# Environmental Health Impact Assessment., Evaluation of a Ten-Step Model

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"Environmental impact assessment" denotes the attempt to predict and assess the impact of development projects on the environment. A component dealing specifically with human health is often called an "environmental health impact assessment." It is widely held that such impact assessment offers unique opportunities for the protection and promotion of human health. The following components were identified as key elements of an integrated environmental health impact assessment model: project analysis, analysis of status quo (including regional analysis, population analysis, and background situation), prediction of impact (including prognosis of future pollution and prognosis of health impact), assessment of impact, recommendations, communication of results, and evaluation of the overall procedure. The concept was applied to a project of extending a waste disposal facility and to a city bypass highway project. Currently, the coverage of human health aspects in environmental impact assessment still tends to be incomplete, and public health departments often do not participate. Environmental health impact assessment as a tool for health protection and promotion is underutilized. It would be useful to achieve consensus on a comprehensive generic concept. An international initiative to improve the situation seems worth some consideration. (Epidemiology *1999;10:618625)*

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**Context**

The term "environmental impact assessment" usually denotes the attempt to predict and assess the impact of development projects on the environment. First introduced as a formal procedure in the United States,' a variety of approaches now exists for public and private development projects worldwide, for example, approaches suggested by the United Nations Environment Programme' and the World Bank.[3]

In the European Union, environmental impact assessment is based on a European Council Directive4 that covers highways, train lines, airports, industrial plants, waste disposal facilities, and many other development projects. In article [3], the directive states: "The environmental impact assessment will identify, describe and assess ... the direct and indirect effects of a project on the following factors: human *beings,* fauna and flora, soil, water, air, climate and the landscape, the inter-action between the factors, . . . , material assets and the cultural heritage"[4] (emphasis added). In Germany, environmental impact assessment was enacted by federal law in 1990.[5]

A component of environmental impact assessment dealing specifically with impact on human health is often called "environmental health impact assessment" (EHIA). It is widely held that EHIA offers unique opportunities for the protection and promotion of human health[.6,7] In the World Health Organization (WHO) "Health for All" program, the target environmental health management calls for EHIA.[8] Practical approaches to EHIA were described by WHO,[7,9] the Asian Development Bank,[10] the National Health and Medical Research Council in Australia," and others.

At the University of Bielefeld, in cooperation with the Institute of Public Health for North Rhine-West, phalia, a project on EHIA was performed, which aimed to improve the coverage of human health in the process of environmental impact assessment.[12-16] The project included the following components: analysis of the status quo concerning EHIA, including the legal basis and existing approaches; survey of current practice and involvement of public health departments concerning EHIA; analysis of EHIA documents with respect to coverage of health aspects; comparison and evaluation of existing EHIA approaches; development of a "generic" EHIA concept that would be broadly acceptable from scientific as well as from practical perspectives; deployment of quantitative risk assessment as a key methodology for EHIA; and evaluation of this concept in model applications.

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This paper summarizes selected project results. In particular, it describes the ten-step EHIA model, pres
synopsis of the outcome of two major field applications, and presents selected conclusions.

## Current Situation

As a foundation for an integrated concept, a number of existing approaches were identified, including "health and safety component of environmental impact assessment,"[7] "environmental and health impact assessment," [9] "baseline risk assessment,"[17] "effectvoorspelling" and "gezondheitseffectrapportage" in The Netherlands,"[18] "health aspects of environmental impact assessment" in Canada,[19,20] "Public Health assessment,"[21] "health risk assessment,"[22] the Australian "environmental and health impact assessment,"[11] and New Zealand's "health impact assessment."[23]

The list includes prospective impact assessment in the stricter sense, for example, the approaches of WHO-Europe[7] and the Australian approach,[11] as well as generic quantitative risk assessment, such as the approaches of the U.S. Environmental Protection Agency[17] and the Agency for Toxic Substances and Disease Registry.[21] The approach[22] of the California Air Pollution Control Officers Association seems to be unique in applying quantitative risk assessment prospectively to development projects.[24]

The current EHIA situation in Germany was examined by means of document analysis and postal survey. In an existing collection of environmental impact assessment documents, all documents dealing either with transportation or waste disposal projects were analyzed.[25,26] This set contained 51 EIA documents concerning transportation, including 46 highway projects and 5 rail projects, as well as 20 documents concerning waste disposal, including 8 dump site projects, 10 incinerator projects, and 2 recycling plants. The document analysis was performed as a screening version for all documents and then as an in-depth version for a subset of documents. The screening analysis found limited or missing coverage of human health aspects in the majority of documents. The in-depth analysis confirmed a lack of systematic approaches. In summary, the coverage of human health aspects in the documents tended to be highly incomplete.

To investigate the involvement of the Public Health Service in prospective impact assessment, a survey was performed covering the local health departments in the state of North Rhine-Westphalia.[13] From the total of 54 local departments, 46 (85%) responded to a questionnaire survey. Three years after environmental impact assessment enactment in Germany, 41% of the departments had never participated in this procedure. The health departments were also asked about access to data regarding exposures and health effects. Whereas data on exposures to chemicals seemed often available, data on other exposures, for example, noise, and also on health effects were mostly missing. The need to receive EHIA training was widely accepted. Ninety-one per cent of the

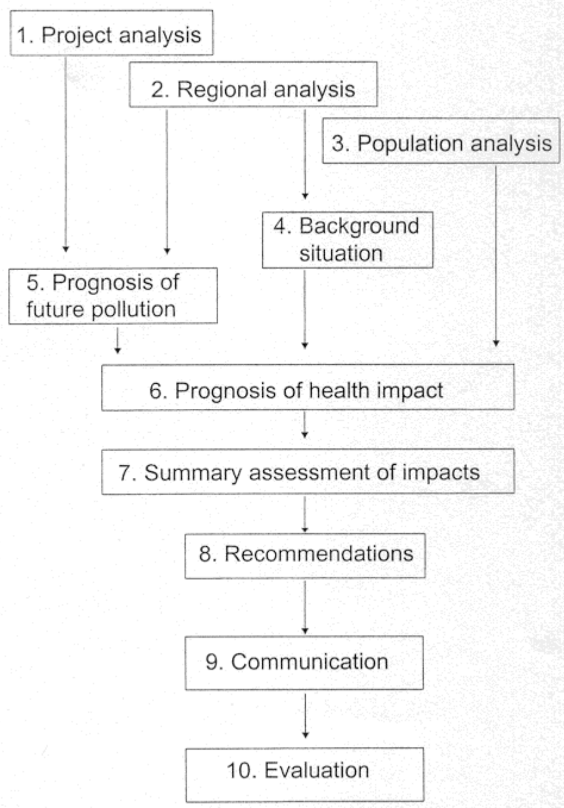


FIGURE 1. Environmental health impact assessment: ten-step model approach.

health departments expressed the need for training, especially in methods (87%), procedures (67%), and tools (63%).

In summary, the survey showed the Public Health Service to be highly motivated to engage in EHIA. At the same time, because of the inherent complexity of EHIA, the survey demonstrated the need to provide guidance. The demand of a feasible procedure for inclusion into the "tool box" of local health departments became obvious and triggered the refinement of the integrated EHIA approach.

## Integrated EHIA Approach

The following components were identified as key elements of an integrated EHIA model: (1) analysis of status quo, (2) prediction of impact, and (3) assessment of impact. In addition, there is a need for communication of the results and for evaluation of the overall procedure. On the basis of elements of several of the approaches mentioned above, a "generic" EHIA concept was designed.[12,13] With appropriate adjustments both for specific project types and to local situations, this concept is meant to be applicable to a wide range of development projects.

The model consists of 10 steps (Figure l), which build on each other. Project analysis is expected to cover both

**TABLE 1. Steps 1 and 2 of the Ten-Step Environmental Health Impact Assessment, Illustrated by Two Applications**

| | Extension of Waste Disposal Site | City Bypass Road |
|---|---|---|
| 1. Project analysis<br>• Project specification in qualitative and quantitative terms<br>• Expected emission of chemicals, odors, noise, microbes, and other hazards | ▪ Additional waste disposal area of 16.9 hectares annually to receive 240,000 tons<br>▪ Complex physicochemical processes within waste site<br>▪ Discharge ofiases, fluids, dust, microbes, an fungi<br>▪ Stack emission of inorganic and organic chemicals<br>▪ (Un-)treated leachate<br>▪ Truck-related emissions, including noise, injury hazard | PPlanned city bypass road: seven routing variants (length of 6,163-6,628 m), daily traffic flow of 10,000-28,000 vehicles<br>PAnticipated relief function of inner-city areas<br>PEmission of benzene, soot, $NO_2$, CO, etc.<br>PEmission of noise and vibrations<br>PInjury hazard from traffic crashes |
| 2. Regional analysis Physiogeography, natural features Anthropogenic features, land use Study area(s) | ▪ Rural county of Hildesheim<br>▪ Four villages in the vicinity of waste disposal site<br>▪ Study area: hilly profile; dominant land use: agriculture; federal highway (Autobahn) crossing the study area | PCity in the Northwestern part of the Rhinelands<br>PStudy area A: mixture of agricultural use and residential area<br>PStudy area B: inner-city area, to be partially relieved from current traffic |

$NO_2$ = nitrogen dioxide; CO, carbon monoxide.

normal operation and accidental releases and aims at the characterization of expected hazards, including acute toxicity and carcinogenicity. Regional analysis refers to physiogeography, meteorology, natural features, and land use and includes a definition of the study area for further investigation. The population is described by size, age, gender, health status, and behavioral patterns, for example, food consumption patterns and hobby activities. In step 4, the background situation is characterized on the basis of the preceding three steps and on environmental monitoring of existing pollution.

Using analogies and dispersion modeling, the next step refers to prognosis of future pollution, including air, surface and ground water, soil, flora, and fauna. On this basis, prediction of health impacts is attempted. Obviously, this step (step 6) is a key component of the whole procedure. It consists of three interrelated components. First, there is a qualitative assessment of changes concerning neighborhood features and quality of life as well as citizen concerns. In accordance with common scientific reasoning, a distinction is then made between agents for which a "threshold" of exposure can be defined vs other agents without this feature. Second, for threshold agents, predicted levels of chemical pollution and intensities of other agents, such as noise, are being compared to appropriate (for example, medium-specific) limit values. For these agents, the assessment is implied in the comparison of the predicted values vs limit values. As a third component, for nonthreshold agents, especially carcinogens, quantitative risk assessment is necessary, including all relevant pathways and agents. In addition to the quantitative estimate of risk, decisions are needed on "acceptable additional risk." A commonly used level is a risk of $10^{-5}$, ie, one additional lifetime cancer case per 100,000 persons exposed. In the next step, a summary assessment of the predicted health impacts is given.

On the basis of all the information of the preceding steps, recommendations are given concerning planning alternatives, emission control, monitoring, public information, postproject analysis, etc. Considering the complexity of the overall procedure, the numerous details of the methods and the range of assumptions involved, it is no easy task to communicate the results. EHIA demands special efforts to communicate the underlying assumptions, the resulting predictions, and the assessments correctly and efficiently to all parties involved, including planners, decision makers, and the public at large. Risk comparisons and visualization methods may be helpful in this respect. Whenever one of the project alternatives that were scrutinized by EHIA is actually put into reality, the opportunity arises to evaluate EHIA methods and assumptions. This can be done by comparing the predicted impact to the actual situation, for example, by establishing specific monitoring procedures and continually evaluating the state of the environment as well as human exposures and health outcomes.

## Field Applications

The ten-step model described above was first applied to the enlargement of an existing waste disposal facility in Lower Saxony. Another model application refers to a highway planned in the City of Krefeld, North RhineWestphalia.

Regarding the planned extension of a nontoxic waste disposal site, [27] a task force on EHIA was formed, and the ten-step EHIA model approach was applied. Selected results of the first four EHIA steps are summarized in Tables 1 and 2. Even in the "common," nontoxic waste disposal site, complex physicochemical processes take place, depending on the waste composition, including solubility and volatility of components, on humidity, acidity, and temperature. These processes last for long time spans (decades) beyond the filling phase of the disposal site. They strongly change over time and involve discharges of gases, dust, microbial contamination, and fluids (leachate). In the typical case, gases are col-

**TABLE** 2. Steps 3 and 4 of the Ten-Step Environmental Health Impact Assessment, Illustrated by Two Applications

| | Extension of Waste Disposal Site | City Bypass Road |
|---|---|---|
| 3. Population analysis<br>▪ Size, composition<br>▪ Health status<br>▪ Behavioral patterns | ▪ County population: 287,000<br>▪ Study area population: 5,863<br>▪ Vulnerable populations, indicated by two hospitals, four nursery schools (N = 144), three schools (N = 388), and playgrounds and sportsfields<br>▪ Local food production, including gardening, fishing | ▪ City population: 248,000<br>▪ In addition to vulnerable populations documented in the environmental impact assessment, a senior citizen home was identified<br>▪ Traffic-related injuries in 1994: 66 cases in study area A and 65 cases in study area B, including 1 fatal case in each area |
| 4. Background situation<br>▪ Environmental monitoring<br>▪ Existing pollution<br>▪ Identification of additional data needs | ▪ Existing waste disposal site located on a hill, with one of the villages located downhill<br>▪ Treated leachate currently discharged into creek that crosses a village and is tributary to river used for fishing<br>▪ Elevated lead concentration in river sediment, probably from mining in the Han mountains<br>▪ 14 documented sites of contaminated soil in the area No indication of existing relevant emissions, no outdoor air | ▪ Emission from vehicles using the existing roads<br>▪ Long-distance transmission from residential and industrial sources, including chemical industry and energy production<br>▪ In study area B: several industrial emission sources<br>▪ Telemetric outdoor air measurement station of statewide 'TEMES" system<br>▪ Existing noise levels (day/night) according to noise control program (1992): elevated noise levels in several parts of study area B |

lected and incinerated, resulting in stack emissions composed of a variety of inorganic and (chlorinated) organic compounds. In addition, trucks delivering waste will travel to and from the waste disposal site, so traffic emissions (chemicals and noise), and traffic-related injuries also need to be considered.

The second EHIA application reported here refers to a planned major bypass road in the City of Krefeld.[28] Because of a long-standing problem of traffic congestion within inner-city areas of Krefeld, plans were made to build a bypass road, relieving inner-city areas partially from traffic flows. The environmental impact assessment procedure for the bypass road took six different routes into consideration. Changes of traffic flow had been computed using two different planning scenarios, the first of which implied constant numbers of employees in the area, whereas the second scenario implied slightly increased numbers in future years. The environmental impact assessment had led to the recommendation of one specific route alternative (variant No. 6).

For the EHIA, we selected two of the route variants and added the "null" variant, *ie,* the option to build no additional city bypass road at all. These three variants were studied in both study area A, *ie,* the area potentially impacted by the new bypass road, and study area B, *ie,* the area potentially relieved from traffic. In both study areas, receptor points were defined for each routing variant. Selected results of the first four steps of EHIA for this project are summarized in Tables 1 and 2, in a parallel way to those of the waste disposal project.

Results concerning the predicted changes of pollution levels and the health impacts are shown for both projects in Tables 3 and 4. For the extension of the waste disposal site, the prognosis of future pollution levels was based on extrapolations of measurements of current emissions from existing disposal fields, supplemented by data from the technical literature. "Receptor points" corresponding to the four villages in the study area were defined, and dilution factors were obtained from modeling results performed by an outside agency (TOV Hannover Sachsen, using the Miktoskaliges Klima- und Ausbreitungsmodell (Microscale Climate and Dispersion Model). For all receptor points, the predicted air concentrations were below recognized limit values. It was calculated, however, that in a neighborhood close to the waste disposal site, 1,1-dichloroethane concentrations and hydrogen sulfide concentrations would surpass current limit values. Although these concentrations would

TABLE 3. Step 5 of the Ten-Step Environmental Health Impact Assessment, Illustrated by Two Applications

| | Extension of Waste Disposal Site | City Bypass Road |
|---|---|---|
| 5. Prognosis of future pollution levels<br>▪ Prognosis of chemical and physical agents<br>▪ Coverage of environmental media and food chain, where indicated | ▪ Gas discharges: selection of inorganic and organic chemicals, including a total of eight carcinogens<br>▪ Model-based estimation of dilution factors* for four receptor points<br>▪ Noise from trucks delivering waste (assessed for 12 places): additional 3.2 db (A) in 1 place (nonresidential neighborhood); <1.6 db (A) in all other places | • Outdoor air concentrations predicted by different models in densely built-up vs other areas<br>• Additional chemical pollution in study are A: small for benzene and soot, large for NO2 in some places<br>• Reduction of chemical pollution in study area B: <5% in most places<br>• Prognosis of elevated night noise levels for residential areas |

$NO_2$ = nitrogen dioxide.

* Modeling performed by TÜV Hannover Sachsen.

**TABLE 4. Step 6 of the Ten-Step Environmental Health Impact Assessment, Illustrated by Two Applications**

| | Extension of Waste Disposal Site | City Bypass Road |
|---|---|---|
| 6. Prognosis of health impact | | |
| (a) Comparison with media-specific limit values<br>• Comparison of ambient concentrations of chemicals with limit values<br>• Comparison of other hazards with limit values | ▪ Predicted air pollutant concentrations for all receptor points (ie, villages) below available limit values<br>▪ Leachate containing a variety of toxic substances, underlining the need of efficient purification and continuous control<br>▪ Additional noise burden insignificant in residential areas | ▪ Using the least favorable receptor point for each route variant<br>▪ Predicted concentrations below legally binding limit values<br>▪ Increased noise exposures of residential areas in study area A, including senior citizens' home<br>▪ Potential moderate noise reduction in study area B |
| (b) Quantitative risk assessment (QRA)<br>▪ QRA for carcinogens, including all relevant pathways and chemicals | ▪ Pathways: air, soil, dermal exposure, meat, milk, water, fish<br>▪ Individual additional lifetime cancer risks: maximum risk 1.3 x 10` for air pathway in one village, all other risks <1 x 10-6 per pathway<br>▪ Estimated cancer burden of <0.01 additional cancer cases in the study area during "active" period of disposal site (70 years) | ▪ Simplified risk assessment, restricted to air pathway and two carcinogens (benzene, Diesel soot)<br>▪ Four receptor points (three in study area A, one in study area B)<br>▪ No noticeable increase in cancer risk in study area A<br>▪ Potential slight reduction of cancer risk in study area B |

not lead to significant exposure of the resident population, the finding may be relevant for waste disposal workers. The leachate was found to contain a variety of toxic substances, thus underlining the need for efficient purification and continuous control. Traffic noise levels were predicted to increase by 3.2 dB(A) in one place and <1.6 dB(A) in several other places.

Concerning the prognosis of impacts, a qualitative assessment was prepared in close cooperation with the local health department, medical practitioners, and local citizens and included concerns about odors as well as a loss of recreational functions. Because of compliance of predicted environmental burdens with relevant limit values, specific negative health effects from threshold agents were not expected to take place.

As for carcinogenic effects, a quantitative risk assessment based on the following eight chemicals was performed: benzo(a)pyrene, benzene, dichloromethane, trichloromethane, dioxins (toxic equivalents), ethylene trichloride, ethylene tetrachloride, and vinyl chloride. Using the Health Risk Assessment computer program," the exposure analysis was based on a wide range of pathways, including air, soil, skin, meat, milk, water, and fish, and calculated individual cancer risk for 70 years of exposure, as well as cancer burdens of the four villages. In this analysis, maximum emission of burned gas over the whole study period was assumed, although in reality the true level of emission is lower for much of the time. Under these health,conservative assumptions, for the study area, the additional cancer burden caused by the waste site emissions over a 70-year operational period was calculated to be below 0.01 additional cases. The estimates of the additional lifetime cancer risks in the four villages are shown in Fig. 2.

Similarly, the change of pollution levels and the resulting health impacts were predicted for the city bypass road project in Krefeld (Tables 3 and 4). Outdoor air concentrations were predicted using the appropriate models for densely built-up areas (SR1,92 model29 ) and for other areas (MI-uS-92 mode110 ). Detailed examination was performed for five receptor points, ie, two in study area A and three in study area B, including the prognosis of carbon monoxide, benzene, nitrogen dioxide, lead, sulfur dioxide, and diesel soot as a function of estimated future traffic flows. According to the models used, the predicted additional burden of pollutants in study area A is small or even unnoticeable, except for nitrogen dioxide, which would increase by about 5070% at the receptor points. For both routing alternatives that were studied in detail, the benzene and diesel soot concentrations at the most unfavorable receptor points were predicted to be 60% and 230% higher than the recommended values, respectively.[31] Concerning study area B, the predicted reductions were mostly smaller

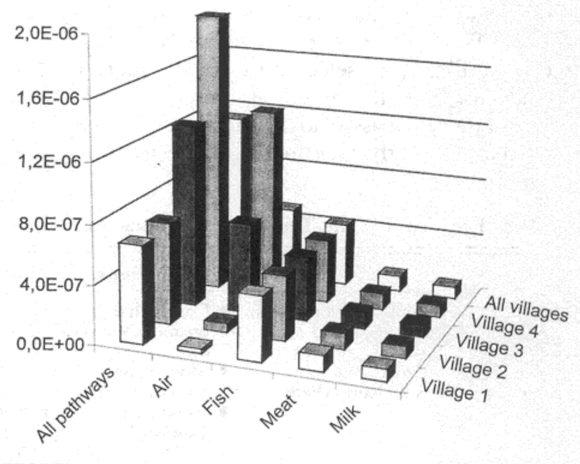


**FIGURE 2.** Waste disposal site extension project; estimates of additional lifetime cancer risks in four villages, by pathway. Numbers on the vertical axis are the estimates of additional lifetime cancer risks, by village and pathway.

than 5%, and very little difference between route variants 1 and 6 was found in this respect.

Concerning the noise impact of the various bypass road options, variant 6 affects longer stretches of (planned) residential area and areas of higher population density.

In both model applications, the prediction of future exposures turned out to be the hardest part of the exercise. In the study concerning the waste disposal site, it was necessary, for example, to estimate the fractions of diet produced at home. A smallscale survey showed these fractions to vary considerably. For example, the fraction of eggs produced on site ranged from 10 to 100%, and the fraction of meat varied between 10 and 30%. For risk analysis, the individual estimates were averaged. Another important source of uncertainty refers to the long-range prediction of discharge from the waste disposal site. Although it is known that there will be considerable decreases of gas and leachate emissions after initial peaks, the expected maxima were applied to establish a safety margin. As a consequence, true exposures may be about 45% lower than in our model. On the other hand, by limiting our analysis to the eight carcinogens listed above, we incur a chance of underestimation, although there is no evidence that inclusion of additional carcinogens would have changed the result significantly. Similar reasoning holds for the bypass road project. Methods to handle uncertainty as well as true variation more adequately and to produce interval estimates were not available to us at the time when these analyses were done.

On the basis of the predictions outlined above, both EHIAs included a number of recommendations. Concerning the extension of the waste disposal site, the recommendations can be summarized as follows. (1) As for emission and exposure reduction, inactive surface areas of the disposal site should be sealed as early as possible. An existing water well in close downhill vicinity of the disposal site should be closed, except for groundwater monitoring. Because of current high levels of noise exposure in several parts of the study area, traffic noise control measures should be considered, even without the extension of the disposal site. (2) Monitoring measures should include the amounts and concentrations of gaseous dumpsite emissions; of leachate, treated wastewater, and creek water; and of the health status of village population and dumpsite workers. In addition, and independent from the project under study, existing contaminate0 sites in the study area containing galvanic sludges should be examined in detail. (3) Finally, there should be increased transparency on all emissions, including periods of temporary malfunction of the incinerator or of the leachate treatment plant.

Concerning the city bypass road project, recommendations included the following items. (1) More consideration should be given to the "null" variant. The environmental impact assessment should be extended in this respect. (2) Variant 6, which was favored by environmental impact assessment, should be abandoned, because a relatively large population would negatively be affected, especially by noise exposure. (3) In addition to the impact of changes of traffic flows, the impact of noise control measures should be modeled prospectively to improve the basis for decision making. (4) If any bypass variant were actually to be built, monitoring measures should be implemented.

## Study Results and Conclusions

The two applications presented in the previous section illustrate features of EHIA, including problems and limitations. EHIA can refer to an "isolated" project, which will either be implemented or not, as in the first application described above. In this case, the examination of other siting options, of alternative waste disposal procedures, and of waste reduction measures was excluded. Accordingly, there was only one study area, restricted to the environs of the site under examination. Alternatively, EHIA can refer to a set of project alternatives. For the second application described above, six alternate bypass routes were under discussion. Because of an anticipated relief function for inner-city areas, it was necessary to define two study areas: one of these had to be considered because of potential negative impact from the new bypass road, and the other area with respect to potential relief effects. Obviously, the scope of project alternatives to be studied will have implications for the definition of study areas.

Likewise, the range of hazards to be studied needs careful consideration. For a traffic project, the minimum list includes chemical air pollution, traffic noise, and injury hazard from traffic crashes. For a waste disposal project, the spectrum of relevant air pollution components includes gases, fluids, dust, microbes, and fungi. In addition, because of waste delivery, the problem of traffic exhaust, noise, and injury hazard arises here, too. The emissions from waste disposal sites differ from traffic emissions in several respects. Whereas vehicle emissions and their determinant parameters, such as traffic flow, engine technology, and catalytic converters are largely known, there is more uncertainty concerning waste site emissions, especially in future decades and beyond. Long-term predictions of waste disposal sites would need to cover a century and more; this is a problem, because disposal sites of current type were not introduced until about 20 years ago, which implies insufficient time for long-term observations.

Adequate modeling of pollutant dispersion and of human exposures will often require interdisciplinary cooperation. There is limited availability of multimedia exposure modeling procedures. Required input data, such as data on local food production, etc, may lack reliability or may be unavailable altogether.

In our field applications, the ten-step EHIA model approach was found to work. Positive responses were received especially from local health departments. The ten-step approach was formally approved and recommended by the German Conference of State Health Ministers.

Currently, however, the coverage of human health aspects in environmental impact assessment still tends to be incomplete. Possible reasons include the following: complexity of the task of prospective impact assessment; insufficient provision of specific methods, tools, and instruments; inadequate access to data that are both current and reliable; and lack of systematic evaluation of EHIA applications.

TO date, public health departments often seem to be left out of participation, especially from the initial "scoping" step, which is of crucial importance for the whole EHIA procedure. Despite the difficulties mentioned above, public health departments were found to be willing to participate in EHIAs, and they strongly expressed their training needs.

For most of the ten procedural steps described above, there is a range of information tools and resources, such as inquiry systems or exposure-modeling programs that can facilitate practical work.` The feasibility of EHIA is likely to be increased by identifying, adjusting, and evaluating such tools and then providing an adequate selection, for example, as components of environmental health information workstations.

## Perspectives

Prospective health impact assessment cuts across several disciplines, combining elements of epidemiology, toxicology, mathematical modeling, and quantitative risk assessment. It is difficult to properly assess the value of EHIA for health protection and promotion yet, while avoiding pitfalls of both overestimation and underestimation of the value of EHIA. As a rule, the prediction of health impact will tend to be incomplete, and the assessment of the predicted impacts by necessity implies subjective decisions. In addition, it may be difficult to successfully introduce the EHIA results into the process of decision making where many other aspects (for example, economic considerations) also call for attention. On the other hand, there is a chance of underestimating the role of EHIA, because the very existence of this procedure may already exert influence on decision makers. These opportunities for health protection and promotion offered by prospective impact assessment seem to be underutilized.

EHIA, by its scope and nature, depends on efficient interdisciplinary cooperation. Epidemiologic skills are essential for the completion of steps 3, 4, 6, and 10. The analysis of the background situation (step 4) is similar to a standard community diagnosis, and the impact prognosis (step 6) relies heavily on epidemiologic input, especially for exposure estimation. Step 10, where feasible, draws on epiderniologic techniques developed for program evaluation. Still other steps of the procedure, such as the weighing of evidence in steps 7 and 8 and appropriate communication with decision makers and the public (step 9), may benefit from the experience of professional epidemiologists.

The results of this project lead to the following conclusions. For the sake of improved feasibility, the overall EHIA procedure needs to be broken down into manageable components. It would be useful to achieve consensus on a coherent concept of comprehensive EHIA. On the basis of such a generic EHIA concept, specific standards and recommendations for each type of development project are desirable, for example, concerning highway projects, waste disposal projects, etc. Specific recommendations are particularly needed for the scope of noxious agents to be covered in EHIA. To reduce current problems related to (health) data access, the existing systems of surveillance and health reporting could be improved. Health departments should regularly be involved in the scoping and, if necessary, in the subsequent complete EHIA procedure. To handle uncertainty and true variation of parameters (for example, concerning exposure assessment) more adequately, new approaches of probabilistic modeling should be explored.

For gradual improvement of current approaches, EHIAs need to be systematically evaluated, including postproject analysis. There is a need to develop specific EHIA training programs to exchange theoretical concepts and to accumulate practical experience.

An international initiative to improve the situation seems worth some consideration. A collaborative project on EHIA might deal with the following topics:

- Status quo analysis, concerning EHIA needs, legal frameworks, and existing approaches;
- Development of an assessment concept, covering both health risks and health benefits;
- Recommendations concerning a standard procedure, quality criteria, and evaluation strategies;
- Development of specific tools and resources, including software and databases; and
- Provision of dedicated EHIA training programs.

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