ENVIRONMENTAL MONITORING AND THE DEVELOPMENT OF HEALTH STANDARDS*

E. SOMERS

Environmental Health Directorate, Health Protection Branch, National Health and Welfare, Ottawa, Canada

Abstract. The relationship of environmental monitoring to health protection control measures is described and the monitoring programs divided into those that measure targets and those that measure factors. The models are illustrated by descriptions of Canadian programs on the monitoring of chemicals in the media—food, drinking water, and air—and the factor monitoring of a physical agent, radiation. With lead it has proved possible to combine all the monitoring data from the principal sources of human exposure and derive the received dose. Finally, the manner in which some risk acceptability decisions are developed from risk estimations of chemicals and radiation is described.

It is axiomatic that the ability to make sound policy decisions for environmental health issues rests on the quality of our scientific data. Defined in the broadest sense as 'a system of continued observation, measurement and evaluation for defined purposes' [1] environmental monitoring plays a central role in this process. This internationally-accepted definition emphasizes the purposeful nature of monitoring: it is not the mindless collection of data. In its most universal form the concept has led to the establishment of the United Nationals Global Environmental Monitoring System.

The relationship of monitoring to the development of health standards from the initial recognition of the problem to the enforcement of control measures is shown in Figure 1, adapted from Holdgate [2]. Monitoring data may be used to support, or

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initiate, research or may be fed directly into the assessment process where the scientific evaluation is converted by political judgement to the legislative reality of guidelines, standards, or regulations. The effectiveness of compliance with the standard can be checked by further monitoring to give 'feed-back' to a management system. A regulatory agency will often direct its sampling in a non-random fashion choosing suspect, defective, or unacceptable products – a particular form of monitoring, sometimes termed surveillance, which will lead to enforcement action if the samples do not comply with the legal requirements.

A useful general division of environmental monitoring programs is into those that measure targets, which may show changes in distribution or performance, and those that measure factors, which may cause changes in the environment [2]. These classes are termed 'target monitoring' and 'factor monitoring' (Figure 2). The major use of target monitoring is in the realm of ecology, where changes in say fish population or tree density are measured, but observation of changes in the health status of human populations, namely epidemiology, is of great value in deriving health standards. Factor monitoring is concerned with measuring chemical, physical or biological variables and can be made at any point from the emission source to the target, or even within the target particularly for human studies. For all monitoring measurement capability, comparability, reliability, accuracy, and precision of measurements, and statistically sound sampling methods are required.

![Fig. 2. Environmental monitoring.](image)

Assessment of the exposure of human populations to environmental agents demands an integrated approach to monitoring so that the relative contributions from each route of exposure can be evaluated. Once the critical routes have been established for routine monitoring the process becomes more cost-effective. Thus the major health hazard to the general population from mercury is considered to be due to its presence in fish as methylmercury: monitoring of mercury can be limited to this critical pathway. A sophisticated systems approach to integrated monitoring for the critical human receptor has been developed by the EPA's Las Vegas laboratory [3].

A particularly valuable approach in determining human exposure is factor monitoring within the target, which may be termed internal, or biological monitoring. Biolo-