Appendix

I. Environmental monitoring

I-1. ***What was done for each country over the past year?***

Country	Target materials	Techniques used
Australia	Mineral	NAA (k0)
Bangladesh	Soil, river sediments, dust, coal, tobacco, medicinal plants	NAA, AAS, XRF and ICP-OES
China	PM10/PM2.5	NAA,PIXE
Indonesia	Determination of micro nutrients in foodstuffs and marine products at stunting prevalence areas in Indonesia	INAA
Japan	Geological samples	INAA, RNAA
Kazakhstan	Wire chromium, nickel, nichrome, gold	NAA Wire "snail"
Malaysia	Soil	NAA
Mongolia	Soil, air filter, sediment, plans	ED-XRF, NAA, GAA, (ICP, WD-XRF)
Philippines	Agricultural Soil, Sediments, Volcanic Ash, Drinking Water	NAA, HG-AAS
Thailand	PM2.5, PM10, soil, crop	PM2.5 (NAA, PIXE, ICP-MS) PM10 (NAA, PIXE, ICP-MS) Soil (HXRF, ICP-OES) Crop (HXRF, ICP-OES)
Vietnam	Soil, plant, vegetation (all elements)	k0-method (INAA)

I-2. ***To what extent were objectives achieved?***

a. Australia

Objectives: Meet customer expectations

Evaluation: Good so far, customers satisfied, but we have more to offer.

b. Bangladesh

Objectives: Study of soil and river sediment contamination, elemental characterization of medicinal plants, heavy metals in tobacco etc.

Evaluation: 98%

c. China

Objectives: analysis of concentrations of elements in PM2.5/PM10 samples and evaluation of sources of air pollution.

Evaluation: 100%

d. Indonesia

Objectives: The objective were achieved It has been possible to determine micro nutrient in prevalence stunting area such as in the provinces of West Java, Banten, Central Java, East Java, NTB, NTT, West Sulawesi and this data had presented in international seminar and expect to publish at AIP conference journal.

Evaluation: The data obtained is used to complete the data table on mineral content in Indonesian food, and this data is very useful for use in determining policies for handling stunting in Indonesia

e. Japan

Objectives: Evaluation of heterogeneity of halogens (Cl, Br, I) abundances in mantle

Evaluation: 100%

f. Kazakhstan

Objectives: Reaction rate, Gamma spectra measurement

Evaluation:

g. Malaysia

Objectives: To determine the contents of K, Ca, Ti, Mn, Fe, Cu, Zn, Rb, Sr, and Pb in moss and lichen samples, collected in the territory of the city of Ulaanbaatar, Mongolia.

Evaluation: According to the results of the study, the content of elements such as Ni, Cu, Zn and Pb in samples taken from Mount Bogd, in the base of Mount Nalaikh and Mount Uliastai, is higher than in samples taken from other places, which is probably due to the transportation of ash waste from the power plant and exhaust smoke of the residential area. It can also be seen that the distribution of elements varies depending on the direction of the wind flow, the sampling location and the type of sample. The results of this study will be the basis for assessing the level of pollution in the future through monitoring.

h. Mongolia

Objectives: (i) Air pollution - To compare the results of air pollution research exclusively during the cold seasons, specifically within the time frames of 2016-2019 before the adoption of briquette fuel and the years 2019-2022 when briquettes were in use. For the cold season, a total of 74 samples of PM2.5 fine particles were collected from 2016-2019, and an additional 76 samples were gathered from 2019-2022, spanning the period from October to March.

(ii) To determine some heavy and toxic elements in sediment and soil near Tuul river (in Ulaanbaatar city) using XRF and activation analysis.

(iii) To determine the levels of some heavy and toxic elements, such as V, Cr, Ni, Cu, Zn, Ba, As, and Pb, in soil samples taken from the vicinity of a vehicle battery disassembly site using X-ray fluorescence and neutron activation analysis.

Evaluation: (i) - It is conducted measurements of PM2.5, assessed the content of black carbon (BC), analyzed elemental composition through EDXRF, and identified sources of pollution. Four primary sources of air pollution during the winter season are identified: residential areas in the Ger district (stoves); power plants and small boilers; vehicles and roads; and factories. When evaluating the proportion of overall pollution, the amount of PM2.5 emissions from residential areas in the Ger district was reduced by half due to the use of briquettes. Conversely, the rates from the other three sources have increased by 2-3 times. This can be explained by factors such as urbanization, transportation expansion, industrial activities, and population growth.- 100%

(ii) The concentrations of V, Cr, Ni, Cu, Zn, As, and Pb were determined in the soil samples and compared with the acceptable levels defined in the Mongolian soil standard MNS 5850:2019. The concentrations of V, Cr, Ni, Cu, and Zn in the soil samples were within tolerable limits, while the concentration of As slightly exceeded. In 2018 it was determined that the level of lead (Pb) was 10.7 times higher than the permissible level specified in the standard. This elevated Pb content can be attributed to the widespread use of lead-acid batteries in vehicles today. Hence, it is considered necessary to regularly monitor the environment surrounding such facilities. In 2023, Pb content is decreased 5 times than the result of 2018. Because the battery disassembly company has been discontinued for past 3 years.

(iii) According to the results of the study, the content of elements such as Ni, Cu, Zn and Pb in samples taken from Mount Bogd, in the base of Mount Nalaikh and Mount Uliastai, is higher than in samples taken from other places, which is probably due to the transportation of ash waste from the power plant and exhaust smoke of the residential area. It can also be seen that the distribution of elements varies depending on the direction of the wind flow, the sampling location and the type of sample. The results of this study will be the basis for assessing the level of pollution in the future through monitoring.

(i) Philippines

Objectives: Volcanic ash and soil/sediment samples were processed using k_0-NAA method to determine the Arsenic and Rare Earth Elements contents. The results of analysis are available

Evaluation: The samples sent for analysis indicated that arsenic content in the samples ranged from 1.4 to 7.8 ppm, which is considered safe for soil samples. EPA limit is set at 20 ppm. For REEs,

(j) Thailand

Objectives: To characterize and elemental analysis of PM2.5, PM10, soil and crop samples in Phathum Tani Province, Thailand for source identification and for environment quality and agricultural product security assessments.

Evaluation: 90%

(k) Vietnam

Objectives: Soil, plant, vegetation

Evaluation: A total of 28 elements were evaluated in samples. We have partially assessed the level of heavy metal pollution in the soil as well as the absorption coefficient of plant through the elemental content in the samples

II. Multiple measurement techniques including NAA

II-1. *Performance*

Country	Techniques used
Australia	NAA compared to XRF & ICPs.
Bangladesh	NAA-65%, AAS-30% and XRF-2.5%, ICP-OES-2.5%
China	NAA, PIXE and XRF
Indonesia	100 % NAA
Japan	INAA, RNAA
Kazakhstan	NAA (100)
Malaysia#	NAA, ICP-MS
Mongolia	ED-XRF, NAA, GAA,(ICP, WD-XRF)
Philippines	NAA, EDXRF, IRMS, AAS
Thailand	NAA (70%), PIXE (70%), ICP-MS (100%), hXRF (100%), ICP-OES (100%)
Vietnam	ICP/MS

II-2. *How to use the results of the comparison?*

(a) Australia

Present situation: Satisfied with quality of measurements for matrices where no self-shielding present. High REE samples still need work. Possible additional engagement with new client (silica).

Plan, idea: Perhaps shift (FNCA) focus away from minerals and possibly back to other environmental sample types (eg SPM).

(b) Bangladesh

Present situation: No comparison

Plan, idea: In future we will do the comparison of techniques

(c) China

Present situation: Using the analytical results by different nuclear analytical techniques, such as NAA, PIXE, XRF)

Plan, idea: Comparison of the result of NAA with PIXE, XRF and ICPMS. Many elements, such as halogen elements, can be determined by INAA at high neutron flux reactor with high accuracy and sensitivity.

(d) Indonesia

Present situation: The validity of the data resulting from analysis using NAA was tested using SRM analysis with a similar matrix as a control. The NAA Laboratory plays an active role in Provision tests held by the IAEA

Plan, idea: As last year Indonesia still have same topic with the target foodstuffs and marine product

(e) Japan

Present situation: 50% of samples were analyzed.

Plan, idea: Halogens abundances in mantle is not well known compared with other elements. From

estimation of halogens abundances in mantle, we can discuss about the formation of Earth mantle and origin of volatiles.

(f) Kazakhstan

Present situation: Reactor with HEU fuel (neutron physical characteristic) , Calculation MCNP

Plan, idea: Comparison of NAA with chemical analysis For plan with concrete for biological protection for Nuclear Power Plant reactor in order to identify activation hazardous elements using a INAA method

(g) Malaysia

Present situation: Environmental samples (soil) were collected from industrial areas and analysed using NAA technique

Plan, idea: Soil and vegetable samples were planned to be collected and analysed using NAA and ICP-MS techniques to identify the elemental pollution and also to study the element uptake.

(h) Mongolia

Present situation: Some of results are inaccurate.

Plan, idea: To improve methods and techniques.

(i) Philippines

Present situation: Environmental samples and food products were analyzed for arsenic and REE contents and Haram ingredients, respectively, using NAA techniques. Through this, PNRI will be able to develop, optimize and evaluate various analytical techniques.

Plan, idea: For environmental samples, comparison of results will be conducted with availability of EDXRF, result will be further correlated with Ra-222 and arsenator test kits. For food products (organic/inorganic produce), IRMS data will be completed for further correlation with the results obtained from NAA.

(j) Thailand

Present situation: Comparison of certified reference materials using NAA and ICP-MS

Plan, idea: Comparison of NAA and ICP-MS/ICP-OES on determination of some elements in PM2.5 emitted from biomass burning, agricultural soil and crop

(k) Vietnam

Present situation: We compared reference samples analyzed using ICP/MS and INAA to quality control the analytical process.

Plan, idea: Using the elemental concentration data obtained from INAA in conjunction with the elemental concentration data from ICP/MS can provide insights into soil and plant environmental contamination levels through multivariate statistical analysis (PCA).