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## ENVIRONMENTAL HEALTH INDICATORS IN POLICY EVALUATION

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**Summary:** The set of environmental health indicators (EHIs) proposed by WHO serves a structured description of the underlying cause-effect chains. The set is useful for monitoring and international comparison of the general environment and health situation, thus supporting priority setting. However, a number of methodological and technical difficulties need to be addressed, particularly in relation to health impact assessment.

Indicators for policy evaluation are derived from previously formulated policy targets while EHIs, in contrast, should lead to priority setting and policy formulation. Additionally, the relevance of internationally developed indicators will vary in the national context. Thus, the suitability of EHIs for the evaluation of national environmental health promotion programs is limited. For a comprehensive evaluation of such a program, a specifically adapted set of indicators with a strong emphasis on the implementation process has to be developed.

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## 1 Introduction

Indicators are often used in public health to describe the health of populations as well as determinants of health. Recently, it has been estimated that up to one third of the global burden of disease can be attributed to environmental risk factors.<sup>1</sup> Thus, in the last decade an increasing interest arose for indicators on the relationship between environment and health. Another reason was the development of a novel instrument for action in this area: the National Environment and Health Action Plans (NEHAPs). Based on an initiative of the World Health Organisation (WHO)<sup>2, 3</sup> and also as part of the practical implementation of sustainable development, about 40 NEHAPs have been developed so far throughout Europe. Thus, information is needed to monitor trends in the environment and health situation and to set priorities for action.<sup>4, 5</sup> This led to the development of “environmental health indicators” (EHIs).<sup>6-9</sup> An environmental health indicator (EHI) is a “measure which indicates the health outcome due to exposure to an environmental hazard”, thus consisting of “an environmental indicator or a health indicator plus a known environmental-exposure health-effect relationship”.<sup>8</sup> Definitions also emphasize the policy relevance of EHIs: they should relate to aspects which are important to policy makers and amenable to control.<sup>8, 10</sup> Additionally, EHIs are seen as evaluation and quality control tool of environmental health management.<sup>6, 7, 11</sup>

In 1999, the development of a European environment and health monitoring system has been started by WHO<sup>11, 12</sup> (see also paper of Dr. D. Dalbokova). This project aims at the establishment of a comprehensive system for regular reporting on environment and health within the countries as well as at the WHO European region level. The system shall also serve the Member States to assess their progress and effectiveness in implementing their NEHAPs. At the same time, some countries, including Switzerland, have developed specific evaluation concepts for their NEHAPs.<sup>13</sup>

In this paper we will examine and discuss the requirements for EHIs for policy evaluation in general and, more specifically, their suitability for the evaluation of NEHAPs, exemplified by the Swiss NEHAP.

## 2 The Swiss National Environment and Health Action Plan (NEHAP)

Based on a problem analyses, priorities in the Swiss NEHAP were set on the following three topics:<sup>13, 14</sup>

- Mobility and Wellbeing
- Housing and Wellbeing.
- Agriculture, Nutrition and Wellbeing

For each area, an "ideal situation" as well as specific, quantified targets with a time horizon between three and 10 years were formulated. Subsequently, 14 intervention fields were laid down aiming at the improvement of individual behaviour as well as changes of conditions. Existing legislation and programs were taken into account in the Swiss problem analysis and areas in which the activities were considered to be sufficient were not included. Thus, the Swiss NEHAP is, unlike others, an actual environmental health promotion program which aims at complementing existing action.<sup>13</sup>

## 3 Environmental health indicators: methodology and challenges

### 3.1 Methodology

The theoretical concept underlying EHIs is the *Driving Forces - Pressure - State - Exposure - Effect - Action* framework (DPSEEA framework).<sup>8</sup> It is derived from the Pressure - State - Response Model developed by the OECD for environmental indicators.<sup>15</sup> The DPSEEA framework provides a structured description of the cause-effect chain between socio-economic activities (*driving forces*) associated with products or human activities (*pressures*) which lead to a certain condition of the environment (*state*) to which people are exposed (*exposure*) causing a wide range of health consequences (*effect*). Each step of this chain can be addressed by measures of the societal actors such as political programs or economic developments (*action*).<sup>8</sup> Thus, this framework allows the analytical assessment of the different steps from human activities to health outcomes. EHIs should, as stated above, also be amenable to action and the DPSEEA framework facilitates the identification of possibilities for action on the different levels. Hence, it serves the final purpose of EHIs which is to identify the need for action in environment and health. To better address the needs of policy makers, Health Impact Assessment shall also be used in the WHO environment and health information system.<sup>16</sup> This method allows to assess the health consequences of an activity or policy and thus is a popular tool to support informed decision-making.<sup>17, 18</sup>

### 3.2 Challenges in the application

In general, two types of EHIs can be distinguished: health related environmental indicators or environment related health indicators.<sup>4</sup> Thus, EHIs must be based on a known relationship between environment and health from epidemiological research. This environment and health association should also be consistent over time and space, unambiguous and largely unconfounded.<sup>8</sup> Additionally, it should be sensitive to changes in the condition of interest but ideally robust enough to remain unaffected by minor changes in the used methodology. Furthermore, it

should be scientifically valid, easily understood and accepted by potential users, and based on data of known quality which are readily available.

These requirements, which according to Briggs et al. should ideally met in majority,<sup>8</sup> are not only challenging but sometimes even contradicting. The causal chains in question are not always linear and each step is affected by various factors such as economic and social situation, access to and quality of health systems, pre-existing burden of the respective environmental compartment or vulnerability of different groups of the population.<sup>19, 20</sup> Therefore, “largely un-confounded” information on environment and health relationships can only be obtained through adjusted coefficients from epidemiological studies. These studies are time consuming and costly, thus these data are often not “readily available”. On the other hand, data from routine monitoring are more easily available but they usually can not be adjusted for potential confounders.

### **3.2.1 Health impact assessment and data availability**

As stated above, EHIs must always be based on a known environment and health relationship. Therefore, e.g. often used public health indicators such as “total mortality” or “incidence of chronic bronchitis” are not per se EHIs. They only describe aspects of the health situation of a population in general but do not allow inference on the “attributable number of cases” due to an environmental exposure, i.e. a health impact assessment.<sup>21</sup> To allow a statement on e.g. the incidence of chronic bronchitis due to air pollution, additionally information on the population exposure distribution and on the exposure-response function between an indicator of air pollution and bronchitis is needed.<sup>22</sup>

The number of times a pollutant exceeds a threshold level is commonly proposed as EHI.<sup>11</sup> If these standards are risk based they contain information on the underlying environment and health relationship. Thus, the percentage of exceeded values is a first step to indicate a need for action. Nevertheless, the percentage of the population who is exposed to exceeded pollutant levels and eventually an economic valuation of the health burden would certainly be more informative for policy makers than the percentage of exceeded measurements. To allow such statements, information on the population exposure distribution is necessary as well. Yet, this information is the often lacking. In Switzerland, e.g. it is a statutory requirement to provide safe food and drinking water but a problem focused convenience sampling strategy is applied in the monitoring.<sup>23</sup> The underlying assumption – which is probably correct – is that the general level of safety is high enough in Switzerland to focus on areas where problems are expected. However, such sampling strategies do not provide data on the population exposure to e.g. unsafe drinking water. Additionally, the exposure-response functions are not well known in all fields of environmental health.<sup>20</sup>

### **3.2.2 Challenges in the evaluation of environmental health promotion**

As part of a broader managerial process, evaluation should be an inherent part of every health promotion program to enable specific and effective adaptations in the course of the program.<sup>24, 25</sup> Lately, evaluation has even gained importance in view of the call for “evidence based policymaking”.<sup>10, 26</sup>

Evaluation of health promotion involves some particular difficulties. First, there is the question of evidence. The often encountered “contamination” of the control group of an intervention makes it difficult to determine whether a health gain is the result of an intervention or of secular trends.<sup>27-31</sup> Furthermore, health promotion aims not only at the improvement of individual outcomes, but just as much at the change of political, organisational, social, and environmental conditions.<sup>32</sup> Understanding the implementation process of an intervention (formative or process evaluation)<sup>33</sup> is therefore of great importance: on the one hand, these changes in conditions should be seen as “outcomes” of their own and on the other hand, they are the basis to understand success or failure in achieving quantified outcomes.<sup>24, 27-29, 31, 34, 35</sup>

In environmental health promotion, evaluation is confronted with additional difficulties. The cause-effect chains between environmental exposures and health effects are complex, thus precise measures are rare.<sup>8, 19, 20</sup> Another hindrance for environmental health promotion programs such as the NEHAPs is the fact that environment and health departments still operate within largely separated administrative structures in most European countries.<sup>13, 36</sup> Thus, formative or process evaluation of the implementation and associated structural changes is of special importance in this area.

## **4 Indicators and policy evaluation**

### **4.1 Development of indicators**

Figure 1 illustrates the development process of EHIs as compared to indicators for the evaluation of a specific environmental health program such as a NEHAP. International sets of EHIs are usually derived from an international problem analysis of the environment and health situation and from international initiatives for health promotion and environmental protection such as Health for All or Agenda 21. In its present form, the EHI system proposed by WHO comprises 10 topics and a number of denominator variables. A preliminary list of “core indicators” to be used for international comparison has been selected (table 1)<sup>16</sup> (see also paper of Dr. D. Dalbokova).

The proposed set of core indicators is useful for the monitoring and international comparison of the environment and health situation in general. However, the relevance of the suggested EHIs can vary in the national context. While e.g. most indicators on the topics “air quality”, “radiation”, “noise”, “traffic accidents”, “chemical emergencies”, and “workplace” (table 1) are relevant for Switzerland, the indicators on infrastructure for housing, water supply, sanitation and waste do not address Swiss priorities.<sup>23</sup> Thus, EHIs are only suitable for national policy evaluation when they coincide with the national priority setting and therefore address areas where action is taken within the countries. In this case, national and international indicator sets can partly overlap (figure 1). For a national evaluation, however, they will have to be supplemented with indicators that are derived from a national priority setting process e.g. during the development of a NEHAP.

Thus, indicators for policy evaluation are derived from previously formulated, specific policy targets while EHIs, in contrast, should lead to priority setting and policy formulation. For the evaluation of those policies, a specifically adapted set of indicators will be needed, comprising outcome and impact indicators as well as a concept to evaluate the implementation process.

Therefore, the most important restriction of the WHO set for policy evaluation is that it does not allow a process evaluation of a policy which is, as mentioned beforehand, crucial. E.g. it does neither include indicators on the administrative structures in a country nor on the means which are provided to carry out the interventions. These indicators have to be derived from and adapted to the respective program and the national context. We will exemplify this by the Swiss NEHAP evaluation.

## **4.2 Evaluation of the Swiss National Environment and Health Action Plan (NEHAP)**

A comprehensive approach was applied for the Swiss evaluation, including planning and implementation as well as goal-related outcomes and more indirect impacts.<sup>33</sup>

### **4.2.1 Process evaluation**

The mostly qualitative data are collected by repeated interviews with all persons involved in the implementation process and with the help of a NEHAP-project-database containing information on projects carried out in relation with the NEHAP. Important political decisions relating to NEHAP topics are documented to allow a statement on the “societal climate”. Additionally, a flexible user focused approach is applied to provide additional information according to the needs of the program management. After a first phase of implementation within the administration it was for example important to supply an “external” view on the program. Thus, not directly involved but relevant institutions and interest groups were interviewed to assess their perception of the program and its main objectives to identify possible alliances and opposition outside the administration.

### **4.2.2 Outcome evaluation**

To define appropriate indicators for the Swiss situation, impact models for each of the three topics were formulated (figure 1). Consisting of hypotheses on the presumed relationship between the program measures and expected outcomes, they are useful tools for goal-oriented evaluations.<sup>33</sup> They serve as a basis to understand why targets were reached or what impeded a program success. The formulation of such a program impact theory also facilitates to consider influence factors which have not been comprised in the program but might affect goal attainment. Additionally, potential weaknesses in conceptualisation and formulation of targets become apparent.

Based on these impact models, originally an extensive list of 63 indicators was developed. Subsequently, this comprehensive list was reduced to the 38 most important indicators due to limited data availability and resources. A baseline assessment in the three topics of the NEHAP was carried out 1999/2000 to document the situation before the start of the program, against which progress will be compared five and ten years after the start.<sup>37</sup>

## **4.3 Comparison of the two indicator sets**

Following the priority setting process which preceded the development of the Swiss NEHAP, the indicators for its evaluation cover only three topics while the list of EHIs as proposed by WHO comprises a wide range of issues (table 1). But even if merely the corresponding topics are compared, there is only minor congruence between the two indicator sets. Corresponding

indicators relate on the one hand to traditional environment and health topics such as outdoor air quality, noise, and traffic accidents which are also of relevance in Switzerland. Parallels also occur in areas which have recently received much public attention, such as environmental tobacco smoke. But while the WHO set contains only an *action* indicator on this topic (table 1), the the Swiss NEHAP formulated as aim to prevent the *exposure* to involuntary environmental tobacco smoke (ETS).<sup>14</sup> Thus, additional indicators on ETS exposure are also included in the Swiss evaluation.<sup>37</sup>

The additional Swiss NEHAP evaluation indicators are usually more specific and, since based on the impact models, adapted to the Swiss NEHAP targets. They also address a number of more innovative areas. E.g. one target in the area “Mobility and Wellbeing” is the doubling of journeys made by bicycle until 2007 as an ideal form of ecologically harmless mobility combined with exercise. In 1994, the bicycle was used for 5 to 7% of journeys. Nevertheless, only 40% of journeys made by car were longer than 6 kilometres which demonstrates a large potential for non-motorized mobility. Other indicators relating to this target are e.g. the availability of parking spaces at work or – as a possible negative side effect of bicycle promotion – bicycle thefts. Furthermore, knowledge and attitudes of the Swiss population in the respective topics are included according to the Swiss NEHAP targets. E.g. in the area "Nature and Wellbeing" the Swiss NEHAP aims at 75% of the population being in a position to consume healthy and balanced food, including environmental aspects of food consumption, and thus to contribute to sustainable agriculture until 2007. While over 2/3 of the population paid attention to the type of food they consumed (not too much fat, enough vegetables/fruit etc.), only 44.7% considered seasonality when buying food, 34.2% the geographic origin of a product and 24.4% the type of production (e.g. organic). Only 51.3% had a good knowledge of seasonality.<sup>37</sup>

The additional WHO indicators relate mostly to environment and health problems which are of minor relevance in the Swiss context, such as substandard housing or sanitation infrastructure. Furthermore, a number of health outcomes are included for which an association to environmental exposures has been established. Health outcomes are not included in the Swiss NEHAP evaluation for two reasons: First, none of the Swiss NEHAP targets relates directly to health outcomes. Secondly, a variety of programs and activities are carried out in Switzerland which could influence a health outcome. Thus, it would be almost impossible to isolate the contribution of a single program.

#### **4.4 Action indicators**

As a more direct way to indicate a need for action the WHO indicator set includes “*action*” indicators which describe reactions of the societal actors in view of an environmental health problem (table 1). For example in the area of “air quality” WHO included as one of the action indicators the participation in a variety of international agreements such as the protocols to the Convention on long-range transboundary air pollution.<sup>11</sup> A score is applied on most action indicators to describe the degree of implementation, e.g. from “not signed” to “ratified”. Thus, these indicators allow an assessment of national activities in comparison to a predefined set of international propositions for action. However, the ratification of a protocol does not necessarily imply that the respective legislation is actually implemented. Thus, these indicators are only a first step which has to be supplemented e.g. with information on the compliance with the respective national standards. They do also not allow to explain why a certain standard has not been met which would be an important information in policy evaluation. Unintended side effects of the

actions are not included as well. E.g. in relation to CO<sub>2</sub> reduction policies to address climate change it is often discussed to promote diesel vehicles due to their reduced CO<sub>2</sub> output. However, it is often overlooked that diesel engines produce increased amounts of health relevant substances such as fine particles and carcinogens.<sup>38</sup>

## 5 Conclusions

The DPSEEA framework applied by WHO serves the structured description of the cause-effect-chain between societal influence factors, human actions, associated changes in the environment and related health effects which finally lead to a reaction of the societal actors. Thus, a system of EHIs is useful for the monitoring of the general environment and health situation and for priority setting, especially in an international context. However, their potential usefulness might be restricted by a number of methodological and technical difficulties which have to be addressed, particularly in relation to health impact assessment.

Additionally, the final purpose of an indicator set should be defined beforehand to be able to address the involved issues in due time. The requirements for the development and implementation of a monitoring program to document time trends might differ from those for an indicator system to support (and influence) decision making. A certain reservation has to be made concerning the role EHIs can play in policy formulation in general. The political and the scientific approach to decision making differ considerably and scientific evidence is only one in a variety of factors considered in policy making.<sup>40, 41</sup> This should be taken into account in the development process of EHIs as well as in the dissemination of results, e.g. by the choice of stakeholders to be involved.

Despite the uncertainties and gaps of knowledge on environment and health relationships, previous knowledge on the associations is necessary for all indicator systems based on the pressure – state – response model. Thus, these systems are reactive and do not allow to identify factors which might be important in preventing future problems.<sup>39</sup> They are likewise prone to be determined by the current state of problem awareness and the public debate.

We conclude that, while an international set of EHIs is useful for monitoring purposes and international comparison, their suitability for the evaluation of national programs is limited. For a comprehensive evaluation, specific evaluation concepts derived from the formulated goals and targets need to be developed with an emphasis on the evaluation of the implementation process.

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## **8 Table and figure**

Table 1: Overview on the WHO project on environment and health monitoring (as at July 2001) <sup>16</sup>: proposed topics, environmental health core indicators and position in the driving forces – pressure – state – exposure – effect – action (DPSEEA) framework.

Figure 1 : Development and application of environmental health indicators and indicators for environmental health policy evaluation

Topic	Core indicators	DPSEEA
Air quality	<ul style="list-style-type: none"> <li>• Consumption of fuel by type from road transport</li> <li>• Emissions of air pollutants</li> <li>• Ambient concentrations of air pollutants (urban): population-based exposure</li> <li>• Infant mortality due to respiratory diseases</li> <li>• Mortality due to respiratory diseases, all ages</li> <li>• Mortality due to diseases of the circulatory system, all ages</li> <li>• Participation in International agreements and Environmental initiatives</li> <li>• Policies to reduce environmental tobacco smoke exposure</li> </ul>	<p>driving force pressure exposure</p> <p>effect effect effect action action</p>
Radiation	<ul style="list-style-type: none"> <li>• <sup>a</sup></li> <li>• Incidence of skin cancer</li> <li>• Proportion of companies with permits to use radioactive substances less than five years old</li> <li>• Effective environmental monitoring of radiation activity</li> </ul>	<p>exposure effect action action</p>
Noise	<ul style="list-style-type: none"> <li>• Population annoyance by certain sources of noise</li> <li>• Sleep disturbance by noise</li> <li>• Application of regulations, restrictions and noise abatement measures</li> </ul>	<p>effect effect action</p>
Housing and settlements	<ul style="list-style-type: none"> <li>• Living floor area per person</li> <li>• Population living in substandard housing</li> <li>• Mortality due to external causes in children under 5 years of age</li> <li>• Scope and application of building regulations for housing</li> <li>• Land use and urban planning regulations</li> </ul>	<p>state exposure effect action action</p>
Traffic accidents	<ul style="list-style-type: none"> <li>• Mortality from traffic accidents</li> <li>• Rate of injuries by traffic accidents</li> </ul>	<p>effect effect</p>
Water and sanitation	<ul style="list-style-type: none"> <li>• Waste water treatment coverage</li> <li>• Exceedance of recreational water limit values for microbiological parameters</li> <li>• Exceedance of WHO drinking water guidelines for microbiological parameters</li> <li>• Exceedance of WHO drinking water guidelines for chemical parameters</li> <li>• Access to safe drinking water</li> <li>• Access to adequate sanitation</li> <li>• Outbreaks of water-borne diseases</li> <li>• Number of reported diarrhoea cases in children</li> </ul>	<p>pressure state state state exposure exposure effect effect</p>
Food safety	<ul style="list-style-type: none"> <li>• Monitoring chemical hazards in food: potential exposure</li> <li>• Food-borne illness</li> <li>• <sup>a</sup></li> </ul>	<p>exposure effect action</p>
Waste and contaminated land	<ul style="list-style-type: none"> <li>• Hazardous waste generation</li> <li>• Contaminated land area</li> <li>• Hazardous waste policies</li> <li>• Municipal waste collection</li> </ul>	<p>pressure state action action</p>
Chemical emergencies	<ul style="list-style-type: none"> <li>• Sites containing large quantities of chemicals</li> <li>• Mortality from chemical incidents</li> <li>• Chemical incidents register</li> <li>• Poison centre service</li> <li>• Medical treatment guidelines</li> <li>• Government preparedness</li> </ul>	<p>pressure effect action action action action</p>
Workplace	<ul style="list-style-type: none"> <li>• Occupational fatality rate</li> <li>• Rates of injuries</li> <li>• Statutory reports of occupational diseases</li> </ul>	<p>effect effect effect</p>

<sup>a</sup> = to be developed

**Figure 1 : Development and application of environmental health indicators and indicators for environmental health policy evaluation**

**Environmental Health Indicators**

