International Journal on Advanced Science Engineering Information Technology

Vol.6 (2016) No. 5
ISSN: 2088-5334

Analyses of Water Dynamics in Banda Sea and Its Influences on Continental Shelf Fishing Area

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***Abstract*— Over the rise of the Arafura Sea of the vertical configuration results shown curves which easy to understand about its water dynamics. The water character is oceanic's as cool, salty and stable DO were maintaining by the variability of thermal structure in the continental shelf. The pattern of water masses is the current system surrounding the Banda Sea as an upwelling from undercurrent those enhances and nitrified the shelf. Along the coast of western part of Papua was conducted the parcel of water masses traveling across the fishing area where's kind of fishing boat catches the fish in the whole year, and almost confining in the continental shelf has low current from the southern part. The current flows from west to east at the southern part of Nusa Tenggara Islands bringing water and curve to the southwestern coast of Australia. These water masses characterized the temperature, salinity and oxygen gradients from some points where may have an important implication to the slopes area between the deepest and the shallow water near the coast. The lower temperature ranges from 10.0˚C to 8.0˚C at 300m depth and 34.50‰ to 34.85‰ conducted was circulated back to the deepest layer were higher salinity and stable dissolved oxygen. This continental shelf as a fishing area boundary water dynamic may cause by these water dynamic, especially from data catches of the two fishing vessels catches 17,4 to 39,21kg/haul in the western area and 44.0 to 80kg/haul in eastern coast area.**

***Keywords*— Raise boundary; Banda Sea; continental shelf; fish catch**

I. INTRODUCTION

The interpretation the water masses in the western part of Pacific Ocean through continental shelf area at the boundary of Banda Sea, for better imaging the Arlindo's reducing the warm pool on the westernmost of Pacific were confusing the ENSO (El Niño-Southern Oscillation). The important inter-oceanic exchange regions in the global ocean is The Indonesian throughflow (ITF), it has been the research interest due to its strategic region of not only the current also past regional and global ocean circulation patterns, because of this region those particularly, imperative because of the exchange of water and heat between the Indian Ocean (IO) and the Pacific Ocean [1]. Furthermore, the variations of SST in the ITF region are generally not much as compared to that in the Tropical Pacific Ocean due to the lack of strong equatorial upwelling. However, small variations in SST at this region (ITF) can significantly affect the atmosphere-ocean interaction processes (Fig.1).

The realistically models the throughflow pathway and source, it is becoming increasingly clear that is critical to model the vigorous vertical mixing and geometry of the Indonesian region very accurately. But, in the south of Java has been analyzing there are current flows, the name is The South Java Current (SJC). During east monsoon period the south wind, especially from the Australia drives the upwelling as scales of the sea surface temperature and other oceanographically factors in the end of the ITF.

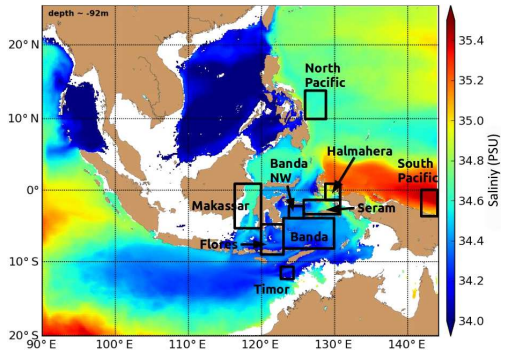

Fig.1. Main areas of water mass transformation. Color shading indicates salinity at 92m depth [7].

Further reading, that the ITF is caused by the local winds especially monsoonal, but at depth its response to the pressure gradient between the Pacific Ocean and the Indian Ocean. This cooling of sea surface at this region observed to be considerably important from middle July to September (Fig.2). In the global ocean route which counters current at

the western coast of Pacific Ocean, its physical properties of the Indonesian through flow may characterize of influence on Banda Sea circulation and the local climate system.

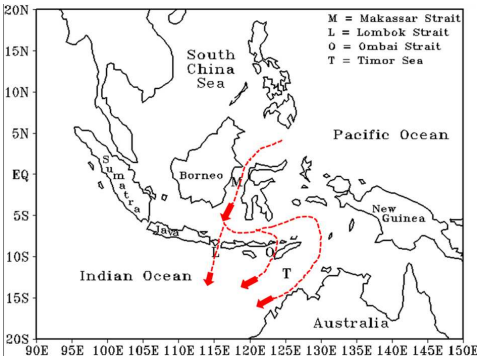

Fig. 2. Map of the Indonesian Through flow (ITF) and it primary passages linking Pacific Ocean with the Indian Ocean. The red dashed lines indicate four important passages denoted with M, L, O and T of the ITF flow [8].

The current flows through the Archipelago of Indonesian which an extremely complex topography and strait, completed by monsoon trades wind system and higher frequency forcing in the western Pacific tropical region contribute to momentum transfer and water mass transformation. From Fig. (3) that the largest variations of the SST occur in the Makassar which is the main region of the ITF where some extent, Ombai, Lombok, Timor as well as the South China Seas are other regions, where the SST ranges between 27.5 and 30°C. However, during October – December, the SST found (27-30°C) to be little variations in the ITF[2]. From the last records the Lombok Strait has low SST (<26°C) and parallel with El Niño and La Niña with warm or cool weathers, and combined with sea-surface winds blend in the Nusa Tenggara regions among the Indian Ocean.

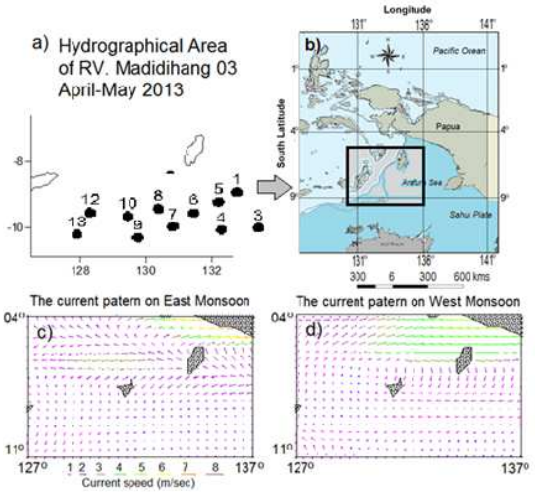

Fig.3. The Banda Sea and The Continental Shelf is the most interesting for searching and fishing. a) The position/area of the hidrographical survey (Sw01 to Sw13), b) Demersal fishing ground nearby research area, c) The current pattern on East Monsoon, and. d) The current pattern on West Monsoon in the western coast of Papua (modified from [9].

Ref. [2] use a high value of vertical diffusivity $K_z > 3x10^{-4} m/s$ within the Indonesian thermocline to account for the modification of the North Pacific thermocline temperature-salinity structure. Moreover, these ITF brings high temperature, low-salinity Pacific waters into the Indonesian waters, which causes the higher sea-surface temperature (SST) and the deepening of the thermocline in the eastern Indian Ocean. Three regimes are apparent in their analysis. The surface and upper thermocline layers σ_θ=25.8, down to, required vertical mixing of surface precipitation and runoff. Vertical mixing is also apparent below σ_θ=27.0.

In the lower thermocline purely isopycnal spreading gives a simple variation in the ratio of sources toward a larger South Pacific contribution with depth. [3] Investigated the mechanisms for shifts in coral communities observed at two natural volcanic seeps in Papua New Guinea. Surroundings of the Continental Shelf at the Banda Sea there is the most important fishing areas as shrimp grounds in the eastern part of Indonesia (Fig.4), where are limited by the Province of North Moluccas. The southeast Moluccas and West Papua (District of Sorong, Fak-fak, Manokwari, and Merauke) along the western coast of Papua, the local community area allows only industrial scale fisheries to exploit the fish resources. These shelf been exploited from 1969, there are almost 47 years. He also said that in the southern coast of Banda Sea is less saline and lower temperature (< 29.0˚C) than the water exiting from the Indian Ocean that is the water entering the eastern boundaries of Sahul Plate. The difference results in a freshwater transport of 0.23 Sv. Since the Indian Ocean is not becoming increasingly fresh, freshwater must be removed via net evaporation over the Indian Ocean (Fig.4).

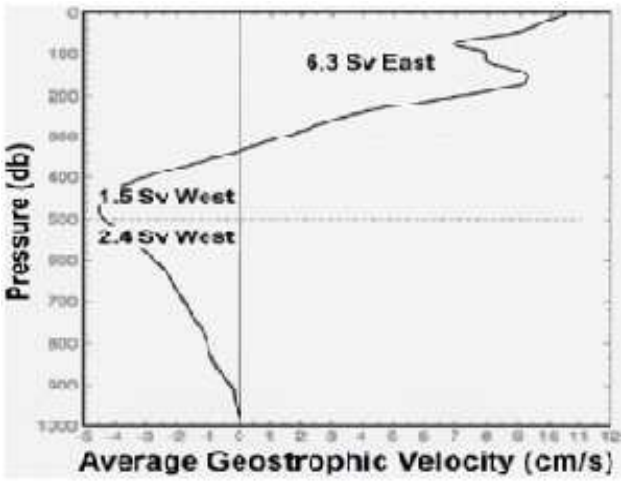

Fig.4. Geostrophic velocity relative to 1000 dB between stn. 22 and 30 of Banda Sea. Transport within the 0- to 300- dB, and 500- to 1000- dB levels shown in Sverdrup (1 Sv = 106m3s-1) [3].

The hydrological and fish catching properties of fishing area constituting the Banda Sea nearby shelf, understanding and connecting the various fish catch from each fishing vessel origins is, therefore, importance (Fig.3). Related to this paper, the fish catching was analyzed from trawlers whose operated at almost the same time and using catch production from the two fishing companies.

The vertical distribution of hydrographic matters shows that the lower layer of the each position is mainly composed Arlindo or Arus Lintas Indonesia. The upper 200 m carry 83 percent of the total transport (10.6 Sv), and 80 percent of this

occurs in the northern part of the section near the coast of Java. And an alarming signal that species transported from different biogeographic regions may become an increasing threat to the still mostly pristine marine ecosystems with their extremely high biodiversity in east Indonesia[4]. In terms of nitrification, the shelf boundaries have a high nutrient, low chlorophyll (HNLC) area that characterized by arising from the relatively low chlorophyll content is possibly from the eastern Indian Ocean to completely characterize its role in the primary production in the Banda Sea's upwelling [5].

The surface layer of the Indonesia throughflow is controlled by the local winds which are primarily monsoonal but at depth its respond to the pressure gradient between the Pacific Ocean and the Indian Ocean. As a summary can be seen in Fig. 2. From a schematic view of the circulation in eastern parts of Indonesia, continue from Fig. 5 present an illustrative view of the circulation in of seasonal currents that maintenance hundreds of island. From the northward coast of Papua when northwest monsoon and Banda Sea current flows southward along the west coast to the Continental Shelf [6].

At East Monsoon period the seasonal current flows southward as a powerful narrow tongue which is passed along the west coast of Papua, these salty water is oxygenated from west of West Papua through the coast of Arafura Sea, searched also around 200m depth there were western part of Banda's basin with gradually rising the bottom paths that widely simulation by[10]. It's upwelled in the western of through nearby Jamdena Island in the Banda Sea and divergence from south-western. The hydrographic matters as temperature, salinity and dissolved oxygen and other properties. It is the main source of water masses upwelled in a south of Banda Sea.

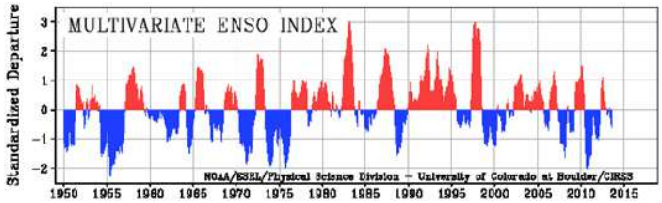

Fig. 5. The Multivariate ENSO Index (MEI) on the six main observed variables over the tropical Pacific as Papua boundaries Klaus.Wolter @noaa.gov [in 11].

About half of the Ningaloo Niño events are associated with La Niña conditions in the Pacific, however, some of the Ningaloo Niño events are associated is neutral ENSO conditions or even El Niño event such as 1982-83 [11]. Along the southern coasts of Java and Sumatra during easterly winds induced strong upwelling the El Niño coinciding with the IOD positive phase 1997/98. Furthermore, the meridional section of temperature was derived from buoy measurements deployed in the EIO region by the Geophysical Fluid Dynamic Laboratory (GFDL), National Oceanic and Atmospheric Administration (NOAA) and eXpendable Bathy Thermograph (XBT) measurements from the World Ocean Database 2005.

A pointed out of view the vertical distribution meridional of temperature near the raising bottom in field (eastern coast of Banda Sea) are almost warmer in <100 m depth across the Western Papua (29.8˚C), attending the northward shift during La Niña like conditions southward with large positive loadings northeast of Australia (northerly anomalies during La Niña) (Fig. 5). There is why no significant sea surface temperature (SST), zonal current, and fishing productivity either ENSO phase in this season. However, the linear correlation between old and new MEI for 1994 through 2010 is +0.998, confirming the robustness and stability of the MEI vis-a-vis input data changes [12].

The authors have shown that the ITF slows and shoals during El Niño events and, consequently, this affects the surface and subsurface heat content as well as sea level in the Indian Ocean between 10° and 15° S. So many rivers runoff significant freshwater input from inland activities like industries, big city waste water, and Indonesia have a rainy season but sometimes with heavy rain.

The continental shelf of the Banda Sea has marked the rise and the shallow water, the easternmost Jamdena Island. Apart from the deep water with a high-resolution bathymetric map, some major continental area with ranges depth 10 until 150 m. The Banda Sea basis is around 4000 m and Weber Trench almost 7000m depth, it's the deepest basins at the Banda Sea, those were imaging the hydrological and nitrification matters that important for our better understanding about *Arus Lintas Indonesia* (Arlindo).

Objectives of the study was to determine the effects of water dynamics towards continental shelf fishing area in Banda Sea.

II. Materials and Methods

The Jakarta Fisheries University was joint in the oceanographical research with PT. EOS Consultants Health, Safety and Environmental Management System (HSE-MS). The data designed by Project Environment Baseline Assessment of Babar Selaru Block-INPEX, it was an ongoing journey with the activities to perform a site survey as physic-chemical, hydro-oceanography, biological characteristic of the benthic and pelagic environments.

The research was held in the rising area of the western coast of Papua : south-westward the Banda Continental Shelf on periodically East Monsoon (April to May 2013). We were using the data from hydrographical surveyed of Training and Research Vessel Madidihang 03 STP Jakarta. From the CTD (Conductivity Temperature and Depth) we calculated the vertical water profiles drawn 15 profile pictures, with several points of potential matters especially shelf boundaries. The number of Sw01 (Station 01) until Sw15 depending on bottom conditions, were interesting one area nearby the shallow waters of the research area. The bottom survey area was variable and closer with the 2 (two) commercial Fishing Vessels used bottom trawling, its was adjusted through along the continent surfaces which two groups of the researcher on board. Data from those two fishing vessels and from a number of fishing groups were analyzed from November 2012 to April 2013, that's data should be connected with Research and Training Vessels Madidihang 03 wich under HSE-MS project.

To keep away from this problem in our study, we analysis how to combine the data and to rich of knowledge each other. The initial conditions for temperature, salinity and DO

were analyzed for vertical and horizontal views. Note that with this spatial and temporal analysis, in the Banda Sea Archipelago likely close area. For better understanding, the surface current of east monsoon and west monsoon through along the west coast of Papua were simulated from BPPT. This paper outlines a method to estimate the small-scale of western Pacific oceanic transport in the ITF by using satellite-measured sea surface temperature and chlorophyll-a from the LAPAN altimeter. The effect of hydrographic factors on the spatial distribution of SST and Chl-a both images investigation was carried out in the western part of Papua (122˚E–140˚E along 10˚N-10˚S) on April 4, 2012. The satellite measurements do not directly measure transport, but they comprise a long, almost global, measurement of sea SST as an in-situ level that may be used to validate index ITF flow.

Oceanographical equipment used from Fisheries Research and Training Vessel Madidihang 03 of Jakarta Fisheries University. CTD completed with rosette a water sampling devices range from a bucket dropped over the side of a ship too large water bottles sent thousands of meters toward the seafloor on a wire, and also depend on kind of data they need. Conductivity, temperature, and depth is the comfortable instrument is situated, stands for conductivity, temperature, density and kinds of oceanographical sensor. The strong frame designed to carry 12 to 36 sampling bottles with range capacities 1.2 to 3.0 liters, which is under control by the operator from a computer on board. As a consequence of the high temperatures and productivity at the sea surface, levels of dissolved oxygen drop rapidly to levels where biological activity is either poor or almost non-existent.

Beyond of previous related efforts were engaged with the oceanographical processes and properties related to fishing conditions (Tabel 1). The study longer and the almost west monsoon in November 2012 until inter-monsoon in April-May 2013, respectively. This data analysis isolates monsoonal periods and productivities of catch rates of the fishing companies especially of bottom shrimp trawl were operated at the continental shelf. We also have yearly of the commercial bottom trawl fishing companies before 1976 to 2012. Data from several commercial fishing boats were collected by the observer whose attended all time of fishing operation. So that data on production could be obtained along with the oceanography survey. This constituted multi-disciplinary program from LAPAN, the effect of hydrographic factors on the spatial distribution of SST and Chl-a both images investigation was carried out in the western part of Papua (122˚E–140˚E along 10˚N-10˚S) on April 4, 2012. The results show SST and Chl-a images average at (0,1˚C + 0,5˚C and 0,15 + 0,25 mg/m3), its concentration at CTD and fishing ground of Arafura Sea, respectively. SST appeared to be higher in the north for longitudinal variations as Chl-a higher concentration. Then, SST and Chl-a there was concentration lower at (29,6˚C - 30,5˚C and 0,09 – 0,45 mg/m3) in boundary to east-southward coast. The maximum temperature as a speficified condition of Banda Plate at surface layer nearby Jamdena Is. (Fig.6). As [3] mentions that the It transfers warm and low-salinity waters from the Western Pacific into the IO, where the Asian Monsoon gathers strength. As an integral part of the global ocean circulation, ITF is important in regulating the climate and rainfall across Indonesia, India and Australia.

These dynamic water mass should be the good moment for interpretation the fishing ground. The two areas are compared in Fig. 7 : Sw01 to Sw09 were dominant processes responsible for oceanic through flow quality and Fig.8 : Sw10 until Sw15 were unrealistic oceanic waters. It's understood that the water mass of Arlindo influences of the oceanic waters through Indian Ocean characteristics maintain and controlling the variability of circulation and thermal structure in the Banda Sea.

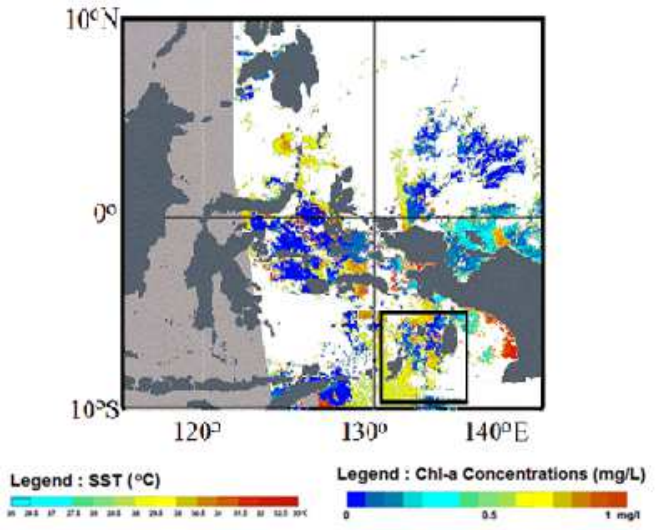

Fig.6. Images SeaWiFS satellite of Sea Surface Temperature (SST) overlays by concentration of Chlorophyll-a in the westernmost of Papua at east monsoon, correspond to the average April, 4. 2012 in survey area and fishing ground of bottom trawling [9].

The performance of vertical section is laid between eastward in the upper side of the shallow water and the westward position of survey west coast layer in the upper of the deep waters. The Banda Sea eastern coast area that's nearby the Continental Shelf reveals a more structured temperature, salinity and oxygen demand (DO) profiles in comparison to the western coast. The Salinity minimum at the west coast of Banda Plate for water warmer than 17˚C. The subsurface water that responds to the shelf boundaries pressures gradient may remain in more a steady balance. Makassar Strait was characterized by a strong jet current that intensive in thermocline depth (75-125 m) and become stronger and dominated by North Pacific Subtropical Water (NPSW), where the flow pattern toward the south to southwest at the entrance of ITF in the northern and continues to approach the 2˚S then the direction changed to southeast down the shallow Kalimantan slope [13].

Below 100m display nearly iso haline structure relative to the western coast of Banda Plate. In the eastern coast the deep temperature (<10˚C) falling from almost 300m (Fig.8 : Sw01-Sw09); is included for completeness are similar to the Banda Sea stratification, through to the eastward with more advanced destruction of the cool, as expected from its downstream level. The salinity values are reduced to less than 33.85‰ from the lower level (100-200m) in all point of nearby the Banda Plate.

III. Results and Discussion

A. Results

The vertical configuration results presented here concern over the rise on the Arafura Sea showed curves for 15 figures, it easy to understand about dynamic oceanic waters. From Sw01 to Sw08 immediately evident that the water masses temperatures, salinities, and DO range were not large. On the other hand, there is a difference condition over the raised area. The lowest temperatures being found between Sw01- Sw03 (3.4˚C – 3.8˚C); and Sw06 and Sw07 (3.2˚C–3.3˚C) at 980m depth. Thus distinguishing between the two lowest temperature almost in the lower layer depth. Along a west-eastern coast axis from Sw15 away the Sw01 seem to be a raising of the bottom through west-eastern coast toward the Arafura Sea. This phenomenon, particularly evident along 128˚E to136˚E longitudes. In general, a condition of water on the eastwest range of sea surface temperature (SST) 28.15˚C – 29.63˚C, sea surface salinity 31.60‰ - 34.62‰; sea surface of DO as 3.3 mg/l – 6.81 mg/l.

The quantity is defined to illustrate the Indonesian Through Flow (ITF) effect on the meridional overturning circulation in the South Pacific where x, y and z denote longitude, and depth; $x_w(y)$ and $x_e(y)$ are longitude of western and eastern boundaries at latitude y; v(x,y,z) is meridian velocity; and $\emptyset(y,z)$ is the meridional transport stream function only if the net volume transport across a zonal section is zero : $\emptyset$ in the South Pacific with and without ITF and their difference [5]. In the western Papua boundary effluent responds to prevailing winds and usually flows to the northwest in the east monsoon period. From Fig.7. the high salinity plume water is separated from the denser 200m of oceanic water by the strong pycnocline near the surface and because of its large load of particle late nutrients, the plume water are heated more rapidly than surrounding waters near the raising ocean floor between west coast in the Banda Sea and the shallow water of the Banda Plate. Therefore, the looks like upwelling waters are distinguishable by cool surface temperature early East Monsoon.

$$\emptyset(y,z) = \int_z^0 \int_{x_w(y)}^{x_e(y)} v(x,y,z)\, dx\, dz,$$

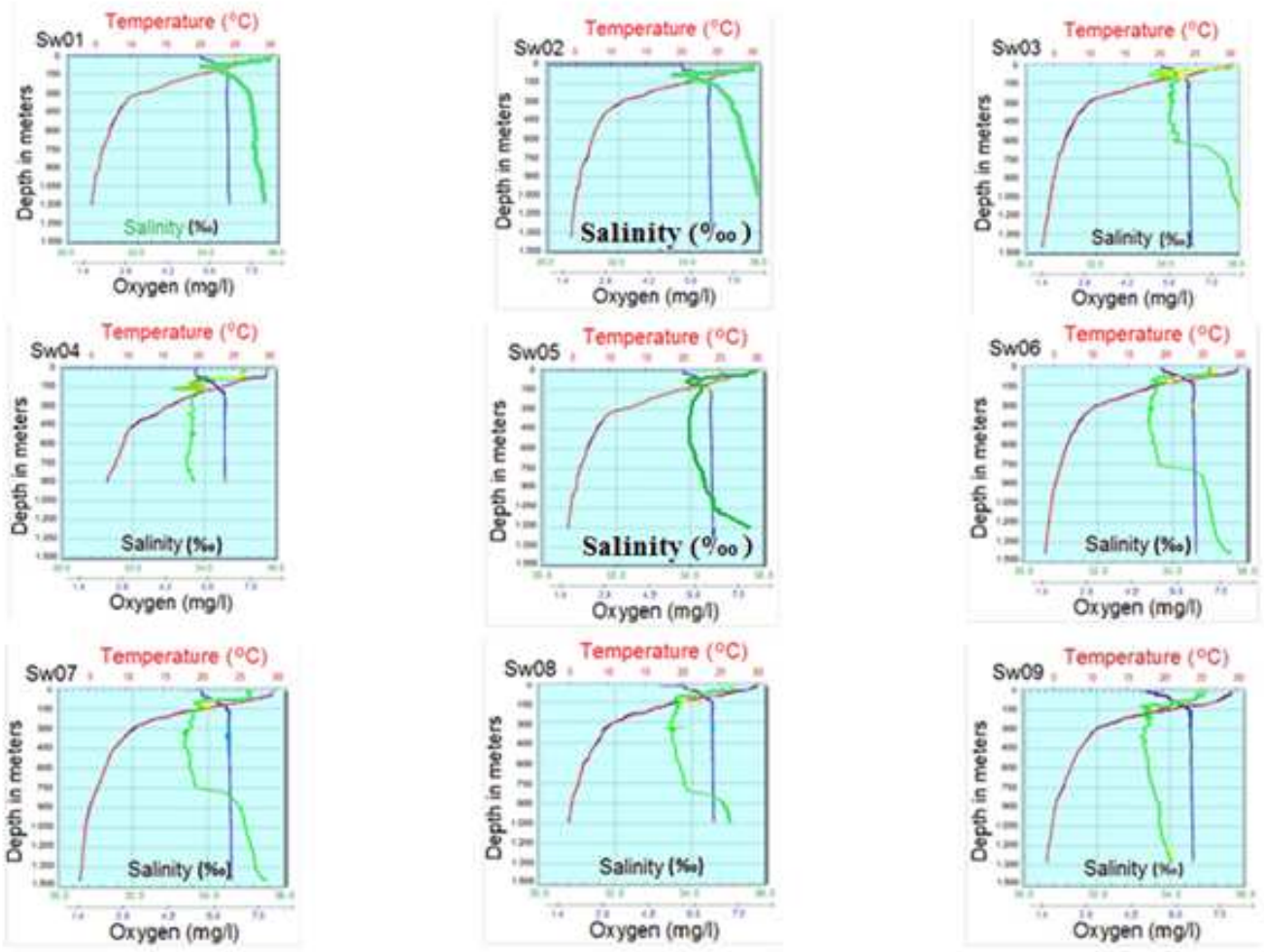

Fig.7. Sw01 to Sw09 are the vertical profiles of temperature, salinity and dissolved oxygen (DO), CTD (Conductivity, Temperature, and Depth) profiler mooring at locations nearby Fishing Ground (FG) of Arafura Sea (April-May 2013)[11].

When we finding the fenomena of changes of watercolor sometimes associated with both upwelling and the plume. The drawn of CTD data indicated a general increase in the vertical temperature nearby the continental through the offshore. This trend could be reversed in the fishing area of the bottom trawls, however, with the catch per unit effort stable to increasing than before of yearly productions. It should be maintained by the recently upwelled water along the coast. The data of catch (1990-1998) collected by HPPI (Association of Shrimp Trawl Companies) and the average number of hauls per vessel as in Fig.9. Kind of shrimps and fishes caught by the shrimp trawler of fishing effort in the Arafura sea in 1999 were estimated to be 86,640 operational days or 632,472 hauls (See Tabel 1). Lastly, the production of shrimp or any species is affected by a multitude of environment factors which change in importance with the season, time of day, and location, physiological state and the population of shrimp, etc. Sahul plate boundary has been exploited from 1970, data from [14] there were 453 shrimp trawlers in operation with ranges volume of 50 GT trawlers, smaller, are stern trawlers and the larger using outrigger, duration in operation is 2 and 3 hours with towing speeds between 2 to 3 knots.

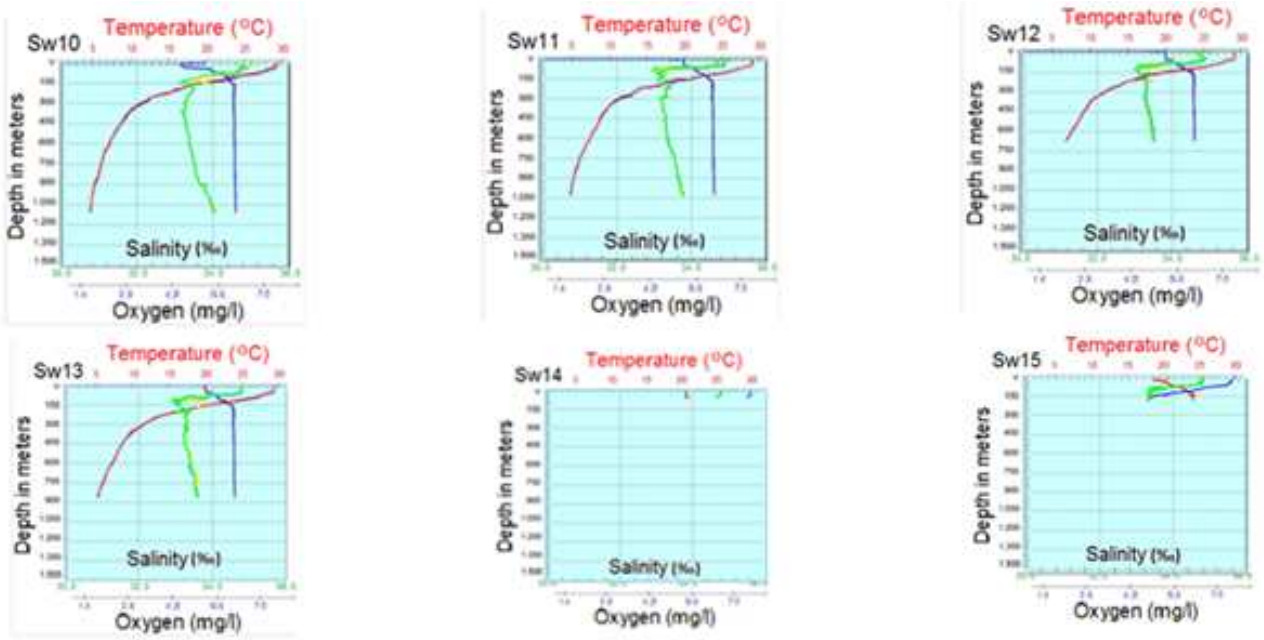

Fig.8. Sw10 to Sw15 are the vertical profiles of temperature, salinity and dissolved oxygen (DO), CTD (Conductivity, Temperature, and Depth) profiler mooring at locations nearby Fishing Ground (FG) of Arafura Sea (April-May 2013) [11].

The absence of obvious changes of environment conditions may be correlated with the decline of catches emphasizes how little we know about the behavior of shrimp. In order to use environmental data as temperature, salinity, an oxygen demand and other simple factors to effectively predict the distribution of migratory fishes and shrimp.

TABLE I
KINDS OF SHRIMP AND FISH CAUGHT BY THE SHRIMP TRAWLER FISHING GROUND ARAFURA SEA BOUNDARY [14].

No.	Name of shrimp	English Name	Scientific Name
1	Udang jerbung	*Banana prawn*	*Penaeus merguiensis*
2	Udang windu	*Tiger prawn*	*Penaeus monodon*
3	Udang dogol	*Endeavour*	*Metapenaus ensis*
4	Udang ratu	*King prawn*	*Penaeus latisulcatus*
5	Udang tiger	*Black tiger*	*Penaeus semisulcatus*
6	Krosok ekor kuning	*Rough prawn*	*Trashypenaeus asper*
7	Kembung	*Stripped mackerel*	*Rastrelliger* spp
8	Bawal hitam	*Black pomfret*	*Formio niger*
9	Kakap	*Barramundi*	*Lates calcalifer*
10	Bawal putih	*Silver pomfret*	*Pampus argenteus*
11	Pari	*Brown stingray*	*Dasyatis* sp
12	Cumi – cumi	*Common squids*	*Loligo* sp
13	Kuwe	*Trevally*	*Caranx sextasciatus*

Connected to use environmental data to effectively predict of demersal species especially shrimp population we must also increase our understanding of their abundant and habitats.

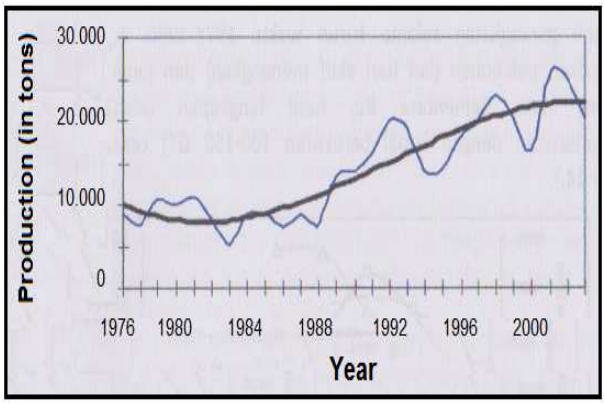

Fig. 9. Multiyear Shrimp Production between 1976 and 2000 at Sahul continental shelf boundary (modify From DJPT, 2012 in [14].

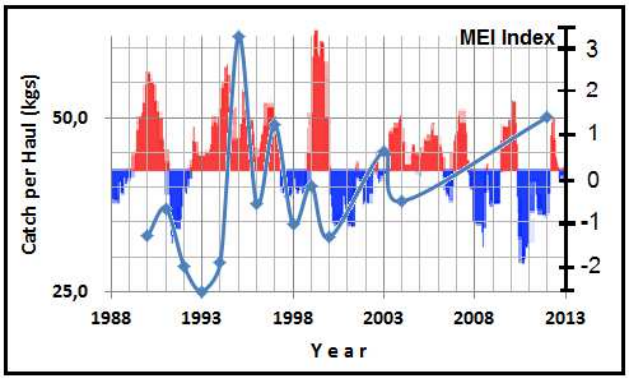

Fig. 10. The Multivariate ENSO Index (MEI) on the six main observed variables over the tropical Pacific (nearby Papua boundaries) (modify From Klaus.Wolter@noaa.gov) related to the shrimp catching rate per hauling from 931fishing vessels yearly 1988 to 2013 at the Arafura Sea (Calculated from the data of fishing effort of shrimp trawlers in the Arafura Sea, year 2007) (Source : DGCF, 2012 in [11].

B. Discussions

The interocean through flow momentum derived from the upper 200 bar pressure, but, may not correspond exactly with the pressure, analysis of the water mass stratification of Banda Plate support this circulation of locally patterns concept.

Banda sea boundaries dynamic of movements its should be the difference of pressure gradient of the upper 200 bar drives the interocean transport within the Indonesia seas by the frictional effects. In the field of CTD measured area of rising bottom the upper 200m has about the same lower salt content as surrounding survey area (Sw01 to Sw15), but below 200 m has the same low salt content as the Arafura Sea near deltas where a number of rivers.

The low salinity at <200m depth that enhancement of Banda Sea is carried into the lower thermocline water of the southward current of the eastern parts of The Indian Ocean induced and nutritively below the rising field of the shelf. This area has a special tropical shrimp fishing phenomena, a study on the reduction of the impact of tropical shrimp trawling on resources, using environmental friendly fishing gear and methods should be going on.

The DGF, 2000 that 1999 were 453 shrimp trawlers in operation. In general, the 50 GT trawlers or smaller are better for stern trawlers or an outrigger trawlers. Haul duration is between 2 and 3 hours, with towing speeds varying from 2 to 3 knots. Catch data (1990-1998) collected by HPPI, gives the catch per unit of effort (kg/haul), average number of hauls per day and average operational days per vessel as presented in Fig.10. Periodically 1990 to 1998 in the Arafura Sea in 1999 were estimated to be 86,640 operational days or 632,472 hauls with increased the catch per unit of effort (kg/haul). Shrimp composition can be categorized shrimp into 5 groups as follows: tiger, banana, endeavor, rainbow and other shrimp. It's consisted of 19-35% tiger shrimp, 29-43% banana shrimp, and 21-31% of endeavor [14]. Furthermore, the data from Bintuni Bay it was on average 30-37 kg/haul, consisting of 8% tiger, 56-69% banana, and 17-20% endeavor.

In Kaimana the catch is on average 23-38 kg/haul, consisting of 16% tiger, 44% banana, and 27% endeavor. In Dolak the catch is on average 20-34 kg/haul, consisting of 15% black tiger, 51% banana, and 23% endeavor. In Aru Islands waters the catch is on average 20-25 kg/haul, consisting of 52% black tiger, 4% banana, and 22% endeavor, respectively. The commercial pelagic fisheries resources such as tuna, tongkol, skipjack, shark and others were important. [12] The Multivariate ENSO Index (MEI) on the six main observed variables over the tropical Pacific it's nearby Papua boundaries, that's point out in Fig. 10. That MEI should be related to the shrimp catching rate per hauling from 931 trawl fishing vessels, yearly 1988 to 2013 at the Arafura Sea.

Fish catch and CPUE exhibited a similar trend over the months, which indicated that fishing effort had positive impact on catch [14]. For better understanding, the increasing rate of pelagic fish was 24% per year from 24,490 tonnes in 1990 to 59,934 tonnes in 1997, the production of demersal fishes increased every year from 14,525 tonnes to 86,326 tonnes its was increased of 82% per year of demersal fishes as snapper, pomfret, catfish, and threadfin fish. There were explored of shrimp resources in the Arafura Sea and many types of research have been carried out based on commercial fisheries. The level of shrimp fishing has already reached a heavily exploited, but we need a complete research on going to improving the productivity of another kind of fishing activities.

IV. CONCLUSIONS

The area of Continental Shelf on Banda Sea boundary has the dynamic of water circulated it's has been implicating to the fishing area, especially for bottom trawling. During the survey periods, from two fishing vessels reported they catch from 17,4 to 39,2 kg/haul in the western area and 44,0 to 80 kg/haul in the eastern coast, respectively.

ACKNOWLEDGMENT

Our multi-disciplinary study on the demersal fisheries at Continental Shelf in the Banda Sea was possible only through the help and cooperation of many individual and agencies. I thank them all. Especially to thank Dr. Ir. I Nyoman Suyasa, MS. as Rector of The Jakarta Fisheries University (STP) and Vice Rectors; Acknowledges the research is funded by STP and PT. EOS Consultants. Acknowledges support by BPPT for current modeling : Dr. Wahyu Pandu, Ir. Bambang Herunadi. Acknowledges support by LAPAN for Remote Sensing images. Acknowledges support by Fikrie Azra Putra, S.St.Pi. (fishing data from KM. Kurnia 03) and Hendra Lesmana, S.St.Pi. (fishing data from KM. Laut Timor). I also acknowledge Dr. Aris Widagdo, A.Pi., M.Sc - Head of Fishing Technology Department STP, for organizing, valuable discussion on the Naval, Oceanographical and join the Fishing Research. Mr. Ilham, M.Sc., M.Sc.Aq Kadarusman, P.hD. and Dr. Gemilang Lara Utama. Acknowledges support by the Captain and Crews of Madidihang 03.

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