Sampling Method for Wet Deposition Monitoring

by

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Prepared for the Third Country Training Program on “Acid Deposition Monitoring and Assessment”

February 18, 2004
Environmental Research and Training Centre

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The overall view of Acid Deposition

Principal relationships
1. Emission - Deposition
2. Deposition - Soil/water quality
3. Water quality - Aquatic biology
Emissions

$SO_2$, $NO_x$, $NH_x$, $CO_2$, VOCs

Atmospheric reactions

$O_3$, Dust, oxidation process

Deposition

S and N are the major precursors of acid deposition

Vegetative canopy interaction. Soil response Surface water chemistry Aquatic biological Communities response

Remark:

Understanding acid deposition is a serious challenge, since pathways through the environment are complex and many disciplines are involved.

E.g., some knowledge of industrial process, of atmospheric physics and chemistry, climate, soil science, hydrology, land use and management, and terrestrial and aquatic ecology is called for.

Some important remarks:

1. Nature changes slowly and provides many compensatory checks and balances.

2. Scientific programs to observe any change may have to match its timescale.

   - Field experiment and modeling suggest that the recovery of surface water to circum-neutral conditions will be slow, even a complete ban on S emission will require about a century for a reversal to earlier conditions.

4. Observations are fundamental to the progress of our understanding of atmospheric chemistry, in the estimation of regional emissions of pollutants, in the follow-up of emission reduction policies and in the assessment of regional concentrations and depositions of the pollutants and their associated effects.
What is acid rain?

“Acid rain” is a term relating to the acids and potential acid generator in rain, mists, fog and snow; it contains natural components as well as man-made one and to some degree is almost always acid due to the presence of un-neutralized anions from natural gases. The acidity of solutions is expressed by “pH” unit.

Examples:
- pure water pH = 7.0
- pure water in equilibrium with atmospheric CO2 pH = 5.6
- rain in remote and unpolluted areas pH = 5.0
- rain in industrial regions pH = 4.0

Scale of pH and H⁺ concentration, and usual threshold of observed effects.
Research is needed for many unanswered questions.

The concept of acidification and its consequent effects on a variety of ecosystems has developed from intuitive responses through an extensive series of observations of environmental phenomena, but it is also dependent on supportive and consistent findings from field and laboratory experiment.

Remember!! that any false step in the logical development of the argument must invalidate further steps.

Atmosphere: - the validity and precision of dispersion models for both S and N species in relation to the scale of sensitive target sites.
 - the relative contribution of global, regional and local sources, including natural sources

Deposition: - the significance of seasonal and short-term patterns of deposition to soil and surface water acidification
 - the relative importance of S and N deposition, their sources and transformations.

Soils and Catchments and surface water:
 - short term responses to deposition episodes
 - quantification of nitrification and de-nitrification processes for variety of soil condition
 - Relationship of surface water quality to changes in emissions and depositions

ERTC experiences on acidification study
Study of possible Acidification in Thailand

Co-operative project between
Department of Environmental Quality Promotion,
MOSTE, Thailand

and
IVL Swedish Environmental Research Institute

Duration: 2 years plus (Jan. 01 - Mar. 03)

Budget: SIDA 1,400,000 SEK
        DEQP 3,160,000 Baht

OBJECTIVES

1. To assess possible acidification of precipitation, and soil water in Thailand

2. To estimate the emissions of acidifying substances in Thailand, as a basis for modelling and for further actions of emissions reduction.

3. To point out the main contributing emission sources and source area in and outside Thailand.

4. Knowledge transfer between Sweden and Thailand as regards sampling and analysis of air and precipitation, long-range transport of air pollution and deposition estimates.
Four major research components

1. Monthly monitoring of air pollution and acid deposition at 7 monitoring sites, covering different regions of the country for the period of one year

2. Spatial “mapping” of gaseous SO2 and NO2 concentrations over the country

3. Development of a national emission inventory

4. Modelling of air pollutant transport and deposition

Monitoring activities

Monitoring siting at the 7 sites over Thailand, which are:

- North: 2 sites
- Northeast: 2 sites
- Central: 2 sites
- South: 1 site
Sampling methods

- Dry deposition
- Passive sampler
- Open field
- Bulk precipitation
Sampling methods

“Throughfall”
**Sampling methods**

“Lysimeter”

**Monitoring results**

**Bulk deposition**

**Throughfall deposition**
Geographical variation of SO2 ambient concentrations (µg/m³) in June 2002 (left) and November 2002 (right).

Geographical variation of NO2 ambient concentrations (µg/m³) in June 2002 (left) and November 2002 (right).
Modeling results: SO$_2$

Modelled annually accumulated total deposition of oxidised sulphur (left), the relative contribution from Thailand’s own emissions only (middle), and the relative importance of wet deposition compared to total deposition (right). Calculations are based on the ERTC-2000 emission inventory.

Modeling results: NO$_2$

Modelled annually accumulated total deposition of oxidized nitrogen (left), the relative contribution from Thailand’s own emissions only (middle), and the relative importance of wet deposition compared to total deposition (right). Calculations are based on the ERTC-2000 emission inventory.
• 70-80 % of the anthropogenic total sulfur and oxidized nitrogen deposition in Thailand arises from sources within Thailand itself.

• Considerably shorter turnover time of acidifying substances in the tropical atmosphere than in the mid-latitudes. Turnover time: SO2 (wet period) 1 day, SO2 (dry period) 2 days, NO2 < 1 day throughout the year.

• Acidifying pollutant levels in air and deposition are high in Bangkok and its vicinity (200*200 km²) and lower levels in the remote areas of Thailand.

• For continental areas wet deposition account for typically 60-80% of the total deposition on an annual average.

• Measured and modeled results on air pollutant levels and deposition of acidifying substances agree within a factor of two, which is considered a successful results.

Wet deposition monitoring for EANET
Objectives of EANET

• To create a common understanding of the status of the acid deposition among countries in East Asia.

• To provide useful inputs for preventing or reducing adverse impacts of acid deposition on the environment caused by acid deposition in the region.

• To provide high-quality data and other information on the chemical composition of wet deposition from all parts of East Asia.

Requirements for meeting the objectives

• Site representativeness and spatial resolution
• Data quality
• Accompanying meteorological data
• Air quality data
• Etc…
Selection of monitoring sites

- Site selection is a critical factor of a monitoring
- Avoid influences of local pollution sources
- Representativeness of surrounding areas
- Land use type and topographic feature around the site won’t change for decades
- Free from local meteorological conditions

Classification of monitoring sites

- (Deposition Monitoring) Sites
  - Remote sites
  - Rural sites
  - Urban sites

- Ecological (Survey) sites
  - Basic survey sites
  - Ecosystem analysis sites
Deposition monitoring sites (1)

1. Urban sites: to evaluate the effects on structures and historical monuments as well as levels of air pollution and their trends in urban areas.

2. Rural sites: to evaluate the effects on agriculture, crops, forest and livestock farming. The site should be free from local sources. Minimum distance to emission and contamination sources should be > 20 km and from main roads should be > 500 m.

Deposition monitoring sites (2)

3. Remote sites: To evaluate of long-range transport and deposition of acidic substances. The sites should be free from the influence of industrialized and urbanized areas. The minimum distance from significant emission sources should be > 50 km and from the main roads should be > 500 m.
Ecological survey sites (1)

Basic survey sites

- At the deposition monitoring sites or in their vicinity in order to accumulate basic data on soil and vegetation, and inland aquatic environment.
- At these sites, chemical & physical analysis of soil, complete enumeration of trees, forest decline and so on should be carried out.
- If forest decline or other changes in ecosystems are detected at these sites, more intensive survey should be undertaken.

Ecological survey sites (2)

Ecosystem analysis sites

- For the assessment of acid deposition impacts on the whole ecosystems through application of, e.g., terrestrial ecosystem analysis and/or catchments analysis.
- The location should be selected in areas where terrestrial ecosystems should be surveyed, and environmental capacity for acid deposition should be estimated.
Local monitoring sites

1. An open, flat, grassy area far enough from trees, hills and other obstructions (no obstruction within few meters)
2. Horizontal distance between a large obstruction and a sampler is at least twice the obstruction height or the top of an obstruction as viewed from the sampler should be less than 30°.
3. Electricity supply with stable voltage
4. More than 100m apart from local pollution sources like waste disposal site, incinerator, open storage of agricultural products, and domestic heating

Thailand monitoring plan for EANET

EANET focal point in Thailand: Pollution Control Department

Thailand incorporates 5 monitoring stations to the EANET activities. They cover monitoring areas as follows.

<table>
<thead>
<tr>
<th>Stations</th>
<th>Class</th>
<th>Monitoring items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vachiralongkorn Dam</td>
<td>Remote/ ecological</td>
<td>Wet/dry, soil &amp; veg. Inland aquatic</td>
</tr>
<tr>
<td>Pollution Control Dept.</td>
<td>Urban</td>
<td>Wet/dry</td>
</tr>
<tr>
<td>ERTC</td>
<td>Rural</td>
<td>Wet deposition</td>
</tr>
<tr>
<td>Thailand Met. Dept.</td>
<td>Urban</td>
<td>Wet/dry</td>
</tr>
<tr>
<td>Chiang Mai Univ.</td>
<td>Rural</td>
<td>Wet/dry</td>
</tr>
</tbody>
</table>
Within the framework of the Acid Deposition Monitoring Network in East Asia (EANET),
ERTC has been selected as a representative sampling site to assess the impacts on terrestrial ecosystem with respect to wet deposition in a rural area in Thailand since 1997.

**ERTC Monitoring site**

**Rural area:** 20 km is the minimum distance to large pollution sources, 500 m is the minimum distance to main roads (500 vehicles/day)
Figure 1: ERTC on-site information within 200 m

Figure 2: ERTC on-site information within 10 km
Sampling Methods

Sample collection: wet only samples
Sampler: automatic wet-dry sampler
Sampling period: 24 hours basis, everyday at 9:00 am.
Amount of sample collected: measure with balance
(rain water density = 1.0 g/ml at 20°C)
Meteorological parameters: precipitation amt.
wind speed
wind direction
Sample preservation: refrigerate at 4°C

Sampling protocol:
- site name
- sample identification number
- sample start-end (date, time)
- sample weight/vessel weight/total weight
- standard rain gauge reading
- sample contamination (PM, bird drops, insects, etc.)
- instrument condition
- site conditions
- operator remarks
- Supply requirements
  (transporting vessels, DIW, freezer packs)
- operator’s name or initials
Sampling Method

Routine handling of sample:

- Collection vessel should be capped and the operator should be wearing disposal plastic gloves whenever handling the collection vessel.
- Collection vessel should be cleaned and the conductivity of the rinse water should be < 2 µS/cm.
- Field blank should be evaluated monthly (with 200 ml DDW).

Sampling Method

Routine instrument checking:

- Checking for proper sensor response and heating.
- Checking for satisfactory hood movement (open automatically within 1 minute).
- The collector bucket or funnel with bottle should be chemically inert to major constituents in acid precipitation.
- Cleaning of the collection funnel and standard rain gauge funnel. The maintenance of standard rain gauge is required at least every 6 months.
- The height of the collection bucket or funnel should be 1.0 to 1.5 m from the ground.
- Trouble-shooting manuals should be available at the site.
Sampling Method

Sample shipment:

- The sample should be stored in 100 ml polyethylene bottles in duplicate.
- Samples should be refrigerated at 4°C. Weekly or biweekly shipment if samples collected in daily basis.
- Minimise the shipping time and cool the samples during transport.

Preparation for sampling

- Items for working at the site
  - sample vessel with cap (wet-only and bulk)
  - plastic gloves
  - watch
  - Aluminum foil
  - cylinder for standard rain gauge
  - a pen
  - sample protocol
  - one bottle of DIW
  - field blank bottles

- Items for working at the laboratory
  - sample bottles (ca. 250 ml)
  - plastic gloves
  - labels
  - balance
  - Filtering set
  - Aluminum foil and white tissue
  - necessary glassware
Flow Chart of Sampling

In lab
- Prepare and measure weight of sampling vessels (gr)

On site
- Samples collection
- Measurement of precipitation amount with standard rain gauge (mm)

In lab
- Measure amount of wet deposition sample (gr)
- Divided the sample into two parts;
  - part-1 use for EC, pH analysis
  - part-2 use for chemical analysis
- Filter the sample that reserve for part-2
- Store the samples at 4°C

Thank you for your kind attention