JP0050164

1.22 EVALUATION OF TRACE ELEMENTS DISTRIBUTION IN WATER, SEDIMENT, SOIL AND CASSAVA PLANT IN MURIA PENINSULA ENVIRONMENT BY NAA METHOD *

H.Muryono, Sumining, Agus Taftazani, Kris Tri Basuki. Sukarman A.
Yogyakarta Nuclear Research Center

ABSTRACT

EVALUATION OF TRACE ELEMENTS DISTRIBUTION IN WATER, SEDIMENT, SOIL AND CASSAVA PLANT IN MURIA PENINSULA ENVIRONMENT BY NAA METHOD. The evaluation of trace elements distribution in water, sediment, soil and cassava plant in Muria peninsula by NAA method were done. The nuclear power plant (NPP) and the coal power plant (CPP) will be built in Muria peninsula, so, the Muria peninsula is an important site for samples collection and monitoring of environment. River-water, sediment, dryland-soil and cassava plant were choosen as specimens samples from Muria peninsula environment. The analysis result of trace elements were used as a contributed data for environment monitoring before and after NPP was built. The trace elements in specimens of river-water, sediment, dryland-soil and cassava plant samples were analyzed by INAA method. It was found that the trace elements distribution were not evenly distributed. Percentage of trace elements distribution in river-water, sediment, dryland-soil and cassava leaves were 0.00026-0.037% in water samples, 0.49-62.7% in sediment samples, 36.29-99.35% in soil samples and 0.21-99.35% in cassava leaves.

INTRODUCTION

In the northernpart of Java island, there are industrial lines from Semarang to Surabaya. The industrial line have been developed fastly. Afterward, the nuclear power plant (NPP) and coal power plant (CPP) will be built in Muria peninsula. The Muria peninsula is an important site for monitoring and collection of environment samples. Kancilan, Balong and Suru rivers were located near the candidate of NPP site. It was very important to know the fluctuation of trace elements concentration in those aquatic environment before and after NPP being operated (1).

---

* Presented at the 1998 Workshop on the Utilization of Research Reactors .
Yogyakarta, February 8-11, 1999

The specimen groups of river-water, water sediment , dryland-soil and cassava plants are potential for elements distribution monitoring in environment. The change of specimens groups condition will be influenced for all living biotics in environment (2). The fixed trace elements relationship were on water, sediment, soil and plant specimens. For instance, the absorption process of plant nutrient from soil need water for media . There are some trace elements in the specimens groups and the concentration will increase after being contaminated by industrial waste from north-coastal industrial line (From Semarang to Surabaya / Gresik). It is very important to know the distribution of trace elements concentration in environtment groups of specimens in Muria peninsula. Activation analysis for determination of trace elements in sea-water were done on 1996. It was detected around of 18 traces elements (3). Analysis of water samples by activation method was done by VAN DER SLOOT et al..1976. In general, it was found that more than 18 elements were detected. Sediment and soil samples have greater elements concentration than those of water sample (4) .

The INAA method was used to analyze of trace elements in water, sediment, dryland-soil, and cassava plant samples. Many environmental investigations were used INAA method. (3,4,5,6,7)

The objective of this work is to know the distribution concentrations of trace elements in water, sediment, dryland-soil and cassava plant (leaves) samples from Muria peninsula, in relation to the possibility of entering environment pollution from north-coastal industrial area, waste from sea-transportation in Java ocean area. etc. The trace elements data in those specimens were used as an environmental monitoring contribution in Muria peninsula.

EXPERIMENTAL PROCEDURE

1.Samples collection

Five litres of water samples were collected from Kancilan, Suru and Balong river on dry season 1996. The water samples were filled into a free contamination container and was made acid with the pH of 2.0 .

The river sediments were collected from bottom of Kancilan, Suru and Balong river on dry season 1996. The sediment samples were filled into a free contamination container.

Dry-soil and cassava plants collected from areas near Kancilan, Suru and Balong river locations on dry-season 1996. Dry-soils samples were collected with 0-30 cm depth in 3 replicates. Cassawa plants were chosen by random sampling and the leaves were taken from middle leaves stalk on fourth direction, north, west, east and south. From each stalk were chosen 3 leaves in the middle sites of five leaves. 100 cassava leaves samples were collected from Muria peninsula.

2. Samples preparation

One litre of water samples from Kancilan, Suru and Balong river was filtered and concentrated until 25 ml volume of residues (40 x of concentrated). Water samples were pipetted 1 ml to 100 mg of cellulose powder and filled into identical vials. The vials were heat-sealed.

Sediment samples from Kancilan, Suru and Balong river were dried in room temperature. The samples grinded and filtered with 100 mesh filter fine. Each sediment samples weighing about 100 mg was placed in a polyethylene vial (10mmx30mm) and identified. The vials were heat-sealed.

Cassava leaves samples were washed in flows water and dried in 60-70 °C. The samples were grinded in steel container in liquid N_2 environment and dried in freeze dryer. The samples grinded in centrifugal Ball mill and filtered with 100 mesh filter fine. Each cassava leaves samples weighing about 100 mg, was placed in a polyethylene vial (10mmx30mm) and identified. The vials were heat-sealed.

Chemical substances (product of) ie. Na, Br, Rb, Cs, V, Mn, La, Co, Ce, Sc,, Sm,Th, U, Ni, Al, and Fe were used as primarily standards. Afterwards, SRM of Water

from IAEA, SRM 1045 of River Sediment and SRM 1572 of Cytrus leaves from NBS were used as a control standard.

3. Irradiation and Counting

All neutron irradiations of samples were carried out in the Kartini Reactor of the Yogyakarta Nuclear Research Centre of using the rotation system (Thermal neutron flux density 1,04 x 10^{11} n cm^{-2} s^{-1}.). Two irradiation times were selected : 10 min for the simultaneous determination of short half life radionuclides (short irradiation) and 12 hours for the simultaneous determination of long half life of radionuclides (long irradiation). Samples and standards both were counted by Ge(Li) detector for 600 seconds. The data were calculated by GUINN method (8)

RESULT AND DISCUSSION

The candidate of NPP site in Muria peninsula was shown in figure 1. and the locations of Kancilan, Balong and Suru river was shown in figure 2. appendix I.

Table 1. Mean concentration of trace elements in water samples in Kancilan (a), Balong (b) and Suru (c) rivers (in ng/g).

Elements	(a)	(b)	(c)	Averages
Br	9±1	8.59±2	9.2±3	8.93±0,25
Cs	2±0.3	2.2±0.5	1.9±0.2	2.0±0.12
Rb	5.4±1	5.0±3	5.4±6	5.27±1.88
Al	1.26±0.18	1.13±0.10	1.19±0.14	1.193±0.53
Fe	69±17	59.7±11	68.6±15	65.77±12.93
K	Ud	Ud	Ud	Ud
Mg	Ud	Ud	Ud	Ud
Mn	36±5	30±3	31±4	32.33±2.62
Na	8.8±1.90	8.21±1.21	7.80±1.21	8.27±4.14
V	15±4	12±3	13±2	13.33±1.25
La	Ud	Ud	Ud	Ud
Co	6±0.4	5.2±0.3	5.5±0.4	5.57±0.33
Ce	3±0.6	2.3±0.4	3.6±0.6	2.97±0.53
			1.6±0.2	

Sc	1.2±0.3	1.7±0.5	2.93±0.4	1.5±0.22
Sm	3±0.8	3.3±0.7	Ud	3.08±0.17
Th	Ud	Ud	Ud	Ud
U	Ud	Ud	Ud	Ud
Ni	Ud	Ud		Ud

Ud = Undetected

The mean concentration of trace elements in water samples from Kancilan, Balong and Suru river could be seen in Table 1. Trace elements K, Mg, U, Th and Ni were not detected in the river-water samples of Kancilan, Balong and Suru rivers. Trace elements concentration of Br, Fe, and Na in water samples from Balong river was greater than those trace elements in water samples from other rivers. Trace elements concentration of Al in water samples from Kancilan river was greater than those elements in water samples from other rivers. The other trace elements concentration in water samples were not signficant. The lower to the higher concentration of trace elements in water samples are follows : Al (1.19±0.53 ng/g), Sc (1.5±0.22 ng/g), Cs (2.0±0.12 ng/g), Ce (2.97±0.53 ng/g), Sm (3.08±0.17 ng/g), Rb (5.27-1.88 ng/g), Co(5.57±0.33 ng/g), Na (8.27±1.04 ng/g), Br (8.93±0,25 ng/g), V(13.33±1.25 ng/g), Mn (32.33±2.62 ng/g), and Fe (65.77±4.29 ng/g).

Table 2. Mean concentration of trace elements in sediment samples in Kancilan (a), Balong (b) and Suru (c) river (in μg/g)

Elements	(a)	(b)	(c)	Averages
Br	Ud	Ud	Ud	Ud
Cs	Ud	Ud	Ud	Ud
Rb	Ud	Ud	Ud	Ud
Al	2250±272	2120±132	2232±116	2200.67±57.51
Fe	9890±78	10400±72	9800±68	10030±264.19
K	1030±69	1130±57	1081±49	1080.33±40.83
Mg	625±15	640±13	610±18	625±12.25
Mn	679±21	693±17	617±19	663±33.02
Na	470±17	510±20	495±18	491.67±16.5
V	18,5±5	19.9±4	18.6±6	19±0.64
La	9.1 ±6	9.7 ±5	8.7 ±4	9.17±0.41

Co	8.95±5	9.22±4	9.81±3	9.33±0.36
Ce	Ud	Ud	Ud	Ud
Sc	1.95±0.5	1.95±0.3	1.83±0.2	1.89±0.049
Sm	Ud	Ud	Ud	Ud
Th	1.51±0.2	1.57±0.4	1.42±0.3	1.5±0.06
U	1.01±0.2	1.21±0.3	1.13±0.1	1.11±0.08
Ni	39.4±6	40.3±4	37.8±7	39.17±1.03

Ud = Undetected

The mean concentration of trace elements in sediment samples from Kancilan, Balong and Suru river could be seen in Table 2. Trace elements Br, Cs, Rb, and Ce were not detected in sediment samples from Kancilan, Balong and Suru river. Trace elements concentration of Al, Fe and K in sediment samples from Suru river were not greater than those elements concentration in sediment samples from Kancilan and Balong rivers. Meanwhile, the trace elements concentration of Al, Fe, and K in sediment samples from Suru river were greater than those trace elements in sediment samples from Kancilan and Balong rivers. Trace elements concentration of Mn, La and Th in Suru river sediments were greater than those trace elements in other sediment samples from other rivers. Trace elements concentration of Na and U in sediment samples from Kancilan river were greater than those trace elements in Suru and Balong river sediments. Trace elements concentration of Al, Fe, K and V in Balong river sediment were greater than those trace elements in Suru and Balong river sediments.

Table 3. Mean concentration of trace elements in dry-soil samples around of Kancilan (a), Balong (b) and Suru (c) river areas (in μg/g)

Elements	(a)	(b)	(c)	Averages
Br	7.41±1.2	6.9±2.1	7.2±2.3	7.17±0.21
Cs	5.26±2	5.1±1.2	5.6±1.8	5.32±0.2
Rb	51.34±6	49±5	53±7	51.11±1.64
Al	41400±124	44000±132	42400±167	42600±1070
Fe	21352±1445	23200±1325	23520±1316	22690.67±955
K	10960±234	11200±164	10890±195	11016.67±132
Mg	10587±167	10700±132	10887±126	10724.67±123

Mn	632±45	627±61	652±52	637±10.8
Na	2090±211	2100±237	2010±265	2066.67±40.28
V	63±5	65±6	61±4	63±1.63
La	25.9±3	26.2±5	23.9±4	25.33±1.02
Co	8.3±2	8.1±4	7.8±3	8.06±0.24
Ce	34.92±6	39.2±6	37.92±5	37.4±1.79
Sc	7.8±1.8	8.0±3	8.3±2	8.0±0.2
Sm	4.76±0.9	4.9±2	4.26±1,8	4.64±0.27
Th	7.5±2	8.0±2	7.8±1	7.77±0.21
U	2.32±0.7	2.42±1	2.23±0.8	2.32±0.08
Ni	23±4	24±3	21±6	22.67±1.25

The lower to the higher concentration of trace elements in sediment samples are follows : U (1.11±0.08μg/g), Th (1.5±0.06 μg/g) Sc (1.89±0.049 μg/g), La (9.17±0.41 μg/g), Co(9.33±0.36 μg/g) , V(19±0.64 μg/g). Ni (39.17±1.03μg/g). Na (491.67±16.5 μg/g), Mg(625±12.25μg/g), Mn(663±33.02μg/g), K(1080.33±40.83μg/g), Al (2200.67±57.51 μg/g) and Fe (10030±264.19 μg/g).

The mean concentration of trace elements in dryland-soil samples from Kancilan, Balong and Suru river areas could be seen in Table 3. Concentration of Al element in soil samples around Suru river were greater than Al element in soil samples from around Kancilan and Balong rivers. Trace elements concentration of Fe and Mg in soil samples around Kancilan river were greater than those element in soil around others river. Trace elements concentration of Br and K in soil samples around Kancilan river were greater than those elements in soil around others river. Trace elements concentration of La and Co in soil samples around Balong river were greater than those element in soil around other river. The other trace elements concentration in soil samples were not greater. The lower to the higher concentration of trace elements in sediment samples are follows: U(2.32±0.08μg/g), Sm(4.64±0.27μg/g), Cs(5.32±0.2μg/g), Br(7.17±0.21μg/g), Th(7.77±0.21μg/g), Sc(8.0±0.2μg/g). Co(8.06±0.24μg/g.), Ni(22.67±1.25μg/g), La(25,33±1.02μg/g), Ce(37.4±1.79μg/g), Rb (51.11±1.64μg/g),), V (63±1.63 μg/g), Mn (637±10.8μg/g), Na (2066.67±40.28 μg/g), Mg (10724.67±123 μg/g), K (11016.67±132 μg/g), Fe (22690.67±955 μg/g), Al (42600±1070 μg/g).

The mean concentration of trace elements in cassava leaves samples from Kancilan, Balong and Suru river areas could be seen in Table 4. Trace element concentration of Fe, Mg, Na and V in cassava leaves which were planted around the Balong river were greater than those trace elements in cassava leaves were planted around the Kancilan and Suru river. Trace elements concentration of Al, K, in cassava leaves were planted around the Suru river were greater than those trace elements in cassava leaves were planted in Kancilan and Balong river. The other trace element concentration in cassava leaves were not greater. The lower to the higher concentration of trace elements in sediment samples are follows : Sc(0.015±0.001μg/g), Co (0.027±0.004μg/g), Sm(0.053±0.02μg/g), Cu (0.062±0.002 μg/g), Cs(0.091±0.001 μg/g), Th(0.17±0.008μg/g), La(0.192±0.004μg/g), Ce(0.24±0.012μg/g.), Ni (0.63±0.02μg/g), V(1.57±0.07μg/g), Rb(4.75±0.09 μg/g), Br(8.06 ±0.06μg/g), Mn (23.67±1.25μg/g), Fe (91.44±1.25 μg/g), Al (92.67 ±1.7μg/g), Na(157.33±3.09) Mg (534±4.55 μg/g), K (1724.33±9.74μg/g).

Table 4. Mean concentration of trace elements in cassava leaves samples were planted around of Kancilan (a), Balong (b) and Suru (c) river areas (in μg/g)

Elements	(a)	(b)	(c)	Averages
Br	8.12 ±1.1	7.98±0.98	8.09 ±1.3	8.06 ±0.06
Cs	0.092 ±0.012	0.089 ±0.013	0.091±0.015	0.091 ±0.001
Rb	4.84±0.92	4.62±0.89	4.80±1.02	4.75±0.09
Al	92 ±7.1	95 ± 3.21	91 ±6.1	92.67 ±1.7
Fe	90.11±8	93.11±9.4	91.11±7	91.44±1.25
K	1728±73	1734±80	1711±92	1724.33±9.74
Mg	540±21	529±32	533±26	534±4.55
Mn	25±3	22±5	24±3.1	23.67±1.25
Na	160±36	153±34	159±31	157.33±3.09
V	1.63±0.21	1.47±0.29	1.61±0.19	1.57±0.07
La	0.198±0.031	0.191±0.05	0.187±0.04	0.192±0.004
Co	0.02±0.003	0.03±0.007	0.03±0.004	0.027±0.004
Ce	0.26±0.06	0.24±0.045	0.23±0.016	0.24±0.012
Sc	0.016±0.0068	0.015±0.0018	0.013±0.002	0.015±0.001
Sm	0.055±0.01	0.051±0.021	0.051±0.007	0.053±0.02

Th	0.17±0.05	0.16±0.07	0.18±0.03	0.17±0.008
U	0.062±0.012	0.060±0.021	0.064±0.023	0.062±0.002
Ni	0.65±0.12	0.61±0.20	0.63±0.062	0.63±0.02

The distribution of elements in water, sediment, soil and cassava leaves samples could be seen in Table 5. Distribution of trace elements in water , sediment, soil and cassava leaves were not evenly distributed and follows : 0.00026-0.037% in water samples, 0.49-62.7% in sediment samples, 36.29-99.35% in soil samples and 0.21-99.35% in cassava leaves.

Table 5. Mean distribution of tracc elements in water, sediment, dryland-soil and cassava leaves samples around of Kancilan, Balong and Suru rivers areas (in %).

Elements	River water (%)	Sediment (%)	Dryland-soil (%)	Cassava leaves (%)
Br	0.058	Ud	47.05	52.89
Cs	0.037	Ud	98.28	1.68
Rb	0.009	Ud	91.41	8.49
Al	0.000026	0.49	94.89	0.21
Fe	0.002	30.57	69.15	0.28
K	Ud	7.82	79.51	12.47
Mg	Ud	5.26	90.25	4.49
Mn	0.00024	50.09	48.12	1.79
Na	0.0003	18.09	76.08	5.79
V	0.016	22.73	75.37	1.88
La	Ud	26.43	73.01	0.0056
Co	0.032	53.55	46.26	0.155
Ce	0.00798	Ud	99.35	0.64
Sc	0.015	19.08	80.75	0.151
Sm	0.066	Ud	98.81	1.13
Th	Ud	15.89	82.31	1.80
U	Ud	31.79	66.44	1.77
Ni	Ud	62.7	36.29	1.01

Ud = Undetected

CONCLUSION

The conclusion of this work are :

1. In general, the concentration of trace elements in river-water, sediment, dryland-soil and cassava plants were not evenly distributed. The mean concentration of trace elements in soil and sediment samples were higher than those elements in the river water and plant samples.
2. The concentration ranges of trace elements in river-water, sediment, dryland-soil and cassava plants were as follows : 1.19-65.77 ng/g of water samples, 1.11-2200.67 μg/g of sediment samples, 2.32 - 22690.67 μg/g of dryland-soil samples and 0.015-1724.33 μg/g of cassava plant samples.
3. Percentage of trace elements distribution in river-water, sediment, dryland-soil and cassava plants were 0.00026-0.037% in water samples, 0.49-62.7% in sediment samples, 36.29-99.35% in soil samples and 0.21-99.35% in cassava leaves.
4. According to WHO data of trace elements in water, sediment, soil, and plant samples, It was showed that no pollution found in Muria peninsula areas

ACKNOWLEDGEMENTS

We acknowledge with thanks to Sutanto, Iswantoro, Sihono, and Sapardjo for their help in sampling and standards preparation. We also acknowledge with thanks to Wijiyono, Mulyono, for their help in samples irradiation, counting and data analysis.

REFFERENCE

1. MURYONO, *Laporan kegiatan EMSB tahun 1995/1996 dan tahun 1997. PPNY BATAN Yogyakarta. 1997. Unpublish.*
2. BOWEN H.J.M. " The Biochemistry of Trace Elements." NATILS. IAEA, Vienna (1972). p.393-406.
3. SUMINING DKK. Metoda APNI untuk penentuan unsur-unsur kelumit dalam cuplikan air laut. Prosiding PPI Penelitian dasar dan iptek nuklir. (1997) Belum terbit.
4. H.A.VAN DER SLOOT, J.B.LUTEN. *Two Application of Neutron Activation for Trace Analysis of Water Samples. Measurements, Detection, and Control of Environmental Pollutants. IAEA, Vienna. (1976) p.435-447.*

5. DRASKOVIC, T.TASOVAC, R.RADOSAVLJEVIC. *NAA of The Aquatic Environment in Danube. Nuclear Techniques in Environmental Pollution. IAEA, Vienna. (1971). p.329-334.*
6. MARGARET MERLINI, F.GIRARDI, G.POZZI. *Activation Analysis in Studies of an Aquatic ecosystem. Nuclear Activation Techniques in the Life Sciences.IAEA, Vienna.1967. p.615-628.*
7. DHINGRA, M.S., C.P.SHARDA, N.S.BIRDIE. *Determination of Toxic Metal in Traces in Aquatic Environment. Trace Analysis and Technological Development. Wiley Eastern Limited. New Delhi. 1983 p.127-134.*
8. GUINN V.P., J.HOSTE." Neutron Activation Analysis".Elemental Analysis of Biological Materials. TRS No. 197. IAEA, Vienna. (1980) p.105-140.
9. ANONIM. Keputusan Menteri Negara KLH No.Kep 02/Men/KLH/I/1988 Tentang Pedoman Penetapan Baku Mutu Lingkungan. Sekretariat Menteri Negara KLH. Jkt.(1988)
10. MARTONO SUGENG. *Dampak Limbah Terhadap Lingkungan. Bahan Diskusi Kursus Singkat Penanganan Limbah Secara Hayati. PPLH, UGM.Yk. (1989)*
11. ANONIM. *Environmental Health Criteria. Vol.3. WHO. Geneva.(1977)*

Appendix I

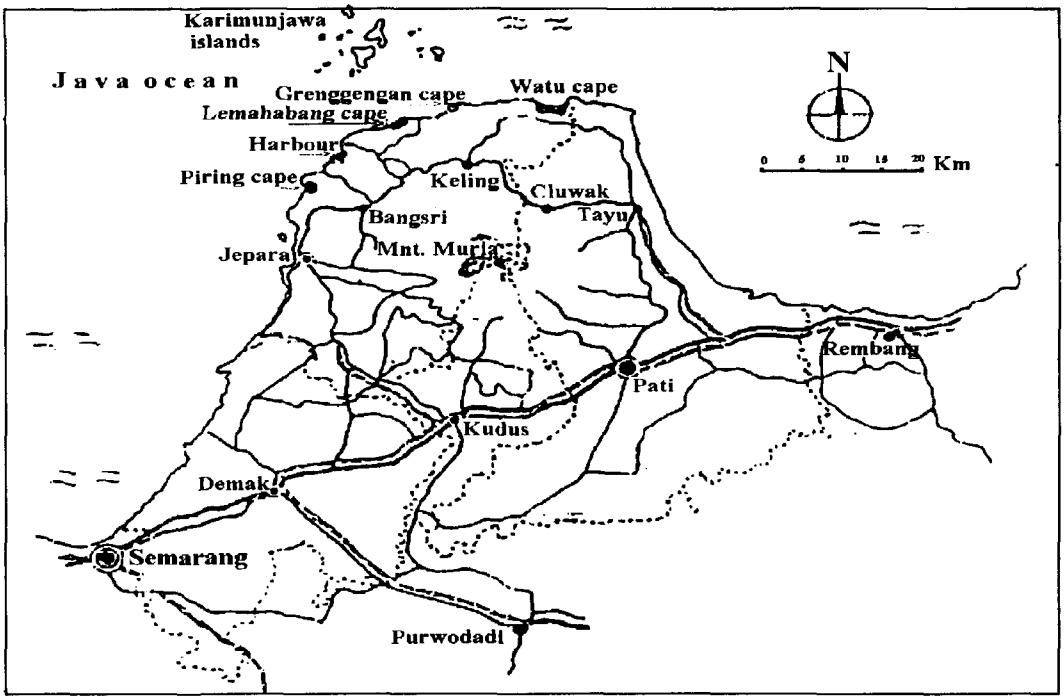

Fig.1. The candidate of NPP site in Muria peninsula, Central Java

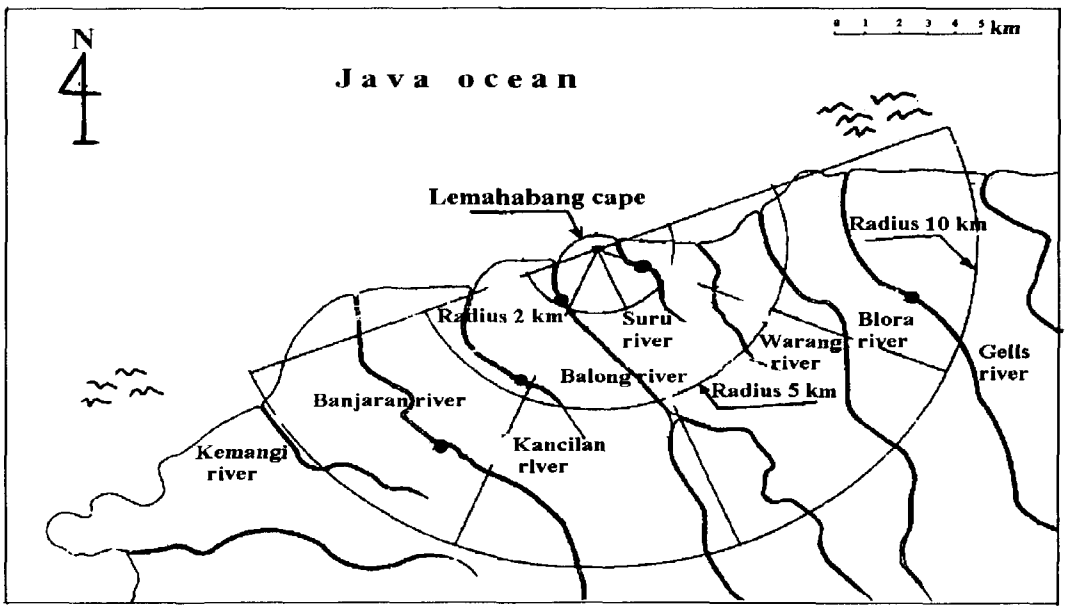

Fig.2. Location of Kancilan, Suru and Balong river in Muria peninsula

Appendix II

Table 6. Mean concentration of trace elements in water, sediment, dryland-soil and cassava leaves samples around of Kancilan , Balong and Suru rivers areas.

Elements	River water ng/g	Sediment μg/g	Dryland-soil μg/g	Cassava leaves μg/g
Br	0.0089±0,25	Ud	7.17±0.21	8.06 ±0.06
Cs	0.002±0.0001	Ud	5.32±0.2	0.091 ±0.001
Rb	0.0053±0,001	Ud	51.11±1.64	4.75±0.09
Al	0.00119±0.000	2200.67±57.51	42600±1070	92.67 ±1.7
Fe	0,657±0,042.	10030±264.19	22690.67±955	91.44±1.25
K	Ud	1080.33±40.83	11016.67±132	1724.33±9.74
Mg	Ud	625±12.25	10724.67±123	534±4.55
Mn	0.032±0.0022	663±33.02	637±10.8	23.67±1.25
Na	0.0082±0.0041	491.67±16.5	2066.67±40.28	157.33±3.09
V	0.0133±0.012	19±0.64	63±1.63	1.57±0.07
La	Ud	9.17±0.41	25.33±1.02	0.192±0.004
Co	0.0056±0.0013	9.33±0.36	8.06±0.24	0.027±0.004
Ce	0.0031±0.0013	Ud	37.34±1.79	0.24±0.012
Sc	0.0015±0.001	1.89±0.049	8.0±0.2	0.015±0.001
Sm	0.0031±0.17	Ud	4.64±0.27	0.053±0.02
Th	Ud	1.5±0.06	7.77±0.21	0.17±0.008
U	Ud	1.11±0.08	2.32±0.08	0.062±0.002
Ni	Ud	39.17±1.03	22.67±1.25	0.63±0.02

Ud = Undetected