京 都 大 学 防 災 研 究 所 年 報　第47号 B　平成16年4月
Annuals of Disas. Prev. Res. Inst., Kyoto Univ., No. 47 B, 2004

Mercury Pollutant in Kapuas River Basin: Current Status and Strategic Approaches

Mardan ADIJAYA* and Takao YAMASHITA

* Centre for Freshwater and Coastal Studies, Tanjungpura University, West Kalimantan, Indonesia

Synopsis

In the last few years, the concerns on mercury pollutant of Kapuas River awareness have grown from the environmentalist groups as well as the whole stakeholders. The sources of mercury pollutant are from small scale gold mining which is considered as illegal. So far, the efforts to prevent water pollution and environmental destruction are in failure as a result, the damage is continuous with no promising solution. This paper tried to present the current status, problems, indicators, and followed by possible roadmaps to resolve such issues. The current data used essentially represent the time periods of 1995 to 2003 which are far from perfect to establish a solid solution, however, it is noteworthy as a basis for establishing the future direction toward pollutant control and environmental damage prevention in Kapuas River.

Keywords: mercury pollutant, illegal gold mining, pollutant control, environmental prevention

1. Introduction

Kapuas River, which crisscrosses west Kalimantan province, has long been recognized supporting either conventional or non-conventional activities. Mostly, it has been utilized for domestic use and industry. However, in 1998, since the economic crisis hit Indonesia along with the claims of reformation era, have made the local people considered that the gold mining activity in Kapuas River as the most promising sector to support their economy. As a result in the last ten years, the illegal gold mining has been dramatically bloomed.

In the gold mining process, mercury is used as the chemical agent to perform amalgam, which facilitates the separation of gold from the unwanted materials. Hence, Kapuas River is undergoing environmental and social problems due to poor mining practices and lack of economic alternatives. The Center for Freshwater and Coastal Studies (CFCS), Tanjunpura University, Pontianak, West Kalimantan, Indonesia, has continuously expressed the concerns on water pollution, including mercury pollutant in Kapuas River. So far, understanding the state of heavy metal pollution is solely deduced from the dose-response approach, which appeared too simple and lame. There are many aspects of the ecosystem which are essentially ought to be considered. Since the problem has raised the social and economic ramifications, solutions can not be simple, however, integrated approaches is necessary.

It is honor to have chance to present our idea and thought about such a matter in the annuals of Disaster Prevention Research Institute (DPRI), Kyoto University. This paper is designed to identify the current status of mercury by recognizing the symptoms, followed by identifying the problems and formulating strategic approaches. The data to support the paper were derived from reports of Bapedalda, Pusarpedal, Dinas Kesehatan Kotamadya, CFCS and DPRI's survey in 2003.

2. West Kalimantan Province and Kapuas River

West Kalimantan is astronomically located between 2^{o} 08' north latitude and 3^{o} 5' south latitude and within 108-114^{o} east longitude. At its northern border, West Kalimantan is separated from Serawak (Malaysia) by a mountain range. Along its western and southern coast, it is separated from Singapore, the Malaysian Peninsula, Thailand and Vietnam by the Natuna Sea. To the east, West Kalimantan borders on the Central and East Kalimantan provinces of Indonesia (see Fig. 1). The population of West Kalimantan is 1,836,757, with density 12.53/km^2 West Kalimantan province is comprised of nine regencies and the total area is 146,807 km^2. Since West Kalimantan contained so many rivers, it is called as "The one thousand island province".

Kapuas River is found crisscrossed the West Kalimantan and constructed from many tributaries (shown in Table 1).

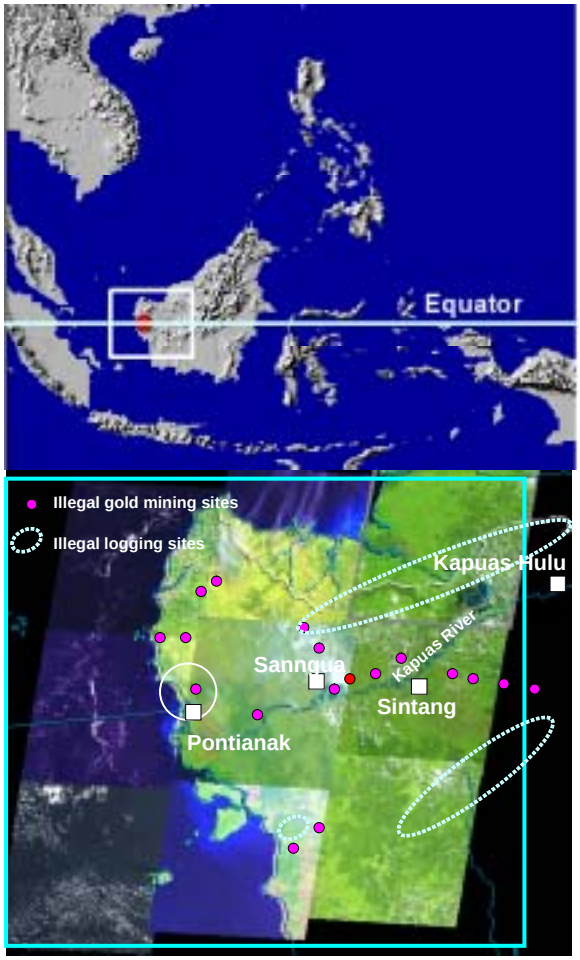

Fig. 1 Location of West Kalimantan (upper) and Kapuas River Basin and irregal mining sites(lower).

Table 1 The distribution of tributaries of Kapuas River

Tributary	Stretches	Area (ha)
Mempawah	Pontianak and Landak	244,798.70
Landak	Pontiank, Landak, Bengkayang	942,069.40
Sekayam	Sanggau	1,012,341.00
Sekadau	Sanggau	664,853.30
Sepauk	Sintang and Sanggau	514,556.30
Melawi	Sintangand Ketapang	2,394,237.00
Ketungau	Sintang	557,589.60
Embaloh	Kapuas Hulu	1,051.341.00
Mandai	Kapuas Hulu	1,150,561.00
Kapuas Hulu	Kapuas Hulu	926,534.00
Kapuas Hilir	Pontianak ans Sanggau	556,531.00

Kapuas Hulu is the regency whereby the upstream of Kapuas River is located. While the downstream regencies of Kapuas River are represented with Sanggau regency and the city of Pontianak. Hence, most of the mercury assessments were designed to cover such regions.

The monthly discharge of Kapuas River ranges between 1964-9432 m^3/s, as shown in Fig. 2. It is seen that the flow is dropped during May, June and July, and its highest ranges appear on November and December. This trend is crucial not only to plan mercury content monitoring periods but also to generate a reliable assessment of pollution load.

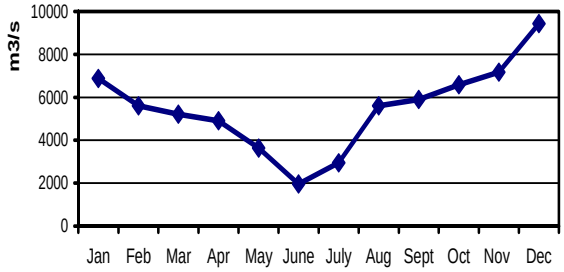

Fig. 2 Monthly discharge of Kapuas River

3. Mercury Pollutant and Illegal Gold Mining

Small scale gold mining by the indigenous mineral exploitation of the rivers is known as the common practices in developing countries. Bugnosen (1998) suggested that the small scale gold mining is mostly labor intensive which engages a large number of men

and women, over six million world-wide. It has been believed as a safety net in the current economic crisis. Most of small scale mining is unregulated and illegal. It is called PETI (Penambangan Emas Tanpa Izin) in Indonesian.

The mercury pollution from gold mining and processing plants causes the contamination of aquatic and terrestrial resources by inhalation and uptakes. The mercury is used in the amalgamation of gold. The contamination is come from the amalgamation process wastes and from the evaporation of the roasting process. No proper protection and care is adopted to guard against poisonous mercury. Commonly, the mercury pollution of gold mining is viewed as the emission halo.

The survey on the parties contributed in illegal gold mining which is conducted in 2001 reported that there are more than 2000 labor and 600 investors involved (Table 2).

4. Current Status of Mercury Pollution

Assessing and identifying environmental problems due to discharges of extra burdens, as mercury pollutant, requires a solid conceptual framework. In an eco-toxicological context, the assessment of one substance toxicity should be viewed not only from the pollutant levels, it is acquired a more complex approaches by involving elements of aquatic ecosystems along with the aquatic trophic levels. It is believed that the ecosystem should be viewed as a balance and interdependence between abiotic-substances-producers-consumers. The changes in one ecosystem element would be reflected in the changes to the others. Mercury, as other heavy metal pollutant, is undergoing bioaccumulation. The bioaccumulation is mostly occurred in higher trophic level in the food chain.

Based on the data reported by CFCS, Bapedalda and Pusarpedal, the level of mercury in water in two different period of times, 1995 vs. 2002 is not markedly different, except for the water taken from the Pontianak City, 1.256 ppb. In general, the seven year elapsed times do not give a significant change of mercury concentration in the water column. However, the sediment suggested a different view. In sediment the level of mercury is found 10^5 fold higher than the water, even though it was measured in the same time (Pusarpedal, 2002).

A much clearer picture on the mercury pollution of Kapuas River is come from its accumulation in organisms from the producer (algae), and consumer (fish, bivalva, human) and river sediment. As seen in Fig., the mercury accumulation in aquatic biota can reach 0.686 ppm in bivalva, 330 ng/g in fish (survey in 1995 and 2000 by CFCS).

Table 2 Parties contributed in illegal gold mining.
INV: investors, LAB: labors

	District	Regency	INV	LAB
1	S. Kapuas, Desa S. Ayak, Kec. Belintang hilir	Sanggau	50	260
2	S. Kapuas, Desa Kanan Hilir, Kec. Sintang	Sintang	21	90
3	S. Kapuas, Desa Nanga Sepauk, Kec. Sepauk	Sintang	27	100
4	S. Melawi, Dusun Kederas Desa Deday	Sintang	78	300
5	S. Melawi, Dusun Gandis Hilir, Desa Gandis, Kec. Deday	Sintang	55	250
6	S. Melawi, Dusun Tajung Baung, Kec. Nanga Pinoh	Sintang	22	100
7	S. Melawi, Dusun Lepadi Kec. Nanga Pinoh	Sintang	24	110
8	S. Melawi, Dusun Kebebu, Kec. Nanga Pinoh	Sintang	19	80
9	S. Melawi, Dusun Lubuk Tapang, Kec. Nanga Pinoh	Sintang	22	100
10	S. Melawi, Dusun Nuguk, Kec. Nanga Pinoh	Sintang	14	60
11	S. Melawi, Dusun Nanga mau, Kec. Nanga Pinoh	Sintang	9	40
12	S. Melawi, Dusun Pandu, Kec. Nanga Pinoh	Sintang	3	15
13	S. Melawi, Dusun Ella Hilir, Kec. Ella Hilir	Sintang	37	150
14	S. Melawi, Dusun Nawa, Kec. Ella Hilir	Sintang	26	130
15	S. Melawi, Dusun Na Sangan, Kec. Ella Hilir	Sintang	32	150
16	S. Melawi, Dusun Nanga Nuak, Kec. Ella Hilir	Sintang	106	350
17	S. Melawi, Dusun Popal, Kec. Ella Hilir	Sintang	3	12
18	S. Melawi, Dusun Ella Hulu, Kec. Ella Hilir	Sintang	59	200
19	S. Tebaung Hilir, Desa Semangut,lu Kec. Banut Hulu	Kapuas Hulu	11	44
20	S. Banut, Desa Nanga Suruk Kec. Banut Hulu	Kapuas Hulu	55	225
21	S. Tebaung, Dusun Nanga Sebilit, Kec. Banut Hulu	Kapuas Hulu	8	32
22	S. Mentebah, Dusun Kerantik, Desa Selaup Kec. Banut Hulu	Kapuas Hulu	11	60
23	S. Embau, Dusun Bogang, Desa Mentawit, Kec. Hulu Gunung	Kapuas Hulu	4	20
24	S. Embau, Dusun Mensasak, Desa Mentawit, Kec. Hulu Gunung	Kapuas Hulu	3	18
25	S. Embau, Dusun Nanga Lidi, Desa Mentawai, Kec. Hulu Gunung	Kapuas Hulu	8	50

The most recent data from the survey of DPRI, Kyoto University, in 2003 December, indicated that an extremely high level of mercury in hair, 39,810ng/g, was found in an 8 year old boy from Mandor. This should be considered as giving an alarming state, and a quick action should be pursued before the impact becomes worsen. The schematic representation of the ranges of mercury content is as presented in Fig. 3.

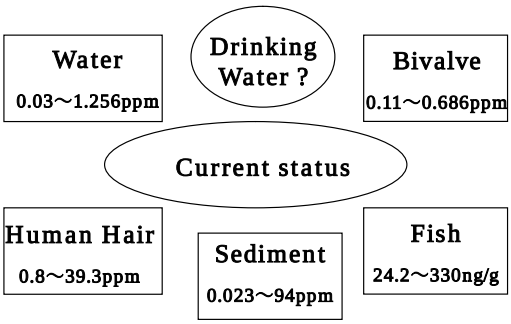

Fig. 3 The summary of the ranges of mercury content observed from various samples

Mandor River currently has been subjected to a heavy gold mining activity, so the occurrence of high mercury content in an 8 year old boy must have been the impact of mercury use in the gold mining activities. The profile of mercury content in water of DAS Mandor was assessed in 1995 and 1996, the result is as presented in Fig. 4. Generally, the total mercury content in both years are within a range of undetected to 5 ppb, except for Sei Dayak, in two points (Nov. 1995 and July 1996), the level of mercury concentration in water reached 15 ppb. The TSS profile is in accordance with total mercury profile.

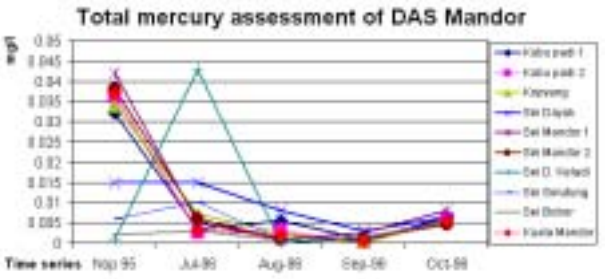

Fig. 4 The trend of total mercury content of DAS Mandor monitored in 1995 and 1996.

The insignificant changes of mercury content in water of DAS Mandor in 1995, 1996 is in agreement with the trend showed by other tributaries (Fig. 5). The figure suggested that the 1995 and 2002 profile is highly similar, except for the sample taken from Pontianak City River (1.256 ppb, triangle line). However, supported from the mercury content in sediment (Fig. 7), conclusion on the insignificant increases of mercury content should be questioned.

To get a factual picture of mercury pollution in Kapuas River, a comparison with other rivers that are similarly exploited for gold mining, is made (Fig. 6) for the water and sediment samples. The total mercury in water reported from all the sites in Cikaniki River, West Java, is much higher than that from Jambi and West Kalimantan. Surprisingly the mercury content of sediments from West Kalimantan is much higher compared to two other rivers (Fig. 7). This should imply that assessments of ecological risks of mercury content are more complicated than merely formulating the road of dose to response.

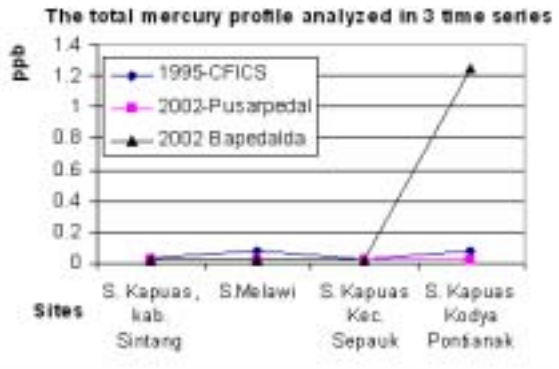

Fig. 5 The comparison of mercury content in water from Kapuas River between 1995 vs. 2002

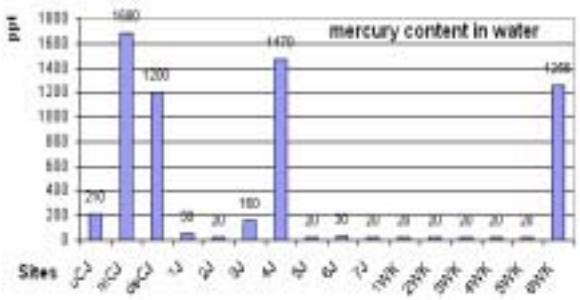

Fig. 6 The comparison of total mercury content in water taken from three different rivers.
CJ = central java, J = Jambi, WK = West Kalimantan

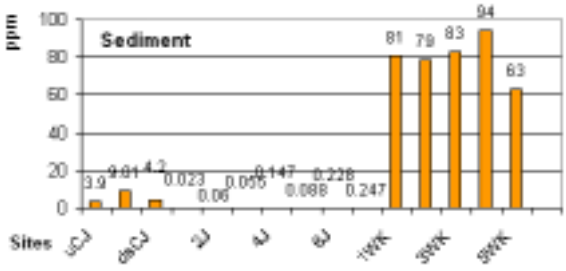

Fig.7 The comparison of mercury content in sediments from three different rivers

This suggested that the dynamic interaction of among elements within one ecological system to the other is varied. Hence, a comprehensive description of

inter-related aspects is required. One of the plausible explanations for such a discrepancy is because of the differences in water flows, river topography, etc.

5. Problems Identification and Roadmap toward Mercury Pollutant Control

To formulate strategic planning and approaches used in resolving the mercury pollution of Kapuas River, problems identification coupled with the causes recognized are crucial. The technical as well as non-technical problems are 1) lack of coordination among institutions and infra-structures, 2) lack of professionalism, 3) unavailability of comprehensive assessment, 4) lack of extensions and public services, 5) no alternative earning.

For instance, only to justify the safety of drinking water seemed to be complicated, due to the high heterogeneity of the outputs.

In order to save West Kalimantan from many pollutants, especially from mercury coming from illegal gold mining, clear vision must be stated. Basically, for the future of West Kalimantan, several conditions need to be established:

(1) Open access of provincial data and information: Based on aforementioned explanation, one of the weaknesses is the availability of data and information. Almost there is no interchange of data from one institution to the others, and the data and information seem to be 'closed' to public. For the future, all necessary information have to be well managed, integrated and opened to public.

(2) Bottom-upward management strategy: Top to downward management has failed to attract public awareness and participation. So that, bottom-upward management should be implemented.

(3) Public consultation and task force: To date, there is no solid coordination among institution, less contribution from stakeholders. Integrated task forces and frequent public open house have to be established.

(4) Sustainable mining: It means that mining activity should be monitored and controlled by the legitimate parties. The MONEV (monitoring and evaluation) program should be established by integrated frameworks among a comprehensive approach along with practical and academic aspects.

The goal should be set for preventing further environmental destruction and health hazard, motivating public awareness and participation, reviving the ecosystem functions and promoting the sustainable development. Any implemented program to reach such goals should take into account the sustainability the activities and the environmental conservation.

The roadmap toward mercury pollutant control program could be set as follows:

(1) To promote active public awareness: pro-active public services/extensions should be pursued.

(2) Any activities should be established based on constructing strategic, zoning, management and action plans. The plans should be socialized to all segments and stakeholders.

(3) Raising public awareness should be preference in public schools and offices.

(4) Research programmes should be strongly supported by local, regional and central government, run professionally. The program formulated should be comprehensive, integrated and accountable.

(5) International collaboration should be encouraged and established. The international involvement is believed as a trigger for government and publics to seriously handling the issues.

(6) The involvement of environmentalist groups must be encouraged and supported.

(7) Law enforcement must be wisely implemented, such as in regulating mercury trading and the zoning of gold mining.

Acknowledgements

This collaboration study with DPRI was conducted as a part of the research program supported by the Grant-in-Aid for Scientific Research (coordinator: Takao Yamashita, 2004-2006) of the Japan Society for the Promotion of Science (JSPS). Authors would like to express grateful thanks to our collaborators in both Indonesia and Japan for their survey assistance and data analysis in this program.

References

Bugnosen, E.M. (1998）: A preliminary assessment of small-scale mining legislation and regulatory frameworks. Intermediate Technology Development Group. 35p.

カプアス川流域における水銀汚染：現状と対策

Mardan ADIJAYA*・山下隆男

*タンジュンプラ大学　淡水域・海岸研究センター，インドネシア，西カリマンタン

要　旨

近年，インドネシア，西カリマンタン州，カプアス川の水銀汚染が指摘されるようになってきた。この水銀の汚染源は，小規模な不法金採掘場である。飲料水や流域環境への水銀汚染を食い止めることは困難で，現在も拡張している状況である。本研究は，カプアス川での水銀汚染の実態，汚染の証拠，内在する問題を明らかにし，この汚染を制御するための解決策を模索するものである。本研究では，1995-2003年に各研究機関により得られたデータを総括して示した。これらは，カプアス川の環境破壊を防ぐために貴重なデータである。

キーワード:水銀汚染，不法金採掘，汚染制御，環境保全