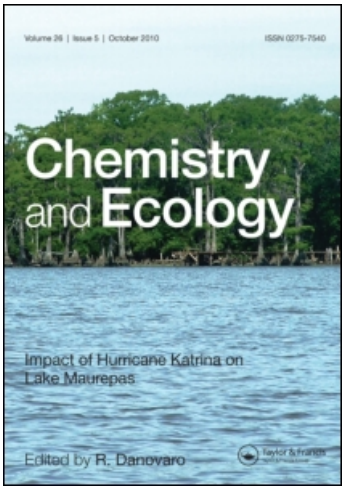

Chemistry and Ecology
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713455114

The Scientific Basis of Marine Pollution Prevention Strategies

Velimir Pravdić[a]
[a] Center for Marine Research, Ruder Bôsković Institute, Zagreb, Croatia

To cite this Article Pravdić, Velimir(1995) 'The Scientific Basis of Marine Pollution Prevention Strategies', Chemistry and Ecology, 10: 1, 25 — 31
To link to this Article: DOI: 10.1080/02757549508035327
URL: http://dx.doi.org/10.1080/02757549508035327

Chemistry and Ecology, 1995, Vol. 10, pp. 25–31
Reprints available directly from the publisher
Photocopying permitted by license only

THE SCIENTIFIC BASIS OF MARINE POLLUTION PREVENTION STRATEGIES

VELIMIR PRAVDIĆ

Center for Marine Research, Ruder Bošković Institute, Zagreb, Croatia

(Received 7 January 1994)

Prevention of marine pollution, particularly in semi-enclosed seas, embayments and areas with limited exchange of water, requires a well conceived and harmonized legal system, specified standards, a monitoring programme, and effective control and enforcement capabilities. This comprehensive approach is often called a strategy. Three generations of strategies have been devised and applied historically in Europe and North America, each a step further in integrating environmental protection, technical advancement and economic capabilities. The overpowering socio-economic problems of transition from a centrally planned to a market economy, a task facing a dozen central and eastern European coastal states, compound the problem of application of an integrated approach.

No management strategy can achieve its set goals unless based on scientific evidence. The data base has to offer information on two basic questions, one **specific** and one of a **general** nature.

The **specific** question is: Has the area under consideration some features, an activity, or one or more living species, which must be protected at any cost? The answer to this question will invoke the *precautionary principle* into strategic considerations, and leads to the general question: What is the carrying (= assimilative or environmental) capacity for each activity and for the discharge of each contaminant into the impacted area? Answers to these questions lead to the choice of the strategy for environmental management.

KEY WORDS: coastal zone management, marine pollution, pollution prevention strategies, societal restraints

INTRODUCTION

This paper discusses conceptual approaches to coastal management of a general nature. Reference to the Adriatic coast of Croatia is simply a suitable test case, where experience has been gained, and where foresight is advisable. The effective implementation of a strategy for coastal and marine environmental protection has to take account, beyond ecological and technological aspects, also of socio-economic constraints; in central and eastern Europe, including the Baltic, the Mediterranean and the Black Sea coastal states, the management issues are compounded by the transition from the centrally planned to the market economy.

Coastal areas in semi-enclosed seas are the most sensitive parts of the world oceans. The problem is not confined to effects of pollution from land-based sources, but also in the unrestrained use of coastal land for diverse activities and for various development projects. These activities, in turn, produce a contaminant load and potentially degrade the natural environment.

THE ENVIRONMENTAL FRAMEWORK

The Croatian Adriatic coast, a part of the central Mediterranean, is a region of some 600 km in the NW-SE direction, but the complex indentation and the 700 islands constitute a shoreline in excess of 5,800 km. It is thus one of the most indented coasts of the Mediterranean, a karst region, and precariously sensitive with respect to soil erosion (Liber, 1987; HAZU, 1992). Of the islands only the 10 major ones have a significant population and minor industry, except for the northern island of Krk which has a significant (chemical) industry. The major present and possibly future revenue-gaining activity of the whole area is tourism, a convergence point of several million people from all parts of Europe, predominantly central. This has produced stiff competition for space use with industrial, transportation, and manufacturing investment projects.

Thus, the Adriatic coast has become a case study for the application of contemporary strategic principles. Most of the countries of the central and eastern Europe are in transition from a centrally planned to market economies. Environmental management appears to be intrinsically a difficult and involved problem, particularly so because ideal models do not exist. Without the objective to offer direct recommendations, the following is an overview of past strategic experience and of available framework options.

THE PRINCIPLES OF ENVIRONMENTAL MANAGEMENT: SCIENTIFIC ASSESSMENT

The danger of contamination and indeed of pollution of coastal and marine areas is mainly from three distinct sources: (i) urban sewage, (ii) ports and shipping and (iii) the chemical industry. The chemical industry is a particularly suitable study case for the various conceptual approaches. Hard data evidence on the impact of chemical industry, its products and effluents, their toxicity, residence times, and ultimate fate, is hotly disputed in spite of many studies and ample scientific data. Most of the previous regulatory efforts have followed a *command-and-control* conceptual framework: this has been termed the *first generation* of pollution prevention strategies (see below). The hot spot problem, *i.e.* siting of industry in a region of great natural and cultural heritage value, often encountered in the Mediterranean region, requires a site specific approach.

Contaminants from point sources from chemical industries are well reported (Asplund and Grimvali, 1991; Wilson, 1982; Eduljee, 1988; GESAMP, 1992; 1993; Ballschmiter, 1992; Calamari and Vighi, 1990; 1992; Berry *et al.* 1993; Miller, 1993). The Croatian Adriatic coast abounds with protected sites of exceptional natural value (national parks, nature parks, natural preserves) and with those of cultural heritage. Accommodating industrial facilities and its associated activities, including transport and waste management, into such a region and understanding the possible consequences for air and for marine waters is difficult and involved. In addition to the scientific aspects, the often conflicting economic, environmental and social requirements compound the complexity of management options (Rocard and Dubuis, 1989; IIED/IUCN, 1993). In particular, the acquired social attitudes, based on a history of easy, albeit modest, prosperity in tourist areas, have always minimized precautionary measures. In times of difficult transitionary problems, environmental management restrictions are often blamed for economic woes.

ENVIRONMENTAL MANAGEMENT STRATEGIES

There is growing consensus that an environmental management strategy is not only a master plan for the sequential and concurrent implementation of environmental legislation, rather it is a conceptual framework to which legislation conforms.

With hindsight, three generations of strategies based on different conceptual approaches can be identified (Canada, 1991; Pravdić, 1992). The overview of historical development provides arguments for more advanced approaches for coastal and marine pollution control. It should be noted that the distinction is only conceptual; in practice there have been overlapping cases, and neither geographical nor temporal predominance can be distinguished.

The first generation strategy is the *command-and-control,* involving the end-of-pipe and the *substance-by-substance* approach. It mandates discharge standards for pollutants, and is industry, not environment, oriented. It legalizes concepts like the *best available technology*, or the *best practical means available* whether or not the implementation fulfils the environmental protection requirements. It has been a mainstay of environmental legislation in the 1960s and 1970s in western Europe and the North America. The centrally-planned economies, if they developed any management strategies at all, considered and interpreted this as the ultimate control needed; the absence of private ownership made incentive and penalty based measures irrelevant.

In the Croatian Adriatic region, it was within this generation of strategies that chemical and processing industries were developed, subscribing to the best available technology concept of environmental management.

The proven failure of the first generation strategies to either improve or prevent further degradation of the marine and coastal environment led to the second generation of strategies. These were conceived in the late 1970s and 1980s in Europe and North America to combine the first generation *command-and-control* principles with economic incentives and penalties, exemplified as the *polluter-pays-principle,* albeit often highly controversial. Tax and credit incentives, juxtaposed with penalties for infraction of laws, regulations, or standards, while powerful instruments, are still possible only within the legislative structure of individual countries. The countries in transition face the difficult task of building an effective market economy structure, including private ownership of industries, before effective management in such terms can become conceivable. Even for the European Union, as a supranational community, the effective implementation of this generation of strategies is far away. In the countries in transition such instruments of environmental economy are at present, little more than a matter for academic discussion.

The same is true of the *environmental quality standards* (Chapman, 1991; Constable 1991; Smith, 1991), a typical conceptual approach of the second generation. Such standards are the regulatory expression of environmental criteria based on scientific research and assessment, mainly ecotoxicological research. The legislative framework of the effluent standards and related measures of the first and second generation of strategies failed to implement strict source-oriented controls. Conceptually these strategies are still industry oriented in the belief that the quest for development cannot be limited, neither for nations or regions, nor indeed for individual industries competing in the markets. These strategies took effect slowly in the 1980s, and then again mostly in the developed market economies of the west.

A third generation of strategies has only recently emerged and has yet to be implemented. Both their concept and their need for international efforts for the preservation of the global environment are exemplified best by the recent adoption of the UN Convention on the Prevention of Climate Change. This Convention is truly environment oriented and mandates source-oriented controls. The Convention on the Preservation of Biodiversity is another, where causes of environmental damage have to be identified and addressed, since there are no end-of the-pipe remedies for the effects alone. The third generation strategies require *interactive* and *adaptive* environmental management, as proposed long ago as the model for future management activities both on the global and the national level (Holling, 1978).

One of the characteristic approaches to the third generation of strategies is the management principle based on the carrying capacity of the ecosystem. This principle has been advanced by the *Strategy for Sustainable Living* of the The World Conservation Union (IUCN, 1991). It goes back to the principle of the assimilative capacity for the disposal of pollutants into the environment, proposed as one of the possible approaches for the protection of marine waters by GESAMP (GESAMP 1986; Jackson and Taylor, 1992; Portmann and Pravdić, 1992). It is good to remember that the best available definition of *sustainability* is 'to live within the carrying capacity of the ecosystem'.

Another expression of the third generation strategies is the concept of the *best practicable environmental option* (BPEO), a strategy incorporating the *Vorsorge-prinzip* (RCEP, 1988). The BPEO strategy is source-oriented and requires the consideration of any new activity or development to decide on the best option for the disposal of waste, and of the use of resources, for the environment as a whole, and not for a single ecosystem, or for a limited, delineated environment.

The paradigm of the third generation environmental management strategies is adaptability. Except for the principles mentioned above, including the respect for the

Table I Approaches in Marine Protection

REDUCTIONISTIC	HOLISTIC
SCIENTIFIC EVIDENCE NEEDED	
Concentrations of individual contaminants: metals, nutrients, hydrocarbons, PCBs etc.	Mechanisms and kinetics Interactions between contaminants, contaminants and various species, within the ecosystem, and between ecosystems
Monitoring on a number of individual contaminants, concentration, species, sites	All + social monitoring (social acceptability), environmental criteria
MANAGEMENT OPTIONS	
Reliance on legislative steps Command-and-control policies	Complex environmental, social, and economic monitoring, economic policies, sustainability and trade-offs, adaptability framework
PRACTICE 1993	
All	None

environmental capacity, there are no hard prescriptions for sustainability. The adoption of a flexible approach, in response to changes in conditions or standards, is needed to sustain environmental quality, taking account of dynamic aspects of the ecosystem. There is little chance that a reductionistic approach, *i.e.* contaminant-by-contaminant, species-by-species, and ecosystem-by-ecosystem, will provide a sufficient scientific basis for strategies of the third generation. A holistic approach will be needed, recognizing that the network of cross-linked influences produces a dynamics beyond the sum total of effects of single steps and single entities. Table I presents an overview of current practices, distinguishing between reductionist and holistic approaches.

The second and the more difficult step is the translation of scientific data into a meaningful form for management purposes. The problem is illustrated in a simplified way in Table II.

In Table II, the sciences component represents accumulated knowledge on the cause/effect relationships, on the environment, on the bio-geo-chemical cycling of substances and on the scope of environmental interactions (Dooge *et al.*, 1992). The socio-economic sphere represents the overall mechanism of the organized society (region, state, the international community) with the invested power to pass legislation, institute controls and exercise enforcement.

The most important segment of the interactive environmental management approach is the interface: science/society. It shows the perennial problem of translation of scientific findings into a form usable for decision making (Bryant, 1991; MacNeill, 1990; Malone, 1993). The analysis of options and the implementation of precautionary measures is a particularly strained domain in the state of war and its aftermath (Pravdić, 1993), as exemplified in the Croatian Adriatic region. Also, the former countries with centrally planned economies have failed in their environmental record mostly by lack of communication across this interface, rather than because of lack of knowledge or expertise.

An enlightened society will approach this task by adopting a value system, decide on priorities and institute feedback mechanisms of reappraisal, often through political, and not only through policy making, institutions. While such a system in the western industrial nations and in Japan is far from ideal, and often fails to respond in time to critical issues, the defects in the socio-economic sphere of the centrally-planned

Table II Interactive Environmental Management

The Sciences	INTERFACE Science/Society	The Socio/Economic Sphere
Data acquisition and interpretation	Predictive models	Enforcement and control
Identification of cause-effect relationships	← Precautionary principle →	Standardization, regulation, legislation
Bio-geo-chemical mechanisms, carrying capacity	Analysis of options	Decision making (=subject to political influence)
Ecotoxicology, physical transport, fate, consequences at community level, etc.		Value system, policies, priorities, social acceptability

economies and their political structure, have led to some of the biggest environmental disasters of the 20th century.

CONCLUSION

Countries in transition have a unique chance to implement environmental management strategies of the third generation. It will mean a radical departure from the *command-and-control* strategies of the first generation, which are inadequate in the face of many major environmental problems.

The task will require a broadened scientific data base, in particular relating to ecosystem dynamics, rather than to the present reliance on concentrations of contaminants and their temporal and site variations. Such scientific input is needed to reformulate effective environmental protection legislation.

Coastal regions, like the Croatian Adriatic, a multipurpose development region, would benefit from such a conceptual basis of environmental management in providing a framework for adaptation and implementation when and if emerging evidence mandates changes. In times when industrial and communication technology changes at an unprecedented pace, the environmental strategies have to follow suit.

ACKNOWLEDGEMENT

This paper is an extended presentation given at the 2nd International Ocean Pollution Symposium, Qinghua Univ., Beijing, People's Republic of China, October 3–8, 1993. Appreciation is expressed to the Open Society – Croatia (The George Soros Foundation) for a travel grant, and to the Ministry of Science of the Republic of Croatia for subsistence support. The studies have been supported by The Research Contract 1-07-147 of the same Ministry.

References

Asplund, G. and Grimvali, A. (1991) Organohalogens in nature. *Environ. Sci. Tech.* **25**, 1347–1350.

Ballschmiter, K. (1992) Transport and fate of organic compounds in the global environment. *Angew. Chem. Int. Ed. Engl.* **31**, 484–664.

Berry, R.M., Luthe, C.E. and Voss, R.H. (1993) Ubiquitous nature of dioxins: a comparison of the Environ. dioxins content of common everyday materials with that of pulp and papers. *Environ. Sci. Tech.* **27**, 1164–1168.

Bryant, R.L. (1991) Putting politics first; the political ecology of sustainable development. *Global Ecology and Biogeography Letters* **1**, 164–166.

Calamari, D. and Vighi, M. (1990) Quantitative structure activity relationships in ecotoxicology: values and limitations. In *Reviews in Environmental Toxicology* (E. Hodgson, Ed.) **4**, 1–112.

Calamari, D. and Vighi, M. (1992) A proposal to define quality objectives for aquatic life for mixtures of chemical substances. *Chemosphere* **25**, 531–542.

Canada (1991) Canada's Ministry of the Environment. *The state of Canada's environment.* Canada Communication Group. Ottawa, Chapter 27, Sustainable Development pp. 27–1 to 27–12.

Chapman, P.M. (1991) Environmental quality criteria: what type should we be developing? *Environ. Sci. Tech.* **25**, 1353–1359.

Constable, A.J. (1991) The role of science in environmental protection. *Australian J. Mar. Freshwater Res.* **42**, 527–538.

Dooge, J.C.I., Goodman, G.T., la Riviere, J.W.M., Marton-Lefevre, J., O'Riordan, T., and Praderie, F. (Eds.) (1992) *An Agenda of Science for Environment and Development into the 21st Century,* ICSU, Cambridge.

Eduljee, G.H. (1988) Dioxins in the environment. *Chemistry in Britain* December, 1223–1226.
GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Pollution (1986) Environmental Capacity. An approach to marine pollution prevention. Rep. Stud. 30. FAO, Rome. 49 pp.
GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Pollution (1992) Can there be a common framework for managing radioactive and non radioactive substances to protect the marine environment. Rep. Stud. 45, Add. 1. IMO, London. 13 pp.
GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Pollution (1993) Impact of oil and related chemicals and wastes on the marine environment. Rep. Stud. 50. IMO, London. 178 pp.
HAZU (1992) (Croatian Academy of Sciences and Arts). Hrvatska (Croatia). HAZU, Zagreb. 140 pp.
Holling, C.S. (1978) *Adaptive Environmental Assessment and Management*, Wiley, Chichester.
IIED/IUCN – Int. Inst. For Environment and Development and the World Conservation Union (1993) National sustainable development strategies. Review draft. IUCN/CESP Working Group Report. Gland.
IUCN – The World Conservation Union (1991) *Caring for the Earth – A Strategy for Sustainable Living*, Gland.
Jackson, T. and Taylor, P.J. (1992) The precautionary principle and the prevention of marine pollution. *Chemistry and Ecology* **7**, 123–134.
Liber (1987) Veliki geografski atlas Jugoslavije (The Great Geographic Atlas of Yugoslavia). Liber Publ. Co., Zagreb. 272 pp.
MacNeill, J. (1990) The dialogue between scientists and policy makers. In *Sustainable Development, Science and Policy*. The Conference Report, Bergen. The Norwegian Research Council for Science and the Humanities, Oslo pp. 505–521.
Malone, Th.J. (1993) Ferment and change: science, technology, and society. *Environ. Sci. Tech.* **27**, 1026–1031.
Miller, A. (1993) Dioxin emissions from EDC/VCM plants. *Environ. Sci. Tech.* **27**, 1014–1015.
Portmann, J.E. and Pravdić, V. (1992) The precautionary principle – does it prevent marine pollution? *Chemistry and Ecology* **7**, 135–137.
Pravdić, V. (1992) Strategic approaches in coastal zone management in semi-enclosed seas. Requirements and realities – environmental protection and economic development. *Intern. J. Environmental Studies* **42**, 115–122.
Pravdić, V. (1993) Strategic framework in environmental management: war and its aftemath. *Intern. J. Environmental Studies*, accepted for publication.
Rocard, P. et Dubuis, Th. (1989) La maitrise de l'urbanisation autour des sites industriels a haut risque: l'experience francaise. *UNEP Industry and Environment* **12**, No. 2, 17–22.
RCEP (1988) Royal Commission on Environmental Pollution, Sir Jack Lewis, Chairman: *Twelfth Report: Best Practicable Environmental Option*. Her Majesty's Stationery Office, London, ref. K. Von Moltke, The Vorsorgeprinzip in West German Environmental Policy, pp. 57–70.
Smith, M.P.L. (1991) Environmental Impact assessment: the roles of predicting and monitoring the extent of impacts. *Australian J. Mar. Freshwater Res.* **42**, 603–614.
Wilson, D.C. (1982). Lessons from Seveso. *Chemistry in Britain*, July, 499–504.