

## PERSPECTIVES OF ENVIRONMENTAL IMPACT ASSESSMENT ON MARINE RESOURCES\*

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### ABSTRACT

Environmental impact assessment on marine resources has become an integral part of planning for the exploitation, development and management of the marine resources. The nature of impact assessment vary according to the conceptual and institutional frameworks and their operation. These involve the scientific and social dimensions, as it is necessary, with the development of modern technology, to provide a measure of the potential changes in environmental and social conditions resulting from the development decisions. Different and diverging needs should be equitably incorporated in the decision-making processes, although the integration of social and biophysical aspects of planning poses problems. This paper presents different perspectives of environmental assessment to provide the basis of linking natural systems, social values and developmental initiatives in an integrated planning process for marine resources.

### INTRODUCTION

THE 224,000 KILOMETRES of Coastline of Canada is the longest in the world with the largest economic zone, extending 320 kilometres from the coast and covers nearly 4.7 million km<sup>2</sup> of ocean area. The Pacific Coast of Canada has a 50 km wide and a complex shoreline of rugged mountains, inlets, fjords and islands. The Atlantic Coast has a 200 km continental shelf which includes the Grand Banks. These waters have major current systems and upwellings and number of estuaries which support large populations of marine life. The Arctic Coast and marine environment contains many unique highly productive polynyas, which are ice-free areas caused by rapid tidal currents. The major stresses on marine ecosystems are overfishing, dams and water diversions and draining of coastal wetlands and pollution.

Sewage discharges have closed shell fisheries on the Pacific and Atlantic Coasts. Both these coasts also suffer from oil pollution.

With a total market value of over one billion dollars, the Canadian Fishing Industry is big and also a significant source of recreation and food. A comprehensive fisheries management includes conservation of existing fish habitats and also their restoration and development. The fish habitats have many areas including the spawning grounds and nursery, rearing, food supply and migration areas on which fish depend for their life processes. Removal of sand or gravel from beaches, industrial and municipal waste discharges, dredging for deep-sea port construction, dredging or filling of tidal flats or marshland, seabed mining, introduction of contaminants like silt and other pollutants, land clearing to provide agricultural or urban development, construction of dams, dykes, cause ways, wharves, marinas, reservoirs, pipelines, electric power installations and transmission lines,

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logging and log storage, and other similar operations are associated with the common threats to fish habitats.

Marine environments though seemingly vast, their resources are easily depleted or devalued in the absence of good management. Those regions around Canada are no exception. Our marine resources are being threatened by over fishing, major energy projects and pollution. However, some of the major fish stocks are responding to management strategies while simultaneous reductions in pollution sources are achieved. The effects of estuarine water quality and coastal waters on the fish larvae and other plant and animal life are also being constantly exposed to the activities of resource exploitation. We have now arrived at a stage when the status of oceans and shore-lines require considerable thought and consideration from the point of view of the impact of the environment, particularly in relation to the exploitation of renewable and non-renewable resources.

The Federal Environmental Assessment and Review Process of the Canadian Government demands the environmental matters to be taken into account throughout the planning and implementation of projects, programmes and activities. Such initiatives are directly undertaken by the Federal Government for which the financial commitment is given and administered by itself and also the activities that may have an environmental effect on the matter of federal responsibility, such as national marine parks or international commitments. At a preliminary stage of assessment, the potential of environmental effects of the proposal if it was found that there is indication that the proposal will have or likely to have the significant effect on the environment and adequate mitigating measures are not readily identifiable then the proposal must be referred, by a Government Agency, to the Minister of the Environment, for a review by an independent Environmental Assessment Panel, the members

of which are appointed by that Minister. This Panel, by practice, will have a majority of non-governmental members and all the members will have to declare that they have no conflict of interest with their role as a panel member and that they will not place themselves in a conflict of interest situation while serving as a panel member. The Federal Environmental Assessment Review Office (FEARO) appoints an Executive Secretary and provides the necessary administration support to the panel (Minister of Supply and Services Canada, 1985).

While the Canadian Government seriously considers the issues of environment as very important, they also at the same time recognise the importance of the role of research and the philosophy and themes for research under the varying situations for which purpose the Canadian Environmental Assessment Research Council (CEARC) was created in 1986 as a body to advise always to improve the scientific technique and procedural basis for environmental impact assessment. This is primarily to provide focus for research on topics and to stimulate interest and support to other research funding agencies. The perspective of environmental impact assessment of marine resources has become an integral part of planning for the exploitation, development and management. The nature of the impact assessment varies according to the conceptual and institutional frameworks and their operation. This will naturally underline the scientific and social dimensions along with the development of marine technique provided the measure of potential changes in environmental and social conditions resulting from the development tests. This also involves the incorporation of equitability in the decision-making process, although the integration to social and biophysical aspects of planning often poses problems. This paper presents different environmental assessment perspectives to provide the basis for linking natural systems, social values

and developmental initiatives for marine resources exploitation and management.

#### ENVIRONMENTAL IMPACT ASSESSMENT

This is a comprehensive analysis and assessment of the ecological characteristic of the receiving environment, the direct and indirect potential affects and/or impacts of the activity on the environment, and as far as possible covers any reasonable alternative to the activity. Normally the strategy of coastal zone management also falls under the marine resource development and exploitation.

Change is a constant and concurrent property of nature and one should try to concentrate on directing the change of nature rather on preventing it. In order to direct the change of nature one should have a better understanding of the nature itself. The aims of environmental impact assessment for the management goals involve implicitly multi-disciplined groups of several persons working in various fields like biology, physics, chemistry, toxicology, pollution control, etc. The aims of such groups are to supply necessary knowledge to meet the needs of marine resource management and to contribute to the progress of scientific and technical knowledge in the field of marine environmental research. The inventory of potential environmental impact sites vary according to the need, either conceptual or institutional; of operation. So also, there is variation in dependent technology and information. For example, preparation of the inventory of potential aquacultural sites; marine parks and natural resources; harbour construction; domestic and industrial influence; nuclear power plants, etc., require short pre-project studies — a two-year intensive project study and followed by ecological monitoring of the site before and after opening of the plants or sites for several years.

A case study on environmental consequences of water resources mis-management was repor-

ted by Balchand (1983) wherein it was stated that the environmental modifications to control flood water and to regulate salt water entry to increase the rice production in Kuttanad resulted in adverse ecological imbalance. The impacts on this ecosystem actually reduced the rice production due to less natural flushing action of the floods, enhanced weed production, accumulation of pesticides and pollutants and persistent acidity in the soil in the absence of saline water. This also reduced the natural prawn culture activities.

In the Indian Ocean another good example for the need of Environmental Impact Assessment and Management Study is the oceanic tuna fisheries. This is a study of migratory species and consequently one has to take into consideration the rivalries between neighbouring states and activities of non-Indian states.

#### RESEARCH STRATEGIES AND PUBLIC PARTICIPATION

Ecological perspective forms the nucleus for the development of interrelationships between social, community and institutional policy and decision-making frameworks. These interrelationships, with a proper understanding of the environmental and social consequences of development, will help towards improving and integrating our ability to forecast and manage the effects of development to meet the stated social goals. In general, the research themes and principles embrace new approaches, will help in improving the scientific methods and rigour of the application of the ecological and social assignments to impact analysis, and guide for the improvement of the effectiveness of the procedures for clarifying and incorporating social values in impact evaluation. As a consequence the identified alternatives help in strengthening the policy and developing proper institutional frameworks for linking the above new approaches. The social frameworks will involve the public and their role

would benefit the concerned citizens. The active public participation generally exposes planners to value systems other than their own, assures that a criteria which develop in a public forum, identifies political expediencies and raises them for consideration in a public planning process. This can also apply political pressure at the local level to resolve problems and implement programmes, keeps single use interest from controlling major decisions of planning and policy development and finally makes the government accountable to people. Thus, the public involvement aids in the planning and coordination and provides substantive input into planning process. In the final analysis, this also includes the expertise of scientists, planners, elected officials, industrialists and media.

OEARC (1986) has identified several methods and strategies for achieving their objectives which include the importance of the education base, building current knowledge, development and promotion of new ideas, spreading the word and networking. They have also identified the areas of research interest such as prediction in monitoring, risk analysis and management of uncertainty, environmental impact assessment, management and decision-making, improvements in administrative procedures, mitigation of compensation and post-project evaluation.

OEARC (1986) further prioritised their selection of research projects basing on the following criteria: a. Address issues which reflect the range of research interests as mentioned above, b. Reflects the need to identify and fill specific knowledge gaps seriously inhibiting current practice and c. should use the potential yielded results as early as possible.

Thus OEARC, although a new organisation, has been trying to develop a unique programme of environmental impact assessment and always open for public input and support to the interested individuals. It serves as a thinking

bank for the Canadian Environmental Assessment Research Implementation Framework.

#### WATER QUALITY MODELLING

Modelling of the environment requires finding analytical relationships between variables knowing some responses of the system under various stimuli (Michel de Broissia, 1986). Many a time the mathematical models are simplified taking into account only some of the fundamental equations. The soundness of the model generally depends upon the assumptions which have been made. Ecological models are still at the boundaries between clean mechanistic models (White box model) and models with incomplete known factors (Black box model). The water quality model is closely related to flow field. In this there are one-, two- and three- dimensional models, well-mixed models, hydrological models and water sediment exchange models. The components of flows of these models vary either in the vertical or horizontal or along the basin or over a basin or in any direction. The well mixed model is generally used for quick approximations or for complex multi-components equilibria. However, there are no ideal models available which could be used universally in the environmental impact assessment studies. For example Acres applied HSP-F program for examining BOD (5), Plankton, pH, Phosphorus and Nitrate simulation. This was applied in the case of Humber River studies in United States. It was found to be reliable and flexible. So also, INRS-Eau has developed several water quality models for total dissolved solids, temperature and suspended solids. However, there is much to be desired in the field of modelling for the environmental impact assessment studies. In case of Biotic models, many models cannot be applied either due to cost factor or due to lack of adequate quantitative knowledge to model reliably certain processes, like energy between trophic levels. Implicit modelling is

more frequent for water quality models to examine BOD (5) where there is implicit model of the organisms consuming the oxygen. Explicit models of biota are usually compartmental and treat the various components under examination either in terms of energy or individual numbers or biomass. Hence quantification of models has been far less frequent. Quasi-quantitative models have been applied to a certain extent in environmental impact assessments, particularly for the studies on the management of British Columbia Salmon Fisheries and Spruce Budworm Management in the New Brunswick. The philosophy of such models is that the information in detail required to make precise predictions are frequently either unobtainable or impracticable to obtain.

#### RISK ANALYSIS

The purpose of the environmental impact assessment is to predict in a systematic manner the consequences of proposed major projects such as nuclear power sites, exploration of hydrocarbons from ocean floor, etc. However, environmental impact assessment and risk assessment are emerging as important research fields and management strategies and these have hitherto been developed in parallel. Risk is defined normally as a measure of probability and severity of harm to human health. Hence in the environmental impact assessment, a risk is used to predict the consequences of a planned action, or the risk evaluation or risk assessment interchangeably mean the same as describing the risk (Crima *et al.*, 1986). Risk theoretically unites a whole range of uncertainties like economic risk, health risk, risk of technical failure, environmental risk and psychological fear of uncertainty. So the benefit cost analysis, risk benefit analysis, multi-attribute utility analysis attempt to clarify the trade-offs among risks, costs and benefits. An acceptable risk is a risk whose probability of occurrence is so small whose consequences

are so slight or whose benefits are so great that a person, group or society is willing to face that risk. The risk evaluation and assessment in the environmental impact assessment study has now become an integral part of the impact studies on the marine resources and this has been often prioritised in the selected research needs.

#### FISHERIES RESOURCE MAPPING AND MANAGEMENT SYSTEM

For the development of a national or regional fishery management strategy for ocean or coastal resources is an inventory of those resources and subsequent portrayal of that information and data in appropriate format for review and analysis. The inventories could include information on fisheries, habitat location, fisheries infrastructure along with other resource and industrial data which may affect the fisheries. The remote sensing techniques along with aerial photography in mapping the country and cataloging its natural resources had long been recognised. The use of such maps help in finding reserved areas for marine aquaculture, under water parks, demarcation of fishery closure and access zones for various purposes. Exclusive Economic zones (EEZ's) demarcation of coastal states and for geographical information for a wide range of purposes (Butler *et al.*, 1987).

#### OVERVIEW AND ANALYSIS OF COASTAL ZONE MANAGEMENT IN THE ATLANTIC PROVINCES

The coastal resources of the Atlantic Provinces are classified (Table 1) in order to facilitate in establishing priorities for future investigation and to aid in the design of policies and procedures or making resource use decisions for the varied types of situations encountered along the coastline. This classification of coastal resources will help in identifying representative situations along the coast

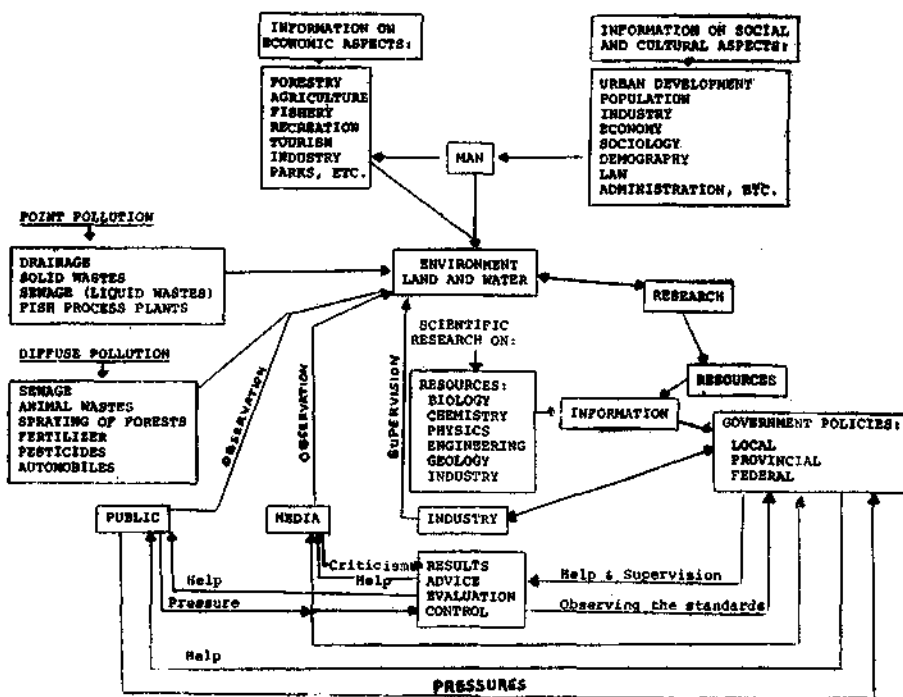


Fig. 1. Interactions in the Coastal Zone Management.

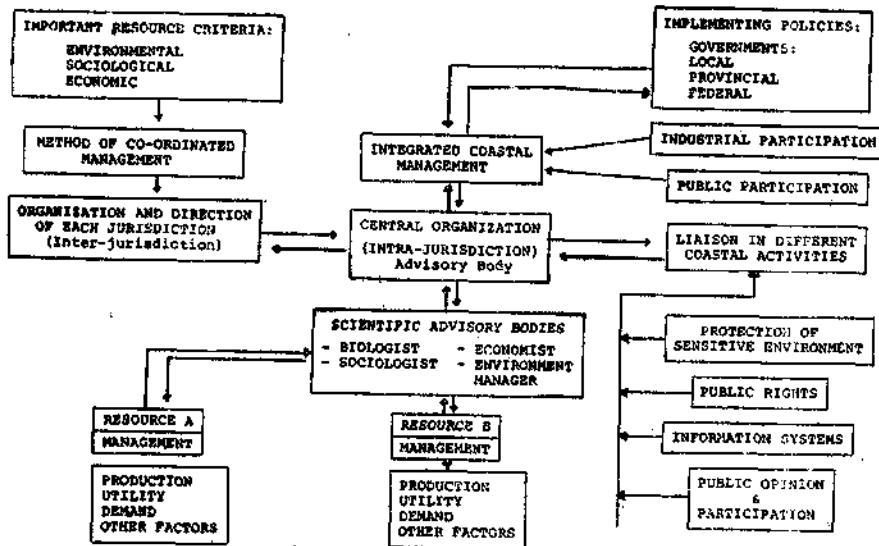


Fig. 2. Organisational structure for Coastal Zone Management.

TABLE 1. *Classification of coastal zone resources*

<i>Physical and Chemical Aspects</i>	
Coastal land	: Capability, type, geology, erosion, use and misuse, urban growth.
Air	: Quality, climate, noise, radiation, microclimate.
Water	: Quality and urban runoff.
<i>Biological Aspects</i>	
Plants	: Forests, grasslands, bottomlands.
Animals	: Wildlife, fish, micro-biota.
<i>Social and Cultural Aspects</i>	
Population	: Urban and rural, Employment, Demography.
Land Use	: Urban, Agriculture, Rangeland, Forestry, Water, Wetland, Barren land, Recreation (Sports fishing, skiing, nature study), Transport, Conservation (Parks, race and scenic areas, wildlife).
<i>Economic Aspects</i>	
	Agriculture, Fishery, Mining, Forestry, Construction, Recreation and Tourism, Manufacture, Utilities, Finance and Trade, Urbanisation, Public Administration, Energy, Resource development, Conservation and Preservation, Transport.

upon which detailed research investigations could be carried out.

The coastline with its complex environment often governed by a varied body of laws and regulations which are administered by local, provincial and federal agencies. With the onset of urbanization, concentration, exploitation of resources and inherent uses and abuses of the coastal zone, the role of the local bodies has increased for proper understanding in the development of management strategies of the coastal resources. The importance of developing suitable evaluation information for different policy issues and implementing tasks based on research programmes, are given in Fig. 1.

The shoreline management (Fig. 2) should

take into consideration the nature of conflicts in different shoreline uses and alternative policies and institutional arrangements. Socio-economic and administrative structure has a great responsibility in determining the future for the 'harvest of coastal riches'.

#### CONCLUSIONS

This paper brings out some of the existing approaches that are currently taken into consideration for prospective environmental impact assessment on marine resources and their management. Prediction or forecasting bring about techniques and methods for monitoring in various disciplines which could be applied in various studies. Integrated research themes and strategies could be developed to employ in achieving the objectives. Public participation focuses the social and/or economic dimensions resulting from the development decision. Risk analysis has become a major component of many environmental assessments. Integration of impact assessment with overall process of decision-making is a must in future project-specific studies related to resources and this should be coupled with the improvements in the legal and institutional analysis. Reducing the potential impacts to a minimum and consideration for the compensation for the loss or reduction of social amenities is an emerging thought of research in environmental assessment in which new thoughts and ideas are being explored. There should always be a post-project evaluation to increase administrative and technical performance followed by information exchange and encouragement of research to fill specific knowledge gaps which inhibit the current practice and develop methods to yield results which could be applied in the near term (CEARC, 1985). Aerial photography in cataloging the site or project specific resources will be very valuable in an overview analysis of an environmental assessment of a resource management system.

## REFERENCES

- BALCHAND, A. N. 1983. A case study on Environmental consequences of water resources mismanagement. *Water International*, 8 (1): 35-41.
- BUTLER, M. J. A., C. LEBLANC, J. A. BELBIN AND J. L. MACNEIL 1987. Marine Resource mapping and introductory manual. *F. A. O. Fish. Tech. Pap.*, 274: 256 p.
- CANADIAN ENVIRONMENTAL ASSESSMENT RESEARCH COUNCIL (CEARC) 1986. Philosophy and Themes for Research. *CEARC Secretariat, Quebec, Canada*, 5 pp.
- MICHEL DE BROISSIA 1986. Selected Mathematical models in Environmental Impact Assessment in Canada. A background paper prepared for the Canadian Environmental Assessment Research Council. *Ministry of Supply and Services, Canada*, pp. 34.
- MINISTER OF SUPPLY AND SERVICES, CANADA 1985. Federal Environmental Assessment and Review Process, Environmental Assessment Panels — Procedures and Rules for Public Meetings. *Federal Environmental Assessment Review Office*, 5 pp.
- 1986. Cumulative Environmental Effects: A Binational Perspective. *The Canadian Environmental Assessment Research Council (CEARC), Ottawa, Ontario and the United States National Research Council (NRC), Washington, D.C.*, pp. 175.
- CRIMA, A. P., P. TIMMERMAN, C. D. FOWLE AND P. BYER 1986. Risk management and EIA: Research needs and opportunities. *Ministry of supply and services, Canada*, pp. 18.