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Original Paper

MULTI LAYER SPATIAL ANALYSIS FOR DEMERSAL SHRIMP FISHERY AND SST WARMING IN THE SEMARANG COASTAL WATERS

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ABSTRACT

Semarang coastal waters is part of coastal zone at the north coast of Java that is still has their characters for coastal demersal fishery. It was known for a long time before, that Semarang coastal water is a very good fishing ground especially for some valuable demersal species, such as white shrimp (Penaeus merguiensis), (Metapeneus.sp); flat fishes (3 species); Gastropods : Tiger snails (Babylonia.sp) and Bivalves : Anadara.sp. Some study that had been developed earlier in transforming from individual station data at coastal and seas, into visual-spatial layer in order to give more accurate spatial analysis of multiple parameters in the invisible coastal waters. This study present further development in the analysis of multi-layer spatial analysis. The samples of demersal coastal shrimp fishery and its closely related ecosystem parameters (depth; sediment; salinity) were taken randomly to represent the area of Semarang coastal zone. Field ecosystem and fishery samples data then processed using spatial method known as Kriging, and overlaid on a Landsat_TM satellite data. The study develops especially a multi layer of the field variables approach in order to analyze possible spatial multiple correlations between ecosystem parameter, such as type of bottom sediment, depth, and salinity to spatial distribution of shrimps spatial distribution as to represent demersal coastal fishery. This benthic fishery resources is regarded as the most vulnerable fishery due it's sensitive character ie. sedentary and limited movement, is a good example to be used to monitor the impact of the environmental changes such global warming and climate change, such as seawater temperature anomaly in Semarang Coastal water (was found 1.39 ºC in March 1983) for the adaptation strategy in the future coastal resources management.

Key words : demersal/ benthic, shrimp-fishery, spatial-analysis

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INTRODUCTION

The important of the paper is that first effort ever to elaborate and discuss a demersal/ benthic fishery resources spatially, which is so far is very limited at present. Two important characters of benthic fishery, is firstly that they are sensitive to environmental changes due to their limited movement or sessile; secondly close relationship of benthic organisms to its bottom texture and character. In other perspective, these two characters can be used to monitor both the impact and dynamic responses of the benthic community due to environmental changes, such as seawater pollution, global changes, climate changes such as seawater temperature anomalies, sea level rise, etc. The study use of spatial analysis approach which had been developed earlier (Hartoko and Helmi, 2004), and furthermore would try to bring "the invisible" of the spatial distribution of the benthic organisms into a 'visible' one. A study on benthic fishery such as fish, shrimp, mollusc, etc which is believed as the most vulnerable coastal/ shallow fisheries would be important database for the adaptation strategy due to climate change, especially to seawater anomaly and for the benthic coastal fishery management in the future.

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Materials And Methods

Study area is the North coast of Semarang, central Java. Measurement of research variables such seawater depth using a Garmin echo-sounder. Salinity was measured in-situ using HORIBA Water Quality Checker. Samples of bottom substrate collected using 5 kg Grab and samples of demersal shrimp using a local fisherman bottom net on board of local fisherman boat 15-GT during the study completed with a GPS station coordinates recorded simultaneously (latitude and longitude). About 22 stations of field data and samples were collected. First step in building a digital layer for the ecosystem model was transferring 'geodetic/ position data' (degree; minute; second / D˚ M' S") of latitude and longitude data into a single-numerical value with a formula of (Hartoko and Helmi,2004):

Numeric Value (Lat; Long) = Degree + {minute + (second/60)}/60

Then the Y (latitude), X (longitude) and Z data (ecological parameters) was grided using Er_Mapper ver 7 software (Licensed user). Root-Mean-Square (RMS) method was used to measure the spatial-accuracy of digital Landsat_ETM7 as a base-map. The world geodetic system (WGS84) for geodetic datum and South-UTM49 for map projection was used in the digital mapping processes for further overlay processes onto a base-map Landsat_ETM7 sattelite image. Grided layer of ecosystem and benthic fishery resources had been numerically and spatially controlled and then overlaid on the administrative-cropped Landsat_ETM7 satellite image of Semarang coastal zone. Then a single, three ecological layer (using RGB-method three band composite technique) and a multy-layer analysis was displayed simultaneously. A pair-wise regression analysis was selected as the analysis method to answer several questions relating to the correlation among digital layer of field data. Correlation coefficient (r) and beta values (or standardized partial regression coefficient) were used to assess the correlation important of each pair in the regression equation (Clark and Hosking, 1986).

Results And Discussion

The depth of Semarang coastal water is found ranged from 0 – 15m with a gentle slope and almost steady depth gradation (**Fig. 1**). Bottom substrate was found dominated by a relatively high content of silt substrate (up to 90 percent), shown in **Fig. 2.** There are two high clusters of silty bottom substrate found spatially, which it's range in most area from 22 – 90 of percent silt.

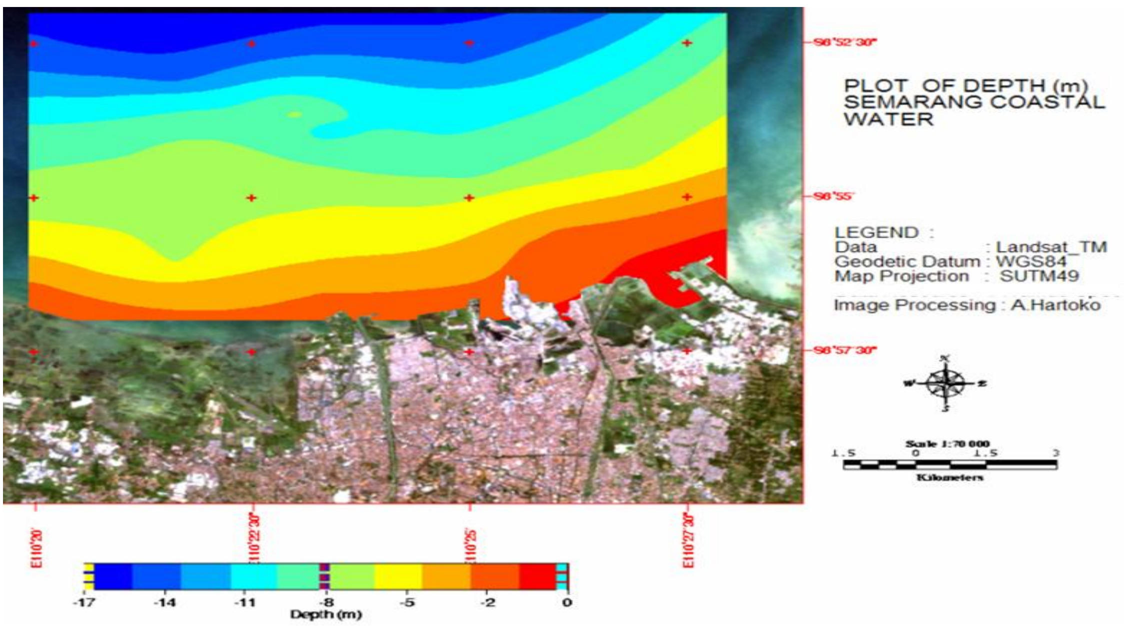

Fig. 1. Plot of depth (m) of Semarang coastal water on the study area

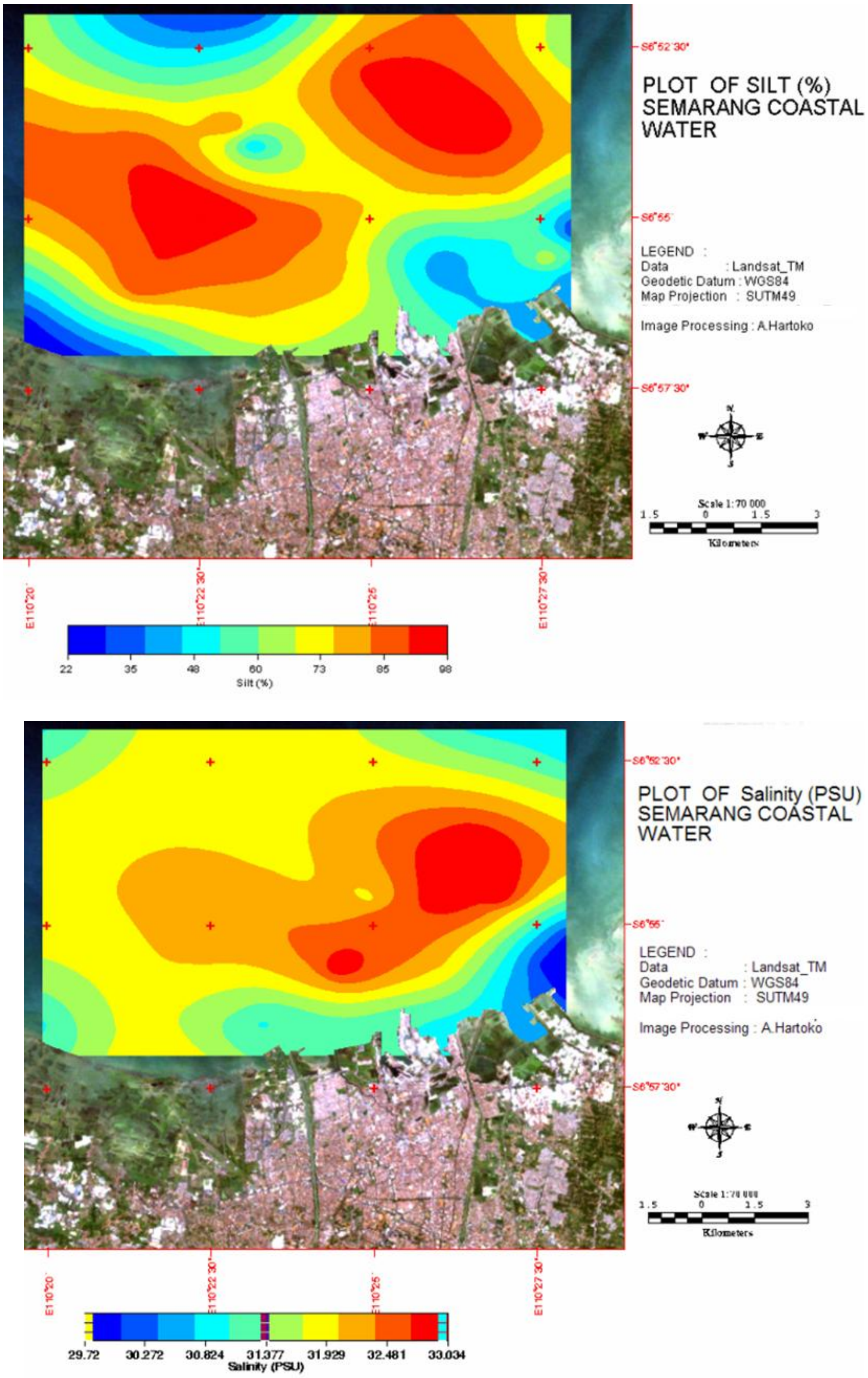

Fig. 2. Plot of silt (%)-above, and seawater salinity (‰-psu)-below, on the study area

This two silt spatial clusters are assume caused mainly by the sediment supply and accumulation of silt material into the coastal water coming from the two main estuary, called

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"Banjirkanal Barat (west-canal) and Banjirkanal Timur (east-canal). Seawater salinity ranged from 29.72 – 32.48 ‰ and there is a high salinity pool has indicated as in **Fig. 2.** In general the coastal area is always turbid through out the year. The 3-layer RGB method spatial analysis as in **Fig. 3** had shown that salinity (Red layer) was found higher in the deeper water. As a whole an even combination (regarded as a same strength of spatial combination) of the three variables, Red layer : salinity – Green layer : Silt – Blue layer : depth is forming a curve zones along with the coastal line (indicated by whitish color). The whitish color means that the same strength in combination of numerical layer of the three variables, red :salinity – blue : silt – blue : depth was occurred in these area.

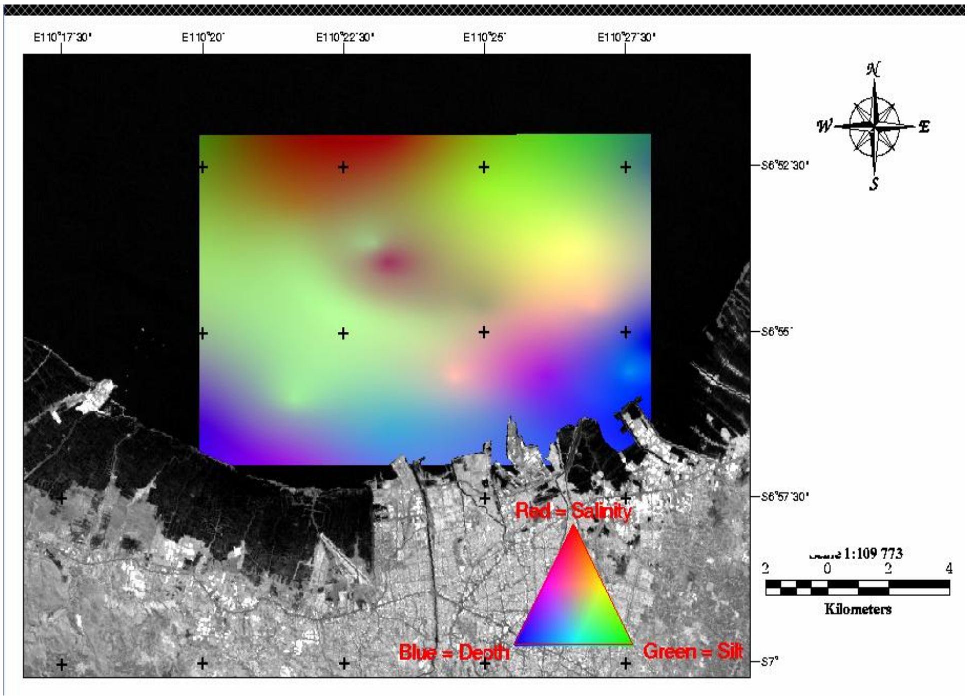

Fig. 3. Three layer RGB-method spatial analysis of seawater Red : salinity (‰-psu) – Green : silt (%) – Blue : depth (m) of Semarang coastal zone

The Semarang coastal water and its adjacent area in a long time before 1981 were widely known as a good shrimp fishery zone. However, it decreased sharply after 1985. The phenomenal shrimp fisheries with its over production before 1981 was due to the use of bottom trawl, which cause a massive damage to the benthic community, until it is totally banned in 1981 by a Presidential Decree (Keppres 81). There are three main shrimp species with its high price known before 1981 period are tiger shrimp (*Penaeus monodon*), white shrimp (*Penaeus merguiensis*) and Metapenaeid. In this study, only two species of shrimp were found during the field sampling, that is white shrimp (*Penaeus merguiensis*) and Metapenaeid. Spatially, Metapenaeid was found distributed randomly across Semarang coastal water and were more associated with the depth variable (r = 0.4424), followed by salinity spatial distribution (with r = 0.4059) rather than to the silt substrate (r = 0.1109). While Penaeid shrimps seems distributed along with the coastal line (**Fig. 4**).

Multi-layer of field data analysis suggest that the two form of 'ecological and biotic composite' spatial layer acting as spectral layer, in that no single biotic factor yield to the 'ecological-cluster', but that several factors in combination yield more accurate spatial analysis or zonation, by means of RGB-method. A similar conclusion was reached by Danson and Curran (1993), who suggest that such multidimensionality of spectral data as representation of the ecological layer as in **Fig. 3,4, and 5** has been recognized (Kauth and Thomas, 1976; Richardson and Weigand 1977; Crist and Cicone 1984).

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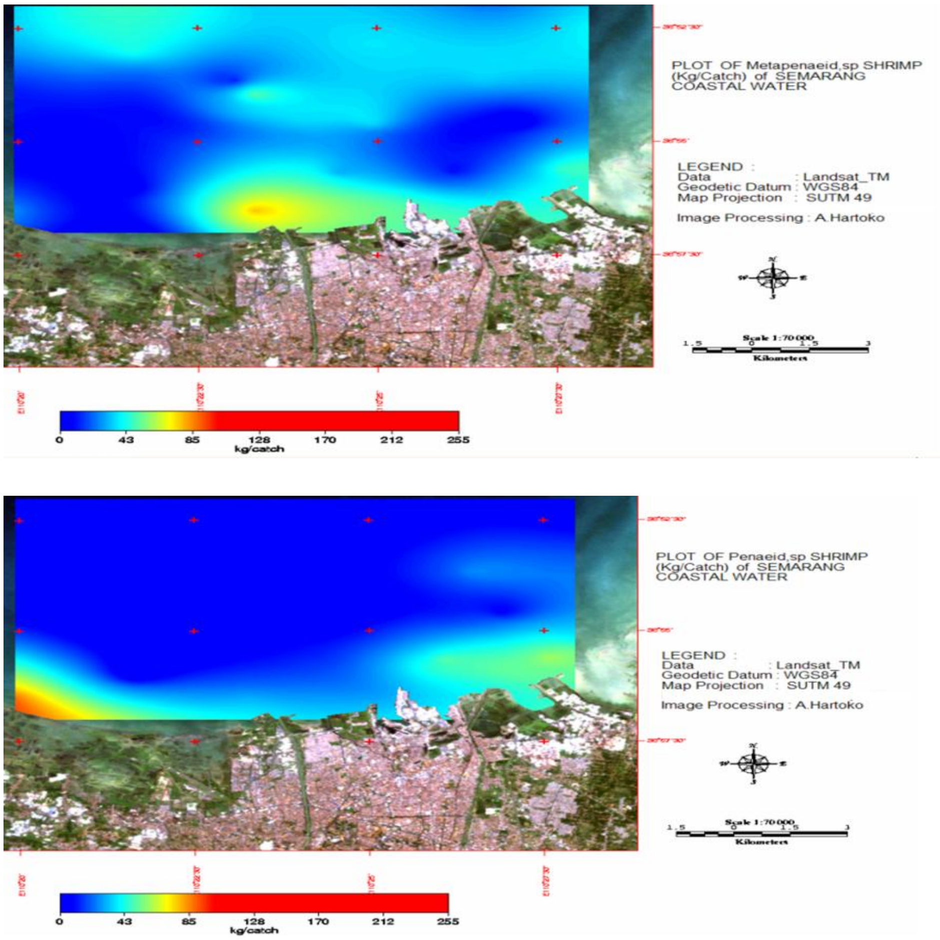

Fig. 4. Spatial distribution of *Metapenaeid.sp* (above) and *Penaeid.sp* (below) on the study area

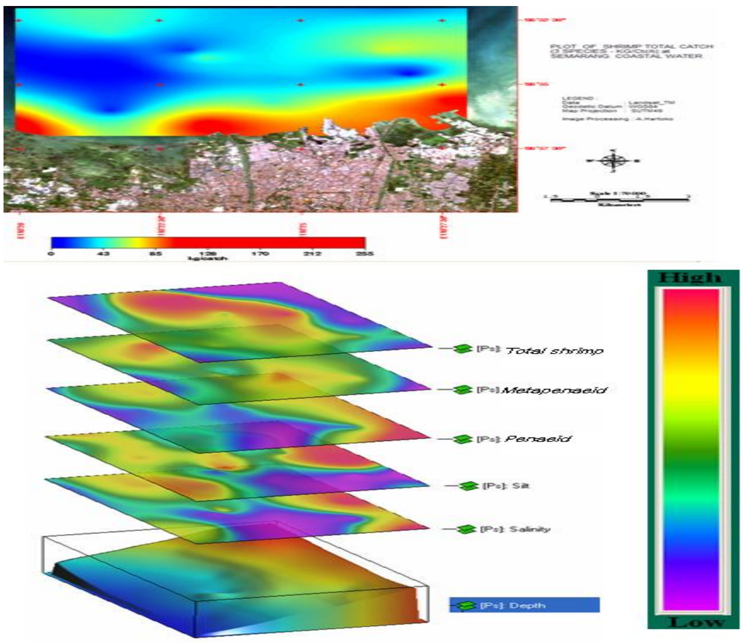

Fig. 5. Spatial distribution of total shrimp (above) and multi-layer analysis of research variables

SST warming in the Java sea

Sea surface temperature (SST) is the most important factor in air-sea interaction due to its influences of weather and climate. Based on three coordinate (represent the west, central and east region) 30 years data recorded monthly numerical satellite data from 1971 - 2000 from National Center for Environmental Program (NCEP) the range of SST in Java sea is 27,48 ^{0}C - 29,66 ^{0}C (**Fig.6**). The highest SST in central region had happened in May and the lowest in August. In general there were two peak and two crest of SST in one year periode. The first peak was during April – May with the first low SST in February and the second in August. There were two cycles of low (February and August) and high (May and November) SST in avearage during 30 years period 1971 -2000.

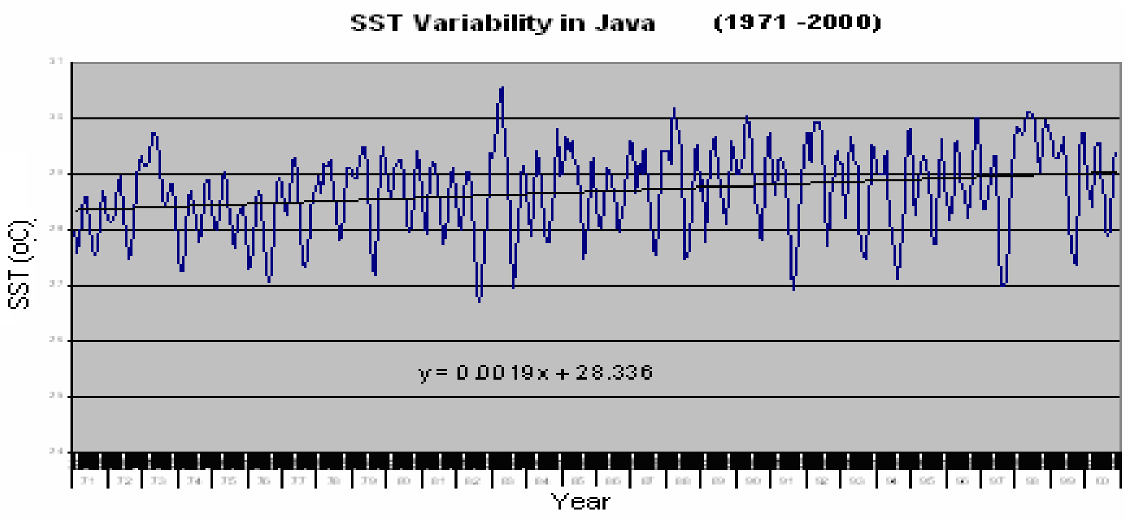

Fig.6. SST Variability in Java : 1971-2000)

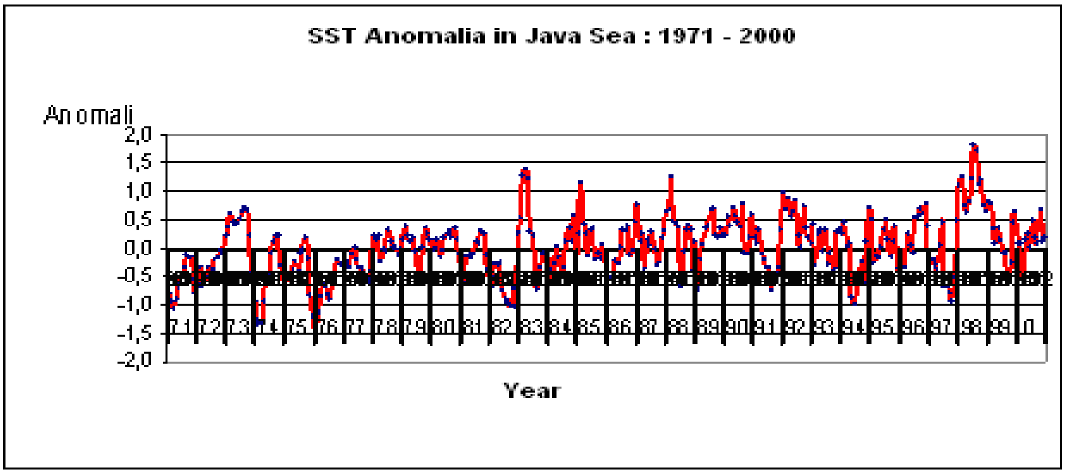

Fig.7. SST Anomalia in Java Sea : 1971 – 2000 (NCEP)

Furthermore the data was used to analyse the trends of SST variability for 30 years, and to detect the SST anomaly (**Fig. 7**). During the periode before 1980, the anomaly of SST was in general below normal, or cooler than its average value. But an important evidence had been discovered that after 1980 indicates an SST anomaly above normal, or above its average. This means that the SST of the Java sea was tends to increase after 1980. The highest SST anomaly during periode of 1971 - 1980 is 0.72 ^{0}C happened in August 1973 and lowest -1. 47 ^{0}C in January 1976. While during the periode of 1981 – 1990 the highest SST anomaly is 1.39 ^{0}C (almost double than befor 1980 period) in March 1983 and lowest is -1.02 ^{0}C in November 1982. In the periode of 1990 – 2000 lowest is -1.0 ^{0}C in June 1994, and the highest deviation is 1.82 ^{0}C in July 1998. A positive SST anomali in Java sea (more warm) were significant in year of : 1973, 1983, 1985, 1988 and 1998. A negatif SST anomaly (cooler) had happened in year of : 1974, 1976, 1982, 1994 and 1997 (Widada.*et al.*, 2009; Hartoko and Sulistya, 2010a). Based on the SST variability and anomaly analysis as above for 30 years periode (1971 – 2000), beside a seasonal variability (regular) as well as interannual (irregular variability) had revealled the consistant increase of 0,7 ^{0}C for 30 years. This persistant seawater temperature increase was assumed as the effect of global ocean phenomena known as *global warming*. Based on small scale fishery resources point of view, SST anomaly of 0.5 ^{0}C (positive and negative) is still tolerable, which is actually happened until 1980. But SST anomaly up to 2.0 ^{0}C and could be more in the future is regarded would be harmfull for small scale fishery resources. That is related to the temperatuare tolerance and survival of microbial, planktonic, larvae, and fish biomass, gonad maturation, egg development, and spawning where the extreme SST anomaly had been detected during the periode 1980 – 2000 (Hartoko and Sulistya. 2010a; Hartoko, *et al.*, 2010b).

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Appendix.1. Fish sampling at Semarang coastal zone

Appendix.2. Some shrimp found in Semarang coastal zone