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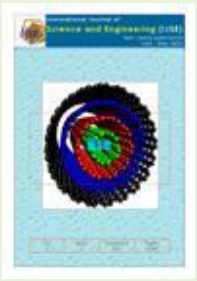

The impact of the local dairy cattle farm toward the river water quality in Gunungpati Subdistrict Central Java

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Abstract -People's awareness on the living environment nowadays is not yet comes up to the dairy-farmer community. In fact, the dairy-farm subsector contributes load pollution in the form of waste. The waste that is produced by a dairy-farm can be in the form of solid waste derived from the rations and forage, and liquid waste from the urine and the wastewater of cleaning the cattle and the pens. There is still no cultivation effort toward the wastes in a traditional dairy-farmyet, thus most of the wastes are disposed to the closest river, so that in the surrounding dairy farm area is frequently found pollution toward the water quality. The aim of this study is to identify the effect of environment pollution that is caused by local dairy farm in Gunungpati Sub-district, especially toward the river water.The result of this study in Nangkasawit Village before and after the dairy farm was build was still under the quality standard for the third rate water quality. In Plalangan Village, the water quality was also under the quality standard, except for COD concentration. In the Sumurejo Village there was an upturn tendency on the observation value, but the water quality was under the quality standard, except for Fe concentration. Based on the Biodiversity Index before and after the dairy farm was established in Nangkasawit, Plalangan, and Sumurejo were 2.22, 1.49, 2.11, 1.90, 1.78, and 1.88, respectively. It means that Nangkasawit showed no pollution before the dairy farm was established, while there was a medium pollution after the dairy farm establishment. In Plalangan, the water was clear, but it was light polluted after the dairy farm was established. In Sumurejo, before and after the dairy farm establishment the water was light category pollution.

Key words: Local dairy cattle; Farm waste pollution

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INTRODUCTION

People's awareness on the living environment nowadays is not yet comes up to the dairy-farmer community. In fact, the dairy-farm subsector contributes load pollution in the form of waste. The waste that is produced by a dairy-farm can be in the form of solid waste derived from the rations and forage, and liquid waste from the urine and the wastewater of cleaning the cattle and the pens. There is still no cultivation effort toward the wastes yet in a traditional dairy-farm, so most of the wastes are disposed to the closest river contributing to the bad river water quality in the surrounding dairy-farm area.

In managing dairy cattle farming, a lot of aspects have to be considered to gain high-grade and unpolluted milk as the product. The aspects include the pen system, copulation, health control, ration availability and the other maintenances, as well as the environment, tool, equipment, and farm worker cleanliness. All of them are needed to produce clean and unpolluted milk (Hendarto, 1999).

The continuing dairy cattle farm is identified as a continuing dairy effort for todays and there will still be exist for the future and it will lasts endlessly. It is beneficial for all human kind and initiates no harm. According to *Food and Agriculture Organization* (FAO, 2004), the continuing farm is a natural source management and conservation. The orientation on technology and institutional changing is conducted well in order to ensure the continuing fulfillment and

satisfactory of the human needs for today's and the upcoming generation. Therefore, the ecological insightful local dairy farm is aimed to secure the agriculture and environment preservation (Budinuryanto, 2010).

The developing farm business produces the increasing waste. The total waste resulted from a farm depends on cattle species, the business level, business type, and the byre floor. The manure is mostly in the form of feces and urine, and it generally obtained from ruminants as well as cows, buffalos, goats, and sheep.

Melse et al (2009) state that a sustainable farming does not merely concern about the survival and the production of the cattle, but also pay attention to the waste handling which may pollute the environment, specifically in the areas with high cattle density. As the result of managing cattle without considering the environment, many farming businesses did not succeed. That is due to the great loss caused by the wrongly-handled waste (Sudiarto, 2008). Meanwhile, according to Martinez et al (2009), the environmental impacts of farming business might emerge in the forms of soil, water, and air pollutions which potentially affect the cattle's health and people's health as well.

Most of farming businesses are of home-industry scale and they send the waste to the river without managing them properly, causing environmental pollutions. These pollutions are mainly from the feces, urine, ration waste, and wastewater of cleaning the cattle and the pens (Kasworo, et al., 20130). The produced waste is organic waste containing high-concentrated suspension (turbid) which smells unpleasant. The main pollutants of farming waste are sediment, nitrogen phosphate, and BOD.

The pollutions caused by the dairy cattle waste evoke protests from the people around the farm. It is particularly due to the itchiness after they use the water from the river as well as its very bad smell (Hidayatullah et al, 2005).

The river pollution is caused by the liquid waste quality that goes beyond the liquid waste standard quality, and also determined by its debit. The indicator of the river pollution can be physically, chemically, and biologically found, as the plankton and macro benthos life (Tanjung, in Nurmayanti, 2002).

Pollutions are able to change the ecosystem structure and decrease the number of the species in a community, causing the varieties to decrease as well. Therefore, the diversity index of a polluted ecosystem is always lower than that of a natural ecosystem. The diversity of a water area is commonly valued in a diversity index (Astirin, et al., 2002).

The aim of this study is to identify the effect of environment pollution that is resulted by local dairy farm in Gunungpati Sub-district toward the surrounding river water quality.

MATERIAL AND METHODS

The research was conducted in June 2012 until Februari 2013 over three (3) Dairy Farm Groups (DFGs) in Gunungpati SubdistrictSemarang., are Pangudi Mulya DFGs in Nangkasawit village, Ngudi Rahayu DFGs in Plalangan village, and Rejeki Lumintu DFGs in Sumurejo village.

a. Material and Instruments:

The material used was the river water contaminated by farm waste, Formalin 40% to preserve the biota, *Rose Bengal* for dye, and Gelatin nutrient. The instruments were: Thermometer, pH meter, Analytic Scale, Spectrophotometer, Microscope, Burette, Plankton net number 25, Eykman Dredge, coller box, sieve, Petri Dish, sample bottles, pincer, loop, and water bucket.

b. Methods :

1) Physically-Chemically Water Quality
The river water is obtained from two observation stations at before and after the establishment of dairy farm inthree (3) Dairy Farm Groups (DFGs) Gunungpati Sub-district. The samples of the water were taken using sample bottles and analyzed in the laboratory.
2) Biologically Water Quality
The plankton is derived from sieving the water with plankton net number 25, and then the sieved water is kept in a bottle and added with Formalin 40% as the preservative. The macrobenthos is resulted from sieving the mud in the brook by using Eykman Dredge. The sieve used is 1 mm in diameter. The benthos that is already separated from the mud is kept in sample bottle, and then it is added with Formalin 40% and Rose Bengal. The macro benthos identification is conducted in a lab with APHA Reference (1981) in Davis (1985). The listing of the number of individual was done by binocular microscope or loop.

c. Anaysis :

1) Physically-Chemically Water Quality
The method and the instruments used in the water quality analysis is shown by Table 1.

2) Biologically Water Quality
- Diversity Index
Diversity Index is an ecological analysis used for plankton and benthos. It is the calculation of the result information on system randomness; dealing with plankton community and macro benthos. The calculation applies the Shannon-Winner Diversity Index (Odum, 1971).

$$H' = - \sum p_i \ln p_i$$

where;
$p_I = - ni / N$
H' = Shannon-Winner Diversity Index
N_I= Individual Number Type I
N = Total Individual Number

Table 1. Water Analysis Method

No.	Parameter	Unit	Metoda	Alat
1.	Temperature	^{o}C	Mercury expansion	Thermometer
2.	pH	-	Potentiometric	pH meter
3.	Dissolved Residue	mg/l	Gravimetric	Analytic Scale
4.	Nitrate	mg/l	Spectrophotometry	Spectrophotometer
5.	Nitrite	mg/l	Spectrophotometry	Spectrophotometer
6.	Sulfate	mg/l	Titrimetric	Burette
7.	Cl	mg/l	Titrimetric	Burette
8.	Fe	mg/l	Spectrophotometry	Spectrophotometer
9.	$CaCO_3$	(mg/l)	Titrimetric	Burette
10.	Ca	mg/l	Potentiometric	Burette
11.	Mg	mg/l	Potentiometric	Burette
12.	COD	mg/l	Tetrimetric	Burette
13.	BOD	mg/l	Digestion	Kjedhal
14.	Amoniac	mg/l	Spectrophotometry	Spectrophotometer

- Distribution Index
  Distribution Index is used to see the number of distribution on each biota that lives in a community (plankton and benthos). This can be calculated by using formula:

  $e = H'/ H_{max}$

where;
e = Distribution index
H' = Diversity index
H_{max} = ln S
S = Number of type

RESULT AND DISCUSSION

- **Physical-chemical aspect**

Based on the lab analysis on the river water quality in Nangkasawit Village on the observation station before and after the dairy farm establishment, it shows that the third rate water quality is below the quality standard; that is the water which can be used for bream farming, husbandry, irrigation, and other usages that require proper quality of water. However, there is a tendency of several parameters in the observation station to increase after the dairy farm establishment; they are soluble solids, BOD, COD, and acidity (pH). This is in line with the opinion of Hidayatullah et al (2005) which suggests that the main pollutants of farming waste are sediments, nitrogen phosphate, and BOD.

Acidity is the expressed number or activity of hydrogen ion in a water area. Acidity shows the condition of the water, whether it is acidic or basic. In general, pH value expresses how high the acidity or the basicity of a water area (Pujiastuti, et al, 2013). From the research result, the acidities in Nangkasawit village are 8,5 and 8,6 which mean that the areas still have good condition for the aquatic biota to live in. The analysis on the river water in Nangkasawit is shown by Table 2.

BOD (Biological Oxygen Demand) is one indicator of organic pollution in a water area. Organic materials will be biologically stabilized by involving microbes through aerobic or anaerobic oxidation system. Therefore, the amount of oxygen needed by microorganisms to degrade the organic waste in the water area is called as BOD.

In Plalangan Village, the analysis on the river water quality based on the observed parameter before and after the dairy farm establishment shows that the water quality is under the quality standard, yet the soluble solid parameter has a tendency to increase the concentrations of COD and BOD over the standard. The analysis on the river water in Plalangan is shown by Table 3.

The COD (Chemical Oxygen Demand) Parameter proves the oxygen needed for decomposing the organic material chemically and resulted in the decreased dissolved oxygen in the water (Wardhana, 2004).

The existence of organic materials can be taken from the nature or household and industrial activity. Waters that has a high COD level is inappropriate for fishery and agricultural fields. COD level in unpolluted waters is about less than 29 mg/liter. Moreover, in the polluted waters, the COD level is about 200 mg/liter, while in the industrial waste the COD level reaches 60.000 mg/liter (UNESCO/UNEP, in Effendi, 2003).

Biological Oxygen Demand (BOD) is the amount of oxygen needed by the aquatic microorganisms to degrade the organic materials in the water (Wardana, 2004).

The high BOD and COD concentrations in the observation station after the dairy farm establishment in Plalangan village are caused by the cattle waste in the form of feces and from the ration remnant which is left behind the pen above the river. This is in accordance with Widya, (2009) who states that the high concentrationof BOD5 in wastewater signs the high amount of organic material, high number of decomposer organisms, and the organic material decomposing which utilizes soluble oxygen.

Nitrate is a form of nitrogen which is soluble in water. Pollutions from fertilizers and animal and human feces are the cause of the high concentration of nitrate (Pujiastuti, et al, 2013).

Table 2. Analysis Result of River Water Quality in NangkasawitVillage

No.	Parameter	Unit	Calculation Result		Quality Standard
			ST1	ST2	
1.	Temperature	°C	27	27	
2.	pH	-	8,6	8,5	6-9
3.	Dissolved solids	mg/l	89	89	1000
4.	Nitrate	mg/l	0,46	0,68	10
5.	Nitrite	mg/l	0,02	0,02	1,0
6.	Sulfate	mg/l	3,74	5,55	400
7.	Cl	mg/l	10,21	11,21	250
8.	Fe	mg/l	1,22	2,24	0,3
9.	$CaCO_3$	(mg/l)	70	72	500
10.	Ca	mg/l	22,4	22,4	-
11.	Mg	mg/l	3,36	3,84	-
12.	COD	mg/l	27,35	42,98	50
13.	BOD	mg/l	3.85	4.60	6
14.	Ammoniac	mg/l	0,10	0,09	-

Notes:
ST1 = sampling before the dairy farm establishment
ST2 = sampling after the dairy farm establishment

Table 3. Analysis Result of River Water Quality in PlalanganVillage

No.	Parameter	Unit	Calculation Result		Quality Standard
			ST1	ST2	
1.	Temperature	°C	27	27	
2.	pH	-	8,5	8,4	6-9
3.	Dissolved solids	mg/l	49	70	1000
4.	Nitrate	mg/l	0,26	0,12	10
5.	Nitrite	mg/l	0,01	0,11	1,0
6.	Sulfate	mg/l	0,04	0,06	400
7.	Cl	mg/l	7,81	13,41	250
8.	Fe	mg/l	2,10	1,17	0,3
9.	$CaCO_3$	(mg/l)	32	40	500
10.	Ca	mg/l	11,2	12,8	-
11.	Mg	mg/l	0,96	1,92	-
12.	COD	mg/l	1,95	82,05	50
13.	BOD	mg/l	1,02	9,24	6
14.	Ammoniac	mg/l	0,04	0,06	-

Notes:
ST1 = sampling before the dairy farm establishment
ST2 = sampling after the dairy farm establishment

Amoniak merupakan senyawa nitrogen yang berubah menjadi ion NH_4 pada pH rendah. Amoniak berasal dari nitrogen organik dan nitrogen anorganik yang terdapat dalam tanah dan air berasal dari dekomposisi bahan organik oleh mikroba dan jamur. Selain itu, ammoniak juga berasal dari denitriikasi pada dekomposisi limbah oleh mikroba pada kondisi anaerob (Sastrawijaya, 2000 dalam Pujiastuti, et al, 2013).

In Sumurejo Village, the analysis on the river water quality based on the observed parameter shows that the river water on the observation stations before and after the dairy farm establishment occur an increasein its observation result value, that is on the soluble solids and CaCO3 concentrations but it is still below the quality standard, except for Fe level. It is caused by the tofu factory that disposed the waste into the river before the dairy farm is built, so that the contamination is detected before the establishment of dairy farm. The analysis on the river water in Sumurejo is shown by Table 4. The high soluble solids and CaCO3 concentrations are suspected to be caused by the farming waste flowing to the river, as well as the waste from the tofu industry near the farm.

Table 4. Analysis Result of River Water Quality in SumurejoVillage

No.	Parameter	Unit	Calculation Result		Quality Standard
			ST1	ST2	
1.	Temperature	^{o}C	27	27	
2.	pH	-	8,3	8,1	6-9
3.	Dissolved solids	mg/l	79	119	1000
4.	Nitrate	mg/l	0,25	0,07	10
5.	Nitrite	mg/l	0,02	0,05	1,0
6.	Sulfate	mg/l	1,7	0,41	400
7.	Cl	mg/l	7,2	10,81	250
8.	Fe	mg/l	1,15	3,42	0,3
9.	$CaCO_3$	(mg/l)	68	114	500
10.	Ca	mg/l	20,8	32,0	-
11.	Mg	mg/l	3,84	1,70	-
12.	COD	mg/l	1,95	1,95	50
13.	BOD	mg/l	1,76	1,82	6
14.	Ammoniac	mg/l	0,08	0,38	-

Notes:
ST1 = sampling before the dairy farm establishment
ST2 = sampling after the dairy farm establishment

- **Biological Aspect**

Based on the value of Biodiversity Index, we know that before and after the dairy farm was established in river on Nangkasawit, Plalangan, and Sumurejo Village, were 2.22, 1.49, 2.11, 1.90, 1.78, and 1.88, respectively. The plankton abundance and its diversity in the waters around the local dairy cattle farm are shown by Table 5.

According to Lee *et al.* (1978) the number of plankton biodiversity index in a waters area will show the water quality in the surrounding region. If the biodiversity index is higher or equal with 2.0 it indicates that the water is in a good condition or unpolluted, if the biodiversity index ranged between 1.5 – 2 it indicates that the water is light polluted, if the biodiversity valued 1.0 – 1.5 it indicates that the water is medium polluted and if the biodiversity index less than 1.0 it indicates that the water is heavy polluted.The abundance and the diversity of benthos type in the waters around the local dairy cattle farm is depicted in Table 6.

Table 5. The plankton abundance and its diversity in the river around the local dairycattle farm

No	Spesies	Number of Individual/ L					
		Nangkasawit Village		Ds. Plalangan Village		Ds. Sumurejo Village	
		Before	After	Before	After	Before	After
	CHRYSOPHYTA						
1	*Achnanthes sp*			17		17	
2	*Amphiphora sp*	17			17		
3	*Amphipleura sp*	35					
4	*Cocconeis sp*				17		
5	*Cyclotella sp*		35	70	17		
6	*Daitoma sp*		52	70	52		
7	*Epithemia sp*			35	17	17	
8	*Frustulia sp*	17	17				
9	*Gyrosigma sp*	17	17				17
10	*Melosira sp*				17		17
11	*Navicula sp*		35		17		
12	*Pinnularia sp*			17			
13	*Rhopalodia sp*					17	
14	*Surirella sp*		17		17	35	
15	*Synedra sp*	35					35
16	*Teballaeia sp*		17				
17	*Terpsinoe sp*		17				
	CHLOROPHYTA						
18	*Closterium sp*		17				35
19	*Pediastrum sp*					17	

No	Spesies	Number of Individual/ L					
		Nangkasawit Village		Ds. Plalangan Village		Ds. Sumurejo Village	
		Before	After	Before	After	Before	After
20	*Scenedesmus sp*				17		
21	*Spirogyra sp*			17		70	35
	EUGLENOPHYTA						
22	*Phacus sp*	17	17			17	17
	CYANOPHYTA						
23	*Coelosphaerium sp*			17			
24	*Hamatoidea sp*				35		
25	*Nostoc sp*			52			
26	*Oscillatoria sp*		17				17
	ZOOPLANKTON						
27	Nauplius		17				
28	*Arcella sp*	52			17		
Number of Individual		275	190	240	295	190	173
Number of Type		12	7	11	8	7	7
Diversity Index (H')		2,22	1,49	2,11	1,90	1,76	1,88
Distribution Index (e)		0,89	0,76	0,88	0,91	0,90	0,97
Number of Individual		275	190	240	295	190	173

Based on those criteria, we may know that in the river on Nangkasawit Village there is no water pollution before the dairy farm establishment, while there is a medium pollution after the dairy farm is established. In the river on Plalangan Village we can find that there is no pollution before the dairy farm establishment, while there is a light pollution after the establishment. In the river on Sumurejo Village we identify that there is already a light pollution before and after the dairy farm establishment because of the existence of tofu factory that drain the waste into the river, so that the water has been polluted. The decrease of diversity index is due to the flowing of the farming waste into the river, causing BOD, COD, and soluble solids to increase. These substances decrease the number of the plankton in the river.

Table 6. The abundance and the diversity of benthos type in the waters around the local dairy cattle farm

No.	Specimen Name	Number of individual per meter^3					
		Nangkasawit		Plalangan		Sumurejo	
		Before	After	Before	After	Before	After
A	Annelida (Cacing)						
1	*Pheretima sp*	150	-	-	-	-	-
2	*Tubifex tubifex*	-	-	-	-	150	225
B	Bivalvia (Kerang)						
3	*Sphaerium sp*	-	15	-	-	-	-
C	Decapoda (Ketam)						
4	Ketam sungai	15	-	-	-	75	-
D	Gastropoda (Siput)						
5	*Brotia costula*	-	-	-	135	60	-
6	*Brotia spadicea*	-	-	30	225	-	-
7	*Melanoides tuberculata*	-	-	-	90	-	-
E	Ikan						
8	*Poecilia reticulata*	-	-	-	-	-	45
F	Insecta (Serangga)						
9	*Baetis sp*	-	-	-	-	275	-
10	*Chironomous thumii*	-	30	-	-	-	285
Number of Individual		165	45	30	450	585	555
Number of Type		2	2	1	3	4	3
Diversity Index H'		0,44	0,92	0,0	1,49	1,62	1,32
Distribution Index e		0,09	0,24	0,0	0,24	0,25	0,21

Based on the number of benthos biodiversity, we may distinguish that the biodiversity in the river onNangkasawit Villageon the location before the dairy farm establishment index is 0.44, and in waters after the dairy farm establishment is 0.92. In the river on Plalangan Village, the biodiversity index before the dairy farm

establishment is 0, and 1.49 after its establishment. Inthe river onSumurejo Village, the biodiversity in the location before the establishment of the dairy farm is 1.62, and in waters after the dairy farm is established is1.32. The low index of benthos diversity is caused not only by the flowing of farming waste into the river, but also by the form of the basic substrate, sand, which is not a proper medium for benthos to grow. This is in accordance with Widya et al (2009) who say that the abundance of makrobenos is in the observation station whose substrate has the highest sand substance.

CONCLUSION

Based on the research result, it can be concluded that the establishment of dairy cattle farm in Gunungpati increases the concentrations of BOD, COD, and suspended solids which cause minor pollutions in the river where the aquatic biota live in.

BIBLIOGRAPHY

APHA. 1989. Standard Method for the Examination of Water and Wastewater. 19th Edition.Washington D.C. 60 pp.

Astirin, OP., AD. Setyawan., M. Harini. 2002. Plankton diversity as bioindicator of Surakarta river quality. Biodiversitas 2(2) : 236-241.

Budinuryanto, D.C., 2010. Restructured of Local Diary Production System on Sustainable Development Strategy (The case study of Citarum River). A National Seminar on Continuing Animal Science Developmet of Padjadjaran University, Bandung.

Effendi, H. 2003. The Study of Water Quality Management Resource and environmental, Kanisius Publisher, Yogyakarta.

Food and Agriculture Organization. 2004. Guide to Good Dairy farm Practice. International Dairy Federation Food and Agriculture Organization of the United Nations.

Hendarto, E. 1999.Waste Controlling Effort on dairy cattle farm. Animal Production 2 (1) : 63 – 74.

Hidayatullah, Gunawan, K. Mudikdjo and N. Erlita. 2005. Liquid waste handling of dairy farm through the net production concept. Journal of Pengkajian dan Pengembangan Teknologi Pertanian 1 (8) : 124 – 136.

Kasworo, A. M. Izzati and Kismartini. 2013. Recycling Animal Feces as An Effort to Support Sustainable Cattle Farming in Jogonayan Village, Ngablak Subdistrict, Magelang Regency. Proceeding of Natural Resource and Environment Management National Seminar. Diponegoro University Semarang ISBN 978-602-17001-1-2

Lee, C.D., S.B. Wang and C.L. Kuo. 1978. Benthic Macroinvertebrates and Fish as Biological Control of Water Quality with Reference to Community Diversity Index. Water Pollution Control in Developing Countries.Asia Institute Technology. Bangkok.

Martinez dan Jose, Patrick Dabert, Suzelle Barirngton, dan Colin Burton. 2009. "L:ivestock Waste Treatment Systems for Enviromental Quality, Food Safety and Sutainability." Jurnal Science Direct Bioresource Technology 100 (2009) 5527 – 5536

Melse, Roland dan Maikel Timmerman. 2009. "Sustainable Intensive Livestock Production Demands Manure and Exhaust Air Treatment Technologies." Jurnal Science Direct Bioresource Technology 100 (2009) 5506 – 5511

Nurmayanti, 2002. Contribution of Domestic Waste Water to Water Quality Kali Garang Semarang. Program Pasca Sarjana Gadjah Mada University, Yogyakarta

Odum, EP., 1971. Fundamental of Ecology, 3rd. Edition, W.B. Sanders, Toronto, Canada

Pujiastuti, P., B. Ismai, and Pranoto. 2013. The Quality and Pollution in Gajah Mungkur Reservoir. Journal of Ekosains1 (5) : 59 – 75.

Sudiarto, Bambang. 2008. Integrated Farming Waste Management and Environmentally Sound Agro-business. Animal Husbandry Technology and Veterinary National Seminar. Padjajaran University Bandung

Wardhana, W.A. 2004. The Impact of Environmental Pollution. Andi Publisher, Yogyakarta

Widya, N., W Budiarsa and MS Mahendra. 2009. A study on the influence of wastewater from animal and poultry slaughtering towards the quality of the water in river Pakel I in Darmasaba village, Abiasemal Subdistrict, Badung Regency. Journal of Ecotropic 3(2) : 55 -60.