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DEVELOPMENT OF A NATIONAL HEALTH AND ENVIRONMENT GEOGRAPHIC INFORMATION SYSTEM (HEGIS) FOR COUNTRIES IN CENTRAL AND EASTERN EUROPE

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ENVIRONMENTAL HEALTH MANAGEMENT

By the year 2000, there should be effective management systems and resources in all Member States for putting policies on environment and health into practice.

ABSTRACT

The participants attending the Consultation on the Development of a National Health and Environment Geographic Information System (HEGIS) for Countries in Central and Eastern Europe agreed that health and environment information systems, on both national and international levels, are useful tools for systemic collection, analysis and interpretation of health and environmental data. However, their objectives differ depending on the level of data aggregation involved. (a) At a European scale, HEGIS is a tool for health risk assessment and management of the main known environmental hazards. Assessments of the impact of environmental pollution on human health can be made by extrapolating the results of epidemiological studies (where these are consistent), taking into account the uncertainties in the data, and using the estimated population exposure to levels above the European guideline values. (b) At national and subnational level, the aim of HEGIS is to describe country-specific environmental health profiles and to forecast trends as a basis for developing national priorities, carrying out environment health impact analysis, and evaluating the cost-effectiveness of interventions. (c) At the local ("small area statistics") level HEGIS can also help to identify associations between adverse health effects and environmental and other (confounding) factors, based on epidemiological investigations of exposure-response or exposure-effect relationships, or on environmental impact assessments. Two categories of indicators can be defined for use in HEGIS: Environment-Related Health Indicators (ERHIs) relate to health outcomes which may suggest an environmental cause, or a contribution from environmental factors; Health-Related Environment Indicators (HREIs) describe definable environmental conditions or trends which suggest potential harmful health effects. The participants agreed in principle on a core set of ERHIs, suitable for international comparison. These comprise: the actual number of residents, number of births including children with low and very low birth weight, number of deaths including cause-specific and infant mortality, perinatal mortality, morbidity according to some notifiable diseases. Participants exchanged experience of national HEGIS development, as well as information on case studies, and discussed the feasibility of data collection and dissemination of the information using the DISCET software. The urgent need for the development of a core set of HREIs, as well as methodologies for health risk assessment, at different level of data aggregation, was emphasized.

Keywords

INFORMATION SYSTEMS
ENVIRONMENT HEALTH
HEALTH STATUS INDICATORS
CCEE

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INTRODUCTION

To develop and implement policies on the environment and health that ensure ecologically sustainable development, effective prevention and control of environmental health risks, and equitable access to healthy environments, is one of the main targets in health for all policy for Europe. This requires the establishment of systems for linking environment and health information to monitor and assess environmental impact. The need for the development of European environmental health information systems as a means of improving the relevance, quality and availability of data on the health-related environment is highlighted in the Environmental Health Action Plan for Europe (endorsed by the Second European Conference on Environment and Health in Helsinki, 20-22 June 1994). For this purpose there is also a need throughout the Region to develop or improve national information systems, including National Health Environment Geographical Information Systems (NHEGIS).

For these purposes the following actions are required on behalf of WHO:

- to encourage the use of a set of core indicators, when available, for EH monitoring throughout the Region;
- to help Member States to develop appropriate and harmonized HEGISs, incorporating adequate procedures for data quality assurance and control;
- to ensure that, in future, environmental monitoring and data collection provides information that better reflects actual human exposures to environmental agents, as a basis for assessing potential environmental impacts on health;
- to cooperate closely with Member States and with other relevant organizations in ensuring that national environmental health databases are compatible and accessible, having regard to the overriding right to confidentiality of the citizen.

A WHO Consultation on the Development of a National Health and Environment Geographic Information System (HEGIS) for Countries in Central and Eastern Europe was held in Bilthoven from 13 to 15 December 1994. This was organized as a follow-up to the Consultation on the Concept of Health and Environment Geographic Information System (HEGIS) for Europe and Requirements for Indicators held in Bilthoven from 8 to 9 November 1994. It brought together national representatives from focal-points, responsible for NHEGIS development, experts in epidemiology, information systems, demography, health and environment from different countries, and staff members from WHO regional office. The meeting was chaired by Dr Gerhard Fulop; Professor Dr Yuri I. Kundiev served as Vice-Chairperson and Professor David Briggs was Rapporteur. The working papers and the participants are listed in Annexes 3 and 4, respectively.

The objectives of the meeting were:

- to promote the development of pilot HEGIS programmes in Central and Eastern European countries;
- to identify procedures for the harmonisation, collection and analysis of environmental health indicators in Europe.

To this end, the meeting aimed to:

- finalize the concept of the Health and Environment Geographical Information Systems (HEGIS) for Europe

- review current progress in developing HEGIS for Europe and in some Member-States
- agree upon a core set of Environment-Related Health Indicators (ERHIs)
- formulate a strategy for data acquisition in support of HEGIS

DISCUSSION

HEGIS concept and applications

The need for HEGIS is based on the presence of marked geographic variations in population exposure to different environmental hazards - variations which reflect the geographic diversity of industrial and agricultural activities, living conditions and urban/rural differences in the Region. It is widely recognised that estimation of the impacts on health of the population of environmental agents requires both information on exposures at the possibly lowest level of aggregation, and knowledge of the quantitative relationship between exposure and health effects. In this context, one of the main functions of HEGIS is to pin-point "hot spots", with environmental degradation and/or poor health, as a basis for taking ameliorative or preventive action, at the national or international scale, under the umbrella of Health Action Plan for Europe.

Member-States are free to develop their own information systems, together with indicators for specific applications. Comparability between countries is only required insofar as comparison is necessary within the context of international policy. The role of the WHO Regional Office is to enhance the availability and comparability of health data across Europe by encouraging harmonization, improving data standards, developing new methodologies for information collection and analysis, and encouraging the establishment of national HEGIS.

An essential characteristic of HEGIS is that the data needs to be georeferenced in a consistent yet flexible manner. Georeferencing of data adds considerably to the costs and efforts of data collection and capture, so needs to be undertaken sparingly. On the one hand, as noted, there is a need to obtain data at the lowest possible level of aggregation; on the other hand, it is important to avoid imposing unnecessarily stringent requirements on the data. It is therefore important to be realistic about the potential scale of application of the system from the outset, so that redundancy in the data can be minimised. Equally, it is important that users are aware of the limitations implied by the geographic scale and resolution of the data which are available.

At a European scale, HEGIS can perform two main functions: it provides a tool for health risk assessment, and a means of environmental monitoring and health surveillance as a basis for identifying and managing the main known environmental hazards. Assessments of the impact of environmental pollution on human health at a European scale require the extrapolation of results from epidemiological studies (where these are consistent). In the process, it is vital to take account of the uncertainties involved, and to base assessments on the estimated population exposed to levels above the European guideline values. The lowest level of aggregation at which geocoded health and demographic age-specific information is available for this purpose is normally NUTS level III or equivalent and sometimes cities with the population beyond 1 million.

At national and subnational level, the aim of HEGIS is to help construct country-specific environmental health profiles and forecast trends, as a basis for:

- developing national priorities
- carrying out environmental health impact analysis
- assessing the cost-effectiveness of interventions, as required for national evaluation or for international environmental policy development
- monitoring national progress in the implementation of environment health action plans.

The level of aggregation of geocoded health and demographic information required for these purposes is lower than that for analysis at the European Regional scale, but is inevitably dependent on the needs of the Member State concerned.

At the local ("small area statistics") level, HEGIS can also help to link information on adverse health effects to data on environmental and other (confounding) factors, as part of analytical epidemiological investigations or environmental impact assessments.

HEGIS current status, problems and development issues

The system is located at the Bilthoven Division of ECEH, linked to the RIVM network. In the near future, HEGIS will be integrated on the Bilthoven LAN which is linked by ISDN to the WHO Regional Office LAN in Copenhagen and WHO-ECEH LAN in Rome and in Nancy, and via Internet to WHO-HQ in Geneva and RIVM.

The system is based on the ARC/INFO Geographical Information System, supported by the UNIFY/ACCELL relational database management system. The Hardware platform is a UNIX work station. Spans and SAS are also available.

Data are provided by a range of international and national agencies including: WHO, UN-ECE, UNEP, EU-EEA, EUROSTAT, OECD, national ministries of health, national ministries of environment, institutes of hygiene, national central statistical offices, NGO's, environment protection agencies and focal points.

Currently, HEGIS contains population, mortality demographic and some socio-economic data at national and subnational level (mainly NUTS II/III) for 1980/81 and 1990/91 for most European countries. Geographic data include administrative boundaries (NUTS 0 /I /II /III). Some problems exist with the present data in that the regions vary greatly in size and population both between and within countries. The WHO-EURO region also extends far beyond the range of the existing European data.

In addition some data on air pollution (measured concentrations of NO_x, SO₂, TSP, ozone etc.) and city populations are available. Emission data have also been used in association with long-range transport models to map pollution excesses (e.g. to NO₂, ozone). When combined with population data, these provide estimates of the numbers of people exposed to excess pollution.

On the European scale, issues of comparability arises when using demographic data and health statistics due to differences in the definitions used (e.g. of urban and rural population), diagnosis, and coding and recording of mortality and morbidity data in different Member States. The first obstacle can be overcome by adopting a pragmatic definition of urban and rural populations: for example, populations living in cities of 50,000 inhabitants or more may be classified as urban, while those living in towns or villages of less than 50,000 inhabitants may be

defined as rural. The quality of mortality and morbidity notification depends to a large extent on the system of health care in the different Member States.

There is a danger that GIS techniques can be misleading when data on environment and health are superimposed and interpretations are made without consideration of other factors (e.g. lifestyle, socio-economic...). The key application of the system is thus to expose and highlight variations in risk (e.g. as expressed by environmental pollution, lifestyle, health outcome etc.), as a basis for monitoring the effects and effectiveness of policy action and to target policy at specific areas and problems. Harmonisation and improved documentation of data are crucial in this context. Explanations for these variations and their relationships should, however, be sought not by interpreting the aggregated data, but through detailed epidemiological or other investigations. In this sense HEGIS should also direct research to unexplained variations and trends.

Participants agreed that HEGIS could provide a valuable framework and tool for describing country-specific environmental health profiles as a basis for national priority setting. It can also be useful for forecasting trends, for environment health impact assessment, and for evaluation of the cost-effectiveness of interventions. The system will similarly be able to monitor national progress in implementation of environment health action plans and, at the same time, the effects of the economic and political changes currently taking place in the countries concerned. These same changes, however, may be expected to generate difficulties in setting up the system and in obtaining consistent data.

Another valuable contribution of HEGIS will be to encourage collaboration, communication and data exchange between national agencies (e.g. Ministries of Health and Environment), and between different regions and countries. Traditional divisions and rivalries between the different authorities - many of whom have overlapping responsibilities - will, however, need to be overcome in many cases.

HEGIS will also provide a powerful means to disseminate information. In this way it will help to encourage participation of different policy actors (including the public, government agencies, scientists) in the policy process.

Developing and using HEGIS both requires, and will generate, a wide range of new expertise and experience. Training and exchange of experience will be vital requirements to ensure effective use of HEGIS and will be an important vehicle for developing the levels of expertise and understanding of users.

National experience and case studies

Austria

UGIS (Umweltbezogenes Gesundheitssystem für Österreich) is a national HEGIS for Austria. Its main goal is to collect and organize data on the environmental health status in Austria as a basis for directing preventive measures in environment and health. The system is currently in its second version, and is being further modified and developed for version 3.

Software comprises two main elements: a desktop mapping system (MapInfo) and a statistical package (Minitab). Information is linked through a data dictionary, which provides

definitions of all available data. Most area data are owned by the Central Statistical Office or Ministry of Health of Austria.

The system contains several hundred indicators, organized into five main modules:

- i. GEODAT - basic geographic data (e.g. administrative boundaries, topography)
- ii. SOZDAT - socio-economic data
- iii. UWDAT - environmental indicators (e.g. population density, air pollution, drinking water quality, forest damage)
- iv. GESDAT - health data, including mortality and morbidity (e.g. hospital admission, survey data, traffic accidents)
- v. GESVAT - regional health care information (e.g. GP's, emergency services, hospital beds)

Data are aggregated at four main levels: provinces (9 areas); microcensus areas (43 areas; to be replaced by 35 NUTS III regions in the near future); districts (99 areas); communities (2300 areas; populations in these vary from 100 to 200,000 people).

Many environmental data are related to point locations (e.g. air pollution, drinking water contamination, forest damage).

The system is currently being used mainly for the identification of hotspots and clusters of health outcome (e.g. stomach cancer, lung cancer) at the community level as a basis for more detailed investigations.

Bulgaria

Bulgaria is divided into 9 regions (oblast), 248 communities and 29 districts. A national HEGIS is now being developed with participation of the Ministry of Health and the Ministry of Environment at the National Centre of Hygiene, supported by WHO-ECB. This will be based upon ARC/INFO running on a SUN workstation. A stepwise approach is being followed i.e. to start with GIS on a smaller input scale (1:200,000) based on greater aggregation units (districts) and then continuing with smaller aggregation units (communities) on a larger scale.

Mortality data are available at district level from the Ministry of Health and Central Statistical Office; data at community level are available from the district authorities. Morbidity data (contagious diseases, cancers, tuberculosis, sexually-transmitted diseases) as well as other information on absenteeism, self-reported health, hospital admissions etc., are held by the Ministry of Health.

Environmental data on drinking water quality, surface water quality, air quality, atmospheric emissions, etc. is collected and held by a number of agencies within the Ministry of Health, the Ministry of Environment, and the Institute of Hydrology and Meteorology.

Demographic data are collected and held by the Central Statistical Office at both district and community level and may also be available in computerized form. A wide range of socio-economic data is available at community level as well.

Problems exist with basic maps, since co-ordinates accurate to less than 150 metres are classified as confidential. This limits the map scales which can be used.

Czech Republic

Currently a GIS (PC ARC/INFO) is being established within the Ostrava Regional Institute of Hygiene. This has been provided by the US-EPA. The system will be used for environmental risk and impact assessment as part of the joint SILESIA project, with Poland. The main aim of the project is to improve health and living conditions. It covers 5 districts in the Czech Republic, selected to represent environmentally damaged areas. Sub-projects cover air pollution modelling, water pollution modelling, food contamination modelling, cancer risk from coke-oven emissions, and information systems.

To assess cancer risk, GIS are used to combine data on health, socio-economic indicators and emissions. Following the US-EPA methodology, three steps were carried out:

- - identification of hazards of coke-oven emissions based on data from other studies (e.g. levels and sources of cancer risk)
- - establishment of exposure-health risk relationships from coke-oven emissions
- - determination of individual life-time cancer risk (ILTCR) for all cancers in the study area.

Dispersion modelling (using ISCST2) was carried out to assess pollution concentrations for a detailed grid across the area, and these converted to ILTCR using exposure-risk relationships. By overlay with pollution density, this was converted to an estimate of the population-weighted risk (expected incidence) for each urban district. Results from the dispersion model will be compared with PAH concentrations monitored at six cities in the local area; preliminary comparisons for SO₂ for 12 cities across Ostrava show good agreement. Estimates of cancer incidence will also be compared with rates from the cancer register.

Use of the results from the analysis contributed greatly to raising awareness about the problem in the city. As a result, the decision was taken to close two of the coke-ovens by 1999.

Germany

A high level of concern exists about the potential health effects of environmental pollution in Germany and, since environmental pollution in western Europe is generally low, effects are more likely to be detected in morbidity than mortality.

The MORBUS Sentinel Practice Network was set up in 1991 to survey health problems which might be - at least in part - caused by environmental pollution. The study originally covered ca. 100 doctors in the areas of Braunschweig, Hannover and Verden, but has since been extended to include two areas in eastern Germany.

Data were collected through doctors on both childhood and adult symptoms (e.g. expiratory wheezing in children 1-2 years old, bronchial asthma in children, 8 years, dermatitis in adults, asthma in adults). Data are exchanged by mail, PC or the telecommunications network.

The system has been used to investigate a number of issues, including the relationship between air pollution and childhood asthma. No correlation was seen between emission level and prevalence of asthma. Comparison of emission levels with concentrations, however, suggested that the emission data underestimated actual pollution levels. Asthma prevalence did

seem to increase across the first three quartiles of practices, however, ordered in terms of mean exposure.

Hungary

Development of HEGIS in Hungary started at the end of 1992 as an organic part of the Public Health Information System, with the aim of monitoring the environmental effect on health. It is intended to include data on the chemical, physical, biological and microbiological environment, as well as on infectious and non-infectious diseases.

The system comprises the ARC/INFO GIS; hardware includes a UNIX workstation and server, linked to PCs.

The national HEGIS will include the following data organized in several modules:

- i. - basic data - administrative boundaries, topography, settlements, road network, register of physicians and health care units, etc.
- ii. - population data - distribution of population by sex, age-group, place of residence, education, income etc.
- iii. - health data - morbidity, mortality, birth defects health status indicators (cholesterol, overweight, vital capacity) etc.
- iv. - life style data - nutrition, smoking habits, alcohol, coffee consumption, etc.
- v. - environment data - natural: air, surface water, soil, and artificial: drinking water, food contamination, buildings, communal waste etc.

Data are aggregated at a number of different levels, including: counties (20 areas), communities (3000 areas) and individual points. Health data are postcoded.

The system will be used for:

- - data description and mapping, based on simple inspection and classical statistical analysis of the data
- - identification of hotspots (by displacement of data geographically)
- - simple spatial analysis (e.g. buffering around point emission sources, derivation of probability maps, generation of contour maps etc.)
- - advanced spatial analysis (e.g. identification and analysis of health clusters, intersection of environment and health)

Poland

In the past, mapping of health has been carried out using in-house systems. The first GIS was a PC-based Polish system, prepared by the military authorities, and including 1:50,000 scale base maps. Through collaboration with the EU-funded SAVIAH project, ARC/INFO has now been purchased, running on a SUN workstation. Data from the previous system have now been transferred to ARC/INFO, partly due to WHO-ECB collaboration. Mapping has been carried out of health and socio-economic indicators at voivodship level, and correlations have been assessed between socio-economic factors and health outcome. No attempts have yet been made to link environment and health at the voivodship level.

Though in its early stages of development, the system comprises more than 300 indicators for the last 3 years. In the framework of the SAVIAH project, it has also been used in the project

of investigating air pollution impact of SO₂ and NO₂ on health outcome of children, taking into consideration home conditions in the city of Poznan.

The Polish health information system is based on individual records and allows the collection of information at the lowest administration level - the gmina. The list of Polish health service indicators consists of:

- i. - demographic data (total number of population by age and gender, live births, death by cause, life expectancy etc.)
- ii. - morbidity data
- iii. - hospitalized morbidity
- iv. - mortality by causes
- v. - personnel (number of physicians of different specialities)
- vi. - infrastructure (number of hospitals, beds etc.)
- vii. - performance (number of consultations, bed occupancy etc.)
- viii. - costs (local budget expenditures on health and social welfare)

Environmental data available from sanitary epidemiological stations consist mainly of air quality data (SO₂, NO₂, particulates, etc.). The so-called WATER system covers information on water quality in waterworks and public wells and includes basic biological and chemical characteristics of drinking water. Emissions data are also available at the first administration (voivodship) level.

Socio-economic data are available from censuses, at the small-area level (census tracts) and include population density, level of crime, employment, energy use, car ownership, housing conditions, etc.

Poland is divided into 49 voivodships, up to 4000 gminas and several thousand census divisions.

Romania

A HEGIS has not yet been set up in Romania, but studies are being carried out in different areas, such as air quality and respiratory diseases, drinking water quality and health status, workplace environment and health status, waste collection and health status of the population etc. Pre-feasibility studies are also being undertaken of some socioeconomic and demographic indicators.

Romania is divided into 41 counties (300,000 - 800,000 people), 260 municipalities (2,000 - 1,000,000) and 2688 communes (1,000 - 10,000). Each county collects environmental and health data through a range of agencies, including the Environmental Protection Agency, Water Agency, Health Authority and Public Authority.

Data are available on:

- i. - demographic data (population by age and gender, death by age and gender, fertility data, live births, life expectancy etc.)
- ii. - health (mortality by cause at county scale, morbidity (new cases of infectious diseases) etc.)
- iii.- socio-economic data (alcohol, drug use, education employment, unemployment, etc.)

- iv.- environment (air pollution: ambient concentrations of NO₂, NH₄, dust suspended particulates and in some areas heavy metals, surface water and drinking water quality etc.)

Slovak Republic

Currently, HEGIS is being developed and used by the Institute for Hygiene and Epidemiology in Banske Bystrica to support a PHARE project on a study of health impact of environmental air pollution in the Novaky region. The region of Novaky, which is a part of the district of Prievidza, is located in the central part of the Slovak Republic (area ca. 70 km², population ca. 10.000 inhabitants). This study started in 1991 and is due for completion in 1995. Data are being obtained both from routine sources and from special surveys, modelling, etc.

The system is based on the Arc View 2 software.

The Slovak Republic is divided into 38 districts (37 + capital), each of which is subdivided into a number of regions and communities. A large amount of health data are available from various sources, partly provided by the national health information system, partly produced within the context of specific projects.

Data are available on:

- i. - socio-economic status (population by age and gender, migration, occupation, etc.)
- ii. - health (mortality, birth weight, notified cases of infectious diseases, birth defects, suicides, cancers, etc.)
- iii. - environment (emissions, ambient air quality, drinking water quality, connections to public water supply, surface water quality, etc.)
- iv. - background geography (administrative boundaries, topography, roads, industry, etc.)

Ukraine

Proposals for the development of a National Geographical Information System for Ukraine were put forward in 1993, and published in 1994 after discussions at an ad hoc organized meeting. The discussion covered the problems of development of the system for multi-purpose usage, one part of which would include health and environment.

The Ukraine is divided into 24 oblast, 1 autonomous republic and 486 rayons. Health and demographic data are available on the second administrative level (rayon).

Data are available on:

- i. - demography (population by age and gender, death by age and sex, fertility data, live births, life expectancy etc.)
- ii. - health (mortality by cause at oblast scale, morbidity, number of physicians of different specialities, number of hospitals, beds etc.)
- iii. - socio-economic conditions

The ecological situation in the Ukraine is monitored by the State Committee of Hydrometeorology, Ministry of Ecology, Ministry of Agriculture and Ministry of Forestry, State Committee of Geology, State Water Committee and Ministry of Health. The Ministry of Health, through its network of state sanitary-epidemiological stations, is monitoring air quality, water quality (including surface and sea water) and soil. The information system is based on a PC, but to date all available data within the Ministry have not been integrated within the system.

Health atlases covering the Ukraine have been produced in the past; a new national atlas is being prepared, at the scale of the *öblast*. This will include data on both mortality and morbidity. Data are available for smaller geographic units (*rayon*), though the quality of these is variable.

Environment-related health indicators for HEGIS

Rationale

The effects of the environment on health can be seen to operate through the process of exposure. On this basis, two categories of indicators can be defined:

Environment-Related Health Indicators (ERHIs) - health outcomes which may suggest an environmental cause, or a contribution from definable environmental factors.

Health-Related Environment Indicators (HREIs) - definable environmental conditions or trends which suggest potentially harmful health effects.

HEGIS can thus be used in both directions: to characterize and/or predict health risk, on the basis of available environmental indicators (i.e. "environmental hot spots"); and/or to identify possible environmental problems, on the basis of health indicators ("health hot spots").

Indicators may be defined and used at different points in the source-effect chain: from source activity → hazard emission → concentration (level) → exposure → burden (amount of a substance in the body) → adverse health effects → morbidity → mortality. The two end points of this chain (i.e. source activity and mortality) are reasonably open to international comparative analysis; the inner links are often concealed because reliable data are rarely available.

The discussion at the seminar was focused on Environment-Related Health Indicators (ERHIs).

The participants agreed that the health status of a population, as usually measured by disease mortality or morbidity, is determined by many interacting factors, such as life-style (smoking, alcohol consumption, nutrition, etc.), social environment (education, income, effectiveness of health care system, etc.) and occupation. Among these it is often very difficult, if not impossible, to assess the role of environmental factors (e.g. the proportion of disease that can be attributed to environmental exposures or the preventable proportion).

On the other hand, real differences in health status of the population in different countries can be recognised with some degree of confidence, especially when expressed in terms of age-specific mortality, life expectancy or broadly defined cause-specific mortality. International comparisons of infant mortality can be made, for example, if vital differences in registration and reporting between countries are taken into consideration. There are, however, virtually no population-based data available with which to make meaningful international comparisons on the prevalence of diseases and disability.

Against this background, the participants agreed, that environmental health impact assessment using HEGIS would generally involve the extrapolation of exposure- adverse health effect relationships derived from epidemiological investigations to new areas and populations. In the process, it was essential to take account of the uncertainties in the relationships and the

limitations of the available data. Methods for both qualitative and quantitative environment health risk analysis, and a core set of Health-Related Environment Indicators (HREIs), need to be developed for this purpose.

Basic demographic and health indicators

At the national level, Member States are encouraged to measure and report the indicators defined in Health for All targets. To characterise or predict possible environmental impacts on health, however, this core set of indicators needs to be extended to include indicators of general health. To ensure international compatibility, and permit international comparisons, the core set of basic demographic and environment-related health indicators should be collected at least at subnational (i.e. NUTS II/III or equivalent) level, on a five-yearly cycle. In addition, some indicators are required for all cities and urban agglomerations of 1,000,000 inhabitants or more.

In EU countries, the NUTS (Nationale Unites Territoriales Statistique) nomenclature is already well established under the auspices of EUROSTAT. This therefore provides an appropriate basis for data collection and comparison. To ensure wider compatibility and comparison, it is recommended that this system be extended to all WHO European countries, based on the list of administrative territorial regions drawn up by EUROSTAT.

Countries will also be asked to indicate all administrative territorial regions where boundary changes resulting in more than a 5% population change have occurred within the last 5-10 years.

Actual number of residents

Mid-year population estimates should be obtained by year, country and administrative territorial region of residence, by age and sex: If these data are not available, the size of the population at 1 January by administrative territorial region of residence, by age and sex should be used.

Data obtained from official censuses are preferable. Countries will be requested to provide a description of the sources and methods of intercensal estimations and post-censal projections, from which calculations of subpopulations by age-groups and sex were made.

Because of different definitions being used for urban and rural population in different countries, subdivision of the whole population by sex into the following groups will be used, if not defined otherwise:

U(urban)-	Residents in cities of 50,000 inhabitants or more
R(rural)-	Residents in towns of less than 50,000 inhabitants

The rural population in an administrative territorial region will usually be calculated as the difference between the total population and the number of people classified as urban residents.

Population density is the quotient of the division of the total number of inhabitants in an administrative territorial region by the total area of the region, expressed in persons per km².

Total population and population density should be indicated per administrative territorial region, per year. Separate data should be presented on total, male and female population. Data

should be provided for different age groups with an interval of five years, as follows: 0-under 1 year; 1-4; 5-9; 10-14; 15-19;...(5 years' intervals)..., 65-69; 70-74; 75-79; 80-84; 85+; "age not specified group"; and for the total population including "age not specified group".

Countries will be requested to provide these statistics (if available) by place of residence classified both by administrative territorial region (NUTS II/III or equivalent) and by city, town or agglomeration of 1,000,000 inhabitants or more.

Number of live births

Tables should be provided for each country giving the total number of live births (with a separate indication of single and multiple births) by sex, year, and administrative territorial region. These data should be obtained from routinely collected Birth Certificates data.

A birth should be considered live if the newborn child (irrespective of the duration of the pregnancy) breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether the umbilical cord has been cut or the placenta is attached.

Low birth weight (low weight at child's birth) results from premature birth, poor growth, or a combination of the two, and is associated with a high risk of death. The total number of single births and the number of infants born alone with low and very low birth weights should be reported in each country by sex and administrative territorial region.

The definition of the birth weight is as follows:

Low birth weight: Less than 2,500 g (up to and including 2,499 g).
Very low birth weight: Less than 1,500 g (up to and including 1,499 g).

Countries will be requested to provide these statistics (if available) by place of residence classified both by administrative territorial region (NUTS II/III or equivalent) and by city, town or agglomeration of 1,000,000 inhabitants or more.

Calculations should be provided of all of the following derived indicators: crude birth rate (CBR) expressed as the number of live births per 1,000 inhabitants; crude death rate (CDR) - the number of deaths per 1,000 inhabitants; natural population increase (rate of population natural growth-PNGR) per 1,000 inhabitants, calculated as the difference between crude birth and death rates by sex, by place of residence classified both by administrative territorial region (NUTS II/III or equivalent) and by city, town or agglomeration of 1,000,000 inhabitants or more.

Number of deaths

Tables showing the total number of deaths by year, country and administrative territorial region, by five age groups and sex, should be provided. These data should be obtained from routinely reported mortality data.

Countries will be asked to define the method used for the calculation of the mortality in age group 0 (infant mortality). The figure indicating the number of deceased persons of unknown age ("age not specified group") should be included in the totals.

Age specific death rate is the annual number of deaths among persons of a given age group divided by the estimated mid-year population of that age group.

Life expectancy tables¹ should show the average further number of years that a person of either sex and a specified age can expect to live, assuming that the age-specific mortality levels remain constant (i.e. the rates observed in a population for the period under review). These data will make it also possible to calculate the probability of someone of a certain age dying before a certain age at a later stage. The life expectancy tables describe the mortality pattern of one generation or cohort during a number of calendar years.

An indicator of premature or untimely death - "years of potential life lost" or number of years of life lost as a result of death from all and specified causes of death occurring before the certain age - should be calculated, including deaths prior to the age of 65 and 85. Member States will be asked whether mortality during the first year of life has been included in the calculation of this indicator.

Countries will be requested to provide these statistics (if available) by place of residence classified by administrative territorial region (NUTS II/III or equivalent) and by city, town or agglomeration of 1,000,000 inhabitants or more.

Causes of deaths

Tables should be provided giving the total number of deaths by cause, by year, country, administrative territorial region, age group and sex. These data should be obtained from routinely reported mortality data.

Member States will be encouraged to provide statistics for mortality according to the HEGIS Mortality List (List of cause of death of 33 categories) (Annex 1). This consists of 9 main groups of causes of death and 25 more specific diagnostic categories, included in the main groups, which constitute the most important causes of death in the European population. It corresponds with the HFA Targets, and is based on the definitions of a cause of death according to the ICD-9 List of Three Digit Categories and the ICD-9 Basic Tabulation List. In a cause-specific analysis of mortality data a group "Symptoms, signs and ill-defined conditions" is included.

The age classification for cause-specific mortality data should be the same as that used for population calculations and for the analysis of the total number of deaths, i.e.: 0-under 1 year; 1-4; 5-9; 10-14; 15-19;...(5 years' intervals)..., 65-69; 70-74; 75-79; 80-84; 85 and over; "age unknown", "all age groups".

Where the aforementioned is not possible, groupings should be made according to the recommendations of ICD - 10 and ICD - 9: under 1 year; 1-4; 5-14; 15-24; 25-34; 35-44; 45-54; 55-64; 65-74; 75 and over; "age unknown", "all age groups".

Countries will be requested to provide these statistics (if available) by place of residence classified by administrative territorial region (NUTS II/III or equivalent) and by city, town or agglomeration of 1,000,000 inhabitants or more.

¹Calculation by the WHO is made according to the Weisler method, based on calculation of age-specific death rates.

Number of infant deaths

Tables should be provided giving the total number of deaths of live-born children under 1 year of age, with a separate indication of single and multiple births by sex, year, country and administrative territorial region. These data should be obtained from routinely reported mortality data.

Infant mortality is often used as a yardstick for comparing the outcomes of health systems in countries at similar levels of socioeconomic development although it does not represent the overall health status of a nation.

Infant mortality rate (IMR) is measured as the annual number of deaths of live-born children under 1 year of age per annual number of live births and is expressed as deaths per 1,000 live births per year. International comparisons of infant mortality should be made separately for single and multiple births. Infant mortality can be calculated in a number of different ways, for example in relation to: a weighted average of live births in the current and preceding years; half the number of live births in a current year and half the number of survivors aged 0 at the end of this current year; the actual number of residents below the age of 1. As a consequence, data for the denominators used for the calculation of infant mortality should be submitted by countries, together with a description of the method used.

Perinatal mortality rate (PMR) is the number of deaths of foetuses weighing at least 500 g (or, when birth weight is unavailable, after 22 completed weeks of gestation or with a crown-heel length of 25 cm or more) plus the number of early neonatal deaths (during the first week), per 1,000 births. For international comparisons countries will be encouraged to present supplementary data in which both the numerator and the denominator are restricted to foetuses and infants weighing 1000 g or more or, where birth weight is unavailable, the corresponding gestational age (28 completed weeks) or body length (35 cm crown - heel). In other words: perinatal mortality rate for purposes of international comparison can be defined as still births (foetus delivered after the 28th week of pregnancy, without evidence of life) and deaths of live-born children under one week old per 1,000 births (live-births + still births).

Perinatal mortality rate, weight-specific (PMR-WS) is the number of foetal deaths weighing 1,000 g and over, plus early neonatal deaths of infants weighing 1,000 g and over at birth, per 1,000 total births weighing 1,000 g and over.

Countries will be requested to provide these statistics (if available) by place of residence classified by administrative territorial region (NUTS II/III or equivalent) and by city, town or agglomeration of 1,000,000 inhabitants or more.

Morbidity

One of the main objectives of the environment health information to be collated at WHO European Region is to support national health policies of Member States by means of comparisons and monitoring developments in health status and environment. For these purposes indicators which are to be collected must meet criteria of reliability, validity, comparability and comprehensiveness. Unfortunately, at present, the majority of available morbidity indicators collected by countries from permanent, regular reporting systems (because of differences in health care systems and other reasons) do not meet the aforementioned criteria.

However, most European countries have their own lists of notifiable diseases and disease surveillance systems. In some countries notification is mandatory, in others it is not, and the thoroughness of the reporting varies with the seriousness of the condition. The proposed morbidity list from infectious diseases (Annex 2) will follow with the priorities of the Environmental Health Action Plan for Europe. These include both direct pathways of infection (i.e. contamination of water and food by microbiological agents), and indirect pathways (e.g. air pollution). The total number of cases of selected notifiable diseases by year, country, number of outbreaks of water and foodborne diseases in administrative territorial region will be obtained from routinely reported data and will not provide an early warning system.

Member States will be asked to provide information about their lists of notifiable intestinal infectious diseases and to give the percentage of children (and their age) immunized against tuberculosis each year per administrative territorial region of the country.

Countries will be requested to provide these statistics (if available) by place of residence classified by administrative territorial region (NUTS II/III or equivalent) and by city, town or agglomeration of 1,000,000 inhabitants or more.

The aforementioned data on morbidity in HEGIS can be supplemented by the rates of reportable diseases, the incidence of diseases for which there are registries (e.g., birth defects, cancer), and the prevalence of disabilities and chronic conditions reported from special designed national and/or international surveys. The latter have the advantage of being able to respond to changing needs in new areas of interest and a survey designed specially for that purpose might be an appropriate means to collect reliable and comparable information.

A tentative list of environment-related diseases or impairments is suggested, as follows: cancer, respiratory diseases, allergic and cardiovascular diseases, effects on reproduction, and diseases of the nervous system. Inevitable uncertainties exist in collecting information (which is often scanty) from existing public health monitoring systems in the different Member States. It is therefore suggested that incidences of these diseases (together with associated environmental factors) should be monitored via internationally (or nationally) designed, and carefully controlled, epidemiological programmes in the European Region.

Specifications of the data to be included in HEGIS, and methodologies for the collection and international analysis of these data, need to be developed. Key issues include: the examination of background variability in disease rates across small areas; geographical surveillance to detect areas at high risk; and extrapolation of results obtained in "small area" analyses to the national and international scale.

DISCET- a system for data collection and exchange

Structure and functionality

The DISCET has been developed as a system for the collection, exchange, query and display of environment and public health data at the sub-national level. It is PC-based, running in Windows, is written in C and is freely available from RIVM and WHO-ECB. At present data provided with the DISCET include:

- European administrative territorial boundaries (NUTS 0/ I/ II/ III)

- national population numbers by age and gender
- subnational population totals
- national mortality rates by age and gender
- selected environmental data
- cities and urban populations

It provides facilities for viewing data through maps, tables and graphs. Data input/output is available through ASCII comma delimited files and dBASE files. Data can be linked to polygons, lines, points and grids (raster), referenced through a unique identifier. Links between the attributes and geographic structure are stored internally. Data supplied with the DISCET can be copied to new files and thereafter edited. Meta-information (data descriptions) can be added to describe attributes, and can be viewed through the tables.

Output can be edited according to need (e.g. by changing map symbols/colours, class ranges titles). Areas can be selected by pointing on the map by delimiting boxes on the screen or by defining conditions in the data tables (e.g. country, population size). Selected areas can be highlighted on the map, and relevant data displayed separately. Zoom facilities are also provided.

Future development

Currently the DISCET is in its first version. Additional tools are being developed, including:

- - limited exploratory spatial analysis functions (e.g. simple overlay and combination)
- - facilities for transfer and distribution via the international telecommunications network
- - improved procedures for data preparation

Additional facilities suggested include:

- - inclusion of the names of the administrative territorial regions in the data sent out to member states
- - output to picture files, for inclusion in Word and other word-processing packages
- - simultaneous selection of more than one group of areas
- - simple statistical processing and display (e.g. standard deviations, mean range, histograms) for user-selected areas
- - save, recall and transfer of user-defined views
- - improved interfaces with other software (e.g. GIS, statistical packages, spreadsheets)

CONCLUSIONS AND RECOMMENDATIONS

It was agreed that health and environment information systems, at both the national and international level, are useful tools for systemic collection, analysis, comparison and interpretation of health and environmental data. However, their objectives differ depending on the level of aggregation of the data which are being collected.

Development of any information system should take into account the purposes for which it will be used and the needs of the end-user. Even at the highest possible level of resolution, any information system is only a simplification of reality. To describe the environmental or health status of the population in time and at different geographical levels, and to try to link these data,

thus requires the selection and specification of indicators which closely relate to the problem of concern and which are specific and sensitive to variations or changes in the phenomena of interest.

The effects of the environment on health can be seen to operate through the process of exposure. On this basis, two categories of indicators can be defined:

Environment-Related Health Indicators (ERHIs) - health outcomes which may suggest an environmental cause, or a contribution from definable environmental factors.

Health-Related Environment Indicators (HREIs) - definable environmental conditions or trends which suggest potential harmful health effects.

At a European scale, HEGIS can perform two main functions: it provides a tool for health risk assessment, and a means of environmental monitoring and health surveillance as a basis for identifying and managing the main known environmental hazards. Assessments of the impact of environmental pollution on human health at a European scale require the extrapolation of results from epidemiological studies (where these are consistent). In the process, it is vital to take account of the uncertainties involved, and to base assessments on the estimated population exposed to levels above the European guideline values. The lowest level of aggregation at which geocoded health and demographic age-specific information is available for this purpose is normally NUTS level III or cities with the population beyond 1 million. Towns with inhabitants less than 50,000 provide a threshold for distinction between rural and urban populations

The main use of European HEGIS will be the international comparison of environmental conditions and health status. This requires data of both high quality and a high degree of comparability. As a result, the number of indicators suitable for inclusion in European HEGIS is limited.

At national and subnational level, the aim of HEGIS is to help construct country-specific environmental health profiles and forecast trends, as a basis for developing national priorities, carrying out environmental health impact analysis, assessing the cost-effectiveness of interventions, and monitoring national progress in the implementation of environment health action plans. The level of aggregation of the geocoded health and demographic information needed for these purposes is lower than that for the European Region, and is dependent on the requirements of the Member-State concerned. Because international comparability is only desirable, the set of potential indicators being developed ad hoc for specific purpose can be more flexible and extensive.

At the local ("small area statistics") level HEGIS can also contribute to epidemiological investigations of exposure-effect relationships and environmental impact assessments by providing facilities to link data on health effect and environmental and other (confounding) factors.

It was agreed that the further development of HEGIS for environmental health impact assessment would rely to a large extent on results from thoroughly planned and performed epidemiological investigations. These needed to take account of existing information on cause-effect relationships of pollutant exposure from toxicological and occupational studies.

The participants agreed in principle on a proposed core-set of environment-related health indicators (ERHIs).

Participants also emphasised the urgent need to develop a core set of health related environment-indicators (HREIs), together with methodologies for health risk assessment, which could be used at different levels of data aggregation and different geographic scales.

Methodologies for applying known exposure-effect relationships (obtained from epidemiological investigations) for environmental health risk assessment and management need to be developed and tested at subnational, national and regional levels within HEGIS.

The participants agreed that the DISCET system, developed in collaboration between RIVM and WHO-ECB, can be used for collection of information concerning environment and health in countries of WHO European Region, particularly in Central and Eastern Europe and NIS. For those Member-States with well-established national HEGIS, DISCET can be used as a vehicle for collecting environment and health information at subnational level.

Annex 1

HEGIS Mortality List

ICD-9 List of three digit categories	ICD - 9 Basic Tabulation List	Description
001 - E999	01 - E56	All causes of death
001 - 139	01 - 07	Infectious and parasitic diseases
001 - 009	01	Intestinal infectious diseases
140 - 208	08 - 14	Malignant neoplasms
150 - 159	09	Malignant neoplasm of digestive organs and peritoneum
150	090	Malignant neoplasm of oesophagus
151	091	Malignant neoplasm of stomach
153 - 154	093 - 094	Malignant neoplasm of colon, rectum, rectosigmoid junction and anus
155.0*	095	Malignant neoplasm of liver, specified as primary
162	101	Malignant neoplasm of trachea, bronchus and lung
163		Malignant neoplasm of pleura
172	111	Malignant melanoma of skin
174	113	Malignant neoplasm of female breast
180	120	Malignant neoplasm of cervix uteri
185	124	Malignant neoplasm of prostate
188	126	Malignant neoplasm of bladder
204 - 208	141	Leukaemia
390 - 459	25 - 30	Diseases of the circulatory system
410 - 414	27	Ischaemic heart disease
415 - 429	28	Diseases of pulmonary circulation and other forms of heart disease
430 - 438	29	Cerebrovascular diseases
460 - 519	31 - 32	Diseases of the respiratory system
480 - 486	321	Pneumonia
490 - 493	323	Bronchitis, chronic and unspecified, emphysema and asthma
490 - 496	323, 324, 325	Chronic obstructive pulmonary disease and allied conditions
520 - 575.1*	33 - 34	Diseases of the digestive system
571	347	Chronic liver disease and cirrhosis
580 - 599	35	Diseases of urinary system
740 - 759	44	Congenital anomalies
780 - 799	46	Symptoms, signs and ill-defined conditions
E800 - E999	E47 - E56	External causes of injury and poisoning
E800 - E949	E47 - E53	Accidents and adverse effects
E810 - E819	E471	Motor vehicle traffic accidents
E800 - E848	E47	Transport accidents
E950 - E959	E54	Suicide and self-inflicted injury

* According to "Tabular List of Inclusions and Four-Digit Subcategories".

*Annex 2***HEGIS Morbidity List of Notifiable Diseases**

ICD-9 List of three digit categories	ICD - 9 Basic Tabulation List	Description
001 - 009	01	Intestinal infectious diseases
001	010	Cholera
002		Typhoid and paratyphoid fevers
010 - 018	02	Tuberculosis
070	046	Viral hepatitis

*Annex 3***WORKING PAPERS AND BACKGROUND MATERIAL***Working Papers*

- ICP/CEH 257/6 Concept: Health and Environment Geographic Information System for Europe (HEGIS).
by Dr Alexander Kuchuk
- ICP/CEH 257/7 Requirements to indicators to be used in HEGIS.
by Dr Alexander Kuchuk & Mr Robert Merineau
- ICP/CEH 257/9 Draft report on Health and Demographic Indicators for the Development of a Health and Environment Geographic Information System (HEGIS) for Europe Working group, Bilthoven, the Netherlands, 8-9 November, 1994.

Background material

- ICP/CEH 087/A Consultation on Data Requirement and Methods for Analysing Spatial Patterns of Disease in Small Areas, Rome, 20-24 October 1990
- ICP/CEH 090/A Development of a health and environment geographic information system for the European Region, Bilthoven, 10-12 December 1990
- EUR/ICP/CEH 246 Environment and Health Indicators for Use with a Health and Environment Geographic Information System (HEGIS) for Europe, Bilthoven, Netherlands 11-13 March 1993
- ICP/CEH 212 Rev.1 Declaration on Action for Environment and Health in Europe, Second European Conference on Environment and Health, Helsinki, 20-22 June 1994
- ICP/CEH 257/8 Development of National Health and Environment Information for Member States. Feasibility of DISCET use for information exchange. Unedited drafts from Austria, Hungary, Slovak Republic, Romania, Poland, Ukraine, Bulgaria, Czech Republic, Germany, Netherlands.
- Wills J.T. Developing Indicators for Environment and Health (Manuscript)

Environmental Health Action Plan for Europe. Sixth Draft. Second European Conference on Environment and Health, Helsinki, 20-22 June 1994

EUROSTAT Statistical Office of the European Communities. DG34/F3 mw, Mattias Wohlen V.1., February, 1993.

International Statistical Classification of Diseases and Related Health Problems. Tenth Revision. Vol.1, WHO, Geneva 1992.

International Statistical Classification of Diseases and Related Health Problems. Tenth Revision. Vol.2, Instruction manual. WHO, Geneva 1993.

Health for all targets. The health policy for Europe, Copenhagen, WHO Regional Office for Europe, 1993 (European Health for All Series No. 4).

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