



NETWORK FOR INDUSTRIAL
ENVIRONMENTAL MANAGEMENT (NIEM)

PHASE I FINAL REPORT

EXECUTIVE SUMMARY

APRIL 1989

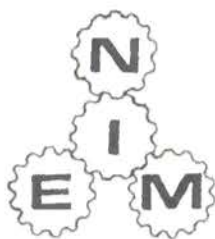


SWEDISH
INTERNATIONAL
DEVELOPMENT
AUTHORITY



UNITED NATIONS
ENVIRONMENT PROGRAMME
REGIONAL OFFICE FOR
ASIA AND THE PACIFIC

BANGKOK, THAILAND



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The Report consists of three volumes. The Volume 1 is the "Main Report" which provides conclusions and recommendations about the NIEM Phase I programme as a whole. The Volume 2 includes the first six Annexes to the Report which are the "Manuals and Guidelines" produced during Phase I. The Volume 3 contains the Annexes 7-12 of the Report which include the six reports on the field studies carried out during Phase I. Additionally, a brief "Executive Summary" for the Phase I Report was also produced.

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EXECUTIVE SUMMARY

1. Introduction

A Network for Industrial Environmental Management (NIEM) was established comprising of research institutions, laboratories, government agencies, and pulp and paper mills located in seven countries of the Asia and the Pacific region (China, India, Indonesia, Malaysia, Philippines, Sri Lanka and Thailand). The network catalyzed the participating institutions of the seven countries in cooperating and coordinating on information exchange regarding environmental management in small pulp and paper mills. It established a procedure for information exchange and collaborative research, which was previously non-existent among these institutions.

During NIEM Phase I, Network members:

- agreed upon protocols for collaboration, coordination mechanisms, report formats, and monitoring procedures to facilitate exchange of information;

- prepared and disseminated a bibliography of publications related to environmental control in the pulp and paper industry held by member institutions; and

- began circulating a quarterly newsletter to inform regularly and systematically about Network activities. The newsletter contains articles contributed by Network members regarding their research study and other news related to the pulp and paper industry.

Using this established, information-sharing framework, Network members collaborated in:

- conducting and preparing reports on a series of six related field studies regarding:

- (1) mill discharge characterization;
- (2) evaluation of receiving media; namely, land and water;
- (3) assessment of environmental impacts of small existing pulp and paper mills;
- (4) reuse of pulp and paper mill effluents.

- developing three manuals and three guidelines for use in conducting the field studies and to assist in dissemination of information. The manuals and guides include:

- (1) Manual on Discharge Characterization;
- (2) Manual on Receiving Water Quality Evaluation;
- (3) Guide on Determination of Acute Lethal Toxicity Pulp and Paper Mill Effluent to Freshwater Fish;
- (4) Manual on Receiving Land Quality Evaluation;
- (5) Guide on Preliminary Assessment of Environmental Effects of Existing Small Pulp and Paper Mills;
- (6) Guide on Conducting National Training Workshops.

Finally, twenty-six personnel of Network institutions participated in a training workshop held at the end of Phase I. Phase I activities were reviewed and the plan of activity for Phase II was discussed.

A main achievement resulting from the above activities was the providing of techniques, methods and criteria to ensure that analytical results can be reproduced and compared. The manuals and guides developed during Phase I activity (see Sec. "2. Manuals and Guidelines") recommended harmonized procedures for producing reliable and comparable data. Using these procedures, NIEM members could then obtain basic information from their own studies about mill operation and environmental impacts, while also being able to compare their results with those obtained from the studies of other members. Thus, these harmonized procedures would facilitate technical cooperation amongst member organizations and expand the information-base available to Network members now and in the future.

Focusing on the regional pulp and paper industry, NIEM activities addressed environmental management problems related to this area's particular conditions. These include small average mill size, common use of various non-wood raw materials and processes, and aspects of the local tropical environment. Phase I research produced information pertinent to these regional conditions that, combined with members' existing expertise, helped to develop specific research methods and guidelines appropriate for analyzing environmental impact of pulp and paper mills in the region.

The research on discharge characterization helped develop knowledge of appropriate:

- pollution parameters to be examined in assessing environmental impact of non-wood pulping processes; and
- methods of flow rate measurement and sampling methods in small existing mills.

Conducting land and water quality evaluation research, NIEM members gained experience in, and developed guidelines for:

- monitoring the effects of mill wastewater irrigation on local crops;
- establishing priorities for investigated pollution parameters;
- monitoring local river waters, especially flow dispersion effects; and
- assessing wastewater salinity and its impact on local soils.

In addition, a standard freshwater fish toxicity test was modified for regional use in assessing the biological effects of mill effluents.

Finally, in attempting to develop a guide on preliminary assessment of environmental effects of the region's existing small mills, Phase I research produced a simple method for calculating effluent parameters when only the raw materials and processes used in a mill are known. This methodology will be further tested during Phase II studies.

Much of the information used to develop these above mentioned methodologies was obtained through the six separate Phase I field studies. Additionally, results obtained from these studies, though not yet comprehensive, produced several conclusions (see Sec. "3. Field Studies") about the specific nature of the regional mill effluents and their environmental effects. These conclusions give direction to member countries in organizing future pollutant monitoring and control programmes.

NIEM members recognize the importance of improving environmental management through expanded training and cooperative efforts between mill and government personnel responsible for pollutant monitoring and control measures. The direct participation of industry personnel in Phase I activities proved to be particularly important and fruitful in conducting the field studies and producing the manuals and guidelines. Industry personnel's first-hand knowledge of mill physical plant and process peculiarities combined with government and research institutions' resources proved an effective combination in completing research activities and preparation of manuals and guides.

This multi-institutional Network cooperation also resulted in establishing contacts nationally and regionally that can be built on to facilitate further regional environmental management activities and to strengthen individual Network members' effectiveness. Whether future activities are organized locally or regionally, Network members now have:

- experience in coordinating research with harmonized procedures;
- trained personnel from the regional training workshop with access to other Network members in the region; and
- reference documents from Phase I and personnel familiar with them and their use.

The NIEM Phase I programme was completed over 25 months, from February 1987 to March 1989. The delay in final outputs has been caused primarily by delayed completion of one field study due to technical difficulties during the research. Total cost of Phase I was over US\$355,000, of which, approximately 43 per cent was provided by SIDA and the rest by NIEM cooperating institutions in the seven Asian countries. From preliminary estimates, national counterpart contribution by NIEM cooperating institutions was US\$203,000, of which, US\$105,800 was allocated to the subprojects with the remaining for other indirect expenses.

The financial contribution by SIDA to the Network served two important goals:

- (1) It catalyzed and enabled the mills to cooperate in this network, which are usually financially constrained with the lack of foreign funds to conduct pollution control and environmental management measures on their own; and
- (2) By encouraging their participation in the projects, ensuring the success of the network's final objective, which is better environmental management in those pulp and paper mills.

The success of NIEM Phase I programme can be illustrated by attainment of the expected goals, and shows the viability of cooperative regional efforts in environmental management. Through the enthusiastic participation in research studies and information exchange, as well as, in-kind contributions, financial and technical, by the NIEM members, effective institutional arrangements were set up to complete Phase I activities and the resulting outputs. This established Network coordination, the resulting data base, and the willingness to participate in a Phase II programme provides a good foundation for further NIEM activities and success.

2. Manuals and Guidelines

The Manuals and Guidelines were drafted by Resource persons and comments provided by NIEM members through a cooperative exchange of information, experience and the findings of the field studies. At the training workshop, the comments were consolidated and the draft documents finalized.

2.1. Manual on Discharge Characterization

The primary objective of the manual is to outline the appropriate methods for NIEM members to characterize mill effluents before these are discharged to any receiving media. Since the regional pulp and paper industry consists of comparably small mills with limited facilities for process and discharge control, emphasis is placed on simple, low-cost techniques giving acceptable and comparable results to assist mill managers, researchers, and government regulatory personnel in their day-to-day work. The general objective of this and the other manuals and guides is to help the NIEM members to harmonize procedures and provide reliable data, thus obtaining better basic information about mill operation and environmental impact from their own and other members' experience.

2.2. Manual on Receiving Water Quality Evaluation

The objective of the manual is to provide guidance to those individuals charged with the complicated task of monitoring the environmental quality of pulp and paper mill receiving waters. This could be an expensive undertaking, if not properly carried out. The procedures given in this manual provide a systematic approach to conducting a receiving water quality monitoring programme for use by NIEM research teams. The approach produces comparable data which can be used:

- to determine the overall quality of the receiving water and its ability to sustain various beneficial uses;
- to plan the extent of pollution control measures to be taken; and
- as part of the environmental impact assessment studies and other research activities.

2.3. Guide on Determination of Acute Lethal Toxicity of Pulp and Paper Mill Effluent to Freshwater Fish

Toxicity determination is aimed to compliment the physical and chemical characterization of the effluents by providing a biological test having relevance for a first assessment of the biological effects caused by the discharge. The guide provides a standard test modified for members' use based on evaluations and experience gained by Network members during Phase I. These modifications include recommendations to use local indigenous test species, use unpolluted parts of the receiving body as dilution water, and aerate the test solution throughout the test period.

2.4. Manual on Receiving Land Quality Evaluation

This manual addresses the assessment of soil quality of lands irrigated with industrial wastewaters, particularly pulp and paper mill wastewaters. Its objective is to provide concise information and guidance to environmental scientists and engineers engaged in monitoring the impacts of wastewater application on land. The focus is on assessing and evaluating positive and negative impacts on soils. The manual details harmonized methods for sampling and analyzing soils and discusses interpretation of results and suggested remedial action.

2.5. Guide on Preliminary Assessment of Environmental Effects of Existing Small Pulp and Paper Mills

This guide was prepared based on experience and results obtained from Phase I study of discharge characterization and receiving media quality evaluation. Since many regional mills have insufficient resources to conduct a complete discharge characterization programme or receiving media quality study, this guide gives advice on simplified methods for a first, basic assessment of environmental effects of discharges from small existing mills. Further Phase II study data will be needed to compliment the information in this guide and test it further under operating conditions.

2.6. Guide on Conducting National Training Workshops

This guideline outlines brief methods and procedures to be considered for organizing and conducting training workshops at national and regional levels. The workshops will aim to train a large number of regional industry and government personnel to monitor mill process discharges and use this information for process control utilizing the manuals, guidelines and other NIEM outputs.

3. Field Studies

Six field studies were conducted in four different countries during NIEM Phase I. The mills investigated included:

- four mills discharging to freshwater streams;
- one mill discharging to both freshwater and onto land; and
- one mill discharging onto land only.

The six mills use various wood and non-wood raw materials; such as, rice straw, wheat straw, bagasse, grasses and purchased pulp, employ several different chemical and chemo-mechanical processing methods for pulping, and have various levels of wastewater and chemical recovery capacity. The exact research methods used and scope of investigation at each mill was different. However, efforts were made to compile the study reports in a standard form, and from these studies, several common conclusions about the nature of the mills' environmental effects were drawn, including:

- Pulping units using non-wood raw materials are the highest process contributor to pollution loads in most mills, especially in contribution to suspended solids, COD, and colour.

- Paper machines are the lowest pollution load contributor except regarding suspended solids when certain papers are being produced such as newsprint. However, paper machines consume the highest amount of water.

- The most significant pollution parameters observed were pH, color, COD, BOD, suspended solids and conductivity.

- By the use of efficient recycling practices, wastewater volume generation can be reduced considerably to 70-80 m³/t, compared to mills not using recycling schemes generating in the range of 470 - 600 m³/t.

- Though some mills discharge very high organic loadings, few significant effects on river water quality were reported that could be easily differentiated from the effects of other river pollutants in the affected areas. This is largely due to high dilution ratios, as all those mills discharging to freshwater discharge their effluent to relatively large, flowing rivers. However, it was observed that flow variations, particularly regarding dispersal and aeration, in the rivers could make the mill pollutant loads significant under certain circumstances.

- Continuous land application of pulp and paper mill wastewater was found to increase the soluble salt content in soils, especially in heavy clay soils but less so in coarse and medium texture soils. This increase of salt adversely affects sensitive crops. Where salt accumulation is not a problem, rice crops were observed to benefit from the organics in the wastewater and produce slightly higher yields.

- Crops grown on soils irrigated with mill wastewater showed no accumulation of toxic heavy metals harmful to human beings or animals.

- Land application of pulp and paper mill wastewater was observed to increase groundwater pollution particularly by the increased salinity of the water.

- Freshwater fish showed toxicity to the mill effluents at high concentrations and was attributed by some to the resins, chloro-organic compounds and high alkali from pulping and bleaching processes.

4. NIEM Training Workshop

As a final activity of NIEM Phase I, the first NIEM Training Workshop was conducted in Bangkok, Thailand during 27 June to 1 July 1988. A total of 26 mill personnel, representatives from the 7 NIEM countries and resource persons attended the workshop. The central purpose of the Workshop was to exchange information through informal discussion and presentations of the field studies of Phase I, discuss the applicability of the manuals and guidelines, assess the progress of the Network, and plan for Phase II of the NIEM programme.

Valuable information and experiences were exchanged among the participants on field studies, and constructive comments and recommendations were received from participants regarding modifications and improvements of manuals and guidelines.

This workshop provided a unique forum for the regional mill personnel to exchange ideas and obtain a better understanding of each other's views and experiences.

5. Recommendations

The Phase I study of the pulp and paper mills in NIEM countries has revealed the major problems encountered by mills in improving environmental management. Keeping in mind that most mills in developing countries have small production capabilities, use non-wood raw materials, and are not equipped with chemical recovery systems, much work remains to be done in promoting better environmental management in the mills. The following measures are recommended for future study and implementation.

- To improve environmental management, there should be more training of personnel at national and regional workshops using particularly the information and experiences gained in the field studies. In its future activities, the network's training component has to be strengthened in different areas and targets in order to facilitate the effective and more productive dissemination of information at national and regional levels.

- As data available from the Phase I studies is limited to only some raw materials and processes, further data should be collected on discharge characterization for the mills using raw materials and processing methods other than those investigated in Phase I.

- Studies have to be carried out to relate process data to pollution parameters in order to prepare a manual to be used by government agencies and mill personnel to improve house-keeping measures.

- Study on feasible methodologies for chemical recovery in small mills, including use of spent liquors for various environmentally sound applications outside the mills.

- Further study is needed regarding the reuse of mill wastes, particularly raw effluents and treated wastewater in agriculture. Emphasis will be on protection of soils from excessive salt accumulation, groundwater contamination and effects on crops.

- Study to assess how mill pollution affects, changes and threatens tropical aquatic ecosystems, by conducting in-depth study on ecological impacts on receiving waters. Based on this study a manual on assessment of ecological impacts of pulp and paper mill effluents should be prepared to guide qualified scientists in modern methodologies to be used in conducting a comprehensive ecological assessment of the impacts mills have on tropical waters.

- Methodologies for color removal in pulp and paper mill effluents need to be assessed with particular emphasis on cost efficiencies.

These recommendations are now included in the Phase II activities.

6. Conclusion

The NIEM Phase I programme was successful in establishing the Network as a viable mechanism of cooperation in regional efforts to improve environmental management in the pulp and paper industry. The Network members successfully established a procedure for information-sharing through agreement on protocols for collaboration and coordination mechanisms, disseminating a bibliography of publications related to the industry, and circulating a quarterly newsletter. This procedure was used as a foundation for collaboration in conducting and preparing reports on six field studies, as well as, developing six manuals and guidelines regarding discharge characterization, receiving media quality evaluation, assessment of environmental impacts of the mills, and reuse of mill effluents. These programme activities achieved several goals; including, establishing harmonized procedures for conducting field studies, developing appropriate methodologies to deal with particular regional mill conditions, the training of a number of regional personnel in the use of the developed procedures and methodologies, and encouraging and facilitating collaborative activities.