



CASE 2: CONTAMINATED WATER RESOURCES, THE 'DEAD' OF FISHERMEN INCOME

WATER RESOURCES SYSTEM (WRS)

Surabaya river is stretched 42 km long from Mlirip weir (Mojokerto regency) to Petekan barage (Surabaya city), flowing through 3 different administrative areas, which consist of Mojokerto and Gresik regency, and Surabaya city. Surabaya river divides into 2 tributaries at Surabaya city: Mas and Wonokromo river. More than 100 industries depend on it's water as raw materials for their production process. There are 3 big paper factory operated in Surabaya River (PT. Adiprima Suraprinta, PT. Surabaya Mekabox, PT.Gunung Giliad). These factories produce recycle paper and need to import most of their raw materials from other countries. Other than paper factories, there are iron and steel, detergent, MSG, cooking oil, etc. In addition, there are 1,000 houses in the riverbank without proper sanitation systems (including septic tank) which increasing pollution load to the river.

Surabaya tributaries which are Wonokromo and Mas river accept bigger pollution load. Mas river was one of central government priority for rehabilitation in clean river program (Program Kali Bersih). Supporting action done by provincial government for Clean River program, including: providing toilet facilities for riverbank communities, prohibiting toilet discharge, waste disposal, and bathing into the river. Based on the Statical Bureau (BPS) data in 2013, there are more household with toilets, increased 20.37% since 2000. There was no difference between Mas and Wonokromo river pollution condition. The impact of pollution was bigger in Wonokromo, particularly for fishermen. Fisheries areas are more concentrated near Wonokromo river. Fishery industry in their golden age below 2000. Deterioration of water quality forced a lot of fishermen sold their ponds because of harvest failure and become labour¹.

The most vital function of Surabaya river is as clean water resources for local water company (PDAM) in Karang Pilang, Driyorejo, and Ngangel which serve clean water for more than 4 million customers in Surabaya and Gresik. The pollution load (combined from domestic and industrial waste) around 75 ton/day which exceeds Surabaya river carrying capacity. East Jawa Province Environmental Protection Agency (EPA) have regular water quality monitoring to assess the Surabaya river health. The main parameters measured for regular monitoring don't show the toxic compound to aquatic ecosystem and human health.

Research done by Syamsuri (2006) had indicated existance of natural hormone in form of 17β -estradiol which comes from human and animal excretion (urine and feces). The concentration of 17β -estradiol at Wonokromo river was 117.5 ng/L. Compare it with other countries such as european countries, the concentration of 17β -estradiol in Wonokromo river was very high. European countries have concentration

¹ Yue, Yu Yang. The evaluation of companion modelling (ComMod) approach in IWRM: an application of ComMod for water resources management in Surabaya river basin, Indonesia. Thesis: 2016



<0.05 – 15.5 ng/L 17 β -estradiol². The high concentration of estradiol in Wonokromo became indication of contamination of EDCs in Surabaya rivers.

WATER QUALITY SAMPLING METHOD

Surabaya river has become provincial government priority and research site for researchers. Some researchers had interest on evaluating EDCs concentration in Surabaya river. There are 3 research which found EDCs in Surabaya river, and 1 research found impact of EDCs pollution to fish reproduction. These research was used to evaluate the EDCs concentration in Surabaya river. ECOTON proposed for 2 cases of EDC contamination in 2 different location: Lakardowo village and Surabaya river. For water quality sampling, ECOTON is prioritizing Lakardowo, for there were no pollution data and the urgency of the case which is directly impacting the health, livelihood, and activity of 2,000 people in the area. While for Surabaya river, ECOTON had already collected EDCs data and the need is understanding the impact of EDC pollution on the livelihood of downstream community who live in the estuary and worked as fishermen.

EDC CONTAMINATED RIVER

EDCs data on Surabaya river can be categorized into 3 different sources: metal/metallurgy (Pb, Cd, Hg), pharmaceutical (ethinyl estradiol or EE₂), mixture of activities (PCB, PBDE, HBCD, BPA, PE). It's not surprising that the EDCs concentration in Surabaya river was high. Pesticide, production process (such as battery production, iron and steel), domestik waste become the source of heavy metals in water bodies. When Pb and Hg (which have anti-estrogenic effect) have very low concentration in water and sediments, Cd with its estrogenic effect was detected.

Considering there was 1,000 houses in the riverbank without proper sanitation infrastructure (particularly: septic tank), EE₂ high concentration which is active compound for birth control pills is predictable. Farmers in Lamongan regency, use birth control pills and mixed it with fish feed to increase fish growth (weight) and stop the breeding process. Bisphenol A (BPA) is a well-known plasticizer compounds, while PCBs were found in transformer oils, PVC, latex, etc. PCB, BPA, and EE₂ acts as estrogenic compounds. As estrogenic compounds, these compounds would increase the estrogen and suppressed testosterone, which leads to health problems such as infertility, cancer, etc. In wild fish, estrogenic compounds are the caused for feminization or chemical castration by making male fish developing female organ.

Estrogenic compounds concentration in Surabaya river (Cd, PCB, BPA, and EE₂) distrurbed the wild fish reproduction, where male produced mature sperm percentage was low while the mature egg cells were abundant in female⁵. The disturbance was higher in Surabaya river tributaries which is Mas river. In 2013, joint research between local university (Brawijaya University) and France university led found fish in Mas river was feminized (testis-ova), where testis produced egg cells (ovum)³

² Darmawanti, Riska. Estrogenic compounds analysis in Surabaya river's sediment and their impact to Asian red-tailed catfish (*Hemibagrus nemurus*) intersexuality. Thesis: 2013

³ Shobikhuliatul J.J, Andayani S, Couteau J, Risjani Y, and Minier C. Some aspects of reproductive biology on the effect of pollution on the hispathology gonads in *Puntius javanicus* from Mas River, Surabaya, Indonesia. Jou Bio. Life Science. 2014; 4(2):192-205



Bubble bath, detergent contamination on fishpond freshwater resources (picture was owned by Hanie Ismail)

Table 5. EDCs concentration recorded in Surabaya River

Activities	EDC		
	Water	Sediment	Organism
Metal/metallurgy			
Lead (Pb)	• <BDL ⁴	• <BDL ⁷	• 0.05-0.32 mg/kg (fish) ⁷
Cadmium (Cd)	• <BDL ⁷	• <BDL – 0.02 mg/kg ⁷	• 0.01-0.045 mg/kg (fish) ⁷
Mercury (Hg)	• <BDL ⁷	• <BDL ⁷	• 0.001-0.009 mg/kg (fish) ⁷
Pharmaceutical			
Ethinylestradiol (EE ₂)	•	• 0.1-3.65 mg/kg ⁵	•
Mixture of activities			
BPA	•	• 0.1-0.5 mg/kg ⁵	•
PE	•	• 0.1-2.51 mg/kg ⁵	•
PCBs	•	• 1.8-3.0 ng/gr ⁵	•
PBDEs	•	• 6.6-21 ng/gr ⁷	•
HBCDs	•	• 0.29-5.4 ng/gr ⁷	•

ACTIVITY ANALYSIS OF WONOREJO AQUACULTURE

⁴ Mutaqien, Amiruddin. Heavy metals contents in *Puntius javanicus*, *Mystus nigriceps*, water, and sediment in Surabaya rivers. Thesis: 2016.

⁵ Ilyas M, Sudaryanto A, Setiawan E. I, Riyadi S. A, Isobe T, Takahashi S, Tanabe S. Characterization of polychlorinated bisphenyls and brominated flame retardant in sediments from riverine and coastal water of Surabaya, Indonesia. Mar. Poll. Bull. 2011; 82: 89-98



The Fishermen group in the downstream area is the most impacted stakeholder for the deteriorating water quality. Wonorejo is one of Surabaya river downstream area, where water pollution had impacted the their activities and livelihood. More than 20 years ago, Wonorejo fishermen was in golden age where fishermen was wealthy. Nowadays, harvest failure and deteorating water quality become their main concern. The good fishpond management are the key for good production, where water quality play vital role for the fisheries commodities growth and health. There was 2 fisheries commodities in the area: shrimp and milkfish (polyculture). The resource persons for the interview was fishpond tenant and labour.

Table 6. Production process

Production activity	Commodities: Milkfish and Tiger shrimp
Fisherpond preparation	<ul style="list-style-type: none"> • Drying fishpond took 7 – 30 days. Some farmer choose to pass this step and continue with filling the pond with water. The reason for this action was to reduce labour cost. • Farmers who tilling the soil, they hired labour for 5-10 days. Tilling works depend on fishpond size, number of labour and availability of labour cost. Labour payment range from 100-125 thousand rupiah/day. • Farmer lefted out the liming process, again to reduce the production cost. They used to lime the pond because they have good harvest and able to cover the liming cost. • Fertilizer that was used are urea and manure. The price for urea is 150 thousand rupiah/sack. Farmer used manure to fertilize the soil, while urea was used to grow natural feed (algae) • Filling the fishpond with water took 2-3 weeks. The main water resources was seawater and riverine water. • After the fishpond filled with water, the farmer would put the shrimp and milkfish fries. Farmer waited for milkfish fries become 2 months old to release tiger shrimp fries
Water circulation	<ul style="list-style-type: none"> • Farmer in Wonorejo area have 2 different habit in term of water circulation: (1) when farmer saw the water volume decreasing, they would open water gate so that seawater/riverine water could come. Farmer said that shrimp prefer new water so the water need to be circulated more often. On the contrary, milkfish prefer water that has been settled for a while. Water changes happened when harvesting. (2) For other farmer, the indicator for water circulation was when the water turned yellow reddish and open water gate to dispense to fishpond water when low tide and enter the water when high tide. • They didn't have to pay water retribution
Procurement of fries	<ul style="list-style-type: none"> • The price for milk fish fries around 110-600 thousand rupiah/rean (1 rean = 5,000 fries) with the size of a matches from breeder in Gresik area. The fry cost already included transportation cost, while tiger shrimp fries cost 90-140 thousand rupiah/real. • Other option for the fries was bought it in Surabaya reseller agent. The price for shrimp fries was 115 thousand/rean and milkfish about 125 thousand/rean.
Pest management	<ul style="list-style-type: none"> • Fish disease which often found in milkfish was 'salad', a worm. The worm produces slime and when the fish ate the slime, the fish would die. Survival rate of milkfish fries was 50-80%. Farmer caught 'salad' as a crab's bait. There are



	<p>no specific treatment for the worm. It would leave the fishpond when the farmer drying the pond.</p> <ul style="list-style-type: none"> • Shrimp often died with reddish color, looked like it was cooked. Survival rate of the shrimp often reach to 0-5%. If the shrimp died, the farmer would catch the floating shrimp. This practice increased disease distribution and decrease survival rate of the shrimp • Other pest were snake, bird, and other fish (such as snapper, nile tilapia). Wonorejo area was stated as protection area, which means the farmer couldn't kill the bird. Fish which considered as pest but have economic value would sold. • A farmer admitted that he used samonen to kill the pest
Harvesting	<ul style="list-style-type: none"> • Farmer lowered water level until it reach 15-30 cm deep. As farmer using traditional, catch by hand, they need to pay for labour to harvest. Tiger shrimp was caught by hand, while the milkfish was herd toward the nets. • The labour cost between 100-200 thousand rupiah/day. Some of farmer gave 3 kilos of milkfish/labour. • The milkfish buyer came to the fishpond and took the harvest, while farmer needed to send tiger shrimp harvest by themselves to the buyer. • If the middle man bought milkfish, he/she would give the average price for different weight of milkfish around 12 thousand rupiah/kilos, where 3-4 milkfish/kilo. Milkfish size determined the market price. For a milkfish with weight more than a kilo it cost about 40-60 thousand rupiah/kilo, while the smaller one (1 kilo consist of 3-4 fish) around 20-25 thousand rupiah/kilo • The price for tiger shrimp from the middle man was 90 thousand, which quite cheap when the market price around 110 thousand/kilo
Post harvesting	<ul style="list-style-type: none"> • After finishing the harvest, they would drained and dried up the fishpond. • Some farmer used potassium cyanide and samonen to kill small fishes
Money lending practice	<ul style="list-style-type: none"> • There were money lender but farmer avoided them because then they would set up lower prices for fisheries commodities and the farmer would not have stable and fair price. The money lenders wouldn't let go the fishfarmer which make them went vicious cycle of money lending practice • Farmer haven't try to lend from local bank, because of the uncertainty of harvest and concern on bank interest. One farmer, Mrs. Sindun (68 years old), used to have fishpond in Gresik and lend money from a Bank to rent a tractor for tilling her fishpond. • Most farmer said that if they had enough money, they would like to tilling the fishpond and improve the pond banks and open a small store to increase household income
Training	<ul style="list-style-type: none"> • There was a field trip held by Unilever to visit Maduranese fishermen and saw their shrimp cultivation process. But only 4 out of 30 members of fishermen group that able to join on it.
Hope	<ul style="list-style-type: none"> • The fishfarmer hoped to have cooperation (money lending practice) that would help them to improve their productivity without high interest and regulated their commodities price.



- There was research activities to find out the fishpond problems and shrimp and fish disease
- Farmer were hoping for a pilot project to reduce water pollution in their fishpond and training to increase their skill in fishpond/aquaculture management

Cost Benefit Analysis (CBA)

Table 7. Example of CBA from fisherpond labour

Farmer name		Darmanto			Malik	
Age		50			52	
Fisheries commodities	Milkfish and Tiger shrimp					
Ownership of the fishpond		labour			Labour	
Farm land (m2)		12,000			3,750	
Sharing agreement	sharing profit about 10% for Pak Darmanto payment			Milkfish= 2:1; for tiger shrimp = 3:1 (ratio employer: labour)		
Production Cost	item	Cost	Total	Item	Cost	Total
Milkfish fries	7,00	Rp125.000,00	Rp875.000,00	2,00	Rp90.000,00	Rp180.000,00
Tiger shrimp fries	15,00	Rp115.000,00	Rp1.725.000,00	3,00	Rp150.000,00	Rp450.000,00
Labour cost			Rp-			
1. Fishpond preparation	65,00	Rp125.000,00	Rp8.125.000,00			
2. Harvest	8,00	Rp400.000,00	Rp3.200.000,00	6,00	Rp100.000,00	Rp600.000,00
Total production cost			Rp13.925.000,00			Rp1.230.000,00
Harvest income						
Milkfish	2700,00	Rp12.000,00	Rp32.400.000,00	1,00	Rp24.000,00	Rp24.000,00
				35,00	Rp16.000,00	Rp560.000,00
				76,00	Rp14.000,00	Rp1.064.000,00
				42,00	Rp12.000,00	Rp504.000,00
				41,00	Rp10.000,00	Rp410.000,00
				20,20	Rp8.000,00	Rp161.600,00
				1,50	Rp12.000,00	Rp18.000,00
Tiger shrimp	120	Rp90.000,00	Rp10.800.000,00	-		
Total harvest income			Rp43.200.000,00			Rp2.741.600,00
Profit			Rp29.275.000,00			Rp1.511.600,00
Income for labour (7 months)			Rp2.927.500,00			Rp503.866,67

LIVELIHOOD OF WONOREJO FISHPOND LABOUR

The activity analysis shows that the fisherpond labour had to experience difficulties to manage their fishpond and deal with low income. Based on this reason, the livelihood analysis was done to the fishpond labour household. The age of respondents were 48 – 65 years old, with household consists of 2 – 5 people. Most of the respondents children were grown up, and the parents education levels were elementary and



middle schools. While education level of the children was high school and after graduated they would choose other works than being a fishpond labour, such as factory worker and house maid. The children who has already worked couldn't give regular additional income to the family. The amount of money was given to the family were 0.5 – 2 million rupiah. To increase family income, the head of household would take another labour work where the numbers of payment different based on their work load (between 75-100 thousand rupiah). Other source of income was caught crabs, which could give better income but irregular. Mr. Sutrisno could collect 8 million rupiah for 4 months, where the price of crab per kilo varies from 80 – 150 thousand rupiah (based on size and with eggs or not). But now, with ministry of fishery and oceanic (MFO) regulation on crab fishing and the decreasing of crab population, Mr. Sutrisno and his friends can't depend on crab fishing anymore. For household where the wife works, could get additional income about 1 – 1.3 million rupiah (mostly working as house maid).

For household with children in elementary/middle school, they give pocket money around 2 – 5 thousand rupiah/day. The children went to school by bikes, with distance around 0.2 – 1 km from the house. The administration fee for school around 0.8 – 1.5 million rupiah/year. The children who already worked helps their parents by paying their brother/sisters school fee. Almost every fishpond labour have motorcycle (around 1 – 4 items), with instalment around 350 - 750 thousand rupiah/months. Labour who came from other regency usually lived in boarding house, with minimum payment 250 thousand/months. In addition, they still need to pay for electricity bill around 50 – 80 thousand/months. Meanwhile, household who lived in their own houses needs to pay more than 80 thousand/months due to the use of water pump. General electrical devices own by household were television, table fan, sound system.

Money lending practice become one of the solution for urgent need for cash, aside from employer, family members and friends. Mr. Malik lends from village cooperation and using his motorcycle ownership certificate (BPKB) as assurance and got loan 500 thousand rupiah for a year. Mr. Sutrisno lend from his employer about 2 million for covering medical bills. The employer then calculated his debt and reduced his payment from fishpond management fee and total harvest income. Religious group gathering in the village were divided into women and man group. Women have two religious gathering each week with total contribution 11 thousand rupiah/week, while man about 2 thousand/week. Within the fisherman/ fishpond labour group, there are contribution 5 thousand/months as deposit to help member who got sick. The minimum income as labour made them unable to make some savings. Mr. Sutrisno said that he used to gain good income as fishpond labour and his wife able to save 15 – 20 grams of gold jewellery every time they've harvest.

Table 8. Household budget picture of Mr. Darmanto

Item	Income	Expenditure
Fisherpond labour income	Rp418.000	
Crab catching income	Rp300.000	
Additional income from wife working as wife	Rp1.000.000	
boarding house fee		Rp270.000
motorcycle instalment		Rp750.000
man religious group meeting (Rp 2.000/week)		Rp8.000
women religious group meeting (Rp 11.000/week)		Rp44.000
Gas tank (3 gas tank/month, Rp 16.000)		Rp48.000



Fishpond labour gathering contribution		Rp5.000
Water gallon (2 gallon/month, Rp 16.000)		Rp32.000
Daily needs (Rp 15.000/day, 30 days)		Rp450.000
	Rp1.718.000	Rp1.607.000

The health of fishfarmer/ fishpond labour (and their family) and the consumer are impacted by the water quality. Toxic compounds (heavy metals, plastics, and other EDCs) was accumulated in the aquaculture products and such as shrimp, milkfish. The accumulation of heavy metals has already detected in 2009 but below the accepted daily intake (ADI). Heavy metals (copper and zinc) was detected in tiger shrimp, where copper (Cu) concentration was 2.18-3.84 mg/kg while zinc (Zn) was 18,30- 21,80 mg/kg⁶. Other concerning research was detection of mercury in feathers of Ardidae birds (0.998 – 5.252 mg/kg)⁷.

The heavy metals also was detected in the hair of fishermen who live in Kenjeran beach, Surabaya. Surabaya Kenjeran Beach, as a part of eastern coastal area at East Java, in addition to has function as a sea recreation (a tour) place and fishing, it also became the estuary for community channel and rivers from city. The concentration of mercury (Hg) was observed showed that water, sediment, and fishes from Kenjeran Beach were accumulated by Hg at dangerous level. This research took place at Kenjeran district, Bulak sub district, Surabaya. As result, at the fisherman group who consumed sea fish at average 99.11 g/day, they have degree of Hg in their hair is 256.086 ppb, when average degree of Hg in their hair is 0.511 ppb. Hg poisoning symptoms are kidney, lever disorder, headache, painful, tremor, bleeding gums, and visual disorder.

⁶ Setyaningtyas, Larasti. Heavy metals analysis Cu and Zn in tiger shrimp (*Panaeus monodon*) at Wonorejo fishpond, Rungkut, Surabaya. Thesis. 2009

⁷ Marini, S. Dewi. 2008. Mercury contents in the feathers of Birds (family: Ardidae) caught in Wonorejo fisherpond area. Final Paper. Intertide Ecological Community. 2008