New Developments in Water Quality and IWRPM

by
Marilyn Crichlow BSc., MPhil.

Introduction

New developments in the context of water quality management, like other dynamic topics, capture a particular point in time. Having addressed water demand and water quality management, this lecture highlights a few important developments, which address some of the problems and issues of concern.

The past thirty (30) to forty (40) years has been a period when emphasis was placed on the development of available water resources all over the world. Despite the benefits, the environmental, social and cultural impacts have had a mixture of desirable and undesirable effects. These considerations must therefore be integrated into the development process so as to make water resource use sustainable.

As a consequence, Environmental Impact Assessments (EIAs) of water projects and other development projects, identified as having negative impacts, have been made mandatory to address the problem areas within integrated water resources management.

Addressing some problem areas include

a) handling the environmental, social, and cultural impacts of water resources projects by
   - incorporating studies of such impacts (consequences) for alleviating adverse effects at the initial stages of project planning rather than considering them only after decisions have been made.

b) Integrating watershed land management and water resource development of all sources in order to deal effectively with land water linkages such as erosion, sedimentation, pollution, flooding and water yield in the river basins.

c) Allocating water rationally among competing uses in the context of efficiency, equity, sustainability and other objectives.

d) Attaining effective implementation of project plans through
   - use of economic and other incentives
   - decentralization of project management

- involvement of local people in planning and implementation
- making necessary changes in institutions including policy and laws.

Environmental Impact Assessment (EIA)

Environmental Impact Assessment is an integrated approach to the planning process devoted to the identification, quantification and qualification of environmental impacts due to the development of a plan or a project as well as the definition of policies and strategies required to monitor and control such impacts.

The main purposes of an EIA are to

- identify and forecast the possible positive and negative impacts to the environment resulting from a proposed project
- provide a plan which on implementation will reduce or mitigate the negative impacts of a project resulting in acceptable environmental charges
- measure the level of plan implementation and the degree of effectiveness of the environmental protection measures.

EIA Steps

Environmental Impact Assessment is a process comprising a series of steps, which should be integrated with project development phases and allows a timely public participation.

The main phases of the EIA process are Screening, Scoping, Prediction and Preparation of the Environmental Impact Statement (EIS).

Screening determines whether further environmental studies and investigations related to the plan or project are required or not and what regulatory requirements are to be satisfied for approval. The screening process classifies the project according to its environmental sensitivity.

Scoping identifies the key environmental issues of the project, typically during general planning and prefeasibility studies. An important result of scoping is the establishment of the terms of reference for further EIA action.

Prediction and Mitigation is the main part of EIA and has the following objectives

- forecast of environmental impacts due to the project on the basis of available data and prediction methods and models. Forecasts are usually carried out for several project alternatives and degrees of mitigation.
  It must be noted that environmental impacts are measured as the difference between the scenarios with and without the projects.

- Conception and detail of measures for the mitigation of environmental impacts, including preventive, corrective and compensatory mitigation; measures for environmental enhancement; their cost, schedule and responsibilities.

Management and Monitoring in the EIA results in the Environmental Management Plan, which provides the implementation of mitigation measures in the short and long terms including the institutional requirements for this implementation.
Environmental management is usually needed during the lifetime of the project and is concerned with who is responsible for the various aspects of the project.

Auditing is the last phase of the EIA and is focused on the evaluation of the adequacy of the process as applied to a specific project.

The Environmental Impact Statement (EIS) is the resulting report from the EIA process. Its purpose is to present the consequences of different choices of action and to make recommendations for decision-making.

<u>**Cleaner Production**</u>

The exponential increase in population in the world and the accompanying environmental impacts due to the very existence of life, socio-economic development and industrialisation have given rise to the many problems we face.

Problems like inefficient use of natural resources and raw material in industrial activities and increased waste production per capita have created greater environmental pollution. A few problems industrial activities have contributed to are global warming, waste production and acid rain. Cleaner production addresses industrial inefficiency and therefore assists in reducing global environmental problems and its impact.

EXAMPLE INDUSTRIAL IMPACT: INDUSTRY & WASTE:

- by producing environment unfriendly products such as dyes, synthetic fibers, paints and plastics,
- by producing sludge containing heavy metals, by concentrating on cures and treatments for waste ("end of pipe") rather than preventing its creation,
- by not investigating methods for recycling and re-use of waste, such as paper and metals, by
- by failing to investigate waste-exchange schemes

Eco-Management Guide, 1998

What is Cleaner Production?

It is the practical application of knowledge, methods and means, so as to provide the most rational use of natural resources and energy, and to protect the environmental (First UN seminar organized by the ECE, 1976)

The cleaner production approach reduces or even prevents the generation of waste before it is produced. It focuses on prevention of waste production and reusability of materials whereas the conventional approach or ‘end of pipe’ approach towards environmental protection over the years dealt with cleaning up the waste after it has been generated.

Experiences of companies, which have adopted cleaner production, reveal enhanced industrial economic efficiency resulting from improved raw material usage and improved environmental efficiency from reduced waste material production. Both aspects have led to an improved financial position.

Example: 3M CORPORATION’S
WORLD-WIDE POLLUTION
PREVENTION PAYS (PPP)
Program, 1975 – 1990.

Material savings in 15 years:

- 126,000 tons of air pollutants
- 16,600 tons of sludge
- 6,600m^3 of wastewater
- 409,000 tons of solid/hazardous waste
- 210,000 barrels of oil annually

Financial savings in the same period: US$506,000,000

Eco-efficiency

In terms of Cleaner Production, improved industrial management implies eco-efficiency. Previously improved industrial management meant increased economic efficiency where economic efficiency is defined as

$$\eta = \frac{\text{Products generated}}{\text{Raw materials converted into products + product waste}}$$

According to this conventional approach increased efficiency means increasing the volume of product generated for the same raw material consumption. This is represented as

$$\eta = \frac{\text{Products + more products generated}}{\text{Raw materials converted into products + product waste}}$$

With Eco efficiency means reducing the volume of product waste generated in the production process and at the same time increasing the volume of product generated. This approach has the advantage that less raw materials are used for the generation of the same product volume plus the waste that is not produced, does not have to be dealt with through some form of treatment and/or disposal. In fact, the material that would have been used in the waste generation can be used for the generation of products. This eco efficiency is represented as

$$\eta = \frac{\text{Products + more products generated}}{\text{Raw materials converted into products + }\textbf{reduced}\text{ product waste}}$$

Monitoring

An integral part of any industry's management plan and a prerequisite for improving industrial efficiency, whether related to environmental or economic efficiency, is adequate industrial monitoring. Industrial leaders are usually insufficiently familiar with the process – technological detail of production processes therefore improving industrial efficient could be a difficult task. In monitoring, information on aspects such as composition and flow of raw materials input, energy input, composition and flow of product output, output of waste materials and heat release are obtained. Monitoring includes both technical details and non-technical aspects such as health and safety conditions and labour conditions.

The potential for efficiency improvement can only be defined and improvements made when there is sufficient knowledge into the technological process details and efficiency data.

Application of Cleaner Production.

Cleaner production as already mentioned is the approach to reducing environmental impact from human activities through a better use of resource, methods, technologies and management of processes and activities. Cleaner production is applicable to products from conception to disposal of a product and to services.

Cleaner production can be achieved through various methods such as

- Demand management
- Materials Choice (e.g. oil based lubricants vs. water based lubricants/paints)
- Least environmental impact design (e.g. refrigerators not based on PCB's as coolant)
- Least impact utilization – this is using products or services such that the impact during usage is as low as possible e.g. using public transport instead of a private car or plane.
- Reutilization i.e. either directly (reuse) or after some type of processing (recycling) or after valuable components are recovered (recovery) e.g. reusing glass bottles, recycling plastic or recovering nutrients from sludge.

For Urban Water Management the control of pollution, through the cleaner production approach, is based on the prevention or reduction of pollution at source before its generation.

The basic principles of cleaner production for urban water services are

- keep separate what is produced separately as combining waste flows generates problems
- use no more resource than is strictly necessary
- do not use water of a better quality than is strictly necessary.
- implement cleaner production approaches at the household level using demand management, water saving equipment, etcetera.
- implement fully cleaner production approaches in industries.
- practice treatment and recycling at the lowest scale possible.

Other New Developments

1. Virtual Water - this is the water needed to produce a product. Hence importing products, where water is a component, is a means of supplementing the water in a country. For example Holland imports Soya from Asia for meat rearing. Meat is exported on a large scale. Indirectly Holland is therefore importing water from Asia- virtual water.

   Examples of water uses,
   To refine 1 ton of petroleum requires 18,000 litres of water
   To produce 1 kg of meat requires 25,000 litres of water
   To grow a hectare of corn requires 3,000,000 litres of water
   To grow a hectare of rice requires 12 to 20 million litres of water.

2. A proposal for sustainable wastewater treatment based on a decentralized sanitation approach with an objective to recover and reuse resources and reduce costs of sewerage and treatment facilities. This strategy is based on the concepts of the application of
   - A holistic view of the relationship between pollution discharge, carrying capacity and present and future uses of the water resource
   - A mix of appropriate technology and management options
   - An ongoing process of water pollution abatement

   The procedure in this strategy is as follows with the conventional high cost option considered as the final alternative
   - Pollution prevention to minimize pollution from both point and diffuse sources
   - On-site treatment and reuse close to production
   - Non-conventional treatment at (off-site) small scale plants using low technology and ecological engineering for the conversion of wastewater into resources
   - The use and/or simulation of the natural self-purification capacity of receiving water bodies

- Conventional off-site sanitation collection and centralised high–technology end-of-pipe treatment

  (Taken from Prof. Huub Gijzen 2000 – Technical Measures – Water Quality Management Strategy for Sustainable use of Water Resources)

The new development in this area is in the cost-effective application of ecological engineering for sewage treatment example the duckweed based sewage treatment and resource recovery in Bangladesh.

Advantages in the duckweed based wastewater treatment are

- Effective nutrient removal/recovery
- Production of high quality feed
- Low mosquito count
- Reduced water losses via evaporation and transpiration
- Reduced odour problems (high BOD)
- Possible cost recovery via aquaculture or other feed applications.

However, sustainable wastewater management in developing countries is affected by the inadequate technical knowledge of the purpose and capabilities of wastewater management, the lack of appreciation of all the relevant factors in the selection of treatment technology and the existence of inappropriate discharge standards.

3. To increase effective decision making, one of the recent developments in information technology is the ability to capture and codify knowledge and experience into a 'knowledge base'. There are also new predictive capabilities that integrate database and knowledge-base technologies, which bring domain expertise (i.e. knowledge of a field or discipline) to local decision making. The use of knowledge–base technologies is a relatively simple and cost effective means of gathering information for decision making and can be beneficial for developing data–poor countries.

   The knowledge–base (K-B) approach, begins with the premise that most policy choices require the ability to screen for changes in environmental responses and that a mathematical model is not the central issue, and presumes that the processes included in mathematical models can be adequately represented by domain or local knowledge.

The K-B approach combines domain knowledge and local knowledge/expertise with or without some level of mathematical modeling, to produce a scoping ‘tool’ for evaluating options towards decision making. This approach is now being applied in western countries for issues in river basin development options, effluent and toxics management and air quality control.

Specifically the K-B approach begins with assessing what is known about the subject area and, using this information, works with local managers to develop meaningful objectives, from which the investigative process (which may include mathematical modeling) can be chosen and developed into a decision-support (DSS) tool.
This decision support system provides choices that are expressed in degree of uncertainty inherent from the knowledge and assumptions that went into the analysis.

4. Geographic Information Systems is a useful tool to make better decisions faster. A GIS can link spatial data with geographic information for a location and therefore can be used for a variety of operations, maintenance and planning applications in water resources management and for water quality management.

   A GIS is a computer system capable of assembling, storing, manipulating and displaying geographically referenced information. It allows the integration, management and analysis of large volumes of spatially referenced data and corresponding attribute data. The nature of a GIS, in that it allows the analysis of data visually, in terms of patterns, trends and relationship and it incorporates a database management system makes it a powerful tool in water resources management.

   Examples of GIS applications include watershed analysis, integration of multiple land uses into planning, determination of the suitability of various sites for development, evaluation of environmental impact and identification of most suitable location for a facility.

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