THE JAVA SEA SMALL-SCALE FISHERIES IN CHANGING ENVIRONMENT: EXPERIENCES FROM INDONESIA

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ABSTRACT

The north coast of Java Sea is home to thousands of small-scale fishers fishing for small pelagic fish. The small pelagic fisheries have been the main economic and social activities for coastal communities where other alternatives are limited. The fisheries have been experiencing turbulent states during the last thirty years due to various transitions in regulatory regimes. As early as twenty years ago, the fisheries have been declared as overfishing, and the livelihood of the fishers has continued declining ever since. Government of Indonesia has initiated various policy schemes to save the fisheries, including the recent introduction of right based coastal areas to address ill-defined property rights in fisheries. Nevertheless, the results of such policies are unclear. Poverty and resource degradation are still rampant in the area. This paper attempts to address the fate of the fisheries within different policy regimes from centralized policy to decentralized policy. It also addresses how the transition from de facto open access to more regulated regimes designed to achieve responsible fishing has been a failure. Lessons learned are then drawn, and policy prescriptions are recommended for the fishery in the future.

Keywords: Small pelagic fisheries, the North Coast of Java, instability index, decentralization, growth oriented policy

Introduction

Small pelagic fisheries of the north coast of Java have been playing a greater role in Indonesia. During period of 1980s-1990s, the fisheries contributed the largest share of small-pelagic landing in the country and have become “engine of growth” for coastal area of the north coast of Java. The fisheries have now undergone significant changes over the last twenty years. The Contribution of fish landing from the north coast of Java has been declining. In 2006 this area has contributed around 16% to total fish landing, and in 2007 this contribution has decreased to 15% of the total landing. There are several factors that contribute to this declining. First, massive influx of fishing vessels, particularly purse seiners, following trawl ban in 1980s has put significant pressure on the fisheries. McElroy (1991a) describes this period as the modern tragedy of the common. Second, massive developments in coastal areas along the North Coast of Java have caused severe environmental degradation which causing the loss of mangroves and coral reef as well as producing runs off pollution. Third, climate variability and natural hazard have caused significant pressure on fishing fleets reducing their fishing operation and increase in cost of fishing. All of these factors contribute to considerable decline of small pelagic landing in the North Coast of Java. Recognizing the importance of these fisheries in the national economy has prompted us to evaluate the development of the fisheries. This paper attempts to examine the development of the fisheries during the last three decades. Emphasize of the analysis was given on the evaluation of the pattern of growth, variability of growth and instability in production and level inputs exerted into fishery. This analysis is not only important to have a broader picture of the fisheries but also it is important for policy makers who are always confronted with the problems of accurate performance of the fisheries.

The Fisheries

The coastal area of Central Java has been the main fishing hub for small pelagic fisheries in the north coast of Java Sea contributing to more than 50% of small pelagic landing of the Java Sea. Even though, the share of landing from Central Java shows a slight decline during the last five years, Central Java till maintaining its central role in the small pelagic fisheries of the Java Sea. The majority of small pelagic fish was landed and sold in the main port of Pekalongan by two dominant fishing gears i.e., purse seine and gill nets. The catch of small pelagic fish was predominantly four species i.e., scads (*Decapterus macrosoma*), Indo-pacific mackerel (*Rastrelliger brachysoma*), trevallies (*Selar spp*), and sardines (*Sardinella spp*). Landings of these species have been fluctuated considerably during the last thirty years as can be seen from Figure 1. All four species show similar pattern in terms fluctuation in landings, increase dramatically prior to mid 1980s than decrease significant afterward. Part of higher landing during period of 1970s- late 1980s was attributed to the increase in the number of vessels, particularly purse seiners and gillnet whereby after the trawl ban in 1980s, there was not only an increase in new gears operating in the java sea, but also due to an increase in the number of ex-trawlers fishers who switched their gears to gill nets and purse seines.

Despite their positive contribution to the landing of small-pelagic fish, increase in the number of vessels has also put added fishing pressure on pelagic resources. The productivity of fishing measured by catch per unit effort tends to be declining after late 1980s (Figure 2). This pressure was felt not only through the North Coast of Java but also for the Java Sea as a whole. McElroy (1991a, 1991b) even noted that the increase pressure on the pelagic stock, indicated by a large fluctuation in the catch scads and mackerel, may lead to stock collapse of these species.

A recent study by Fauzi and Anna (2010) shows that, the decline in small pelagic landings in the North Coast of Java has disrupted socio-economic livelihoods of fishermen and coastal communities as a whole. Income from fishing has been declining and fishers have to seek alternative livelihood, including exploiting terrestrial resources to survive to changing and uncertainties situation in the fishery.

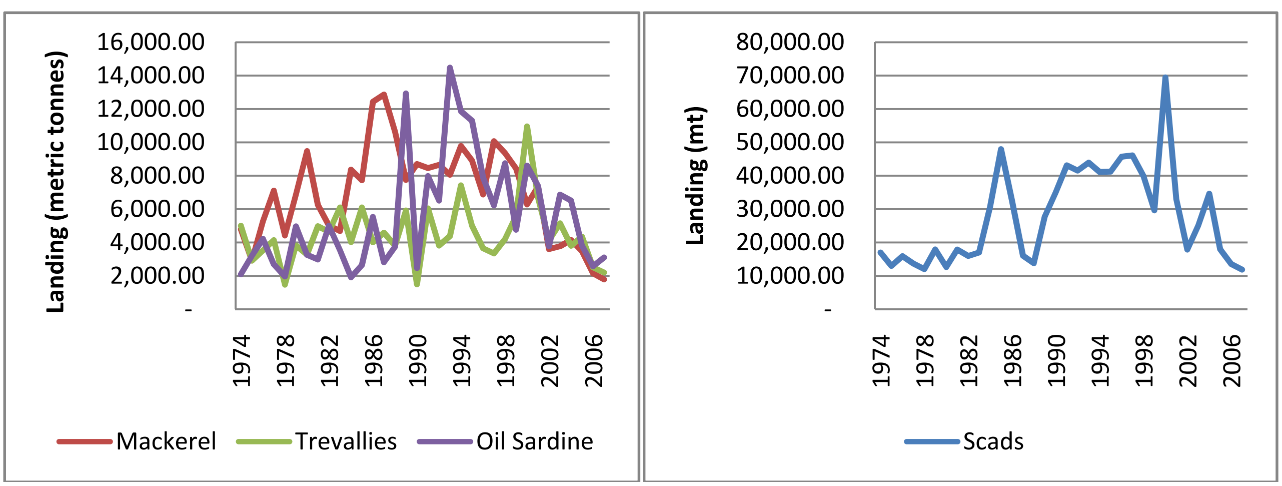

Figure 1. Landings of small pelagic fish in the north coast of central Java

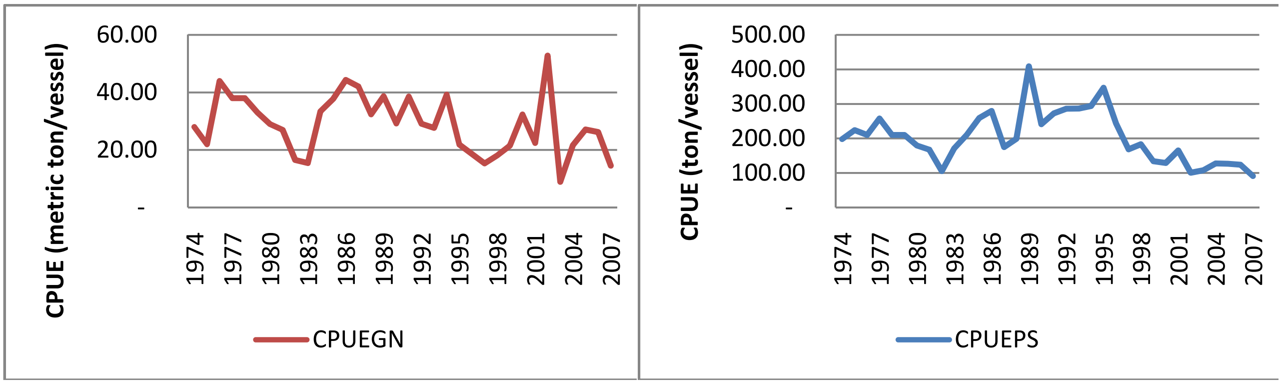

Figure 2. Catch per unit effort of gill net and purse seines.

Assessment of the fisheries

In order to gain an insight into and understand what had happened with the fishery during the last thirty years, an evaluation based on observable data was carried out.

There are various methods to evaluate the state of fisheries. Among these are non-parametric technique introduced by Pitcher and Preikshot (2001), growth analysis as done by Squires (1994), Squires and Reid (2004) and Jin et al (2004), econometric modeling (Agnarson and Arnason, 2007) and many others. Pitcher and Preikshot (2001) develop a method to evaluate the sustainability of fisheries using what so-called Rapfish (Rapid appraisal for fisheries) technique. The method can be used to assess how sustainable the fisheries based on FAO code of conduct. Growth analysis such as those Squires (1994) and Jin et al (2004) focus on the evaluating the sources of growth and factors of inputs and outputs that contributes to Total Factor Productivity (TFP). Agnarson and Arnason (2007) in the meantime use Error Correction Model (ECM) to assess fishing industry in Iceland. All those techniques can be beneficial to evaluate the fluctuation and changing in fisheries over a long period of time and the results could be extremely meaningful understand the fisheries and the policies that have been applied to them. Despite the advantages, those methods require extensive data set both at macro and micro levels. This could be difficult for fisheries in developing countries where data are sometimes are incomplete. A less elegant but powerful method that can be used is to measure growth and instability index to evaluate the fisheries. Coppock Instability Index (CII) (Coppock, 1962), for example, has been used in various assessments of the fisheries in developing countries such Shah, 2007, and Wasim, 2007). This technique has also been applied to evaluate other agricultural products such as found in Reddy (2009), and Karjogi et al (2009). This method requires less extensive data set and suitable for evaluating the fisheries policies in developing countries. This paper will use such a method to evaluate the fisheries of the small pelagic in the north coast of java which have been subjected to various policy initiatives to manage the fisheries.

Growth of small pelagic landings in during period t was evaluated using the following formula:

$$Log(h_{it}) = \log\alpha + t\log\beta \qquad \text{(Eq/ 1)}$$

where h_{it} is landing (catch) of species i at time t, α is constant, β is coefficient containing growth rate (i.e $\beta = 1 + r$ where r is growth rate) and t is time variable (in year). This compound growth rate was chosen because it fits well with data compared to that linear model.

Instability index was calculated using Coppock Instability Index i.e.:

$$CII = \left| anti\log\sqrt{\log V} - 1 \right| \times 100 \qquad \text{(Eq. 2)}$$

where

$$\log V = \frac{1}{n-1}\left[\sum\left(\log x_{t+1} - \log x_t\right) - \frac{1}{n-1}\sum \left(\log x_{t+1} - \log x_t\right)\right] \qquad \text{(Eq. 3)}$$

and n is the number of years, x value of the variable being observed, and t is year.

Growth and Instability of the fisheries

Table 1 presents growth rate and instability index of small pelagic landings. Both growth and instability index were divided into four phases i.e. phase I (1974-1983), phase II (1984-1993), phase III (1995—2007) and overall periods (1974-2007). As can be seen from Table 1 and Figure 3, in general, instability is higher during phase II, while overall period shows modest instability index. Species wise, instabilities in production for scads were higher during phase I and phase III, while for mackerel instabilities were higher during phase III and overall period. Sardine shows highest instability in production during phase II, while trevallie shows highest instability during phase III. Higher instability was also shown for sardine during period III with CII of more than 40. Higher level of instability in phase III perhaps attributed to negative growth of production in phase III as indicated from Table 1 and Figure 1. As for sardine, this case is different, higher growth in phase II is related to higher instability index in the same period. These findings, are to some extent, similar to those found in other fisheries studies such as Shah (2007) and Wasim (2007) who found that for some fisheries, higher growth rate is related to higher instability while for others the situation is the opposite.

Table 1. CGR and CII for small pelagic landing

Fish	CII-P1	CII-P2	CII-P3	CII-overall	CGR-P1	CGR-P2	CGR-P3	CGR-Overall
Scads	19.09	1.97	38.83	6.32	1.35	4.11	-9.08	1.945
Mackerel	17.94	4.75	56.73	18.36	3.50	-1.78	-11.76	-1.19
Trevallie	6.70	19.87	37.92	15.12	4.33	-2.05	-4.57	0.47
Sardines	2.69	71.56	42.49	6.98	4.69	17.90	-8.80	2.35

The trade-off between growth and instability of these small pelagic landings can be categorized into four types following Reddy and Mishra (2007). First, high growth-low risk (low CII). Second, high growth high risk. Third low growth-low risk. Four low growth- high risk. These patterns are depicted in Figure 4. Looking closely at Figure 4, one can see that only three patterns emerge. The first one is cluster of low growth-low risk as indicated by bottom left corner of Figure 4. This patter is undesirable from economic point of view since it indicates that landing must be restrained. However, this might be preferable from ecological point of view. It also gives signal to policy makers and fisheries managers that the state of the fisheries is indeed call for strict management of controlling the catch of these species. The second cluster is attributed to low growth and medium to higher risk. This can be seen from landings of sardine, mackerel and trevallies during period of phase III. This pattern is also undesirable. It conforms to the fact that phase III of the fisheries in the north coast of Java was indeed phase where overfishing was rampant and control of the fisheries was lacking.

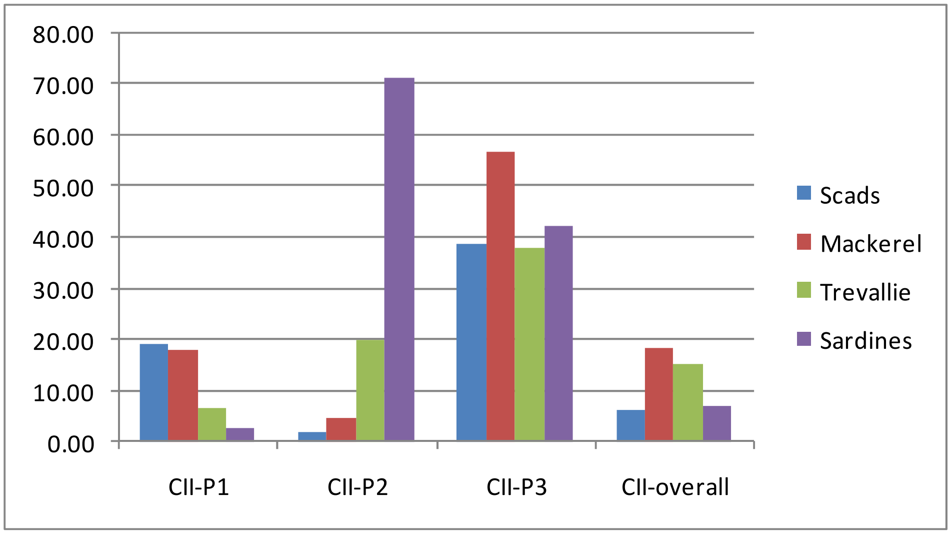

Figure 3. CII for small pelagic fish

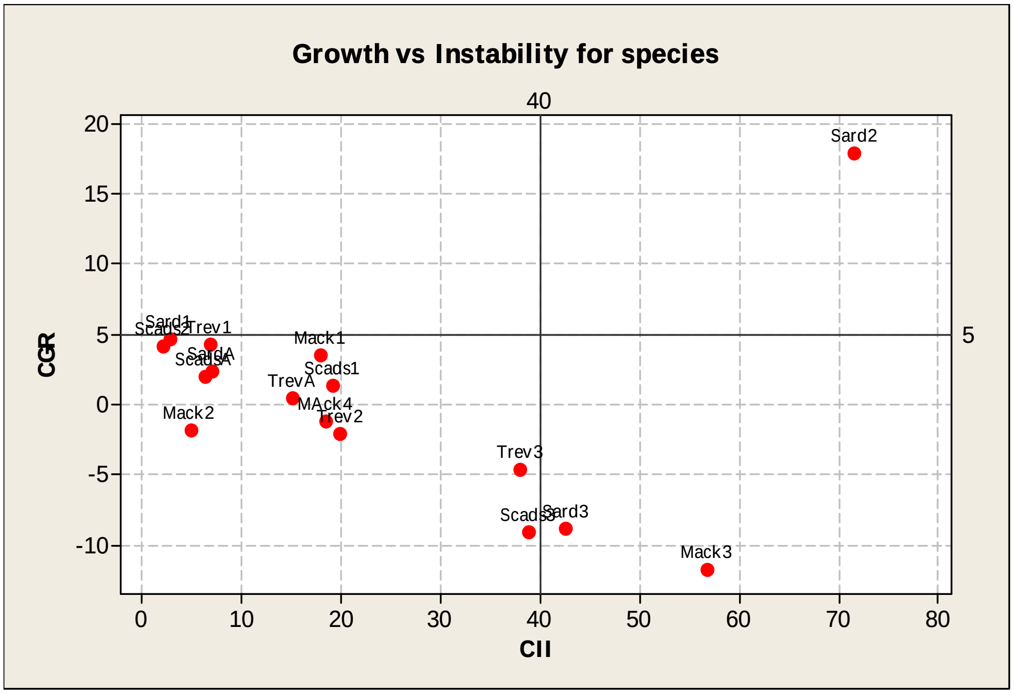

Figure 4. Matrix Graph of Growth vs Instability for small pelagic landing

Fluctuations in production that leads to instability are not stand alone phenomena. They are attributed to other indicators such as inputs that were exerted into the fisheries. In the following Table 2, instability index as well as compound growth rates were measured for other indicators which were related to the landing of small pelagic. This includes the number of vessels operating during the period in question, disaggregation of catch per vessel and total catch by vessels (i.e. purse seine and gill net). As can be seen from Table 2 and Figure 5, number of purse seine and landing of small pelagic fish by this vessel shows highest instability index during the first phase. This conforms to some analyses (McElroy, 1991a, 1991b) who found that higher influx of this vessel during early 1980s has caused massive increase in growth production. This can be seen from CGR of phase I where purse seine enjoys highest growth rate in production. In terms of productivity measured by catch per unit effort, Table 2 indicates that catch per unit effort show highest instability during phase III. This is perhaps attributed to the fact that there is lag between growth in production and instability in CPUE. Higher growth of vessels and production affect instability in cpue in later period. Higher instability of CPUE in this period is perhaps affecting higher instability of landing of small pelagic in the same period as indicated by Table 1.

Table 2. Scores of CII and CGR for inputs indicators

	CII-P1	CII-P2	CII-P3	CII-Overal	CGR1	CGR2	CGR3	CGRall
CPUEGN	5.42	4.86	30.08	11.88	-6.40	-3.07	-1.38	-1.39
CPUEPS	1.81	10.43	36.31	14.20	-5.18	3.11	-7.93	-1.66
ProdGN	57.56	14.19	7.64	33.89	12.4	6.6	3.28	2.8
ProdPS	133.48	21.08	51.68	39.24	25.08	4.54	-8.98	3.35
NVGN	49.47	8.90	20.85	49.80	19.97	9.97	4.72	4.25
NVPS	129.34	9.64	11.28	59.00	31.91	1.38	-1.15	5.1

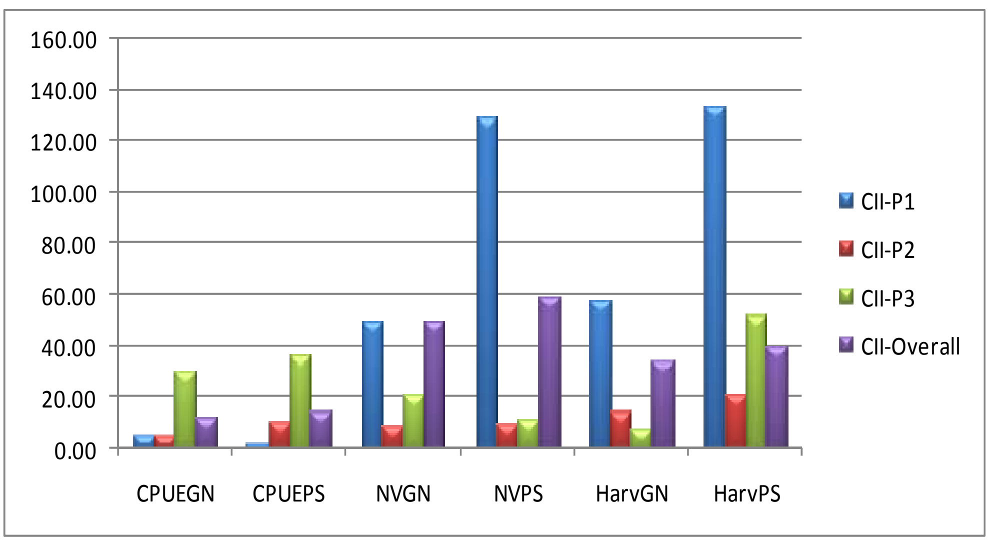

Figure 5. CII for input and output wise

The trade-off between CII and CGR using these indicators is somewhat different than that for species wise. As indicated from Figure 6, three clusters are emerged in terms of CII-CGR trade-off. The first cluster is similar to species wise cluster whereby low growth-low risk pattern is dominant as shown in bottom left corner of Figure 6. This pattern again shows that the fisheries are not in good state since this pattern is undesirable one. Figure 6 also reveals a desirable situation i.e. higher growth with low risk as indicated by upper left quadrant. This is shown by the number of gillnet during phase I and phase II. This implies that stabilizing the fisheries would call for reducing the level of effort to lower level (gill net scale) to at least the same level during period 1974 to late 1980s. On the opposite is indicated by upper right corner in which higher growth-higher risk trade off is experienced. Again this trade off is attributed to the growth of purse seine during the first phase which induce instability in the fisheries in that period and periods afterward.

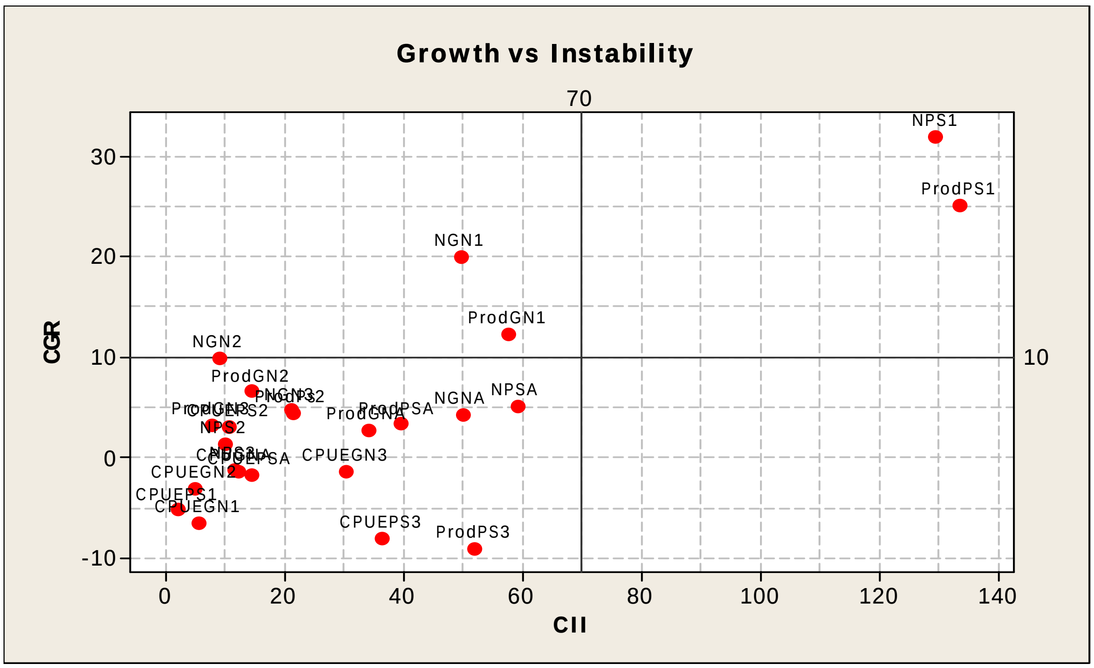

Figure 6. Matrix graph for CII and CGR (input and output wise)

In order to capture the overall interaction between instability and growth rate, a correlation analysis was carried out. Table 3 presents correlation matrix between input variables and output variables for both purse seine and gill net. As indicated from Table 3, in general, there is strong correlation between growth rate and instability index either positively or negatively. On average the coefficient is relatively higher than 50%. Looking closely at Table 3, it shows that there are strong own correlations between growth in purse seine and instability index of this vessel. For example, growth in production by purse seine is negatively correlated with instability of CPUE of this vessel (r =-0.90). Similar sign of correlation was also found for gill net. One interesting finding is that in terms of cross-correlation between these two vessels. For example, growth in the production by purse seine will highly correlated with higher instability of production by other vessels, in this case, gill net (r=0.92). It indicates that since these two vessels compete for the same type of fish, an increase in production of one vessel will likely induce perturbation on the other.

Table 3. Correlation matrix between CGR and CII for input and output

	CIICPUEGN	CIIPRODGN	CIINVGN	CIICPUEPS	CIIPRODPS	CIINVPS
CGRCPUGN	0.63	-0.77	-0.21	0.75	-0.83	-0.79
CGRPRODGN	-0.62	0.73	0.26	-0.74	0.81	0.75
CGRNVGN	-0.62	0.75	0.29	-0.74	0.83	0.77
CGRCPUPS	-0.71	-0.13	-0.34	-0.50	-0.54	-0.27
CGRPRODPS	-0.77	0.92	0.56	-0.90	0.78	0.89
CGRNVPS	-0.52	0.94	0.65	-0.72	0.78	0.96

Discussions and Concluding remarks

The small pelagic fisheries of the North Coast Java have undergone significant transformation driven by various factors. One of these key factors is the inconsistent policies directed toward managing the fisheries. The policies for managing the fisheries have been subjected to various changing governance environment during the last thirty years. To understand this policy changes, we need to refer to what happen in Indonesia political transformation which had happened in 1999. The fishery policy can then be viewed within two major periods i.e., before 1999 and after 1999 (Syarif, 2009). Before 1999, the central government has full authority to manage the fisheries throughout the country. The main mantra during this period is "growth". It was a growth oriented policy that eventually drove the Indonesia fisheries into current state of overfishing. This is no exception for the Java Sea pelagic fisheries. Following the ban on trawl fishing, the fisheries have been subjected to several policies to stimulate growth, including providing loans and massive subsidies for the expansion of fishing fleets as well as for ex-trawls fishers to convert to purse seiners and gill netters. It is not surprising therefore, that growth of landing was higher before 1999 periods causing higher instability to the fisheries. The impact of "growth oriented policy" was eventually become visible in the later periods.

After 1999, Indonesia embarked into new era of decentralization. This new governance system has also affected the policy for managing the fisheries. Under what so-called the autonomy law (Law No 32/2004), 35 of 41 management authorities, including authority to manage natural resources such as fishery which previously under the central government is now delegated into regional level of governments. Under this decentralization system, it is now getting more difficult to manage the fisheries since various levels of governments are now involved in managing the fisheries. Delegating the right to manage the fisheries to local level should indeed lead to better management of the fisheries such as those practiced in developed countries. This unfortunately is not the case for the small pelagic fisheries of the north coast of Java. As stated in annual report of regional fisheries agency of the Central Java (DFO, 2007), one major factor that contributed to the declining in small pelagic landing is conflict over access to small pelagic fishing grounds between fishers of the north coast of Java and those from South Kalimantan. Under the Autonomy Law, the fishing grounds are now claimed by various provinces bordering the Java Sea. This unresolved dispute has caused significant reduction in the number of trips of the Java Sea fishers. This conflict, driven by decentralization process, has also caused another domino effect. Fishers now have to fish further. With increase in fuel price, this has led to double jeopardy for fishers leading to declining in income and increase in incidence of poverty.

In addition to changing policies towards fisheries management, post-1999 was also marked with the new system of managing coastal areas. Under the Law Number 27/2007 on Coastal Zone and Small Islands Management, new coastal right based system was introduced. This system is intended to better management of coastal areas and their resources, including the fisheries. Nevertheless, the policy was failed to be implemented. Resistances from fishing communities as well as potential conflicts with other regulatory instruments such as Law on Spatial Planning are now constraining the implementation of Law 27/2007.

Small pelagic fisheries of the north coast of Java are constantly challenged by various regulatory measures. Yet, none of these is succeeding to bring the fisheries into well-managed fisheries. The declining trend in small pelagic landings and high degree of instability are certainly disturbing features of the fisheries management in the north coast of Java. This calls for serious attention by various policy makers to bring the fisheries into healthy sectors which could bring prosperity to coastal communities as well as maintaining healthy ecosystem. Current regulatory measures need to be reviewed, especially with regards to the regional autonomy law. Similarly, stabilization policy could be introduced to reduce the instability through controlling input prices such as fuel price, improving socio-economic conditions, and strengthening capacity building of local fisheries authorities.

It is also important to note that, the government of Indonesia needs a "blue print" strategies to manage small pelagic fisheries and for all fisheries in Indonesia. This includes a thorough review of the past and current management and direction toward future management. Results of this study could be used as a benchmark for policy makers to understand how fisheries behave in the past. Future direction can then be drawn upon to bring the fisheries into well-managed fisheries.

REFERENCES

Coppock, J.D. 1962. International Economic Instability. McGraw-Hill. New York.

DFO (Department of Fisheries and Ocean Central Java Province). 2007. Laporan Tahunan Perikanan (in Bahasa Indonesia) (Annual Fisheries Report). Semarang, Indonesia

Fauzi, A., and Z. Anna. 2010. Social Resilience and Uncertainties. The Case of small-scale fishing households in the north coast of Central Java. Journal of Maritime Studies (MAST). Vol 9 (2) (in press)

Jin, D., E. Thunberg., H. Kite-Powell, and K. Blake. 2004. Total Factor Productivity Change in the New England Ground fish Fishery: 1964-19931. Journal of Environmental Economics and Management **44**, pp:540_556.

Karjogi, R., B. Namaker., and L.B. Kunnal. 2009. Growth in Area and Production of Eucalyptus in Karnataka. Mysore J. Agric. Sci. 43(4), pp: 641-645

McElroy, J. 1991a. The Java Sea purse seine fishery: A modern-day "tragedy of the common?". Marine Policy. pp: 255-271.

McElroy, J. 1991b. Managing the Indonesian small pelagic fishery. Marine Policy:462-464

Pitcher, T.J., and D. Preikshot. 2001. RAPFISH: a rapid appraisal technique to evaluate the sustainability status of fisheries. Fisheries Research 49, pp: 255-270

Reddy, Amarender A. 2009., Growth and Instability in Chickpea Production in India: A State Level Analysis. Available at SSRN: http://ssrn.com/abstract=1499577

Shah, D. 2007. Managing Fisheries Development in Maharashtra. MPRA Paper No. 3924. available at http://mpra.ub.uni-munchen.de/3924.

Syarif., L.M. 2009. Promotion and Management of Marine Fisheries in Indonesia. In G. Winter (Ed). Towards Sustainable Fisheries Law: A Comparative Analysis. IUCN, Gland Switzeland, xiv+340 pp.

Squires., D. 1994. Sources of growth in marine fishing industries. Marine Policy 18(1), 5-18.

Squires, D. and C. Reid. 2004. Using Malmquist indices to measure changes in total factor productivity of purse-seine vessels while accounting for changes in capacity utilization, the resource stock and the environment. SCTB17 Working Paper. FTWG–5

Wasim, M.P., 2007. Issues, Growth and Instability of Inland Fish Production in Sindh (Pakistan): Spatial Temporal Analysis. Pakistan Economic and Social Review 45(2), pp: 203-230.