Environmental assessment study of atmospheric mercury contamination using tree as bioindicator in ASGM area of Gorontalo Province, Indonesia

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Abstract. Bioindicator is commonly used for monitoring of environmental assessment. They are organisms that are used to assess and monitor environmental pollution. The use of the tree as bioindicator has been mentioned but until now, there is no investigation on monitoring the environmental pollution in previous studies. The purpose of this study is to establish a new bioindicator for atmospheric mercury pollution assessment. This study was conducted in an ASGM area of north Gorontalo Regency, Gorontalo Province, Indonesia. The three experiments have been conducted in this study. The following materials and methods that used in each experiment are as follow: In the experiment I was conducted (1) to investigate the heterogeneity of THg (total mercury weight per unit area 12~18 cm^2) on various tree bark species around the ASGM area and (2) to identify the THg heterogeneity in a macro level of tree bark. The bark samples were collected at Diameter at Breast Height (DBH) about 1.3 m in height. The experiment II was conducted (1) to investigate the heterogeneity of total weight Hg (THg) of the bark in one tree. The tree bark of experiment II was collected into three different height levels, 1, 2 and 3 m. The experiment III was conducted (1) to investigate the relationship of mercury concentrations between tree bark, branch, and root of tree, (2) to investigate the heterogeneity of THg in the outside of ASGM area. The tree bark samples were collected at DBH. The bark from each tree was collected as fragments with dimensions of about 10 × 10 cm to ensure homogenous sampling. The experiment IV was conducted (1) to investigate micro scale analysis of mercury on tree bark using micro-PIXE and (2) to evaluate new bioindicator of atmospheric mercury pollution by ASGM. In the experiment I, the maximum THg of the tree bark samples of *M. indica*, *S. aromaticum, T. catappa* and *L. domesticum* are 74.6, 157, 180, and 63.4 µg, respectively. The map of THg distribution suggests that the mercury concentrations of the tree bark are not affected by the distance to the amalgam burning site. In the experiment II, the THg in the tree bark of *M. indica* samples ranged from not detected (ND) to 9.77 µg. The result showed the heterogeneity of THg in each height level of *M. indica* bark. The map of the THg distribution suggests that the distribution of THg in the tree bark is not affected by the distance to the amalgamation site. This is probably attributable to the wind direction and weathering process, which move the Hg in the atmosphere and deposit it at lower topographic sites in the estuary area. In the experiment III, the THg on tree bark, branch, and root of *M. indica* samples in ASGM were analyzed by PIXE. Each maximum mean value is 110, 334 and 214 µg, respectively. The result showed that there is no correlation among THg of tree bark, branch, and root in the *M. indica.* The THg on the tree bark of *M. indica* even in the Gorontalo City without ASGM activities were 183, 85.6, and 74.9 µg. The results show that atmospheric Hg pollution expands widely in the Gorontalo Province. In the experiment IV, the quantitative 2D elemental images, Hg rich domains in the tree bark heterogeneously scattered on the surface as "hot spot" and their maximum concentrations are 110 were 732 µg/g. This result reveals that micro-drop of liquid Hg in the atmosphere drifted in the atmosphere by wind and then the Hg drop adhered to the surface of tree bark. In this study, a new bioindicator method for evaluating atmospheric Hg contamination has been established based on the THg and their distributions of the bark, branch, and root of the tropical tree including the *M. indica* and micro-PIXE data. In this area, the bark of the *M. indica* tree is a good candidate bioindicator of atmospheric Hg contamination because the *M. indica* is the main species. The results indicate that tree bark of *M. indica* can be used in practical applications for biomonitoring and risk assessment of atmospheric Hg contamination. Moreover, the tree has broad utility as a bioindicator of atmospheric Hg contamination of ASGM areas in the worldwide.