# CHAPTER 2
# LITERATURE REVIEW

## 2.1 DEVELOPMENT OF THE DECISION SUPPORT SYSTEM FOR INTEGRATED POLLUTION CONTROL (DSS/IPC) SYSTEM

The industrial sector in East Asia grew at an extremely high rate of 9.1% per year between 1965 and 1990. In 1993, the sector was ten times the size it was in 1965. Industrial growth in South Asia has also been high (5.6% between 1965 and 1990), and the sector has quadrupled in size in 1993. There has been a region-wide structural shift towards increased industrialization. For example, Malaysia specifically has increased its share of total industrial output from 13% Gross Domestic Product (GDP) in 1970 to 27% in 1990. It has further grown to 32.1% in 1995. This structural shift is expected to continue into the future.

An expanding industrial sector affects the pollution load in two basic ways. The first is to increase the total volume of pollutants in the short and medium terms. (Note: In the long term, total pollutants may decline if dramatic shifts into cleaner industries take place, or if the share of the industrial sector itself falls. Neither is imminent.) The second is to change the pollution intensity of industrial output, defined as the amount of pollution generated per unit of output. In Asia, both the growth and the intensity effects are leading towards heavier pollution loads in the short and medium terms.

On the other hand, the Policy Research Department, Environment, Infrastructure, and Agriculture Division (PRDEI) of the World Bank has extensive research programmes on industrial pollution involving the closely related areas. The first focuses on measuring and predicting the costs and benefits of pollution control efforts in the developing countries. The second involves assessing alternative pollution control strategies. Both bodies of work enable the division to help the Bank and the borrowing countries to formulate and implement more effective pollution reduction strategies.

The World Bank provides technical assistance and works with new environmental protection institutions to stress on cost-effective regulations and implementations of market-based pollution control instruments wherever feasible. It is often difficult to identify the most cost effective way to reduce pollution, since basic data on industrial emissions and abatement costs is inadequate, causing a constraint in fully understanding the extent and the costs of the industrial pollution problem. Therefore, appropriate estimation methods will have to be employed as complements to direct measurements of environmental parameters at the industrial sector level.

In 1994, PRDEI developed an industrial pollution projection/estimation system to initiate the total industrial pollution load assessment. The aim is to assist the governments to identify the major pollution problems facing their countries, the sources of this pollution, and the costs of pollution reduction in specific industries. Built around a comprehensive set of emission and abatement cost parameters, the system is designed for rapid assessment of pollution problems and control options in developing economies. Given data on the manufacturing output, the system predicts the emissions of various pollutants and the costs of pollution control for each type of industry.

In 1998, another modeling tool, the World Bank Environment Department's *Decision Support System for Integrated Pollution Control* (DSS/IPC), was developed to model the industrial pollution loads by media, concentration and geography. It has been developed as an advanced analytical tool to rapidly assess the pollution situation and to support decisions in pollution management.

These industrial pollution projection models are developed based on a massive U. S. database developed by PRDEI, in collaboration with the Center for Economic Studies of the U. S. Census Bureau and the U. S. Environmental Protection Agency (EPA). This database was created by merging manufacturing census data with EPA data on air, water, and solid waste emissions. Three major EPA databases were used in developing these estimation models; i.e., the Toxic Chemical Release Inventory (TRI); the Facility Subsystem of the Aerometric Information Retrieval System (AIRS) and the permit Compliance System of the National Pollutant Discharge

Elimination System (NPDES). In addition, the Human Health and Ecotoxicity Database (HHED) was employed to provide common units for the chemicals reported in the Toxic Chemical Release Inventory. For industrial activity data, the data was drawn from the Longitudinal Research Database (LRD), which is an establishment-level database, constructed from information contained in the U. S. Census of Manufacturers (CM). It draws on environmental, economic, and geographic information from about 200,000 U. S. factories. These industrial pollution projection models cover about 1,500 product categories, all operating technologies, and hundreds of pollutants. They can project air, water, or solid waste emissions, and they incorporate a range of risk factors for human toxins and ecotoxic effects.

## 2.2 APPLICATIONS OF THE DSS/IPC SYSTEM

The DSS/IPC system makes transparent key issues and cause-effect links in pollution management. It demonstrates the comparative effect on pollution load and ambient quality of a number of factors that can be affected by sectoral and environmental policies. These factors include: the scale, composition and density of economic activities in a specific area; geographical location of industrial estates, given spatial variations in absorptive capacities of media; the levels of adopted controls and low-cost waste prevention and good housekeeping programmes.

The system can be used in a variety of research or project preparation and analysis activities. The DSS/IPC database and manual, incorporated into the software, provide information on toxic pollutants, emissions factors, dispersion models, technological processes, control options, and cost units and formulas that can be independently applied in other models or studies, or serve as a reference.

Generally, the analysis of pollution control strategies and policies in DSS/IPC is aimed at large industries and power plants, where control technologies can be installed at reasonable cost. The system allows to estimate emission reductions and corresponding improvements in ambient quality that can be achieved through alternative levels of controlling these sources, and propose a cost-effective allocation of control options across industries for each pre-specified level of improvement in ambient quality within a feasible range. Further, the user can compare associated abatement costs with the estimated benefits of lowering ambient concentrations for pollutants with recognized health effects and well-established dose-response functions.

Furthermore, the DSS/IPC system can be used as a tool for analysing pollution control policies, such as setting environmental standards or applying economic instruments to estimate costs of attaining proposed emission and/or ambient standards in an area; to estimate the impact on ambient quality of proposed emission/technological standards; based on ambient standards, allocate emission limits across pollution sources in the area in a cost-effective way; and using long-run marginal cost schedules, estimate an incentive level of an emission charge rate for a certain environmental target, adopted in the area/watershed.

## 2.3 EXAMPLES OF APPLICATION OF THE DSS/IPC SYSTEM

Total industrial pollution load assessment using the industrial pollution projection system has already been applied in several World Bank analysis, most notably in two comprehensive World Bank publications: Carter Brandon and Ramesh Ramankutty, *Toward an Environment Strategy for Asia* (1993); and Richard Calkins, et. al., *Indonesia: Environment and Development* (1994); which explored the pattern and the growth of Asian pollution problems. Inside the Bank, sector reports for Mexico, China and several Middle Eastern countries have also used pollution projection-based estimates. Benoit Laplante and Karlis Smits, *Estimating Industrial Pollution in Latvia* (1998) adopted pollution estimation modeling to help identify priorities for pollution monitoring and control. Industrial pollution projection system has been utilized to produce the first comprehensive cross-country estimates of toxic pollution in *World Resources 1994-95: A Guide to the Global Environment, People and the Environment* published by the World Resources Institute. Work on trade and the environment by the Organization for Economic Co-operation and Development (OECD) has also been based on pollution projection modeling, most notably the paper by Hettige, Lucas and Wheeler, *The Toxic Intensity of Industrial Production:*

*Global Patterns, Trends and Trade Policy* (1992); which used estimated pollution load to study the relationships 1) between toxic pollution and economic development, 2) between OECD environmental regulation and global changes in toxic intensity, and 3) between trade policy and toxic intensity.

In addition to information on pollution abatement costs, governments also need information on the pollution abatement benefits, in order to decide whether to put scarce resources into pollution reduction or other pressing needs. As a first step in assessing the health benefits of pollution control in developing countries, PREDI is currently estimating the mortality benefits of reducing particulate matter in India using industrial pollution estimation. The project involves estimating a dose-response function that relates daily mortality to air pollution in Delhi and then valuing the mortality changes using compensating wage data from the Indian manufacturing industry.

PRDEI researchers are also examining alternative pollution control strategies using industrial pollution projection system in several collaborative studies with national and state-level pollution control agencies in five developing countries. Areas of research include the design, implementation and impact of pollution control costs (in co-operation with agencies in the Philippines and China); public disclosure of environmental performance ratings (Indonesia, Mexico and the Philippines); financing pollution abatement (Brazil); i.e., in the recent World Bank report *Brazil: Managing Environmental Pollution in the State of Rio de Janeiro*; efficient allocation of monitoring and inspection resources (Brazil, China); and community participation in environmental regulation (Brazil, China and Indonesia).

The DSS/IPC specifically has been used in project preparation and economic sector work, undertaken by World Bank in Algeria, Brazil (State of Rio de Janeiro), Mexico, Morocco, Sri Lanka, Syria, and Saudi Arabia. The DSS/IPC was applied to analyse air pollution sources and possible control measures in the Rio de Janeiro Metropolitan Area (RJMA). In Sri Lanka, the DSS/IPC was further applied to analyse water pollution control options in the Kelani river basin as part of U. S. sponsored technical assistance project. The DSS/IPC database and selected computation modules were also employed in environmental studies for China and the East Asian region.

Since these industrial pollution projection models are not directly based on Asian pollution data, it is not known if they may not be valid. Their accuracy depends on how closely Asian technologies mirror U. S. technologies in 1988. Also, since it is arguable that industries are less regulated in Asia than in the U. S., pollution loads may be higher in Asia. A possible bias in the opposite direction is that Asian technology is, on average, younger than in the U. S., and therefore inherently cleaner. It is not possible to reconcile these and other factors at the present and therefore, these estimates are meant to be indicative only.

Malaysia's application of such industrial pollution projection systems to accomplish total pollution load assessment is currently unknown since no related publications and papers has been encountered during the literature research. Generally in Malaysia, environmental quality data has been complied from *in-situ* measurement of air, river water, coastal and marine water under DOE's monitoring programmes in order to determine the change in quality vis-a-vis the increase or decrease in pollution loads introduced into the environment. Many efforts to appraise environmental conditions and standards in the DOE rely upon these actual measured data, rather than engineering estimates and effluent data obtained from other countries. These data on the state of the environment is used to assess the effectiveness of short and long term environmental pollution control programmes and to identify the direction of future research activities to be carried out for the purpose of strengthening the existing programmes or formulating new environmental management programmes.