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Atmospheric heavy metal deposition in Northern Vietnam : Hanoi and Thainguayen case study using the moss biomonitoring technique, INAA and AAS

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BACKGROUND, AIM, AND SCOPE: The moss technique is widely used to monitor atmospheric deposition of heavy metals in many countries in Europe, whereas this technique is scarcely used in Asia. To implement this international reliable and cheap methodology in the Asian countries, it is necessary to find proper moss types typical for the Asian environment and suitable for the biomonitoring purposes. Such a case study was undertaken in Vietnam for assessing the environmental situation in strongly contaminated areas using local species of moss *Barbula indica*. MATERIALS AND METHODS: The study is focused on two areas characterized by different pollution sources: the Hanoi urban area and the Thainguayen metallurgical zone. Fifty-four moss samples were collected there according to standard sampling procedure adopted in Europe. Two complementary analytical techniques, atomic absorption spectrometry (AAS) and instrumental neutron activation analysis (INAA), were used for determination of elemental concentrations in moss samples. To characterize the pollution sources, multivariate statistical analysis was applied. RESULTS AND DISCUSSION: A total of 38 metal elements were determined in the moss by the two analytical techniques. The results of descriptive statistics of metal concentration in moss from the city center and periphery of Hanoi determined by AAS are presented. The similar results for moss from Thainguayen province determined by INAA and AAS are given also. A comparison of mean elemental concentrations in moss of this work with those in different environmental conditions of other authors provides reasonable information on heavy metal atmospheric deposition levels. Factor loadings and factor scores were used to identify and apportion contamination sources at the sampling sites. The values of percentage of total of factors show two highly different types of pollution in the two examined areas-the Hanoi pollution composition with high portion of urban-traffic activity and soil dust (62%), and the one of Thainguayen with factors related to industrial activities (75%). Besides, the scatter of factors in factor planes represents the greater diversity of activities in Hanoi than in Thainguayen. CONCLUSIONS: Good relationship between the result of factor analysis and the pollution sources evidences that the moss technique is a potential method to assess the air quality in Vietnam. RECOMMENDATIONS AND PERSPECTIVES: Moss *B. indica* widely distributed in Vietnam and Indo-China is shown to be a reliable bryophyte for biomonitoring purposes in sub-tropic and tropic climate. However, the necessity of moss interspecies calibration is obvious for further studies in the area to provide results compatible with those for other Asian countries and Europe

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