Heavy metals content in irrigation water from selected areas in Peninsular Malaysia

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Abstract
Irrigation water originated from streams is exposed to many sources of heavy metals contamination. Contaminated irrigation water when used to irrigate farms may end up in the cultivated crops and eventually be consumed by humans or animals. To ensure healthy and safe agricultural products are produced from our farms, the quality of irrigation water needs to be continuously monitored. Irrigation water from different parts of the country were analyzed for As, Cd, Pb, Ni and Hg. Results were discussed in relation to the suitability and safety of our irrigation water to be used in our farmlands.

Introduction
Agriculture is an important activity for the country and for most nations. Water forms the lifeblood in agriculture and plays an important role in irrigating the crop lands. Water, soils and fertilizers are the source of essential and minor nutrients required by living organisms including plants and animals. Apart from the macro and micronutrients living organisms require some trace amount of metals including cobalt, copper, iron, manganese and zinc for effective functioning of their cells and organs. Excessive levels of essential metals however can be detrimental to the body systems. Non-essential heavy metals can also contaminate our water source and end up in the crops we produced from the field. Non-essential heavy metals of particular concern to surface water systems include cadmium, chromium, mercury, lead, arsenic and antimony (Arvind, 2006). Heavy metals pollution in water is mainly caused by point source emissions from mining activities and various types of industries. Food crop contamination by irrigation water may be caused by physical contamination, where evaporation and repeated irrigation lead to build up of contaminants in soils. Roots may also absorb heavy metals directly from contaminated irrigation water or from contaminated soil. It is therefore very important to ensure that water use for irrigation purpose do not contain excessive amount of heavy metals that can pose threats to other living organism.

Materials and methods
Water samples were collected from seventeen different locations in the country. Thirteen samples were from irrigation water in agricultural areas and four samples were from rivers passing through city areas in Selangor. The samples from rivers in the city areas were taken to assess the suitability of this water source for irrigation purpose. Water samples were kept in clean plastic bottles, labeled and sent to the Water and Fertilizer Laboratory, Ministry of Agriculture in Kuala Lumpur for analysis. Heavy metals analysed include As, Ni, Cd, Pb and Hg. Graphite Furnace Absorption Spectrometer was used for the analysis of As, Ni, Cd and Pb while Hg was analysed using Flow Injection Mercury System (FIMS).

Results and discussions

Table 1 shows the sample locations and the summarized means of heavy metals concentration in the samples analyzed. Samples number 1 to 13 were from irrigation water in selected agricultural areas awhile samples number 14 to 17 were from rivers in city areas exposed to contaminations from surrounding industries.

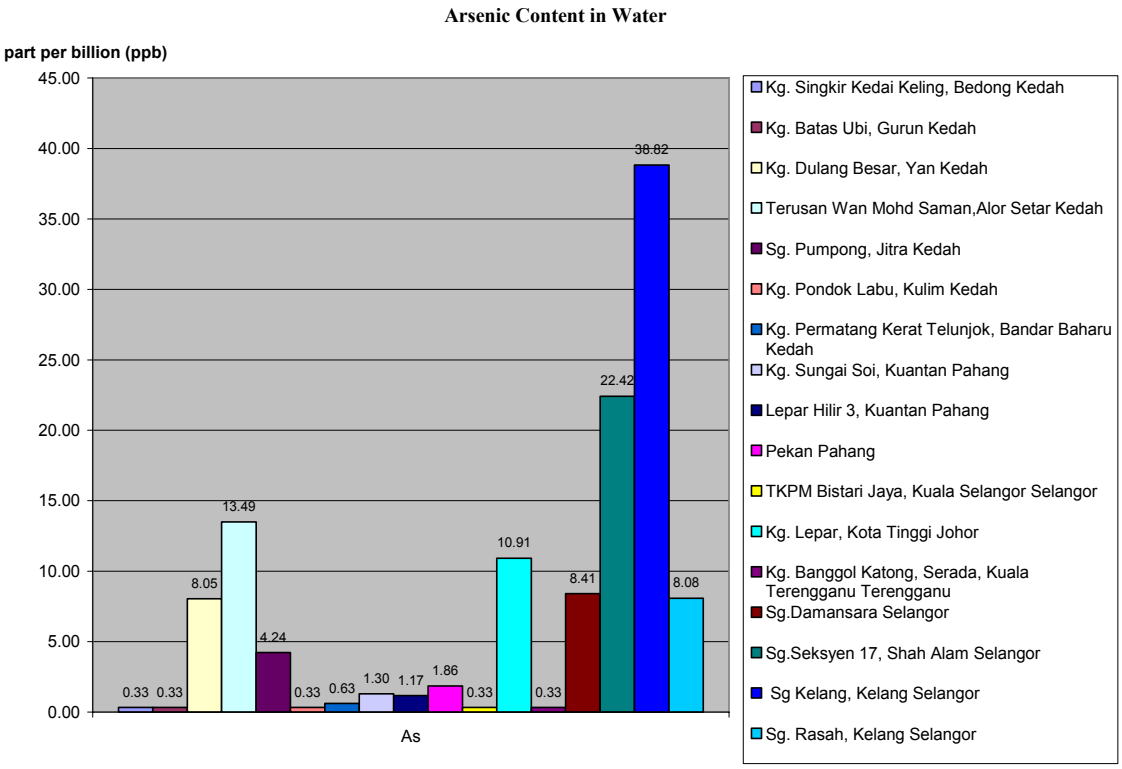
Table 1. Heavy metals content in water from different locations.

LOCATION		STATE	HEAVY METAL CONTENT (ppb)				
			As	**Ni**	**Cd**	**Pb**	**Hg**
1	Kg. Singkir Kedai Keling, Bedong	Kedah	0.33	2.10	0.14	0.28	0.00
2	Kg. Batas Ubi, Gurun	Kedah	0.33	2.10	0.14	0.28	0.02
3	Kg. Dulang Besar, Yan	Kedah	8.05	39.44	0.14	0.28	0.01
4	Terusan Wan Mohd Saman,Alor Setar	Kedah	13.49	2.94	0.14	0.28	0.00
5	Sg. Pumpong, Jitra	Kedah	4.24	2.10	0.14	0.28	1.30
6	Kg. Pondok Labu, Kulim	Kedah	0.33	2.10	0.14	0.28	0.01
7	Kg. Permatang Kerat Telunjok, Bandar Baharu	Kedah	0.63	44.43	0.84	3.99	0.01
8	Kg. Sungai Soi, Kuantan	Pahang	1.30	2.10	0.35	0.28	0.01
9	Lepar Hilir 3, Kuantan	Pahang	1.17	2.10	0.14	0.28	0.14
10	Pekan	Pahang	1.86	2.49	0.14	0.28	0.04
11	TKPM Bistari Jaya, Kuala Selangor	Selangor	0.33	2.10	0.14	0.28	0.02
12	Kg. Lepar, Kota Tinggi	Johor	10.91	5.54	0.14	0.28	0.01
13	Kg. Banggol Katong, Serada, Kuala Terengganu	Terengganu	0.33	2.10	0.14	0.28	0.02
14	Sg.Damansara	Selangor	8.41	3.80	0.14	0.28	3.90
15	Sg.Seksyen 17, Shah Alam	Selangor	22.42	4.60	0.14	0.28	0.03
16	Sg Kelang, Kelang	Selangor	38.82	4.13	0.14	0.28	0.00
17	Sg. Rasah, Kelang	Selangor	8.08	2.10	0.14	0.28	0.01

Figure 1 shows the distribution of arsenic concentration in the water samples analysed. Arsenic content range from 0.33 to 38.82 ppb and the highest content were recorded from samples taken in Sg. Kelang, Klang and Sg. Section 17, Shah Alam with values of 22.42 ppb and 33.82 ppb. Despite their location in the city areas, the arsenic concentration in the rivers were below the critical limit of 100 ppb for irrigation water as stated by the Department of Agriculture (MOA, 2007). Irrigation water samples are much below the limit (0.33 ppb to 13.49 ppb) and are considered safe.

Figure 2 shows the nickel concentration in the samples analysed. Fifteen of the samples contain between 2.1 ppb to 5.54 ppb Ni and two samples from the irrigation water contain 39.44 and 44.43 ppb. However these concentrations are lower than the 200 ppb limit set by the Department of Agriculture for irrigation water (MOA 2007).

Figure 1



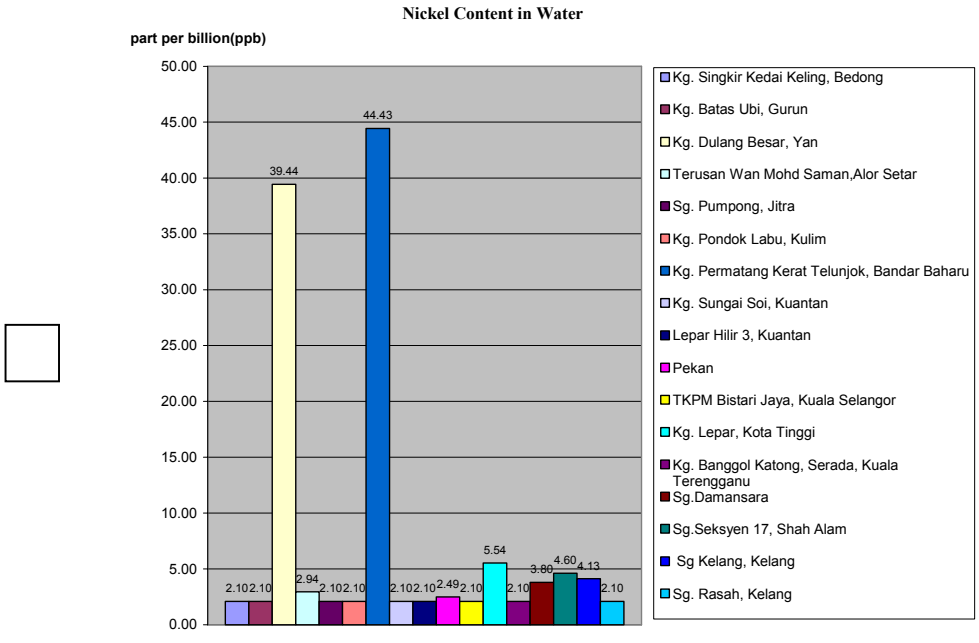


Figure 2

The cadmium content in the water samples ranges from 0.14 ppb to 0.84 ppb. 0.14 ppb was the lowest limit of concentration detectable by the equipment used. Since the maximum allowable content of Cd in irrigation water is 10 ppb (MOA 2007), all the samples are therefore safe for iirigation purpose as far as Cd is concerned.

Figure 3

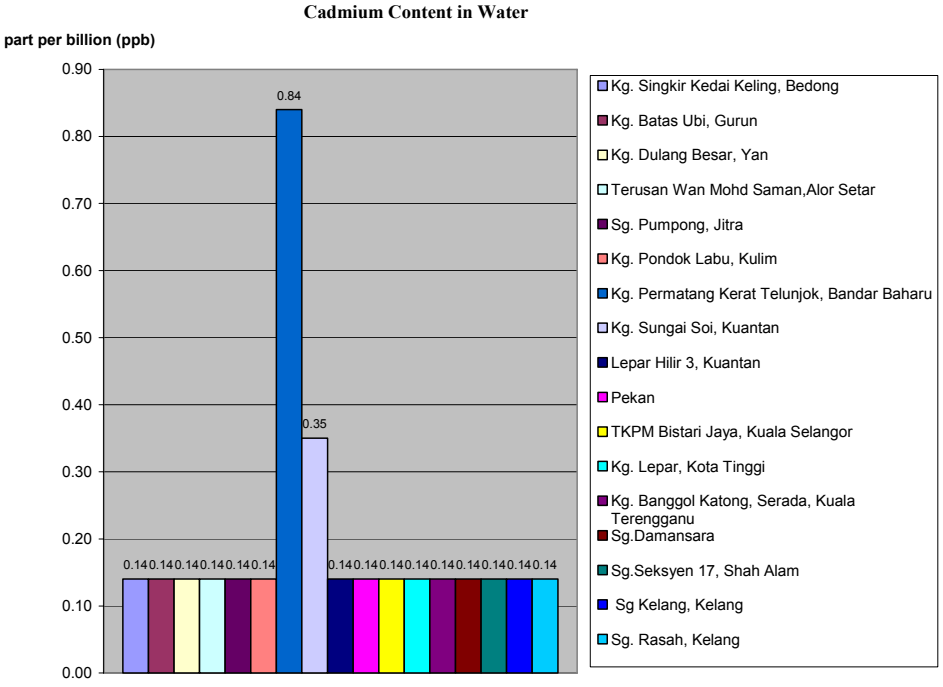


Figure 4 shows the bar charts of lead concentration in the water samples analyzed in the study. The maximum Pb concentration allowed in irrigation water is 5000 ppb (MOA, 2007). All the samples are therefore considered safe for use in irrigation as far as Pb content is concerned.

Figure 5 shows the results of mercury analysis of the water samples. Hg concentrations in the samples range from undetectable to 3.9 ppb. Mercury was hardly detected in the irrigation water samples. However one non-irrigation water sample from Sg. Damansara in the city area recorded a value of 3.9 ppb. This was far above the limit of 2.00 ppb Hg concentration allowed in irrigation water (MOA, 2007). Water from Sg. Damansara is therefore not suitable to be used as irrigation water.

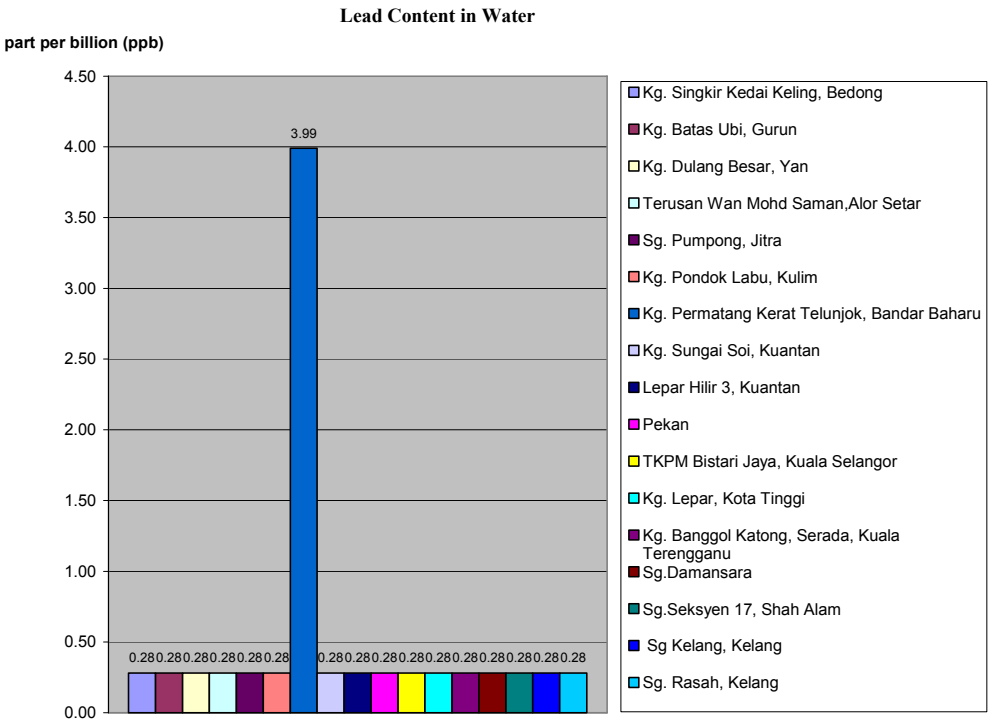


Figure 4

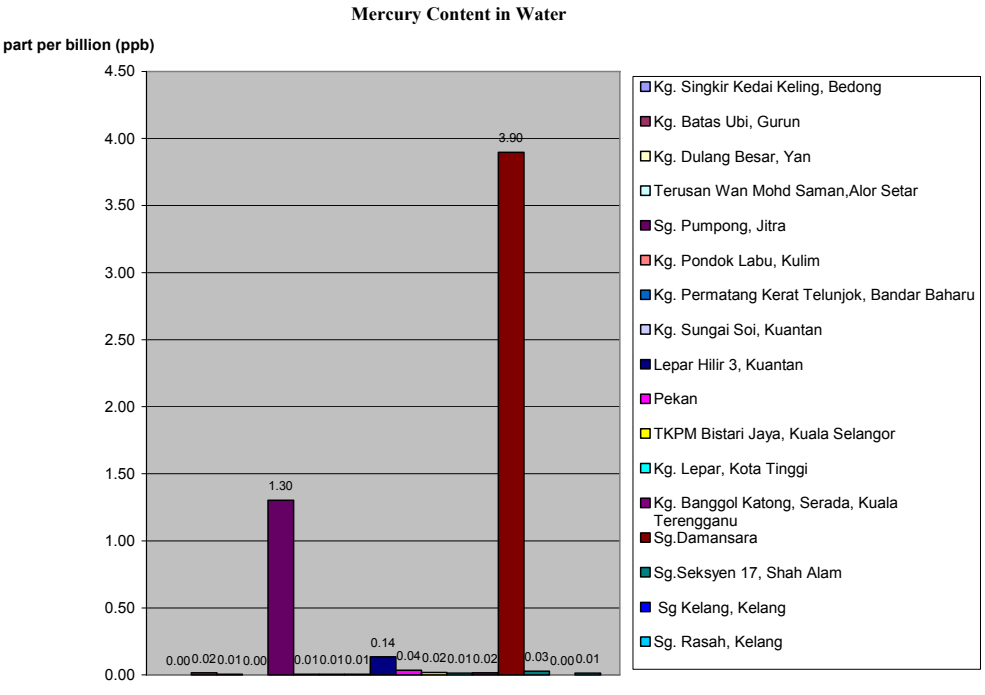


Figure 5

Conclusion

All the irrigation water samples analysed showed that heavy metals content of As, Ni, Cd, Pb and Hg were lower than the maximum allowable limit set by the Ministry of Agriculture. The water was considered safe to be used for irrigation purpose. For the non-irrigation water samples taken from rivers and streams in the city areas one sample from Sg. Damansara showed concentration of Hg to have exceeded the allowable limit for irrigation purpose. Although it was not known if the water has been used for irrigation purpose, care should be taken to warn the public of the danger of using the water to irrigate edible crops.

Although the results showed very low concentration of heavy metals in irrigation water it should be noted that the sampling was carried out only once with three replications. Element concentrations in water are known to fluctuate depending on rainfall events and how often materials containing heavy metals come into contact or are being disposed into the water bodies. Regular monitoring and analysis of the irrigation water is therefore necessary to ensure they are always safe for use. Streams and water bodies within city areas will need more surveillance and monitoring as they are more exposed to industrial contaminants.

Acknowledgements

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