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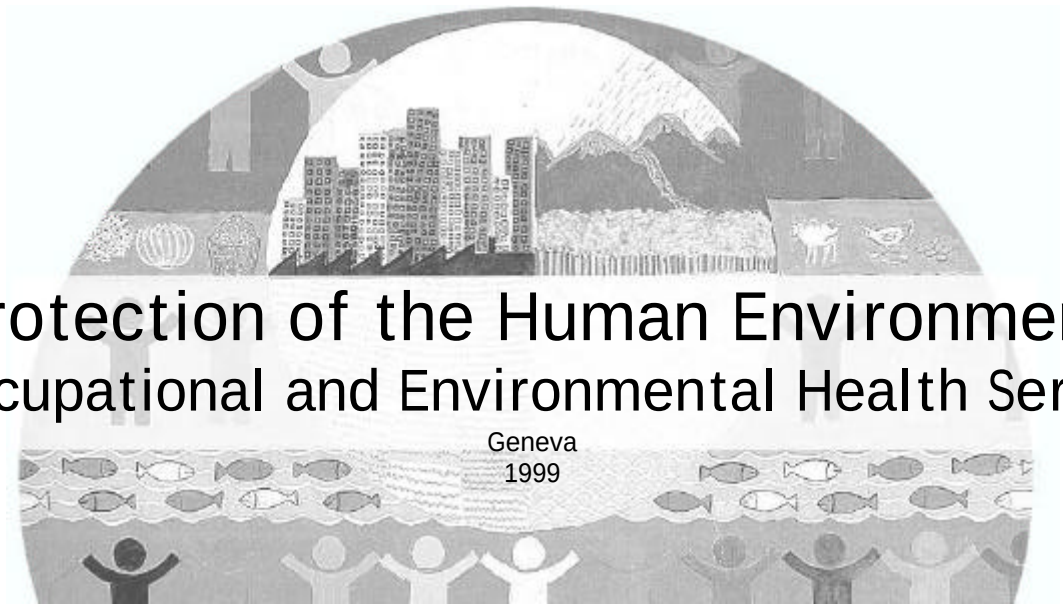
ENVIRONMENTAL HEALTH INDICATORS: FRAMEWORK AND METHODOLOGIES



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Prepared by

David Briggs
Nene Centre for Research
University College Northampton

WORLD HEALTH ORGANIZATION

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1. INTRODUCTION

1.1 The role of indicators

There is an increasing need and demand for environmental health indicators, from agencies and practitioners to help support and monitor policy on environment and health at all levels - from the local to the international. Indicators are needed, for example:

- to help monitor trends in the state of the environment, in order to identify potential risks to health;
- to monitor trends in health, resulting from exposures to environmental risk factors, in order to guide policy;
- to compare areas or countries in terms of their environmental health status, so as to help target action where it is most needed or to help allocate resources;
- to monitor and assess the effects of policies or other interventions on environmental health;
- to help raise awareness about environmental health issues across different stake-holder groups (including policy-makers, health practitioners, industry, the public, the media);
- to help investigate potential links between environment and health (e.g. as part of epidemio-logical studies), as a basis for informing health interventions and policy.

1.2 What makes a good indicator?

The development of good environmental health indicators is nevertheless challenging. To be effective, indicators must satisfy a number of different criteria. In order to meet the needs of their users, who are often not experts in the subject matter or the idiosyncracies of the data, they must provide a relevant and meaningful summary of the conditions of interest. In order to satisfy the wider community - including those who might wish to challenge the message they give - they must be transparent, testable and scientifically sound. If they are to detect variation or change in the world they describe, they must be sensitive to real changes in the conditions they measure, yet robust enough not to be swamped by noise in - or minor differences in the source of - the data used. If they are actually to be developed and used, they must be cost-effective to compile and apply.

1.3 Implications for indicator design

These criteria have various implications which tend to condition and limit the types of indicator that can be developed, and the ways in which they may be constructed, presented and used. Many of these criteria are also to some extent mutually incompatible: that is one reason why indicators are difficult to design. The ultimate need for cost-effectiveness, for example, often means that indicators must be developed on the basis of data which already exist or which - if newly collected - can also be used for other purposes. Unfortunately, many of the data which do exist have been collected for specific purposes, and are therefore not ideal for other applications. The need for clarity and ease of understanding also implies that indicators must often condense large volumes of data into a brief overview, and reduce the complexities of the world to a simple and unambiguous message. The need for scientific validity, on the other hand, requires that this process of précis must not go too far. Indicators must simplify without distorting the underlying truth, or losing the vital connections and interdependencies which govern the real world. At the same time, if indicators are to be sensitive to change, they need to be based on accurate, high resolution and consistent data. Achieving this, whilst also maintaining simplicity, is itself a challenge. To do so whilst also ensuring that the indicators can make use of the limited, and often varied, data which are usually available is even more difficult. To achieve all this cost-effectively is difficult indeed.

The different uses to which indicators may be put - as illustrated by the list of potential applications, above - also creates challenges. Each use may imply the need for a slightly different indicator. An indicator devised to monitor trends over time, for example, should be based on data which are spatially representative, but not necessarily spatially intensive or complete. The same indicator, used to examine geographic patterns and identify ‘hotspots’, will need to be based on data which are spatially detailed and comprehensive: temporal variations will be less important. An indicator developed to raise public awareness about an environmental health issue will need to be interesting and acceptable to the community concerned (in the jargon of indicators it will need to have ‘resonance’). This may mean that some degree of complexity and rigour may need to be sacrificed to make the message bold and clear. In devising indicators for use as part of an epidemiological

investigation, however, emphasis will be placed first and foremost on its scientific validity and accuracy.

For all these reasons, developing multi-purpose indicators is extremely difficult. All indicators are to some extent use-specific and context-bound. Issues such as the geographic resolution of the source data and the level of spatial aggregation, the geographic coverage, the averaging times or periods to which the data relate, the detection limits and precision of the data, the way in which the indicator is constructed and presented, and the interpretations which are finally made, all depend upon the use to which the indicator is put.

Indicators also need to be dynamic. They must be updated and amended as the world changes: not only changes in the conditions they specifically describe, but also in the availability of data, in scientific knowledge, or in the levels of awareness and needs of their users. As new environmental health issues emerge - or even as potential issues begin to be seen - new indicators will need to be developed, while old ones may cease to be relevant and may be left to die.

Indicators, therefore, are neither fixed nor universal. What makes a good indicator at one place at one time will not necessarily be relevant at another. As a consequence, although it is possible to devise definitive indicator sets which serve specific needs (e.g. OECD 1998), the wider utility of these is inevitably limited. On the other hand, it is not appropriate simply to let a form of indicator anarchy - in which everyone develops their own indicators - prevail. This would merely result in a large duplication of effort, the proliferation of indicator sets, and a growing difficulty of comparing or combining indicators from different sources. It may also encourage the development of poorly-conceived and ill-designed indicators which may misinform rather than inform. Instead, the need is for guidelines which can help users develop and construct their own indicators, which satisfy their own needs, yet at the same time which meet high standards of design and validity.
That is the primary purpose of the 'Indicator Profiles' presented here. Their aim is:

- to rationalise the way in which environmental health indicators are formulated, constructed and applied;
- to provide clear guidelines on indicator design;
- to encourage clear and full documentation on the genealogy of indicators;
- to encourage awareness and consideration of the limitations inherent in the indicators; and
- to encourage good practice in indicator construction and interpretation.

To this end, the profiles describe a sample of environmental health indicators and show how they can be compiled and interpreted. The indicators are not intended to be comprehensive: they are a sample, selected to illustrate the range of indicators which might be developed in relation to a number of key environmental health issues, and to show some of the implications involved. Nor are the descriptions intended to be definitive: as argued above, indicators can and must be adapted and adjusted according to circumstance and need. The descriptions, however, provide a useful framework which should be relevant for many applications.

2. ORGANISATION OF THE INDICATOR PROFILES

2.1 Environmental health issues

The environmental health issues for which the indicator profiles have been developed are not to be defended in terms of their global importance or political priority. On the whole, the issues used *are* of widespread significance, but as noted above - and as the recent development of National Environmental Health Action Plans (Briggs *et al.* 1998) show - environmental health priorities vary markedly from one country to another. Major differences in priority occur, in particular, between the less developed and more developed areas of the world (WHO 1992, 1999). The issues illustrated here, however, are intended to represent a range of environmental health concerns: from 'traditional' risks such as poor sanitation, shelter and access to safe water, to 'modern' risks such as radiation and chemical safety of food. They have also been selected to show some of the links and interdependencies which exist between different environmental health issues, and thus between the indicators concerned. Indeed, one of the main messages to draw from the profiles is the need always to interpret indicators, and the issues to which they relate, holistically: to see them within the wider context.
In light of this, the issue-related indicators presented here are preceded by two introductory sets of indicators, relating to the socio-economic and policy contexts. The purpose of these is to provide a description of the wider realm within which the issues exist, and to provide background information which can be used to help interpret the issue-specific indicators.
It should also be mentioned that the definition of environmental health issues is, in itself, a complex task. The way any issue is defined and approached is likely to vary substantially depending on the perspective of those

involved. In defining issues, we are usually attempting to isolate a specific concern from a much wider range of processes and effects. A different person may place the focus of attention at a different point, and different links and factors will thus become relevant. There is no single set of environmental health issues, therefore; rather, each issue is an artefact of the person who defines it. Nor do issues really exist in isolation; instead they connect, overlap and intersect. These are further reasons why there are rarely if ever clearly defined and universally applicable indicator sets.

2.2 The DPSEEA framework

The indicators are arranged in terms of the now widely-used DPSEEA framework (Figure 1) (Corvalán *et al.* 1996). Within this framework, the driving forces component (D) refers to the factors which motivate and push the environmental processes involved. Of these, possibly the most important is population growth; others include technological development, economic development and policy intervention.

The driving forces within the DPSEEA model result in the generation of pressures (P) on the environment. These are normally expressed through human occupation or exploitation of the environment, and may be generated by all sectors of economic activity, including mining and quarrying, energy production, manufacturing, service industries, transport, tourism, agriculture and forestry. In each case, pressures arise at all stages in the supply chain - from initial resource extraction, through processing and distribution, to final consumption and waste release.

In response to these pressures, the *state* of the environment (S) is often modified. The changes involved may be complex and far-reaching, affecting almost all aspects of the environment and all environmental media. They are expressed, therefore, in terms of the frequency or magnitude of natural hazards, the availability and quality of natural resources, and the levels of environmental pollution. These changes in the state of the environment also operate at markedly different geographic scales. Many changes are intense and localised, and often concentrated close to the source of pressure (e.g. habitat loss, urban air pollution, contamination of local water supplies). Many others are more widespread, contributing to regional and global environmental change (e.g. desertification, marine pollution, climate change). Because of the complex interactions which characterise the environment, almost all these changes have far-reaching secondary effects.