Water quality status in the largest Indonesian fishingport

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Abstract. Ocean Fishingport of Nizam Zachman Jakarta (PPSNZJ) is the largest fishingport in Indonesia. It serves as a landing place for fish, fish marketing, berthing place for various sizes of fishing boats, accretion of fishery business unit as well as fishermen's centre. The high activity in this port has the potential to have an impact on the quality of water. To control water pollution from various activities in PPSNZJ, adequate management is required, supported by the availability of data related to the quality of the surrounding waters that meet the water quality standards. This study aims to determine the status of water quality in PPSNZJ. The method used was case study in PPSNZ waters. Water quality status was analysed through Store *et* Retrieval method (STORET). Sampling point location was determined using purposive sampling consisting of five stations in port basin of PPSNZJ by using physical, chemical and biological parameters. Sampling was conducted twice in repetition in transition monsoon and west monsoon. The results showed that physical parameters (odor, debris and oil layer), chemical parameters (ammonia, nitrate, orto phosphate) and biological parameters (coliform) were above the allowable quality standard. The result of STORET method calculation showed that the status of waters condition in port basin of PPSNZJ, for marine biota, has been contaminated with STORET index value of -29 from the range of values of -11 to -30. The condition of waters in PPSNZJ which is allocated for fishingports has been lightly polluted with the STORET index of -5 (from the range of index values -1 to -10).
Key Words: fishingport, Indonesia, PPSNZJ, STORET, water pollution.

Introduction. A port is a complex system, with a wide range of environmental issues such as waste production, water pollution, odor and air pollution. Furthermore, in port areas, fisheries, industrial installations, storage of hazardous materials are carried out that may cause further environmental impacts (Darbra et al 2004; Peris-Mora et al 2005; Dinwoodie et al 2012; Acciaro et al 2014). Fishing port is a special port that handles fish and other catches. Various fishery activities such as fishing, catch landing, marketing and processing are done in the fishing port (Lubis 2012). These activities certainly have an impact on the coastal environment including ports. Coastal and marine pollution generally occurs due to the concentration of population, tourism, and industrialization in coastal areas. These factors have directly and indirectly caused many disturbances of organisms (including humans) on land and water (Costanza 1999; Supriharyono 2000).

Ocean Fishingport of Nizam Zachman Jakarta (PPSNZJ), as the largest fishery port in Indonesia, is prioritized to be a marketing centre for fishery products and fisheries industry. Fishery production landed at PPSNZJ is allocated for local needs supplies (DKI Jakarta) of 39.26%, inter island distribution of 35.83% and export of 24.91% (PPSNZJ 2016). The high activity in this fishing port has the potential to have an impact on the environment, one of which is the decreasing quality of water.

Environmental management, in this case is the water quality monitoring effort, becomes very important to prevent water pollution in port. Pollution in coastal areas is caused by various human activities on land and in the coastal area itself. It can cause health problems, sanitation problems and socioeconomic disadvantages. The quality of coastal waters will affect the living conditions for not only in the coastal ecosystem, but also will affect the existing life in the oceans. Therefore, it is very important to conduct a research to determine the status of coastal pollution for the sake of environmental conservation or interests in fisheries and marine field (Zulfa et al 2016). This study aims to determine the status of water quality in PPSNZJ waters. The water quality status at the port is important to know in order to further develop the management of the area and to minimize the impact of the disaster (Sudirman et al 2013).

Material and Method. This research was conducted in March-July 2017, at PPSNZJ which is located in Muara Baru (Jakarta Bay), Penjaringan Village, Penjaringan District, North Jakarta, Indonesia.

The research was performed by taking water samples which were then analyzed in the laboratory to see the state of each parameter (physical, chemical and biological parameter).

The research was started with determination of water sampling points, data collection, water quality sampling, water quality test and analysis in physical, chemical and biological parameters. Water quality test was conducted by determining the station of water sampling point which is determined in such a way to represent the quality condition of the waters affected by the port activity and the location of the harbour (Hakim 2013). The next stage is water quality measurements which performed directly on the spot (in situ) and conducted in the laboratory (ex situ). The measurements were including physical, chemical and biological parameters. The data (physical, chemical and biological parameters) were then compared with the water quality standard for the port. Water sampling for both physical, chemical, and biological tests was conducted at 5 stations (ST1, ST2 and ST3 stations (PPSNZJ port basin), ST4 station (the exit of eastern shipping lane) and ST 5 (the exit of West Side shipping line)). Sampling point coordinates were recorded by using GPS. Several parameters were measured in situ and other parameters were analysed in the laboratory (ex situ). The location of water sampling points can be seen in Figure 1.

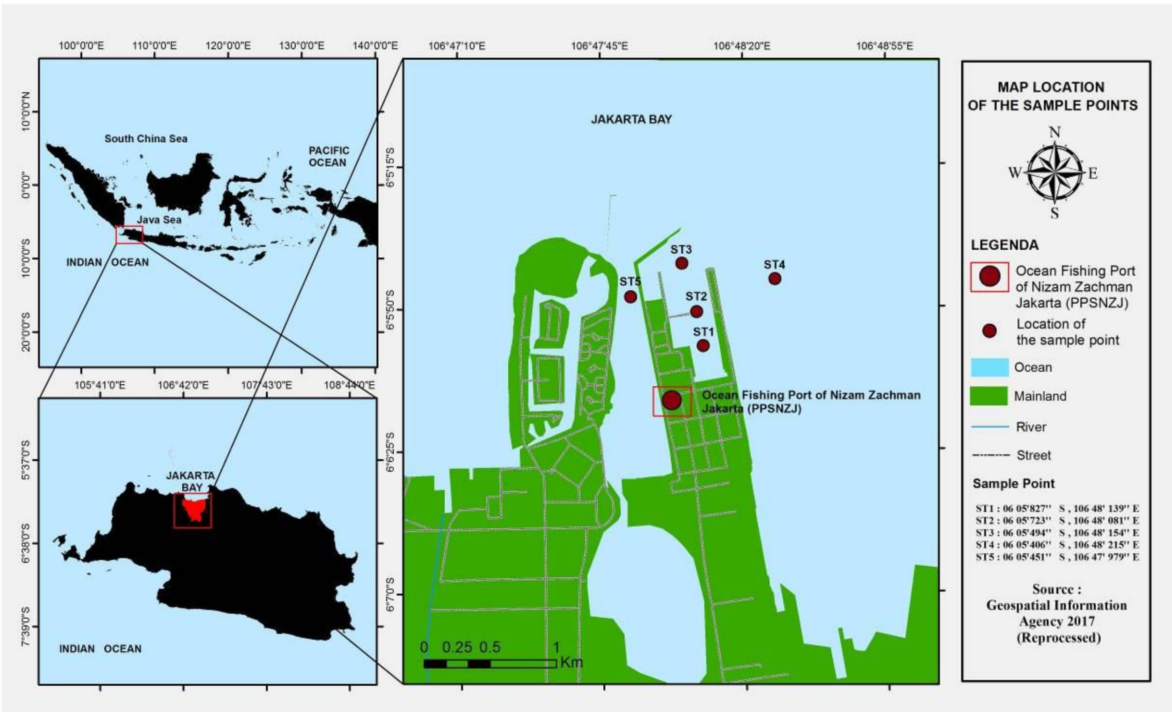

Figure 1. Map of research area and water sampling point locations.

Water quality measurements were performed to determine the status of water conditions in PPSNZJ. The measured data and the methods used can be seen in Table 4 (Appendix). Sampling was conducted twice in repetition, namely in transition monsoon (March 2017) and east monsoon (July 2017) based on Nontji (2008). Water quality measurements were carried out at the Productivity and Aquatic Environmental Laboratory, Department of Aquatic Resource Management - Bogor Agricultural University. The results of water quality measurement were compared to seawater which meets the quality standards for marine biota and fishing port purposes based on the Ministry of environment decree of Indonesia Number 51 of 2004 on the Quality Standard of Sea Water.

Determination of water quality status. Water quality status is the level of water quality condition which indicates polluted condition or good condition at a water source within a certain time by comparing it with the specified water quality standard (Ministry of Environment Decree of Indonesia No. 115 year 2003). Water Quality Status Determination was performed using Store et Retrieval Method (STORET) and Pollution Index Method based on Ministry of Environment Decree of Indonesia No. 115 year 2003. In this research, determination of water quality status of port basin in PPSNZJ was performed by STORET method approach.

The steps of using STORET method are as follows:

a. data of each measurement for each parameter is tabulated into minimum, maximum and average values, then compared with the quality standard (Table 1);

b. if the measurement results meet the quality standard (measurement result ≤ standard quality), a score of 0 will be given;

c. if the result of the measurement does not meet the quality standard, it should be rated according to Table 2;

d. the number of negative scores obtained is used to determine the water status according to the criteria of the value system of the US EPA (Environmental Protection Agency);

e. scoring based on US EPA are:

Class A: score = 0: meet the standard quality,
Class B: score between (-1) to (-10): lightly polluted,
Class C: score between (-11) to (-30): moderately polluted,
Class D: score ≥ -30: highly polluted.

Table 1

Scoring system to determine the status of water quality

Total sample[1]	*Score*	*Parameter*		
		Physical	*Chemical*	*Biological*
< 10	Max	-1	-2	-3
	Min	-1	-2	-3
	Average	-3	-6	-9
≥ 10	Max	-2	-4	-6
	Min	-2	-4	-6
	Average	-6	-12	-18

Source: Ministry of Environment Decree of Indonesia No. 115 year 2003.
Note: [1)] the number of samples used for the determination of water quality status.

The scoring methods for each parameter are as follows (example ammonia parameters, see ammonia measurement data in Table 4):

1. Ammonia is a chemical parameter, then use a score for chemical parameters, since the number of observation stations is 5 then look at the columns for the sample size < 10;
2. The standard quality of ammonia content for marine biota is 0.3 mg L^{-1};
3. Minimum ammonia content measurement score is 0.029 mg L^{-1}, this means ammonia content ≤ standard quality. Then the score for the minimum value is 0;
4. Maximum ammonia content measurement is 0.422 mg L^{-1}, this means ammonia content > standard quality. Then the score for the maximum value is -2;
5. The average ammonia content of the measurement results is 0.223 mg L^{-1}, this means the ammonia content ≤ standard quality. Then the score for the average value is 0;
6. Add the scores for the maximum, minimum, and average scores. For ammonia in this example, the score is -2;

7. Do the same for each parameter, if there is no standard for certain parameters, then no calculations are required. Especially for DO parameters, because the higher value of DO, the better quality waters, then if the above standard quality value is precisely 0;
8. Sum all scores, this indicates the status of water quality. In this example the total score is -29, this means the status of water quality for marine biota in the basin port is moderately polluted and entered in class C.

Results and Discussion. STORET calculation and analysis, which is specified for marine biota in port basin of PPSNZJ (Table 2), obtained an index of -29. This index value shows that the water in port basin of PPNSJ has been moderately polluted (score between -11 to -30). The result of STORET calculation and analysis of port basin in PPSNZJ for fishing port (Table 3) showed an index of -5. This value indicates the quality condition of port basin which is allocated for port activity has been lightly polluted (score value of -1 to -10).

Table 2

STORET calculation results for marine biota purposes

Parameter	*Unit*	*Quality standards*	*Measurement results*			*Score*
Physical			Min	Max	Average	
1. Clarity	M	> 3	1.5 score 0	3 score 0	1.83 score 0	0
2. Total Suspension Solid (TSS)	mg L^{-1}	80	7 score 0	19 score 0	10.5 score 0	0
Chemical						
1. pH		7.0-8.5	6.02 score 0	7.81 score 0	7.30 score 0	0
2. Dissolved oxygen (DO)*	mg L^{-1}	> 5	3.5 score (-2)	7.3 score 0	4.9 score(-6)	(-2)+0+(-6) = -8
3. BOD_5	mg L^{-1}	20	2.4 score 0	3.5 score 0	2.95 score 0	0
4. Ammonia (NH_3-N)	mg L^{-1}	0.3	0.029 score 0	0.422 score (-2)	0.223 score 0	(-2) +(0)+(0) = -2
5. Orto phosphate (PO_4-P)	mg L^{-1}	0.015	0.004 score 0	0.084 score (-2)	0.022 score(-6)	(0)+(-2)+(-6)= -8
6. Lead (Pb)	mg L^{-1}	0.006	0.006 score 0	0.009 score (-2)	0.007 score(-6)	(0)+(-2)+(-6)= 8
Biological						
1. Coliform	MPN 100 mL^{-1}	1000	4 score 0	2400 score (-3)	405 score 0	(0)+(-3)+(0) = -3
Total score						-29
Information	Class C : Moderately Polluted (score-11 to -30)					

Source : Primary Data (2017);
Quality Standard based on Ministry of Environment Decree of Indonesia No. 51 year 2004;
(*): Especially for DO parameter: if the value of DO is above quality standard, it indicates poor water quality.

Table 3

STORET calculation results for fishing port purpose

Parameter	*Unit*	*Quality standards*	*Measurement Results*			*Score*
Physical			Min	Max	Average	
1. Clarity	M	> 3	1.5 score 0	3 score 0	1.83 score 0	0
2. Total Suspension Solid (TSS)	mg L^{-1}	80	7 score 0	19 score 0	10.5 score 0	0
Chemical						
1. Ammonia	mg L^{-1}	0.3	0.029 score 0	0.422 score (-2)	0.223 score 0	(0)+(-2)+(0) = -2
2. Oil and fat	mg L^{-1}	5	< 1 score 0	1 score 0	0.95 score 0	0
3. Surfactant	mg L^{-1}	1	0.072 score 0	0.05 score 0	0.104 score 0	0
4. Lead (Pb)	mg L^{-1}	0,05	0.006 score 0	0.009 score 0	0.007 score 0	0
Biological						
1. Coliform	MPN 100 mL^{-1}	1000	4 score 0	2400 score (-3)	405 score 0	(0)+(-3)+(0) = -3
Total score						-5
Information	Class B: lightly polluted (score -1 to -10)					

Source: Primary Data (2017);
Quality Standard based on Ministry of Environment Decree of Indonesia No. 51 year 2004.

Water quality test results indicated that there are several physical, chemical and biological parameters that have been below the quality standard (Table 4 Appendix). Physical parameters are indicated by the smell of diesel in some observation stations. The odor is caused by the spilling diesel fuel from ships in port basin.

Parameter of trash/debris can be seen from some plastic waste, wood and cigarettes floating in the waters. These wastes are derived from the crew on the ship. The lack of environmental hygiene awareness is one of the causes of this littering behaviour. Oil layer could also be seen in the waters, showing that the oil spilled from the ship has polluted the area of port basin.

The result of DO level of the water taken on transition monsoon showed that all samples in 5 stations have DO value under Quality Standard. DO is very instrumental in the process of food absorption by living creatures in water. The higher DOs the better the quality of the water. If the content is too low it will create an unpleasant odor due to anaerobic degradation that may occured (Zulfa et al 2016).

The result of chemical parameters analysis showed that ammonia contained in samples taken in the three stations is above the permissible quality standard. According to Erari et al (2012) ammonia is one of organic pollution parameters in waters derived from the process of decomposition of organic materials (eutrophication) anaerobically by microbes. High ammonia content in a water will reduce the clarity of the water and produces unpleasant odor. High concentrations of ammonia on the surface of water can cause the death of the fish in these waters.

The result of phosphate parameters analysis showed that samples taken from stations 1, 2 and 3 (sampling during transition monsoon) are above the seawater quality standards allowed for marine life and port designation. High levels of phosphate are caused by high nutrients in the bottom of the waters. This nutrient can be derived from the decomposition of sediments and organic compounds derived from dead bodies of flora and fauna. Phosphate levels at a certain depth can be caused by various factors, including the presence of ocean currents at these depths carrying phosphate and phytoplankton biomass.

The result of lead parameter showed that samples taken from station 5 have exceeded the quality standard, indicating the occurrence of heavy metal pollution in

PPSNZJ. Heavy metal pollution is a very serious problem to deal with, as it harms the environment and the ecosystem in general. Since the case of mercury in Minamata, Japan in 1953, the case of heavy metal pollution is increasing and reported (Bryan 1976). The US Environmental Agency (EPA) reports that 13 heavy metal elements are known to be harmful to the environment, including arsenic (As), lead (Pb), mercury (Hg), and cadmium (Cd). Heavy metals which contaminate the aquatic environment will undergo deposition, dilution and dispersion, then absorbed by the living organisms in these waters (Bryan 1976). One of the causes of the destruction toward marine and aquatic ecosystems is the contamination of chemical pollutants, in the form of heavy metals, derived from agricultural and industrial activities which continue to increase in some countries (Muhammad et al 2011; El Nemr et al 2012). Lead polluting PPSNZJ waters may come from industrial waste discharged into the waters resulting in sediment deposition. Previous research has shown that lead is the major heavy metal contaminating the Jakarta Bay (Hutagalung 1994; Diniyah 1995; Rumanta 2005).

The result of Coliform bacteria measurement showed that samples taken at station 4 (taken in transition monsoon) have higher Coliform bacteria content and above the standard quality. This can be caused by the activities of fishermen throwing dirt directly into the waters. This is occurred because generally the small fishing vessels are still not equipped with toilet facilities. According to Nugroho (2006), the group of Coliform bacteria found in the waters is an indication that the waters have been contaminated by human feces or feces of the warm-blood animals. This group of bacteria can cause infections and diarrhoea.

Water pollution control policy in PPSNZJ. Environmental impact control is an effort to prevent, minimize and/or handle the adverse impacts of a business (development project) on the environment so that environmental quality is maintained properly (Law No. 32 of 2009; Manik 2016). Indonesian government (Directorate General of Sea Transportation) has implemented the Ecoport management policy of the harbour since 2004 to control the environmental impact at the Port. Ecoport implementation is carried out on a number of Public Ports/Commerce in Indonesia, but ecoport has not been implemented in fishing ports resulting the sanitation problems in fishing port (Asmal et al 2016), low water quality (Risnandar 2013; Hakim 2013; Sudirman et al 2013) and causing waste treatment plant to be not optimal (Perdana 2017).

PPSNZJ is the largest fishing port in Indonesia, but it has not conducted periodic water quality monitoring. The condition of port basin which is full of garbage creates a slum scene and an unpleasant smell. PPSNZJ as the centre of landing and largest marketing activities in Indonesia should have a water quality monitoring policy, especially in port basin. According to Chen & Liu (2013), waste at sea is a global pollution problem that has become a major environmental problem on many continents. This condition is caused from various activities such as industry or waste disposal activities to the sea from various sources. In general, it is well known that waste such as plastics, unused/damaged fishing units will negatively impact various aspects such as human health, marine ecosystem habitat, abundance of biota, coastal beauty, navigations security and fishery activities. Furthermore it is said that more than 80% of waste in the sea comes from activities from land through the drainage system, river, wind or human negligence. However, mostly of it comes from marine activities especially ships.

Port basin in PPSNZJ is cleaned in every 2-4 days by using amphibious boat to lift the garbage. But garbage is still visible due to the absence of awareness of the port users, especially the crew who live on the ship docked in the harbour. Law No. 18 of 2008 on Waste Management in Article 3 explains the principle of awareness that local waste management encourages everyone to have the attitude, concern and awareness to reduce and manage the waste they produce. Sea cleaning is a real effort in pollution control.

Port pollution is a problem that must be seriously addressed and needs to be specifically monitored through proper implementation of environmental management, in accordance with environmental legislation and education on port users (Ravikumar 1993). Furthermore, in order to ensure that the implementation is in accordance with applicable legislation, the port manager must provide adequate reception facilities and waste treatment. Currently PPSNZJ already has a waste treatment plant, but its capacity is only able to treat waste as much as 60% due to damage and maintenance that has not been optimal. Reception facilities have been owned by PPSNZJ at the start of construction but have not been used properly.

Environmental management efforts which have been implemented by PPSNZJ are environmental hygiene programs, port basin cleaning, wastes treatment and clean living counselling to fishermen and communities around the harbour. The program has not been fully implemented optimally because port management has not prioritized the environment (Supriyanto 2013).

Ecoport management has been commonly applied to commercial ports in the EU and other developed countries (ESPO 2014). Indonesia as a maritime country with huge marine and fisheries potential should pay attention to the application of the principles of environmentally friendly fishing port/ecofishing port (Ministry of marine and fishery decree No. 45 Year 2009). The availability of periodic water quality data and the level of water pollution in a fishing port are needed to implement an environmental friendly port management.

Conclusions. The results showed that physical parameters (odor, debris and oil layer), chemical parameters (ammonia, nitrate, orto phosphate) and biological parameters (Coliform) were above the permissible quality standard. The result of STORET method calculation showed that water quality status for marine biota purposes in PPSNZJ has been moderately polluted with STORET index value of -29 within the range of -11 to -30. The condition of PPSNZJ waters which is allocated for fishing port has been lightly polluted with the STORET index of -5 from the range of index value -1 to -10. The efforts to control water pollution have been regulated in Indonesian policy, but have not run optimally.

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Table 4 (Appendix)

Results of water quality parameters on Ocean Fishing Port Nizam Zachman

No	*Parameter*	*Unit*	*BMBL*	*BMPP*	*Transition Monsoon (March 2017)*					*West Monsoon (July 2017)*					*Method*
					ST1	*ST2*	*ST3*	*ST4*	*ST5*	*ST1*	*ST2*	*ST3*	*ST4*	*ST5*	
I	Physical														
1	Odors*	-	Nat	Nat	**Solar Odor**	**Solar Odor**	**Solar Odor**	**Solar Odor**	**Solar Odor**	Nat	Nat	Nat	Nat	Nat	Chemical sense
2	TSS+	mg L^{-1}	80	80	12	10	11	10	14	8	19	< 8	< 8	< 8	APHA, ed.22, 2012, 2540-D
3	Debris*	-	None	None	**Plast**	**Plast**	**Plast**	**Plast**	**Plast**	Plast	Plast	Plast	None	None	Visual
4	Oil layer*	-	None	None	**seen**	**seen**	**seen**	**seen**	**seen**	None	None	None	None	None	Visual
5	Temperature*	^{o}C	28-32	28-32	30.1	30.1	30.6	31.2	31.1	30.1	30.1	29.6	29.5	31.5	Thermometer
II	Chemical														
1	pH*	-	7.0-8.5	6.5-8.5	7.50	7.52	7.26	7.81	7.62	6.02	6.69	7.3	7.61	7.63	Refractometer
2	Dissolved Oxygen (DO)*		> 5	>5	**3.5**	**3.5**	**3.9**	**4.6**	**3.6**	5.6	5.2	7.3	7.0	4.7	DO Meter
3	BOD_5		20	-	2.40	2.60	2.40	2.60	2.50	3.4	4.3	3.5	3.5	3.4	APHA, ed.22, 2012, 5210-B
4	Ammonia (NH3-N)+	mg L^{-1}	0.3	0.3	**0.422**	**0.356**	**0.356**	0.296	0.187	0.197	0.078	0.149	0.029	0.157	APHA, ed.22, 2012, 4500-NH3-F
5	Nitrate (NO3-N)	mg L^{-1}	0.008	-	**0.112**	**0.106**	**0.094**	**0.112**	**0.091**	0.149	0.094	0.090	0.107	0.084	APHA, ed.22, 2012, 4500-NO3-E
6	Orto Phosphate (PO4-P)+	mg L^{-1}	0.015	-	**0.021**	**0.017**	**0.018**	0.012	0.007	0.024	0.016	0.016	0.004	0.037	APHA, ed.22, 2012, 4500-P-E
7	Surfactant (MBAS)	mg L^{-1}	1	1	0.050	0.052	0.050	0.056	0.056	0.078	0.086	0.104	0.092	0.098	APHA, ed.22, 2012, 5540-C
8	Mercury (Hg)+	mg L^{-1}	0.01	0.01	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0017	APHA,ed.22,2012 3112-B
9	Lead (Pb)+	mg L^{-1}	0.008	0.05	0.008	0.006	0.006	0.007	**0.009**	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	APHA,ed.22,2012, 3111-C
III	Biological														
	Total coliform	MPN 100mL^{-1}	1000	1000	49	540	79	**2400**	350	540	48	7	33	4	APHA,ed.22,2012, 9222-B

+: accredited parameters; *: in situ analysis by field team; TSS: Total Suspension Solid; Nat: Natural; Plast: Plastic.
Parameters above the quality standard are marked **Bold**.
Quality Standard Based on Ministry of Environment Decree of Indonesia No. 51 Year 2004.
BMBL: Quality Standard of Marine Biota; BMPP: Quality Standard of Fishing Port.