependence of fishermen on fishing. Tzanatos *et al.* (2006) defined, 12 metiers in the small scale fisheries of Patraikos Gulf, Greece considering various parameters *viz*., type of fishing gear, targeted species, vessel size, monthly operation, depth, substrate type and mesh size. The large number of metiers identified in the study were attributed to coastal, close-to-port character of small scale fisheries. Further, Bataglia *et al.* (2010) analysed fisheries of the Aeolian Islands, Italy in the Central Mediterranean Sea, which is characterised by small polyvalent (multipurpose) boats. The highest catch per unit effort (CPUE) values were reported for *Thunnus alalunga* caught using drifting long lines in the fall, *Scorpaena scrofa* caught using trammel net in summer and for *Todarodes sagittatus* using squid hand-jig line in winter. Another study conducted by Schaefer and Reis (2008) in the Patos Lagoon Estuary in Brazil revealed that the level of knowledge possessed by fishermen indicates their direct relationship with the natural environment where they live, and demonstrated the potential use of traditional ecological knowledge (TEK) for fishery management.

Nurani *et al.* (2007) stated that the fishery resources of the South Sea in Java require specific management measures because fishing activities in the area need to based on the characteristics of potential fishing areas. Therefore, study of the ecological, technological, social, economic

and institutional characteristics for each coastal fishing port (PPP - *Pelabuhan Perikanan Pantai*) /fish landing centre (PPI - *Pusat Pendaratan Ikan*) in Gunungkidul is important to provide a better understanding of the utilisation patterns of fishery resources and to develop small scale fisheries management strategies.

In the light of this, the present study was undertaken to identify the characteristics of small scale fisheries along the coast of Gunungkidul, and to classify and map small scale fisheries based on the characteristics of their activities related to the ecological, technological, social, economic and institutional aspects.

The study was conducted in the waters of the Indian Ocean along Gunungkidul coast in Java from September 2012 to January 2013. Primary data was collected through a purposive sampling method from officers of Marine Fisheries Department at provincial and district levels, TPI (*Tempat Pelelangan Ikan i.e.,* fish auction hall)/ PPP officers, Indonesian Fishermen Association (HNSI) of Gunungkidul Branch, traders, fishermen groups, and fishermen.

The characteristics of fishery resources utilisation in Gunungkidul were identified through observations and by interviews with the respondents. Classification of the small scale fishery characteristics was based on ecological, technological, social, economic and institutional aspects in each PPP/PPI. Ecological aspects can identify some indicators such as the diversity level of fish resources, fishing ground areas and fishing season. The fishing resources diversity index was calculated with the Shannon Index (Zhang *et al.,* 2009; Mwangi, *et al.,* 2012). Fishing season was determined by calculating the average value of time when fishermen catch fish. The indicators of technological aspects include the types of vessels, fishing gears, and trips. The social aspects included were the condition of fishermen, activities of fishermen and families, and supporting facilities as well as infrastructure. The indicators of economic aspects were identified from the contribution of fishing sector to the local economy in terms of local revenue value in the forms of levy or tax values, the number of business type and the production value of each PPP/PPI. The institutional aspects were observed from the existing institutions and cultural linkages involved in the utilisation of fishery resources.

The study used hierarchical cluster analysis (HCA, Xi He *et al*., 1997; Rodriguez *et al*., 2006; Stouten *et al.,* 2011). Based on the results of the characteristics already identified, the HCA analysis was carried out to map the characteristics. This analysis was also used to classify the characteristics of fishing development in each of the eight PPP/PPI in Gunungkidul. Results of this analysis form a map of the characteristics of fishery resource utilisation in Gunungkidul.

Fishermen of Gunungkidul are artisanal fishermen concentrated in the eight PPP/PPI *viz.*, PPP of Sadeng and PPIs of Nampu, Siung, Ngandong, Drini, Baron, Ngrenehan and Gesing. Fishermen in each PPP/PPI operate in different fishing grounds (Fig. 1).

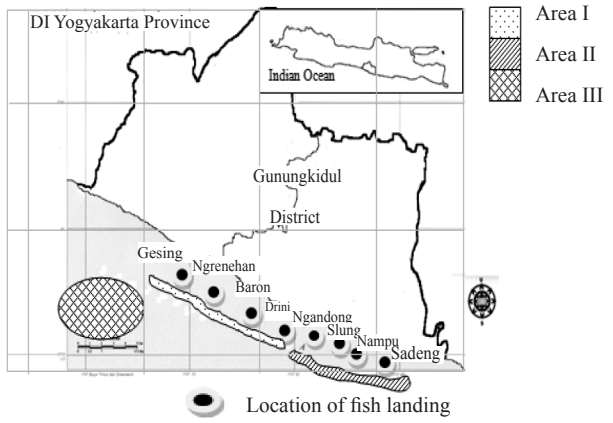

Fig. 1. Location of fish landing centres and fishing grounds in Gunungkidul District
Area I: Fishing ground for fishermen from Drini, Baron, Ngrenehan and Gesing covering waters around Drini, Baron, Ngrenehan, Gesing and estuary of Progo River, Area II: Fishing ground for fishermen from Ngandong, Siung, Nampu and some Sadeng fishermen, covering waters of Ngandong, Siung, Nampu and Sadeng, Area III: Fishing ground for the inboard motor boat fishermen from Sadeng.

Fifteen variables were identified as indicators of the characteristics of fishery resource utilisation in Gunungkidul (Table 1). The first ecological indicator is the diversity of fish resources. The diversity index (Shannon-Weiner = H) varied from 1.3086 to 2.0582 for the fishery resources of each PPP/PPI in Gunungkidul. The highest diversity index value was obtained for the fishing ground of PPI Ngandong fishermen, whereas the lowest one at the fishing ground of Sadeng PPP fishermen. However, according to categorisation by Krebs (1989), the diversity value in Gunungkidul waters is relatively low (the value of the index H' below 2). The diversity index between 2< H<3 is categorised as moderate group; and the value of diversity index H >3 is considered as high (Table 1).

In Gunungkidul, multipurpose fishing gears are used. Types of fishing gear used by fishermen are lift nets, gillnets, fishing line, portable traps and others. *'Krendet'* is a special fishing gear for lobster made of 10 mm dia iron rod bent in a circle shape with nylon nets and baits inside. Fishermen operate this gear by throwing it from the top of a cliff, leaving it overnight, and the lobsters are collected

Table 1. Characteristics of fish recourses utilisation in PPP/PPI at Gunungkidul District

	Ecological	Technological						Social			Economic			Instituitional	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PPP Sadeng	1.4342	7	4	3	3	3	4	2	3	1	4	3,157.6	157.9	7	2
PPI Nampu	1.8290	3.3	2	1	1	1	1	1	2	2	3	77.3	3.9	3	2
PPI Siung	2.0099	6.7	2	1	1	1	1	1	3	2	3	247.5	12.4	3	2
PPI Ngandong	1.8863	6.1	2	1	1	1	1	1	3	2	3	161.8	8.1	3	2
PPI Drini	1.9648	7.8	1	1	1	1	2	1	3	2	3	865.0	43.3	3	2
PPI Baron	1.7107	6.7	1	1	1	1	2	1	3	2	3	1,232.7	61.6	3	2
PPI Ngrenehan	1.5925	7	1	1	1	1	3	1	3	1	3	871.9	43.6	3	2
PPI Gesing	1.8333	8.2	1	1	2	1	1	2	2	1	3	595.5	29.8	3	2

1 : PPP/PPI; 2 : Fish diversity index; 3 : No. of trip duration rate (month); 4 : Fishing ground (1 = Area I; 2= Area II; 4 = Area III and II); 5 : Type of boat (3= inboard 30 GT; inboard 5-10 GT, Outboard motor; 1= Outboard motor); 6 : Type of gear (3 = Purse seine, troll line, hand line, gillnet, *krendet;* 2= line, gillnet*, krendet*, portable trap/*bubu;*1= line, gillnet, *krendet)*; 7 : Type of trip (1 = 1 day; 2= 5-7 days;3 = 2 weeks); 8 : Facility (4 = Landing pool, port, gasoline station, ice factory, fish showcase; 3=Natural landing, port, gasoline station, ice factory, fish showcase; 2=Natural landing, port, fish showcase;1=Natural landing, port); 9 : Fishermen condition (2 : local, nomadic fishermen, 1 : local fishermen);10 : Diversification of fishermen household activities;11 : Connection with other activity (1 : fisheries, 2 : fisheries and tourist); 12 : Type of business (1=fishermen;2= fishermen, local traders; 3=fishermen, local traders, regional traders/collectors; 4=fishermen, local traders, regional traders/collectors, ice factory); 13: Production value (Rp. million);14 : Tax value (Rp. million); 15 : Kind of Institution (3= Port/TPI, Fishermen groups, people of surveillance groups; 7=Port/TPI, fishermen groups, cooperation, people of surveillance groups, Police, Guard, Navy); 16 : Culture (2 : days of fishing prohibited, 1 : no day)

in the morning. Fishermen also operate 100 units or more of *krendet* strung with a rope, from boats which are set in the afternoon around reefs and lifted next day morning.

Fishing duration (trip) in Gunungkidul comprises single day and multiday. In single day fishing, fishermen use boats with outboard motor operated by two or three persons. Majority of fishermen in Gunungkidul undertake single day trips and the fishing ground spreads all over the fishing centers. Multiday fishing trips are of two categories *viz*., 5-7 days per trip and 2 weeks per trip. The first category is operated by fishermen using inboard engine of 5-10 GT, with 5-10 persons. The second category is operated using inboard engine of 30 GT operated by 25-30 persons. Fishermen in PPP Sadeng generally operate inboard fishing vessel.

Based on the observations and interviews with the officers in PPP/PPI of Gunungkidul it was found that, PPP Sadeng has almost complete infrastructure facilities compared with other PPIs. The existing infrastructure in each of the PPIs is almost the same. All TPIs have built in fish auction areas and have natural landing place. Even if there is a difference, it is only in Ngrenehan, which has facility of gasoline station but still not used optimally. However, PPI of Baron and Drini are equipped with fish stalls. Gunungkidul has mostly small scale fishermen and there is a process of acculturation between local and nomadic fishermen (*andon*) (Table 1).

Identification of the characteristics of fishery resources utilisation in each fishing centre is based on HCA analysis. The data validation test (using Squared Euclidean Distance) showed that all of the data pertaining to the 15 characteristics in the utilisation of fishery resources in Gunungkidul District, have been processed without any data loss (100% valid). HCA analysis identified 4 groups based on the characteristics of each fishery resource and the small scale fisheries in Gunungkidul was classified into 4 groups (Fig. 2) *viz*., Group1 (PPP of Sadeng), Group 2 (PPI of Nampu, Siung and Ngandong), Group 3 (PPI of Drini, Baron, and Gesing) and Group 4 (PPI of Ngrenehan). Classification into 4 groups can be used as reference in the management of the four small scale fishing groups. Carneiro (2011) stated that fishery management is highly dependent on human development and well being, where a specific management will have an impact on their life.

The first group, PPP of Sadeng, is the largest fishing port in Gunungkidul and has almost all facilities compared to others. Also, the fishermen here have been using more advanced fishing technology, like inboard motor boat of 5-10 GT to 30 GT. This makes the fishing area farther, as compared to other places. They also have the kind of fish that is not found in other locations, such as tuna, dolphin fish and marlin. These characteristics have made it different from other fish landing centers. The second group consists of PPI of Nampu, Siung and Ngandong. The three fish landing centers are similar in fish species, location of fishing grounds, boats and fishing gear, technology, facilities and infrastructure, local fishing communities and fishing culture. Similarly, the third group involving PPI of Drini, Baron and Gesing also has similar characteristics. What makes it different from the second group is in the location of fishing ground, *i.e.,* around the coast near the landing site up to Parangtritis coast and also in some fishery resources. PPI of Ngrenehan as Group 4 has different characteristics compared to groups 2 and

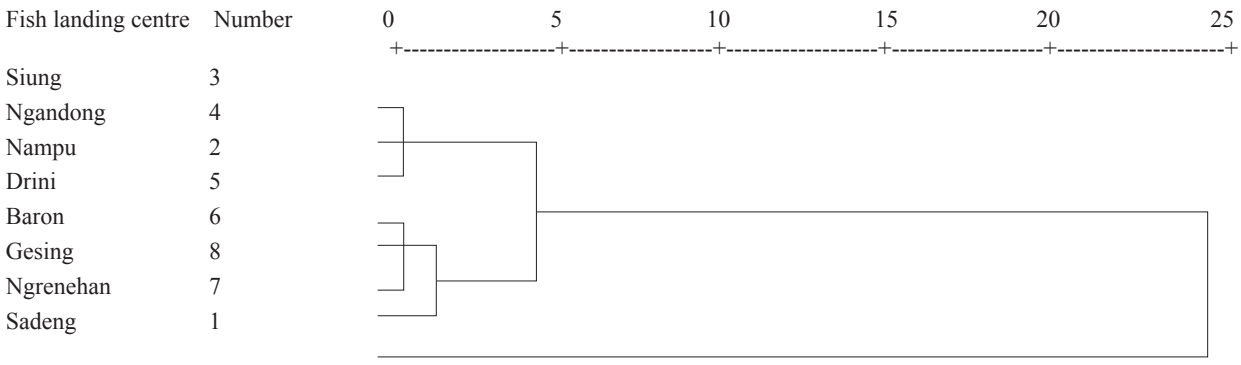

Fig. 2. Grouping of fishing ports by *Hierarchical Cluster Analysis*

3 because the infrastructure in the PPI is more complete with the presence of gasoline station and fish dispaly counters. Moreover, tourist beach and fish landing centers are located in different places, approximately 3 km apart. However, further observations showed that there were some similar characteristics for groups 2 and 3 for *e.g.*, use of fishing gear technology and motorboats, fishermen condition and culture.

Fig. 2 shows that the 4 groups above can be classified into 2 large groups as an effort to formulate a strategy in utilising fishery resources in Gunungkidul, *viz.*, cluster 1 and cluster 2. Cluster 1 includes the PPP of Sadeng with almost complete facilities compared to other PPIs. It also has more diverse fishermen conditions and more advanced technology, resulting in its own characteristics of development in fish resources utilisation. Cluster 2 includes PPI of Nampu, Siung, Ngandong, Drini, Baron, Ngrenehan and Gesing. The seven PPIs in general have similar characteristics in the fishing methods and technologies, fishing gear and fishing culture. However, there are some specific differences characterising each PPI.

Fishery management should not be separated from the role of stakeholders such as fishermen, governments, non-governmental institutions, academia, traders, processing groups and others (Adrianto *et al.,* 2011). Local institutions in Gunungkidul involve the Department of Marine and Fisheries of Yogyakarta Province and Gunungkidul District, PPP of Sadeng and PPIs of Nampu, Siung, Ngandong, Drini, Baron, Ngrenehan and Gesing, the Indonesian Fishermen Association (HNSI) of Gunungkidul, Community Monitoring Group (POKWASMAS) and groups of fishermen and fish processors. The characteristics of formal and informal institutions in each PPP/PPI in Gunungkidul are given in Table 1.

In the context of sustaining coastal resources, the coastal communities of Gunungkidul have awareness about preserving natural resources. This is reflected in the form of POKWASMAS which is a non-governmental organisation comprising public representatives and stakeholders in the region such as the police, fishermen, other related community groups that exist in the region. POKWASMAS are there at all the 8 fishing centers. In terms of fishery resources monitoring, Department of Marine and Fishery of Gunungkidul and related agencies routinely conduct training for groups of monitoring communities related to conservation on protected fish resources. The role of community in natural resource monitoring is very important because Gunungkidul has limited number of supervisory officers. Moreover, the local government of Gunungkidul does not have patrolling boats and depends on the Water Police of Yogjakarta Province. Gunungkidul fishermen also have a special tradition where fishermen are prohibited for fishing on Friday (*kliwon*), a special day in Javanese Calender, in some places and on Tuesday (*kliwon*) in other places. This tradition is certainly useful for the preservation of fishery resources as it reduces the fishing pressure in this area.

Department of Marine and Fisheries of the Province and Gunungkidul District has imparted training to fishermen on improvement of fishing technology, extension related to fishing activities, and others. Besides, they provide infrastructure such as landing facilities, TPI, fish marketing and capital aid and equipment (fishing gear and boats). This certainly has an impact on increased production and economic activity of fishing. From the above description, it can be seen that the existing institutions have a positive effect in terms of supervision and utilisation of fish resources. Further more, the fishing culture developed in Gunungkidul has a positive impact on the sustainability of fishery resources utilisation.

The results of the sudy identified 15 indicators covering the ecological, technological, social, economic and institutional aspects for the small scale fisheries in Gunungkidul. HCA analysis showed that small scale fisheries in Gunungkidul can be classified into 4 groups. Development of small scale fisheries management in Gunungkidul can be

directed into 4 patterns adapted to the characteristics of each location. For the purpose of developing fishery resources utilisation, the groups can be made into 2 clusters, namely PPP of Sadeng and the other PPIs.

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Date of Receipt : 10.02.2014
Date of Acceptance : 09.12.2015