**Assessing trends in marine pollution : Are the data good enough ?**

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The assessment of levels and trends of chemical contaminants in the marine environment is an essential component in any strategy to control and abate pollution. The practical application of all experimental or monitoring data depends upon their quality measured in terms of accuracy and precision. Data Quality Assurance (QA) programmes have the aim of making sure that the measurements are good enough for a particular purpose (such as for food safety or studying long-term trends). Quality control (QC) programmes are designed to maintain the data to a sufficient quality and assure their comparability between different laboratories using different techniques.

Intercomparison exercises on marine samples, first performed in the late 1960's, revealed large disparities in the results obtained by different laboratories. At about the same time, analytical techniques began to improve. "Best estimates" of trace metal concentrations in oceanic seawater, for example, decreased dramatically with time as analytical accuracy improved (3 orders of magnitude for lead in 4 decades, 1 order of magnitude for mercury in one decade). As a consequence our perception of what are "real" and "apparent" pollution problems also changed dramatically.

From the early 1970s, regular intercomparison exercises were organized on a World-Wide and regional scale by the Monaco Laboratory of IAEA (the International Atomic Energy Agency) frequently in cooperation with UNEP (the United Nations Environment Programme), and occasionally with IOC (the Intergovernmental Oceanographic Commission of UNESCO). In parallel, ICES (the International Council for the Exploration of the Sea), organized regular exercises between countries in the Baltic, North Sea and North Atlantic regions. These two data bases, covering organic and inorganic contaminants and radionuclides in sediments, water and biota, have served as a barometer to test the current status of data quality in pollution monitoring programmes. Despite considerable improvements in data quality, the data for some basic parameters remains surprisingly poor. For example, in a recent 24 laboratory World-Wide exercise on sediments the coefficient of variation for total petroleum hydrocarbons (as the fluorimetric chrysene equivalent) was 74%. In other words, measurements of 200 µg/g and 800 µg/g would be statistically indistinguishable from one another! On the other hand the coefficient of variation for plutonium, mercury or some PCB congeners is now below 20%, a remarkable achievement.

If a major objective of regional monitoring programmes is to detect long-term pollution trends (to see, for example, whether new legislation is effective) then the precision of the data must be much better than the expected environmental variation. Intercomparison exercises alone are insufficient to ensure data quality, as quality control is a continuous process which is a basic facet of the work of any credible environmental laboratory. Unfortunately, many laboratories are still not prepared to accept this common responsibility and their data are often inadmissible for regional and global marine pollution assessments. In the Mediterranean, the Mediterranean Action Plan, with the support of the Marine Environmental Studies Laboratory of IAEA-MEL and the World Bank, has initiated a concerted effort to improve data quality. This includes training of technicians, intercomparison exercises, the provision of reference methods and materials, joint monitoring exercises, equipment supply, installation and maintenance and regular methodological workshops. Data from the MEDPOL programme will then be used to prepare regular reports of "levels and trends" of marine contamination. The ultimate objective of the programme is to provide the Mediterranean countries with a valid scientific basis for managing the marine environment and to effectively control and abate marine pollution and assure the harmonious sustainable development of marine resources in the future.

The present report critically assesses progress on data quality assurance, future challenges and current obstacles for resolving them.



**The scientific background for the control of coastal eutrophication**

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Following any dramatic eutrophication crisis, such as the huge $H_2S$ production by decaying ulvae in Venice lagoon (August 1988) or the extensive formation of mucilage by phytoplankton along the Emilia-Romagna coast in July 1989, the question of scientific recommandations for optimal restoration of eutrophicated waters comes again to the surface, such as a mythic Loch'Ness monster... In fact, a well-documented description of the various stages and consequences of marine eutrophication came out of the previous meetings, workshops or conferences on the subject (*e.g.* for the Mediterranean: the UNEP Workshop at Bologna (Italy), 2-6 March 1987, the International Conference on Marine Coastal Eutrophication at Bologna, 21-24 March 1990, the EEC Workshop on Eutrophication-related phenomena at Roma, 28-30 May 1990...). Despite this scientific knowledge, little improvement seems to have been gained in the control of marine eutrophication, which spreads over increasing areas, according to the growing loadings of nutrients coming from land drainage and urban wastes. At this point, at least two questions arise: 1) Are the scientific programmes really focused on the aspects of the eutrophication phenomenon which are pertinent to its control ? 2) Does a real will exist in the scientific community as well as in the decision-makers sphere to build cost-effective, testable and hence, refutable restoration experiments ?

Concerning the first point, it seems of prime importance to determine which is the most efficient controlling nutrient (*i.e.* the most limiting one) and how much it has to be reduced. As pointed out by several authors (STIRN, 1988; HECKY and KILHAM, 1988), no universal agreement could be reached about the nutrient limiting the marine primary production, in contrast to the inland waters, where phosphorus has been identified. This lack of generality is partly due to the natural heterogeneity of marine waters: for instance, the mean N/P ratio for the whole Mediterranean Sea is significantly higher (19) than in the oceans (≅16). But contradictory and confusing results have been -and are still- reported, due to inappropriate use of N/P ratios in determining the most limiting nutrients: the phytoplankton growth is a dynamic process governed by fluxes of nutrients, not by instantaneous concentrations in surrounding waters. It looks as if the dynamic vision of algal growth gained twenty years ago by the physiologists using chemostats would still be ignored by ecologists working at sea: does a physiologist infer the state of nutrient limitation of his culture from the residual concentrations of nutrients in his chemostat ? As a consequence, it seems important to promote the use of techniques measuring the "point of view" of algae, *i.e.* determination of internal quotas of N and P or bioassays, which are an indirect way of measuring the fluxes of nutrients effectively available to the algae. Supposing that the limiting nutrient could be determined without any doubt, the question remains about how much it is necessary to reduce the loadings to get an appreciable effect on the system. As VOLLENWEIDER pointed out for lakes, the residence time of water in the system is the main parameter controlling the effective transformation of inorganic nutrients into algal living matter, just as in chemostat (DROOP, 1975). Instant is the need for good calculus of residence times in open coastal systems, which requires the determination of the water volume to be considered, as mentioned by LEE and JONES (1981), and a good knowledge of lagrangian residual drift (MENESGUEN and SALOMON, 1988). No reliable estimation of the acceptable level of nutrient loading can be computed without a detailed hydrodynamic background.

The second point is not a scientific one, but a psychological one. On the one hand, scientists too often take refuge behind the argument of freedom and non-profitability of the so-called "fundamental research" to avoid the danger -but also the honor- of deducing from their scientific knowledge clear and operational (*i.e.* quantitative) recommandations. It is a singular paradox that, under the cover of science, a lot of studies precisely avoid the decisive phase of testing (or refuting) their theory by experimenting in the real world, which is the only way to progress in science. On the other hand, it is also quite clear that decision makers, politicians and administrations are not always prepared to agree with scientific results and recommandations which do not fit in their planning. A good example is the controversy on the phosphate loading reductions in coastal areas where nitrogen limitation has undoubtly been established : decision makers argue on the effective role of phosphorus in triggering the eutrophication in inland waters to justify massive dephosphatation of urban sewages in these coastal areas, which is far easier than promoting reduced nitrogen fertilization on the corresponding watersheds (D'ELIA and SANDERS, 1987; MENESGUEN and SALOMON, 1988).

As a conclusion, one can say that a step forward in reducing coastal eutrophication could be obtained if all the partners would first go beyond their own psychological gap, and then bring some technical improvements.

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