EUROPEAN CENTRE FOR DISEASE PREVENTION AND CONTROL

MEETING REPORT

Workshop on linking environmental and infectious diseases data

Sigtuna, 28–29 May 2008

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Stockholm, October 2008

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ABBREVIATIONS

CCSA	Committee for Coordination of Statistical Activities
CERC	Cambridge Environmental Research Consultants Ltd
CNES	Centre National d'Etudes Spatiales
EC	European Commission
ECDC	European Centre for Disease Prevention and Control
ECMWF	European Centre for Medium-Range Weather Forecasts
EEA	European Environment Agency
EIONET	European Environment Information and Observation Network
ENHIS	Environment and Health Information System
EPIDEMIO	Earth Observation in Epidemiology
ESDAC	European Soil Data Centre
ESRIN	ESA Centre for Earth Observation
ESTAT	Exploratory Spatio-Temporal Analysis Toolkit
EU	European Union
ESA	European Space Agency
EUMETNET	European National Meteorological Services Network
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EURECA	European Ecosystem Assessment
E3 Network	European Environment and Epidemiology Network
EWS	Equipment for water-treatment systems
GEMS	Global Monitoring for Environment and Security
GEO	Global Environmental Outlook
GEOSS	Global Earth Observation System of Systems
IAP	Integrated Application Programme
INSPIRE	Infrastructure for Spatial Information in Europe
IWG-Env	Inter-secretariat Working Group on Environment Statistics
JRC	Joint Research Centre
MEDANY	Multi-platform Data collection Applications for epidemiological surveillance and outbreak management
MEDES	Institute for Space Medicine and Physiology
MNP	The Netherlands Environmental Assessment Agency
SAFE	Satellites for Epidemiology
SEBI 2010	Streamlining European 2010 Biodiversity Indicators
SEIS	Shared Environmental Information System
SMI	Swedish Institute for Infectious Disease Control
TBE	Tick-borne encephalitis
UNEP	United Nations Environment Programme
WHO	World Health Organization
WISE	Water Information System for Europe

EXECUTIVE SUMMARY

The term 'environment' includes natural, social and behavioural dimensions, all of which strongly impact infectious disease transmission. Thus environmental change — or global change — poses substantial potential risks for public health security. Consequently, there is a need for an integrated analysis of environmental and epidemiological data. The workshop in Sigtuna, Sweden, on 28 and 29 May 2008 brought together experts in the areas of epidemiology, environmental health and information systems to discuss the interrelationship of environment and infectious disease.

The focus of the workshop was to explore the possibilities for the establishment of a European Environment and Epidemiology (E3) Network. Such a network could integrate environmental and epidemiological data, generating information that is essential for public health. In particular, the network might facilitate public health action by:

- performing a trend analysis which could help EU Member States anticipate developments and plan adequate interventions; and
- establishing an early warning system that helps Member States plan adequate and timely actions to prevent or control disease outbreaks.

At the Sigtuna workshop, experts shared information on relevant European databases, information systems and organisations. During the meeting it became increasingly clear that several of them could serve as the basis for the new E3 network.

When setting up the E3 network it will be important to foster partnerships and emphasise the mutual benefits for all involved partners. E3 could be set up as an interdisciplinary initiative, e.g. in collaboration with other EU or international agencies such as the European Environment Agency, the European Space Agency, or the World Health Organization. An important aspect of any collaborative activity is to connect people, create a common vision and establish shared values, rather than rushing to technical details.

Before engaging in data collection and linking, an analytical framework has to be developed, which should be tailored to specific diseases, modes of transmission and geographical locations. The analytic framework can be tested by using historical data: if a retrospective analysis of historical data produces results that reflect, and coincide with, actual developments, the analytic framework is basically sound.

The technical issues involved when linking databases and performing data analyses are extremely complicated. Massive databases are obsolescent. New and innovative approaches to data management rely on software that can create self-learning database systems. Triangulation, i.e. comparing data from different sources (e.g. remote sensing, local samples), is essential in this context.

Two working groups produced proposals for E3 pilot projects:

- tick-borne encephalitis, as a pilot for trend analysis and a model for measuring the impact of interventions; and
- waterborne diseases, as a pilot for an early warning system.

For both pilot projects, the working groups generated ideas for indicators and conceptualised approaches for the development of pilot studies as well as general advice for the pilot project start-up. First and foremost, ECDC should look for partners and collaborators to develop both pilot projects and generate commitment from partners.

1. INTRODUCTION

1.1 About this report

The focus of the Sigtuna workshop was on discussing best practices for linking environmental and infectious disease data in order to develop ideas and concepts for European pilot projects in this area.

The workshop brought together a wide range of experts on infectious diseases, climate change, monitoring and evaluation, and computer modelling. Officials from European scientific and policy institutions as well as independent scientists participated in the workshop. (See Annex 5 for a list of participants.)

This workshop built upon the 2007 'Infectious Diseases and Environmental Change Workshop', which was jointly organised by the European Centre for Disease Prevention and Control (ECDC), the WHO Regional Office for Europe, the European Environment Agency (EEA), and the Joint Research Centre (JRC).[1]

Section 1 of this report outlines several links between infectious diseases and global change (environmental and climate change; socioeconomic change) and explains the rationale behind the planned European Environment and Epidemiology (E3) Network. Some essential network design considerations were discussed during the workshop and are reflected in this report.

Vector-borne and food- and waterborne diseases are the two groups of communicable diseases that are most directly linked to climate change. Therefore, Sections 2 and 3 are dedicated exclusively to these two disease groups. During the workshop, break-out groups examined how exactly an E3 Network could be operationalised for these disease categories.

Section 4 summarises the key insights generated during the workshop, and the Annexes provide further background information.

[1] See report on ECDC website: ecdc.europa.eu/pdf/Environmental_change_and_infectious_disease.pdf

1.2 Background: Infectious diseases and global change

Presentation by Dr. Bettina Menne (WHO): Environmental determinants of infectious diseases

Human society has undergone a series of major transitions that has affected our pattern of infectious disease acquisition and dissemination. These transitions illustrate the interrelationship between environmental, social and behavioural influences on the emergence and subsequent spread of infectious disease. While in 1909 nearly half of all deaths were caused by infectious diseases, the figure for 1999 was 20 %. However, the burden of disease varies widely throughout the world, and in developing countries the proportion of infectious diseases is much higher than in Europe.

The environment has an impact on disease patterns. In this context, 'environment' has a broader definition than the physical environment: natural, social and behavioural elements all play a role as well. The possible change in infectious disease distribution is a risk to public health security.

Climate change causes changes in the ecosystem: for example, water availability is projected to increase by 10–40 % at high latitudes and decrease by 10–30 % in some dry regions. Crop productivity is projected to decrease for even small local temperature increases (1–2 °C) at low latitudes. This will result in malnutrition and the spread of infectious diseases.

Migration (part of the social environment) is increasing: the temporal and geographical scale has changed over the last century. But not only people move — as shown by SARS, avian influenza, etc., the spread of diseases is also accelerated by human intervention.

Antibiotic resistance (as part of the behavioural environment) is increasing, e.g. in tuberculosis or malaria. This is one of the reasons for strengthening prevention and control measures.

Linking environmental and health data is important. However, questions need to be answered: why, what, where, how and who? John Snow set the example when he studied the patterns of cholera in London and detected the source of the outbreak.

The need for a susceptible host, a vector and an infectious agent is well described in infectiology. The environment plays a crucial role in the life cycle of pathogens and can influence the host and the vector in several ways [1]. Although the link between infectious diseases and the environment has been known since the time of Hippocrates, the specific interaction between global climate change and the patterns of infectious disease has only recently been recognised as an important factor. One of the key challenges of modern public health is to identify and quantify the mechanisms of this interaction, in order to develop mechanisms for dealing with emerging health threats and to increase preparedness for action [2,3].

Even if global climate change can significantly influence the patterns of infectious disease, there are other important determinants. As with all diseases, the social environment, economic and cultural factors, and healthcare systems play a significant role. Factors such as land use, land cover, forestation or water bodies [4] are of particular relevance when dealing with infectious diseases — mainly because of the reservoir–pathogen–vector–host cycle.

The complexity of interactions has led to new approaches in the analysis and development of epidemiological models. Eisenberg et al. developed an analytic matrix that encompasses three interlocking components: environment, transmission and disease [4]. For each disease, characteristics can be specified by combining disease and transmission factors (Table 1).

Table 1: Analytic matrix for infectious diseases and environment [4]

Classification of diseases
1. Directly transmitted diseases (e.g. AIDS, TB, STI, influenza, SARS).
2. Vector-borne diseases (e.g. malaria, dengue).
3. Environmentally mediated diseases: ● human host (e.g. hepatitis A, rotavirus, enterovirus); ● non-human host (e.g. *E. coli, Salmonella*).
4. Zoonotic diseases.
Transmission factors
1. Transmission pathway (e.g. human–human, human–vector, human–environment).
2. Modes of transmission (e.g. fluid, air, water, bites).
3. Environmental factors (e.g. chance of survival of pathogens, spreading of vectors).
4. Transmission cycle (e.g. host–vector–human, host–environment–human).

Source: Table adapted from Eisenberg et al. Environmental determinants of infectious diseases [4].

The significance of the influence of different factors varies from disease to disease, and every disease must be considered individually. Ecological processes are presumably more related to climate change and social processes; on the other hand, one might expect a stronger link to human interventions in the environment [4]. All these processes are present in different combinations and can affect each disease in a specific way. Therefore, thorough analysis is required to weigh the impact of different factors on the spread of diseases, and a wide variety of approaches can be applied to understand the relationship between environmental factors and infectious diseases (Table 2).

Table 2: Analytic approaches for interrogating links between environmental factors and infectious diseases [3]

Type of study	**Subtype**	**Characteristics**
Observational and experimental studies	Retrospective analysis of natural variations	Past temporal patterns of climate variability and disease are treated as empirical analogies of future change.
	Retrospective analysis of historical trends	Similar to the above, but comparing trends of change during the period of observation.
	Interregional comparison of natural patterns	Comparison of natural spatial patterns in disease and climate, to identify similarities or differences.
	Experimental studies	Laboratory or field studies to understand the mechanisms of the impact of environmental variables on disease transmission.
Mathematic modelling	Mechanistic modelling (process-based models)	Based on theoretical knowledge of underlying biophysical mechanisms, simulating impact of climate change on health.
	Empirical-statistical modelling	Based on observational studies on the relation between climate and health, which are less explanatory and demand less data .
Risk assessment frameworks1	Hazard identification	Identification of microbial agent and associated illnesses.
	Dose-response identification	Mathematical characterisation of the relation between the microbial agent and the type of disease.
	Exposure assessment	Determines the size and nature of the exposed population and the duration of its exposure.
	Quantitative risk characterisation	Estimates the magnitude of the public health problem and acknowledges the variability and unpredictability of the risk.
Integrated assessment	Structured process of using knowledge from various disciplines for presentation to decision makers: ● characterising complex interactions and feedback mechanisms among facets of global change; ● testing the effectiveness of intervention strategies.	

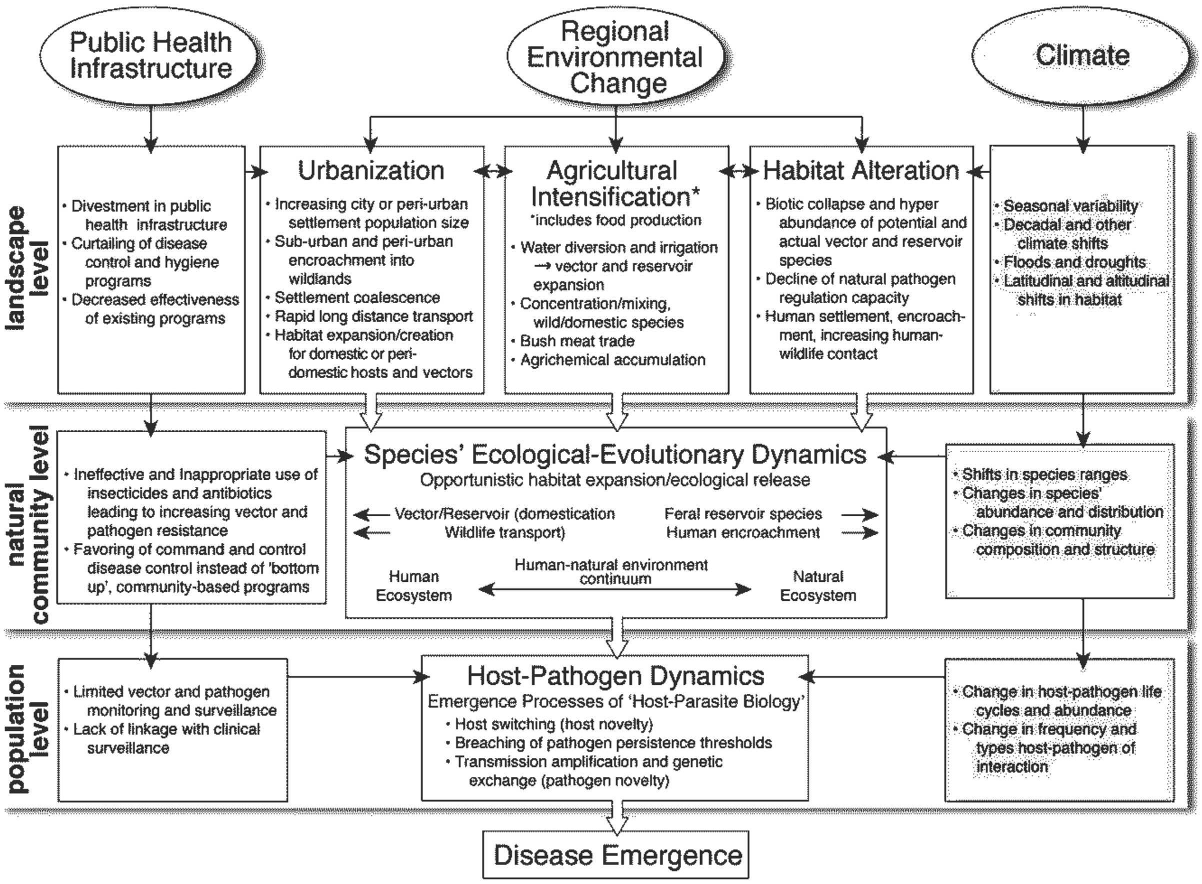
Figure 1 (below) offers an example of an integrated assessment, from macro to micro level, divided into three categories: climate, change due to human intervention, and public health infrastructure. Applying analytical models may lead to insights into transmission patterns. For example, environmental change may affect zoonoses in three ways:

- increasing the range or abundance of animal reservoirs or insect vectors;
- prolonging transmission cycles; or

[1] Subtypes are phases rather than independent types of research.

- increasing the importation of vectors or animal reservoirs (e.g. by boat or air) to new regions, which may cause the establishment of diseases in those regions.

Figure 1: Integrated assessment model[1]



Source: B.A. Wilcox and R. Colwell. Emerging and re-emerging infectious diseases: biocomplexity as an interdisciplinary paradigm [15].

In another example based on an analysis of underlying changes in environmental factors, the expectation is that the burden of Lyme disease (a tick-borne borreliosis) will change substantially in North America and Europe [5].

The table below summarises the effects of weather and climate on different types of infectious diseases in North America. It also lists the possible impact of climate change on disease incidence and burden (Table 3) [5].

[1] Available from: apitmid.hawaii.edu/APCIDE/Blueprint.jpg

Table 3: Infectious diseases, environmental factors and climate change

Infectious disease	Known effects of weather and climate	Possible impact of climate change
Zoonotic and vector-borne diseases (e.g. Lyme disease, West Nile virus, dengue, malaria, chikungunya, tularaemia, rabies)	Increased temperature shortens pathogen development time in vectors. This increases the duration of infectiousness, allowing for prolonged transmission periods to humans. Changes in climate may expand the geographic range and abundance in both vectors and reservoir hosts. Warming and altered rainfall patterns may increase populations of reservoir animals and their predators (e.g. rabbits and foxes). Early onset of favourable transmission conditions may prolong transmission cycles. Flooding provides breeding habitats for vectors and reservoir hosts, increasing their abundance and geographical range, which may lead to more frequent disease outbreaks. Increased risk of travel-associated illnesses.	Increased temperature, rainfall variability and altered dynamics of reservoir populations are predicted which could increase the transmission of some zoonotic diseases. Changes may permit establishment of newly imported infectious diseases in regions that were previously unable to support endemic transmission. Changes likely to vary geographically.
Water- and food-borne diseases (e.g. verotoxigenic Escherichia coli*, Campylobacter, salmonellosis, shigellosis, Vibrio, Legionella,* Clostridium botulinum*, giardiasis, cryptosporidiosis)*	Survival and persistence of disease-causing organisms directly influenced by temperature. Increased air and water temperatures improve the survival and proliferation of some pathogens (e.g. Vibrio). Climate conditions affect water availability and quality. Heavy rainfall and flooding facilitates rapid transportation of disease-causing pathogens into water supplies. Displacement of environmental refugees because of flooding and extreme weather events are associated with increased risk of water- and food-borne disease transmission.	Increased temperature and rainfall is predicted to increase the intensity and frequency of water- and food-borne diseases. Risk levels are particularly elevated in the far north.

Infectious disease	Known effects of weather and climate	Possible impact of climate change
Communicable respiratory diseases (e.g. influenza, respiratory syncytial virus, Streptococcus pneumoniae*)*	Occurrence of respiratory illnesses may decrease as winter temperatures increase. Changes in climate may increase the concentration of harmful air pollutants, which might enhance invasiveness due to damage of host mucus membranes. Forced migration of environmental refugees could enhance transmission of disease due to intermingling of populations with introduction of new diseases into non-immune populations.	A shorter, warmer and wetter winter season may reduce the number of respiratory diseases observed. Such effects may be counterbalanced by changes in air quality and mass movements of people.
Invasive fungal diseases (e.g. Blastomyces dermatitidis*,* Cryptococcus gattii*,* Coccidioides immitis*)*	Ecological and meteorological changes may affect local soil ecology, hydrology and climate, resulting in the persistence of invasive fungal pathogens in the environment and the release of infectious spore forms.	Warm, dry summers in combination with heavy wintertime precipitation provide optimal conditions for infectious fungal spore elaboration and persistence. Changes likely to vary geographically.

Source: Greer, Ng, Fisman: Climate change and infectious diseases [5].

1.3 Towards the E3 network

Presentation by Prof. Jan Semenza (ECDC): Monitoring Environmental Change and Infectious Disease — establishing a European Environment and Epidemiology (E3) Network

A recent European Parliament resolution recognises the importance of monitoring the relationship between climate change and health:

'[The European Parliament recognises] that climate change contributes to the global burden of disease and premature deaths by affecting, in particular, the most vulnerable population groups; invites the Member States to consider measures to strengthen the capacity of health systems to adapt to the adverse effects of climate change; invites the Commission to set up an EU-wide system for the monitoring and surveillance of the effects of climate change on health; calls on the Commission to ensure that the threats posed by climate change to human health are at the centre of EU adaptation and mitigation policy.'[1]

In 2007, ECDC conducted a survey among 30 European state epidemiologists asking their views on the public health impact of climate change. The epidemiologists thought that infectious diseases — particularly vector-borne diseases — could pose the biggest health threat to their countries. There are various examples of diseases spreading as a result of environmental factors, e.g. the chikungunya outbreak in Italy, or the spreading of hantavirus

[1] European Parliament resolution of 10 April 2008 on the Commission Green Paper on 'Adapting to climate change in Europe — options for EU action' (COM(2007)0354). (www.europarl.europa.eu/oeil/file.jsp?id=5606242)

infection in Sweden. There is evidence that suggests a relationship between temperature and the spread of salmonellosis.

The concept of the European Environment and Epidemiology (E3) Network calls for the integration of environmental and epidemiological data, generating essential information necessary to drive public health action for an overall improvement in public health.

Specific aims of the E3 Network could be to:

- enhance analytic capability: link environmental data to surveillance data for trends and forecasts in relation to long-term adaptation to climatic and ecological changes;
- enhance and accelerate response capability: link environmental data to outbreak scenarios for rapid response;
- disseminate information: guide policy, practice, and other interventions;
- support public health research: relationship between disease and the environment;
- advance collaboration: collaboration between EU agencies and other governmental and non-governmental organisations; creation of leverage by utilising existing EU investments (EU agencies, the Directorate-General for Health and Consumers, the Directorate-General for Research, the Joint Research Centre, etc.);
- inform and strengthen Member States: activities to prepare for the health impacts of climate change, building capacity in Member States.

In the context of its mandate, ECDC is looking at possibilities to improve monitoring systems that have the capability to connect epidemic intelligence and infectious disease surveillance data (currently housed at ECDC) with meteorological variables, water quality records, air quality measures, remote sensing information, geology, etc. This monitoring system was given the working title 'European Environment and Epidemiology Network', or 'E3 Network' for short.

Linking such diverse datasets would enable coordination between environmental and public health agencies. Identifying long-term trends would build an evidence base for strategic public health action. Identifying short-term environmental events linked to public health would help improve early warning systems. For example, heavy precipitation may be linked to cryptosporidiosis outbreaks; coastal water contamination with enterococcus or coliform bacteria may be linked to recreational water use. Alternatively, a particularly warm winter may sustain vector populations that would warrant vector abatement measures in the spring.

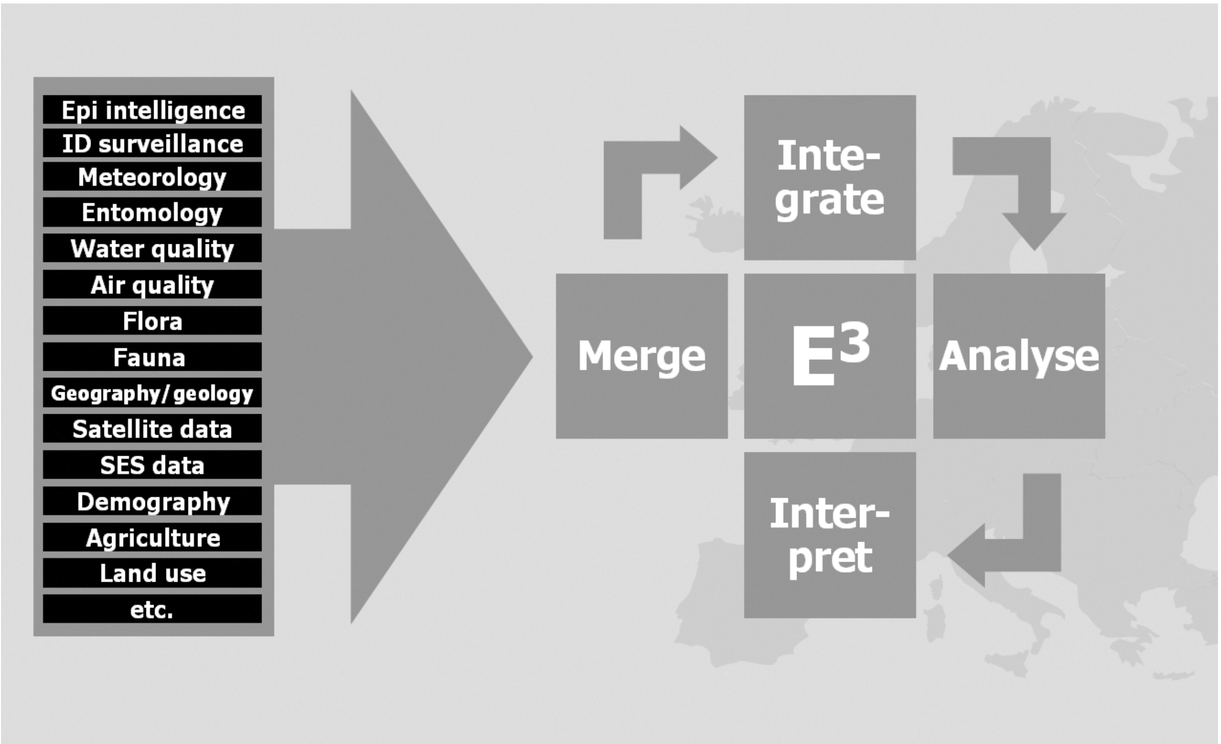
The European Environment and Epidemiology Network could be a distributed, secure, web-based network, providing access to climatic/environmental and infectious disease data collected and analysed by a variety of European agencies. The data hub could serve as a data repository and would support data exchanges and linkages with Member States, academia, legislators, and other authorised users. Such a network could also provide technical support for the analysis, mapping, reporting and monitoring of data (Figure 2).

Ultimately, the network would have the capacity to:

- link environmental with epidemiological data;
- provide rapid access to environmental and epidemiological data;
- integrate and merge different datasets;
- permit Europe-wide analyses across geographic and political boundaries;
- promote Europe-wide standards for environmental data;
- increase the utilisation of available datasets; and
- provide a quality standard for environmental data.

Attempts to initiate the development of an Early Warning System (EWS) within a specific country should be preceded by a decision-making process to identify the principal disease/s of interest. This will depend on the burden of various infectious diseases in the region and on levels of national and international funding available for disease-specific activities.

Figure 2. Core functions of the E3 Network[1]



As described previously, there are various approaches for linking epidemiological and environmental data, such as modelling, risk assessment frameworks, and integrated assessments. It is extremely important to develop an appropriate methodological framework for the analysis of factors that contribute to the epidemiology of infectious diseases. These factors may be disease-specific, time-specific or location-specific. Building up the E3 network will be very much a learning-by-doing process.

[1] Figure from a presentation by Jan Semenza: Monitoring environmental change and infectious disease — Establishing a European Environment and Epidemiology (E3) Network.

1.4 Design considerations for the E3 network

A major focus of the Sigtuna workshop was on the design of the E3 network. Reviewing and building upon existing initiatives was considered a promising starting point.

WHO developed concepts for an early warning system for infectious diseases. Table 4 (below) shows how an early warning system could operate in the context of controlling an epidemic.

In preparation for the workshop, the organisers took an inventory of organisations and data sources/databases that record epidemiological and environmental factors in Europe (see Annex 3). At least 30 relevant databases and organisations were identified, some Europe-wide, some covering at least two European countries. In addition, there are national and sub-national databases that provide relevant information. Universities and research institutions may also have data sources that can be conducive to the E3 network's scope of work.

Table 4: WHO model of an early warning system [9]

<table>
<tr>
<td rowspan="4">Data requirements

Weekly or monthly incidence data.

Frequently updated data on rainfall, temperature, humidity, stream-flow, vegetation indices.

Regional and national seasonal climate forecasts, drought and flood surveys.

Population migrations and displaced persons.

Supplementary data (as capacity allows):
• entomological indices;
• parasitological indices;
• drug resistance testing.</td>
<td>Vulnerability assessment:
• Evaluate epidemic potential of the disease.
• Identify geographical location of epidemic-prone populations.
• Identify climatic and non-climatic disease risk factors
• Quantify link between climate variability and epidemics.</td>
<td rowspan="4">Implementation measures

Develop national and district epidemic response plans; define range of control interventions; assign clear roles and responsibilities

Identify data sources and indicators

Identify case definitions and confounders

Identify key informants (these may be in other sectors, e.g. food security, drought/flood monitoring)

Carry out cost-effectiveness analysis of timely preventive control and treatment options</td>
</tr>
<tr>
<td>Early warning and detection components:
• Seasonal climate forecasts (lead-time in months/low geographical resolution).
• Monitoring of disease risk factors (lead-time in weeks or months – higher geographical resolution).
• Disease surveillance (lead-time negligible/confirmation of epidemic in process.</td>
</tr>
<tr>
<td>Control response:
• Assess opportunities for timely vector control and act accordingly.
• Raise community awareness and call for greater personal protection.
• Ensure prompt and effective case management.</td>
</tr>
<tr>
<td>Post-epidemic assessment:
• Was the early warning system useful?
• Were the indicators sufficiently sensitive/specific?
• Were effective preventive/treatment control opportunities enabled?
• What were the strengths/weakness in control operations?
• Does the epidemic preparedness plan need to be modified?</td>
</tr>
</table>

During the workshop, experiences with information systems were presented and important issues were identified. Comments and discussions are presented below in three categories: merging information systems, integrating data systems, and analysing information.

a) Merging information systems

It may not be easy for those organisations that were identified during the workshop to share data with ECDC. Some organisations may have confidentiality regulations, others may request financial compensation. Data collected for research purposes may be confidential until publication. Workshop discussions frequently touched upon the issue of support: countries are not necessarily convinced of the supra-national importance of data collection and analysis for public health. They may prefer to restrict access to their data to their own national system. But organisations could enter into collaboration agreements on data use and exchange and agree on specific conditions.[1]

In order to create an E3 network it is important to set up partnerships and emphasise the mutual benefits for all involved parties. The E3 network could be set up as an interdisciplinary initiative, e.g. with other EU agencies such as EEA, ESA or WHO. A first step would be to bring people together, create a common vision and establish shared values, rather than rushing to technical details.

During the course of the workshop, it became clear that a lot of important work has been done that could serve as the basis for the new E3 network.

The technical issues involved when linking databases and performing data analyses are extremely complicated. Massive databases are obsolescent. New and innovative approaches to data management rely on software that can create self-learning database systems.

Before engaging in data collection and linking, an analytical framework has to be developed. This framework may be disease-specific, focus on specific modes of transmission or certain geographical locations. The analytic framework can be tested by using historical data: if a retrospective analysis of historical data produces results that reflect and coincide with actual developments, the analytic framework is basically sound.

Establishing a taskforce with technical experts from various organisations and agencies could be helpful to jump-start the process of establishing the E3 network. This taskforce could locate information, develop data mining methods and other ways of accessing data from relevant data sources. The EDEN project (http://www.eden-fp6project.net) has already solved several critical problems of data source interoperability, data sharing and levels of data access.

[1] The Swedish Institute for Infectious Disease Control uses standard user agreement forms.

b) Integrating data systems

Quality assurance of data is a critical issue when working on database integration. Data may have been collected over different time periods (delays), using different standards and different geographical coverage, etc. One of the major problems is incompleteness of data. Different countries, for example, have different systems for infectious disease notification, a fact that leads to huge differences in reported incidence rates. Data control, cleaning of datasets and harmonisation of datasets can be very time-consuming. According to one estimate, up to 50 % of a database experts' time is spent on such clerical processes.

It is important to provide meta-data and sources for all datasets and raw data. Other key questions are: which type of data quality check was performed, how were the data integrated, and how were they analysed. It is better to acknowledge the weaknesses of a dataset than to provoke doubts about the set's quality.

Triangulation, i.e. comparing data from different sources (e.g. remote sensing, local samples), is essential in this context. For example, information from remote sensing needs to be verified by local physical inspection and sampling. Conclusions can be drawn only after verification.

c) Analysing information

When starting the E3 network it is necessary to develop it from the end-users' perspective: who are the users, what do they want to know and what decisions do they want to make based on the supplied information. The answers to these questions will dictate the data that need to be collected and the way that they will be presented. If, for example, local public health officers require information for warning the local population of health threats, the resolution (level of geographical detail) required is much higher than in a situation when country-level information is needed for EU regulations. It is important to avoid data clutter by adding too many indicators and datasets that are scientifically interesting, but have little bearing on decision making. At present, there seems to be too much information not used by decision makers because they cannot understand what exactly is presented to them. For the E3 network, the actual burden of disease is important but perhaps less so than the potential future risk and the potential rapid spread of the disease. A pragmatic approach should always prevail when dealing with complicated matters such as linking databases from different organisations: after all, it is the interests of the end-users that are most important.

Graphical visualisation of data with full-colour maps is very helpful when providing information. Most existing websites are accessible to the general public and put emphasis on a user-friendly presentation.

2. VECTOR-BORNE DISEASES

2.1 Introduction

Vector-borne pathogens include viruses, rickettsiae, bacteria, protozoa, and worm parasites [10]. Unsurprisingly, a main factor in the transmission of these pathogens is the presence of a vector. For many diseases, vectors are cold-blooded arthropods which thrive under specific environmental conditions. Changes in the environment such as ambient temperature, rainfall, land cover, land use or soil moisture can significantly influence the presence of vectors in a particular environment and a particular geographical area.

It is, however, a complex exercise to define whether and to what degree specific environmental factors influence the transmission of a particular vector-borne disease. Climate change and changes in environmental factors may occur in an increasing or decreasing manner. Factors linked to global climate change — warmer winters, longer summers, droughts in some regions, increased precipitation in others — could lead to increases or decreases in the overall incidence of vector-borne diseases. Table 5 lists some vector-borne infectious diseases likely to be affected by climate change.

Table 5. Vectors and diseases

Vector	Disease transmitted
mosquitoes	malaria, filariasis, dengue fever, yellow fever, West Nile fever
sandflies	leishmaniasis, triatomines, Chagas disease
Ixodes ticks	Lyme disease, tick-borne encephalitis
tsetse flies	African trypanosomiasis
blackflies	onchocerciasis
snails (intermediate host)	schistosomiasis

Source: Haines et al. Climate change and human health [11].

2.2 Workshop results

The workshop approach

During the course of the workshop, a break-out group focused on vector-borne diseases. Group work developed along the lines of eleven semi-structured questions:

Question 1: What datasets are available in Europe for the group of diseases under discussion (food- and waterborne or vector-borne)?

Question 2: Based on the list produced in response to Question 1, which infectious diseases should be monitored in Europe? What are the most important environmental drivers of these diseases?

Question 3: What potential limitations are imposed by the datasets, particularly in respect to the development of early warning systems?

Question 4: What datasets would provide the biggest added value to public health in Europe if linked to the E3 Network?

Question 5: What minimal dataset could be used in a pilot to test the feasibility of the E3 Network?

Question 6: Define in few sentences the strategic objectives of monitoring selected diseases.

Question 7: Which critical indicators do we want to monitor?

Question 8: Which datasets are essential?

Question 9: Identify critical success factors for the monitoring system.

Question 10: Describe a pilot and a roll-out strategy for the E3 monitoring of TBE.

Question 11: Based on this case study, what are the general recommendations for setting up the E3 network?

The outcome of the discussion is reflected below.

Data on vector-borne infectious diseases

As a starting point for the group discussion, Elisabeth Lindgren, the chair of the working group, provided a list of potentially climate-sensitive vector-borne diseases:

Mosquito-borne diseases:

- arbovirus: West Nile fever, dengue, chikungunya, Tahyna virus (California group);
- parasite: malaria.

Sandfly-borne diseases:

- arbovirus: Toscana virus;
- parasite: leishmaniasis.

Tick-borne diseases:

- arbovirus: tick-borne encephalitis, Crimean-Congo haemorrhagic fever;
- parasite: *Babesia microti*;
- bacteria: Lyme disease.

Rodent-borne diseases:

- virus: hantavirus pulmonary syndrome, lymphocytic choriomeningitis;
- bacteria: leptospirosis, tularaemia, plague.

Identification of available datasets on relevant environmental factors

Available and relevant data include analytic data, data from research and epidemiological data. The search for information focuses on data that are of interest for Europe.

The working group identified several environmental datasets and data (available or required) that sufficiently describe or document the relation between climate change and vector-borne diseases, namely:

- land use, vegetation, crop yield;
- weather, climate;

- altitude;
- water resources, drainage, basins;
- population density, migration, tourism, immigration;
- socioeconomic factors, vulnerable groups;
- infrastructure, health facilities (WHO has no information for EU), quality of public health services;
- vaccination, immunisation level, antimicrobial resistance data;
- globalisation;
- disease response to intervention;
- veterinary information, traffic/freight containers, air quality, water quality, movements of goods and animals.

Some of these data are available in good quality on second or third administrative levels (weather, temperature, water resources, etc.); some are available as aggregated country or regional data. It is important that data from remote sensing or computer models are validated by ground checks (e.g. hit-and-run sampling).

Selection of diseases for E3 network development

Tick-borne encephalitis and chikungunya were proposed as possible diseases for the E3 pilot surveillance system. The fundamental data sources are available from:

Remotely sensed data	**Vector surveillance systems**
Meteorological data: temperature, rainfall, etc.	Selected vectors
Land use/land cover	Margins of vector distribution ('iso-vectors')

Table 6 (below) summarises the preliminary findings of the working group on these diseases.

Table 6: Selected vector-borne diseases, transmission and environmental factors

	Chikungunya	**Tick-borne encephalitis (TBE)**[1]
Transmission route	Mosquito–human.	Ticks, human, reservoir animals.
Environmental factors	High population density, temperature, microclimate, rainfall.	Land cover, climate, vegetation, biodiversity, altitude, latitude, type of landscape, land use, flightless insect (different means of contact), behaviour of people.
Affected areas in Europe	Italy, Mediterranean, Catalonia.	All of Europe, except for high altitudes.
Level of relevance for area	High; transmission already shown; potential spread in the future.	Relevant in a growing region of Europe.
Database available in Europe?	Field data on vector limited (Italy, Albania); scale of geo-data poor.	Environmental data of good quality; disease data poor; difficult to monitor because of poor data.
Notes or remarks	Focus on French overseas areas.	Role of media in health education, misdiagnosis of the disease — high health costs.

[1] See: Süss J. Tick-borne encephalitis in Europe and beyond — the epidemiological situation as of 2007. Euro Surveill. 2008;13(26):pii=18916. Available from: www.eurosurveillance.org/ViewArticle.aspx?ArticleId=18916

Table 7 (below) shows the added value that the datasets would provide in Europe if linked to the E3 network. (1 = little added value, 2 = some added value, 3 = high added value.)

Table 7: Estimated added value derived from datsets (CH = chikungunya, TBE = tick-borne encephalitis)

Added value/data Type	**Climate**		**Vector surveillance**		**Disease**		**Land use/land cover**	
	CH	TBE	CH	TBE	CH	TBE	CH	TBE
Sensitivity to climate change	3	3	3	3	2	2	3	3
Potential to predict disease	2	3	2	2	3	3	2	2
Potential to prevent outbreak	extremely dependent on vector	extremely dependent on vector	2	3	3	3	2	3
Potential to become platform for routine information	3	3	2	2	2	3	3	3
Potential to provide timely coverage of a specific geographic region	3	3	2	2	3	3	2	2
Cost-effectiveness	3	3	3	3	3	3	2	2
Accessibility	3	3	?	Needs to be built	3	3	3	3
Total	*19*	*21*	*13*	*16*	*15*	*16*	*18*	*19*

It appears that relevant data on TBE are more easily available than on chikungunya. Thus the group advised ECDC to consider TBE as the disease of choice for the development of a pilot project.

2.3 Pilot project for vector-borne diseases

Principles

Objectives of the pilot

The pilot study aims at:

- providing a uniform Europe-wide information base for climate-sensitive infectious diseases — a supranational task; and
- building a fast information system based on multi-sectorial data sources including, but not limited to, health service data.

Uses

Early warning, public preparedness, risk assessment, targeted health service response (adaptation).

Geographical focus

All selected diseases must be climate-sensitive diseases that are of relevance to European citizens. In the medium term, all selected diseases should have a global reach, while still keeping their European focus.

Considered issues

Participants agreed that Europe has a strong potential to become a global leader in the climate change–mitigation–adaptation debate. A very urgent and serious issue is the increasing travel of European citizens to exotic destinations which may lead to infectious disease outbreaks. Obviously, disease vectors and infectious agents are not restricted by national boundaries, and this fact justifies attention at the European level. Furthermore, the fact that there are (sub)tropical areas under the jurisdiction and the responsibility of European countries is very important. In regard to interventions or programme the political will on the part of the Member States is crucial. Resources should be carefully aligned to the size of the task and the implementation should be gradual and well controlled.

Suitable diseases for a pilot project

Among the most intensively discussed infectious diseases that are potentially suitable for the pilot were TBE, Lyme disease and chikungunya. As described above, after brainstorming and evaluating the diseases in terms of data availability, transmission mechanisms (well-defined and described) and relevance, tick-borne encephalitis (TBE) was chosen for a pilot study. One of the main reasons for this choice was the relatively well-known and well-described mechanism of the reservoir–vector–host relationship and existing methods of data collection, especially in the Czech Republic and Slovakia. TBE also allows for the easy comparison between countries with good vaccination coverage — such as Austria where mass vaccination took place — and countries where vaccination is voluntary (Slovakia, Czech Republic). Another reason for selecting TBE was the fact that TBE is a notifiable disease in many European countries (Sweden, Slovenia, Slovakia, Czech Republic). Moreover, scientific and research expertise on TBE exists at many public health and research institutes throughout Europe.

Geographical outreach of the pilot study

The participating experts agreed on a preliminary list of European countries that should be included in the pilot study. The Czech Republic and Slovakia were recommended as examples of countries with relatively poor vaccination coverage but with a high level of expertise and experience. Austria was identified as a country with good vaccination coverage; Sweden, Italy, and Germany were recognised as countries where good quality data are available. It was also pointed out that a larger sample of countries would ensure that results were applicable Europe-wide.

Objectives for monitoring TBE; relevant environmental factors

Participants identified environmental factors that are potentially relevant for the spread and transmission of TBE. They also listed the key objectives for monitoring TBE. Objectives are to:

- minimise the increase of new cases;
- find affected regions;
- find affected populations;
- try to geographically locate the tick bite/case sites;
- identify areas for vaccination programmes;
- predict vulnerable areas;
- identify target populations for vaccination (age, profession, etc.);
- estimate the amount of necessary vaccines: predict demand;
- recommend vaccines;
- take preventive measures;
- raise awareness among physicians (environmental change leads to higher disease risk) and general public; and
- evaluate impact.

Indicators for the TBE pilot project

The working group identified a series of indicators which could be useful in the pilot project. For every indicator, additional information is required, e.g. frequency of measure, geo-resolution or scale, data sources and availability of data. Table 8 summarises these specifications.

Table 8: Indicators for TBE pilot

Indicator	Frequency of measure	Geo-resolution / scale	Source	Availability	Research concepts
Tick activity: identify the onset	Weekly/ monthly	• Czech Republic has data on settlement level; • particularly affected areas (need to be described in detail); • county; smaller resolution where available.	• local-regional level, country specific; • research groups; • countries where the problem is accentuated; • entomological reports.	Dispersed, or research groups/ authorities.	Methods for passive measurement of tick activity.
Temperature/ humidity	Daily	No need for localisation.	Many factors measured six times/day by weather service.	Available and in good quality.	

Indicator	Frequency of measure	Geo-resolution/scale	Source	Availability	Research concepts
Cases	Weekly (Czech Republic: reporting to national level on weekly basis, analysis on daily basis possible)	County level (or better resolution where available).	National public health institute: surveillance data.		
Biotopes/ vegetation (season start); available lists of vegetation types suitable for ticks	3 years to 5 years	County level.	Satellite images/CLC (CORINE land cover).		
Behavioural aspects (Accessibility of tick habitats to human activities, e.g. sports)	3 years to 5 years	County level.		Targeted information from the risk groups.	Done by survey studies annually or every three years; useful for service and communication.
Prevalence of infected ticks (might be part of tick activity analysis[1])	3 years to 5 years	County level.	Entomological reports.	From research facilities and therefore costly.	
Health impacts (complication, sick leave, hospital admissions, etc.)	Annual statistics	County level or smaller scale if available.	National statistics, ICD.		
Vaccination rate (time and area)	Annually	County level.	Baxter, Novartis.		

General recommendations for the pilot

The participants of the working group developed a list of general recommendations. First, all data sources in the public domain should be identified. These public domain sources could serve as possible primary data sources before proceeding with the next step: data collection from researchers or other sources. Activities during the pilot should be clearly differentiated by using two categories: scientific activities and public health activities. Also, cost assessments should be undertaken once the pilot project is fully operational. Engaging in partnerships with existing programmes and agencies was advised. Partnership options are listed below.

- Research project (FP7, Seventh Framework Programme, is a suitable option): initiate a partnership based on experience and available data; create a broad consortium of European centres, e.g. ECDC and institutions that are engaged in long-term TBE

[1] Ticks may be abundant in some areas, but not always a pathogen burden. Once infected, the spread of TBE may be very fast.

research such as the National Public Health Institute in Prague (Czech Republic), the Virological Institute of the Slovak Academy of Sciences, Bratislava (Slovak Republic), Trnava University (Slovakia), or Charles University (Prague, Czech Republic). Also, the Swedish Institute for Infectious Diseases has experience and capacity to serve as lead investigator.

- Project implementation should be based on existing networks or projects with similar objectives. The EDEN network was identified as a good model.
- Another option would be a partnership with the European Space Agency. ESA is currently developing a partnership programme for TBE monitoring.

Success factors for data collection

Finally, the group identified a list of success factors for the pilot. These factors were grouped into 1) factors linked to data collection, and 2) factors linked to data analysis. Both groups are listed below.

Success factors for data collection include:

- TBE case definitions need to be clear and concise;
- laboratory capacities should be available;
- availability of trained and competent staff is crucial;
- TBE should be politically recognised — both nationally and at ECDC — as a public health threat (health impact and costs of care might be used as arguments).

Success factors for data analysis

Success factors for data analysis include:

- trained and competent staff for data analysis;
- retrospective analysis used for routine estimation/indication of risk.

3. FOOD- AND WATERBORNE DISEASES

3.1 Introduction

Food and water safety have always been an important public health issue, especially in areas where safe water supplies are lacking. Inadequate sources of potable water may result in overall increased mortality rates attributable to infectious disease [12].

Among the serious infectious diseases linked to drinking water of poor quality are virus diseases such as hepatitis A; bacterial diseases such as cholera, typhoid fever, shigellosis, campylobacteriosis and gastroenteritis; or parasitic diseases [13].

The most common diseases transmitted through contaminated food are listeriosis, salmonellosis, campylobacteriosis or brucellosis. Salmonellosis remains the most common food-borne infectious disease with a reliable Europe-wide notification throughout Europe. Campylobacteriosis cases have been continuously increasing in the region since 1985, and bacteria of the genus Campylobacter are currently the most common gastrointestinal pathogens in many countries [14].

3.2 Workshop results

The workshop approach

A break-out group of experts focused on food- and waterborne diseases. Brainstorming developed along the lines of the following questions:

Question 1: What datasets are available in Europe for food- and waterborne/vector-borne diseases?

Question 2: Based on the list produced in response to Question 1, which infectious diseases should be monitored in Europe? What are the most important environmental drivers of these diseases?

Question 3: What potential limitations are imposed by the datasets, particularly in respect to the development of early warning systems?

Question 4: What datasets would provide the biggest added value to public health in Europe if linked to the E3 Network?

Question 5: What minimal dataset could be used in a pilot to test the feasibility of the E3 Network?

Question 6: Define in a few sentences the strategic objectives of monitoring selected diseases.

Question 7: Which critical indicators do we want to monitor?

Question 8: Which datasets are essential?

Question 9: Identify critical success factors for the monitoring system.

Question 10: Describe a pilot project and a roll-out strategy for the E3 monitoring of selected diseases.

Question 11: Based on a case study of food- and waterborne diseases, what general recommendations can be made for setting up the E3 network?

The outcome of the discussion is reflected below.

3.3 Selection of diseases

The working group on food- and waterborne diseases started with an inventory of the most important diseases, transmission routes, environmental factors, geographical spread and sources of information on the diseases and environmental factors (Table 9).

Table 9: Inventory of food- and waterborne diseases, transmission routes, environmental factors. Selected diseases are in bold[1]

Name of disease	Transmission route	Environmental factors	Affected areas in Europe	Level of relevance for area	Database available in Europe?
Salmonella	Food contamination.	Surface water and air temperature increase; heavy rainfall; agricultural practices.	all	High for most countries, low for countries with high public health standards.	ENTERNET ECMWF CLC (partially) land use: country level EFSA? GEMS (water) GLOBCOVER WHO-HFA GPHIN
Campylobacter	Food contamination; water consumption; bathing.	Heavy rainfall; agricultural practices.			
E. coli *(VTEC or EHEC)*	Food contamination and water consumption.	Surface water temperature increase; air temperature increase; heavy rainfalls; agricultural practices.	all	High for all.	ENTERNET ECMWF CLC (partially) land use: country level EFSA? GEMS (water) GLOBCOVER WHO-HFA GPHIN
S. aureus	Food handling.	Air temperature increase.			
Hepatitis A	Food consumption and food handling; water consumption; person-person.	Agricultural practices.			
Cryptosporidium	Water consumption and bathing.	Heavy rainfalls; agricultural practices.	all	High for all.	country disease data ECMWF land use: country

[1] This table is based on group discussions during the workshop and does not necessarily represent consensus among all participants.

Name of disease	Transmission route	Environmental factors	Affected areas in Europe	Level of relevance for area	Database available in Europe?
					level GEMS (water) GLOBCOVER WHO-HFA GPHIN
Shigella	Water consumption; food consumption and food handling.	Air temperature increase.			
Giardia	Water consumption; bathing.	Heavy rainfall; agricultural practices.			
Yersinia	Water and food consumption.	Heavy rainfall; air temperature increase; agricultural practices.			
Entamoeba histolytica	Water consumption.	Heavy rainfall; agricultural practices.			
Norovirus	Water and food consumption; person-person.	Agricultural practices.			
Vibrio cholerae	Water; bathing.	Surface water; temperature increase.			
Legionella	Water; environmental exposure.	High temperatures; humidity.	all	High in southern Europe; increasing in northern Europe.	EWGLE ECMWF country meteorology data: humidity WHO-HFA GPHIN
Cyanobacterium	Waterborne.				

The working group concluded that many food- and waterborne diseases are influenced by common environmental factors: temperature (air and water), precipitation, humidity and agricultural practices. The group selected four diseases that could be included in a pilot study — salmonellosis, *E. coli* infection/s, cryptosporidiosis and legionellosis — because of their epidemiological importance in Europe. The working group identified sources of information for the environmental factors temperature (air and water), precipitation, humidity, and agricultural practices (Table 10).

Table 10: Datasets and limitations for databases on waterborne diseases (1 = little added value, 2 = some added value, 3 = high added value)

	ECMWF[1] weather forecast	**ENTERNET[2] infectious diseases**	**CLC[3] CORINE land cover**	**EFSA[4] food security information**
Timeliness	3	3	2	
Geographical coverage	3	3	2 (not all countries)	
Frequency and regularity	3	3 (quarterly)	2 (six-year intervals)	
Costs	?	3	3	
Legal/accessibility	3	3	3	
Geo-coding (resolution)	2	1 (Country level only.)	3	
Notes		Will merge with TESSy.		
Total	14+	16	15	?

	GEMS[5] environment	**GLOBCOVER[6] environment**	**WHO-HFA[7] health indicators**	**GPHIN[8] public health information**
Timeliness	1	1	3	3
Geographical coverage	1	3	3	3
Frequency and regularity	2 (no annual data)	1	3 (bi-annually)	3 (daily)
Cost	3	?	3	2
Legal/accessibility	2 (use and distribution)	?	3	3
Geo-coding (resolution)	3	3	1 (national data)	1 (National, but could be localised.)
Notes				Not a database but source information.
Total	12	8+	16	16

[1] See: www.ecmwf.int/
[2] See: www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1195733766061?p=1192454969657
[3] See: reports.eea.europa.eu/COR0-landcover/en
[4] See: www.efsa.europa.eu/EFSA/
[5] See: www.gemswater.org/index.html
[6] See: www.esa.int/esaEO/index.html
[7] See: www.euro.who.int/hfadb
[8] See: www.phac-aspc.gc.ca/media/nr-rp/2004/2004_gphin-rmispbk-eng.php

3.4 Pilot project on environmental factors for waterborne diseases

Basic principles of the pilot on waterborne diseases

In principle, the pilot study should have a European perspective and analyse data at a European scale, but initially it may be necessary to start the project on a limited scale. The actual scale of the pilot could be linked to a particular disease.

The objective of the pilot study is to develop an early warning system, based on environmental alarm signals. Two elements are of interest: weather forecasts and syndromic surveillance.

In a Canadian study, historical rainfall data were used to predict waterborne diseases (partly due to the vulnerability of rural water systems). The study was able to conclude that after x days of heavy rainfall over period *y*, there would be an outbreak of waterborne diseases. It is also known that a 1 ºC increase in average temperature is linked to additional cases of salmonellosis.

Objectives and beneficiaries: An emergency warning system (EWS) on waterborne diseases

Strategic objectives

It was noted that:

- the expected impact of climate change on waterborne diseases justifies a higher level of alertness;
- an emergency warning system (EWS) can provide advice for the prevention and control of waterborne diseases;
- the forecasting is based on an increase in risk factors (and therefore relatively straightforward);
- the EWS will provide quality integrated information, rather than dissociated information;
- the EWS will contribute to a change from a reactive type of response (mitigation, control) to a proactive type of action (prevention).

Beneficiaries

Beneficiaries should be broadly defined:

- members of the public;
- local public health managers; and
- regional/national public health managers.

Critical indicators for waterborne diseases

The following indicators are related to an increased risk of disease outbreak:

- rain: heavy, after period of drought, or melting snow;
- rain: excessive amount, long duration;
- drought: no rain over a long period, combined with high surface water temperatures;
- population context (urban, rural) for the three indicators above determines vulnerability.

The rain indicators listed above may be used as single or combined indicators, depending on diseases. The specificity of information (resolution) should be based on client needs. Local public health officers prefer the highest resolution possible to give targeted advice to the public. Disease outbreak reports should be collected in order to build up a body of knowledge and eventually refine the threshold values that trigger an alarm.

Datasets for the indicators above are:

- meteorological data: start with available data from national and local stations;
- environmental data:
  - land use/land cover and soil;
  - vegetation;
  - bodies of water and water quality.
- social and demographic data:
  - population and vulnerable groups;
  - recreational and professional activities related to water;
  - infrastructure;
  - health infrastructure;
  - road communication;
  - information on water treatment plants, water reservoirs;
  - physical planning.
- strategies for data collection:
  - use information that is easily available in Europe;
  - clearly state from the very beginning which advantages an EWS has for the users (e.g. explain the cost-benefit situation of taking action/not taking action when alarm signals are detected);
  - use a cost-benefit analysis when lobbying for data from Member States (most of the required data can be obtained from Member States);
  - build coalitions with other users of data and negotiate with data owners (e.g. exchange of data that are of mutual interest);
  - start the EWS as a partnership between institutions, e.g. ECMWF, EEA, WHO, ESA, EC, rather than making it an exclusive ECDC project; and
  - finally, if above strategies fail, try to remind potential partners of their moral and legal obligations.

Prerequisites for building a successful EWS for waterborne diseases

First of all, there must be demand and a political mandate from the Member States for an EWS on waterborne diseases. Agreements with data providers and partnerships with other interested parties should be in place. A critical issue is funding for the system: funding has to be secured first. The EWS should be established as a self-learning system with learning loops: modern information technology should be applied to achieve this goal. As a starting point, retrospective data should be incorporated in the model.

Measuring the success of the E3 Network

The success of the system can be measured by:

- broad involvement of partners in the system;
- bi-directional data flow (feedback loops, input from multiple sources);
- use of information (professional and public).

Success factors in terms of output are:

- public health impact in terms of morbidity and mortality;
- reduction in number of disease outbreaks;
- strategic use of boiled water (in case of contaminated drinking water);
- vaccination coverage as a result of public health advice (e.g. hepatitis A).

Development phases: E3 pilot project on waterborne diseases

The following stages need to be completed:

- gather insight on potential EWS user requirements (perform both an informal and formal inventory);
- conduct research on existing EWS systems (basic templates);
- start EWS only in a few countries or regions;
- identify potential high-benefit areas where an EWS could make a difference (build up a success story);
- set up networks and partnerships for funding, data, use, and communication;
- develop algorithms and analytic frameworks;
- strike a balance between user- and technology-driven processes;
- develop a communication strategy at an early stage;
- evaluate and provide feedback at all stages; build own capacity and the capacity of partners and users.

E3 general recommendations

The following recommendations were made:

- 'start small and think big': the pilot cannot cover a big area and many factors, but should anticipate that it might grow in size;
- maximise access to available data (both formal/informal);
- minimise reporting overload for public health organisations by using already available systems rather than asking for information in a different format;
- engage in interactive stakeholder consultations from the start rather than presenting a ready-made project;
- actively seek insights from the field (globally) where experience has been built up;
- build up a network, both organisational (i.e. experts) and technical (i.e. computers); and
- always add an element of capacity building for the Member States.

4. GENERAL CONCLUSIONS OF THE WORKSHOP

Several experts from international organisations gave presentations at the workshop and provided a wealth of experience, particularly on building information systems linking environmental and epidemiological data. Important points for developing the E3 network are:

- End-user benefit is of the utmost importance. Linking datasets without a clear concept of how and where those data can be used is a recipe for disaster. Predicting change and potential health hazards and then providing advice on public health protection are the final objectives of most systems currently in use. However, most of these systems are not capable of actual predictions and only record changes or detect contributing factors. There is still a long way to go before reliable prediction systems will be in place.

- Systems linking environmental and epidemiological data are complicated, both in organisational terms and in technical terms. The organisational complications are a result of the wide variety of data required from organisations with different backgrounds and interests. In order to build networks based on trust and mutual benefit it is important to obtain relevant information and share this information. Technical complications are connected to a multitude of factors that are related to the changing epidemiology of infectious diseases for which no comprehensive analytical frameworks have yet been developed. Existing systems are an over-simplification of the reality. However, experience and expertise are growing, and so is computing power. In the near future, much more sophisticated models can be built.

The workshop participants did a lot of creative thinking on the potential benefits of the E3 network. The workshop resulted in two very different proposals for two pilot projects:

- The TBE pilot will focus on one disease and its vector; it will be initiated in a well-defined geographical area and will attempt to predict trends or scenarios that can yield information helpful for decision makers.
- The waterborne diseases pilot will concentrate on environmental factors that influence a variety of infectious diseases; at its core will be an early warning system that will serve the general public and public health officers.

For both pilot projects the groups came up with ideas for indicators and approaches for the development of a pilot project; they also provided general advice on initiating the pilots. ECDC should look for collaborators and partners when developing these pilots and, at the same time, generate commitment among potential partners.

The participants discussed several approaches that address the issues described above. According to the participants, ECDC's capacities are too limited to achieve convincing results if it acts alone. Only through collaboration and the establishment of partnerships, ECDC can live up to its full potential — inside and outside the European Union. Because of the nature of the problem (which could be defined as having 'no administrative borders', both for infectious diseases and environmental change) participants pointed out that ECDC should focus on activities inside the EU; at the same time, ECDC has to keep an eye on developments in neighbouring countries and at the global level. ECDC's network of national public health organisations is a definite advantage as this allows the collection of disaggregated data at the province, county, or district levels. This could provide E3 with a particularly suitable tool to deal with processes limited to geographic areas (such as TBE). Pooling researchers and public health professionals could substantially enhance the overall capacity of the E3 network.

Several strategic approaches were identified:

- **Research strategy:** FP7 was perceived as a tool to promote research and science within the EU and as a foundation for a pilot (probably TBE). Given the existing capacities within participating institutions, it is realistic to initiate a proposal for a research project on either one of the pilots.
- **Development strategy:** partnerships with major data providers from international organisations (WHO, UN, etc.) may facilitate data sharing and research and development activities for both pilots.
- **Strategic partnerships**: there are a number of projects dealing with one or more of the subjects discussed during the meeting. The E3 network should build on those experiences and take existing technologies into account in order to achieve its own strategic objectives.

Although it was not explicitly discussed during the meeting, it is important to develop an action plan to develop these concepts. Such a document will outline the objectives, sequence of activities, partners, budgets, and expected results; it will also provide decision makers at ECDC with sufficient information to approve both pilots.

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ANNEX 1: PRESENTATION SUMMARIES

Presentation by Dr Dafina Dalbokova, World Health Organization Regional Office for Europe: Environment and health in Europe: ENHIS – the Environment and Health Information System

ENHIS focuses on the relationship between exposure, health effects and actions. This relationship can range from strong (with abundant evidence in literature) to weak (suggestions in reviews). Evidence comes mostly from WHO publications, e.g. drinking water guidelines, air quality guidelines, recreational water or other systematic environmental health reviews.

In general, for infectious diseases the relationship between agent and disease is clear, while for other environmental factors this is not the case, e.g. the relationship between exposure to outdoor air particles and cardiovascular disease. We are dealing here with the so-called fraction of the environmental burden of disease.

ENHIS selected 26 core indicators — available throughout the WHO European Region — using national and international databases and some specific data sources. This information was integrated, analysed, aggregated into 26 factsheets[1] and used during a large capacity-building exercise in the Member States. In the area of infectious diseases, ENHIS provides information on gastro-intestinal diseases and respiratory diseases. The website provides policy-relevant information for people without a background in public health.

When looking at waterborne diseases, it is obvious that Europe lacks a harmonised surveillance system. Legal provisions in regard to data collection differ; information is often collected retrospectively (by laboratories) after an outbreak.

A good surveillance system for infectious diseases detects health problems and tracks environmental causes. Linking the system to population exposure data is very important in this respect.

ENHIS plans to expand its geographical coverage as well the thematic coverage, which will soon also cover climate change. It also plans to include health system performance reviews. Initially, only a limited number of diseases and environmental factors will be included, but ENHIS will expand, albeit slowly. Disease modelling and interoperability of systems is developing quickly, making it possible to handle bigger and more complicated databases. In the future it should be possible to link complex databases and have real-time information on diseases and environmental factors. This will make it possible to predict and monitor outbreaks and disease trends.[2]

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[1] See www.ENHIS.org
[2] See www.syndromic.org/

Presentation by Dr Renaud Lancelot, EDEN Coordinator: The EDEN project on emerging vector-borne diseases in Europe — successes and challenges

The goals of the EDEN project[1] are:

- to evaluate/catalogue European ecosystems with regard to risks posed by emerging vector-borne diseases; and
- to develop a set of generic methods, tools and skills on disease installation and spread models, on early warning methods, on surveillance and monitoring tools, and scenarios.

EDEN results are to be used by decision makers for risk assessment and provide decision support for intervention and public health policies at EU, national and regional levels.

EDEN researches vector-borne diseases and vectors, which are highly sensitive to environmental changes. These serve as models of disease-emergence patterns.

The project study team operates within a matrix model: diseases are on one axis, technical elements (information systems, sensing, modelling, etc.) on another. The entire project uses the same framework to study the diseases in order to get comparable results.

EDEN successfully demonstrated environmental change, e.g. in reference to vegetation, and its effects on the spread of vectors. Advances were made in statistical modelling techniques. The project also showed the influence of landscape on disease transmission: spatial fragmentation and connectivity of habitats of vectors play an important role in the spread of diseases.

EDEN has been able to demonstrate effects of environmental changes on a smaller scale for a limited number of agents. For each disease it is important to analyse the key elements that underlie changes in epidemiology. From there it may be possible to identify classes of agents, vectors, or hosts. The main challenge lies in generalising the developed methodology in order to make it applicable on a wider scale.

[1] See www.eden-fp6project.net

Presentation by Guy Hendrickx and William Wint: EDEN data management — three years' experience

In order to manage data from various sources, standardisation is necessary. EDEN began with formulating data standards and then asked participating organisations to approve these standards. Approved standards refer to the coordinate systems, the spatial file exchange formats, spatial data metadata, and metadata. Standards on data storage and backup and data access levels were already formulated at the beginning of the project.

Because of the complexity of data processing, the provision of metadata (source and type of processing) is important. This ensures reliability.

EDEN brought together data from various sources, which had to be tailored to one standard, e.g. on remote sensing, on meteorological data, on mammal and avian biodiversity, on population infrastructure, and on protected areas. The next step will be to produce distribution models and spatial risk assessment. Linking biodiversity data with health data may shed new light on the role of vectors and hosts in transmitting diseases.

Climate change scenarios (temperature and rainfall) can be linked to data on vector distribution which will make it possible to develop scenarios for vector distribution, using a method called 'logic criteria decision support'. Logic criteria decision support compares an actual distribution with a future potential distribution, based on the lowest and highest impact model/scenario.

The resolution of epidemiological data is important. Often epidemiological data are provided according to administrative boundaries. There are methods to disaggregate information from larger areas to smaller areas. This approach is particularly interesting for ECDC because reporting countries routinely provide only low resolution data. After converting data into high resolution data, these data can then be validated by the Member States.

Presentation by Stefan Schwartz, United Nations Environment Programme (UNEP): Global Environment Outlook (GEO) data portal[1]

The GEO data portal is a UNEP product. GEO is the acronym for Global Environment Outlook. GEO publishes major environmental assessment reports on a regular basis. It started 11 years ago. The latest report (GEO Year Book 2006, 82 pages) is mainly retrospective but also offers a look into the future by developing scenarios.

Every year UNEP produces smaller reports taking up major environmental issues. GEO covers seven geographical regions. The reports are produced in a bottom-up manner: scientist and co-operators in the countries write their reports on socioeconomic and environmental issues, which are then compiled into regional reports, e.g. on Africa. These regional reports are then aggregated to the global level. One of the main problems is data comparability: different regions use slightly different data definitions. It requires a lot of effort to integrate data sources. Data gaps are followed up in the GEO Data Working Group, and interagency networks such as the Inter-secretariat Working Group on Environment Statistics (IWG-Env), the Committee for Coordination of Statistical Activities (CCSA) and others.

The GEO data portal has a database with more than 500 different variables, covering socioeconomic and environmental issues. Published data come from 25–30 different sources: the World Bank, UNEP, etc.

The GEO website offers user-friendly features, such as keyword searches. Data can be accessed at national, sub-regional or regional levels and graphically visualised in tables, graphs or maps.

Meta information on the type of dataset is available. Some datasets are protected from download: they can be graphically displayed but not downloaded. Agencies providing data to the GEO portal can impose such restrictions (only 5 % of data). The data can be downloaded in different formats (e.g. PDF, CSV, Excel). 85–90 % of the data are statistical data and 10 % are geospatial data.

GEO portal is constantly adding new functionalities such as trend analyses. There are still many areas where data are limited or not included in the database, e.g. water quality, waste, or land degradation.

[1] See geodata.grid.unep.ch

Presentation by Dorota Jarosinska, European Environment Agency: Linking environmental and health data — EEA activities

The EEA has 32 member countries and six cooperating countries. The agency is a strong networking agency: the centre in Copenhagen works with a number of expert centres in Europe that provide expertise in various areas. The network meets three times a year at EEA which ensures a stable network and consistent cooperation. The EEA is an information provider; it receives most of its data from member countries. EEA developed a system called Reportnet, based on a data-warehouse infrastructure, and a series of tools for data quality and exchange.

EEA covers the area of environment and health, mandated through the EU Environment and Health Action Plan 2004–2010[1] and the Pan European Environment and Health Process[2]. EEA works with many partners in Europe. Environmental and health indicators were formulated in collaboration with European agencies. The latest report, 'Europe's environment — The fourth assessment'[3], covers those indicators.

With regard to infectious diseases, there are three areas of interest covered by EEA: land cover and land use, impact of climate change, and biodiversity and ecosystems. As a result of various programmes, EEA now has detailed information on land use, temperature, precipitation, water, animal biodiversity, etc. This information could be helpful to ECDC.

EEA contributes to the Shared Environmental Information System (SEIS). The intention is to move from a centralised reporting system towards a system based on access, sharing and interoperability. Principles of shared systems are also relevant for E3: data should be managed as closely as possible to the source, collected once and shared with others, be readily available, and accessible to stakeholders (taking confidentiality into account when applicable).

The Water Information System for Europe (WISE)[4] is an example of a such a shared system. The OZONE website[5] is a good example of a shared environmental information system: it provides real-time information on ozone, indicating levels and issuing warnings when necessary.

There are three components of SEIS: content, infrastructure and services, and organisation. Adopting a new approach is a time-consuming and intense endeavour, but yields clear benefits: it supports the quality of generated information while reducing the reporting burden, and it may contribute to decision making and may facilitate quick responses to emergencies.

1 See ec.europa.eu/environment/health/pdf/com2004416.pdf
2 See www.euro.who.int/envhealth
3 See reports.eea.europa.eu/state_of_environment_report_2007_1/en
4 See water.europa.eu/
5 See www.eea.europa.eu/maps/ozone/welcome

Presentation by Jason Pickering, Public Health Information Systems Group, World Health Organization: Linking environmental and public health information systems — experiences, challenges and opportunities

In the past 20 years there has been a proliferation of information systems operated by multilateral organisations, national organisations, and non-governmental organisations. However, the quality of data varies. Data may not be comparable, may not be integrated, or may not be complete. There is a need for tools that can assemble data from different sources, different sectors and different levels. We need tools that analyse and communicate rapidly; we need to use that data and translate the data into action, and we need to be able to do it very quickly.

There are many challenges, such as the interoperability of systems, and access to information. Information is often kept in 'silos': collected for specific purposes, and not shared.

In the case of malaria, climate and vector data are known in detail, but the incidence of malaria is not. Moreover, health workers, who need relevant information in order to take action, often do not have access to it.

Man-made environmental change can lead to potential disease outbreaks: in one country, the construction of irrigation canals changed the flora and subsequently the fauna, with an increase in reservoir hosts that eventually caused an outbreak of leishmaniasis. This connection could only be discovered when multiple sources of data on land cover and reservoirs were combined at a very high-level resolution[1]. Continued monitoring over time confirmed the changes in flora and fauna. This clearly shows the need for interoperability and standards.

An outbreak of Rift Valley fever can be stopped with timely access to information. During the 2006–2007 outbreak, several partners (NASA, US Department of Defense, ministries, etc.) combined their data, which eventually lead to the production of a decision-making tool[2]. The national ministries of health could then use the tool for public health interventions.

In regard to disease outbreaks and event management, value can be added quickly by using data integration technology and by adopting standards. Monolithic databases are obsolescent because of technological advances like multiple databases with data-exchange features that offer new opportunities. Advances in technology (Google Maps, Google Earth, etc.) have also established new standards, and modern databases should be able to migrate data to these platforms.

Strategic priorities are:

- integrated databases of diseases, resources and risks;
- tools and methodologies for collecting, integrating, analysing and disseminating data;
- capacity-building for data analysis and decision-making; and
- partner networks: standards for data collection, sharing, interoperability, training, risk mapping and early warning.

Environmental data are a key factor for decision making, in addition to routine surveillance, public health interventions, and demographic data. Most importantly, data can be made accessible to end-users through interoperability, standards, and strong health information systems.

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[1] See www.who.int/tools/geoserver/www/ecomp/index.html
[2] See www.who.int/mediacentre/factsheets/fs207/en/

Presentation by Laurent Braak, executive manager, MEDES (Institute for Space Medicine and Physiology), ESA and CNES: Remote sensing for public health risk mapping

Satellites can provide communication, geographical localisation, and earth observation: these capabilities can be used to specify ecological factors and contribute to developing predictive models of environmentally related diseases. The European Space Agency (ESA) is a European body and has 17 member countries. The ESA Centre for Earth Observation (ESRIN) hosts some of the epidemiological systems run by ESA. ESA has just launched a website to promote applications in the field of health[1]. One of the important topics is environmental health. ESA also provides satellite imagery for disaster management. Projects to which ESA contributed include EPIDEMIO[2] (Earth Observation in Epidemiology), a project using imagery to study diseases, particularly meningitis; AIRTEX, a project on air pollution forecasts and alerts; and the GEO portal. The Integrated Applications Promotion (IAP) programme is a programme under development that combines space observation with terrestrial information. ESA and other partners (e.g. the Directorate-General for Health and Consumers) are in the process of starting a programme for disease risk mapping for tick-borne encephalitis, chikungunya and blue tongue, which gives ESA the unique chance to contribute to public health. The IAP also cooperates with WHO Headquarters on the interoperable open-health platform, establishing communication between various databases.

For over ten years, the CNES (Centre National d'Etudes Spatiales) has been developing special applications for health problems. There are projects in Africa, Latin America and Asia. In this context, tele-epidemiology is most interesting. CNES develops local surveillance and communication networks using low-cost technology. Data are used to develop risk maps that combine local information with satellite information.

Satellites for Epidemiology (SAFE)[3] focuses on environment-dependent diseases. This system is designed to work in routine and in emergency situations. Satellites play a role in routine information used in epidemiology (e.g. aggregating information from the field) and provide emergency communication capabilities.

MEDES is developing the MEDANY platform to develop data collection applications for epidemiological surveillance and outbreak management. New software applications are developed for modeling, presentation and communication.

In conclusion, an epidemiological information system should

- be flexible and quickly deployable;
- be supported by the most appropriate communication infrastructure;
- integrate different types of information;
- facilitate interoperability; and
- implement standards.

It should interface with existing information systems. In Europe, a collaboration between several centres and agencies could make such an information system a reality.

[1] See www.esa.int/SPECIALS/Space_for_health/index.html
[2] See dup.esrin.esa.int/projects/summaryp60.asp
[3] See www.esa.int/SPECIALS/Space_for_health/SEMNVMB474F_0.html

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ANNEX 3: DATABASES AND ORGANISATIONS

The list of databases below follows the listing as proposed for the E3 network input (see Figure 2, section 1.3). Some of the databases serve several elements of the E3 input.

Epidemiological Intelligence		
Host/Sponsor	Database	Description
Multiple	Epidemic Intelligence Databases	e.g. GPHIN, MediSys, HEDIS, ProMed, etc.
ECDC	TTT	Threat Tracking Tool
Infectious Diseases Surveillance		
Host/Sponsor	Database	Description
State of Louisiana	ARBONET http://arbonet.caeph.tulane.edu/	Louisiana ArboVirus Surveillance System
WHO Europe	CISID http://data.euro.who.int/cisid/	Contains data gathered through surveillance of communicable diseases – such as tuberculosis, HIV/AIDS and sexually transmitted infections, and malaria – and data on immunisation coverage in countries and recent outbreaks in Europe. Offers information on recent outbreaks in Europe and some other textual information. Allows detailed review and assessment of the situation on the main infectious diseases in the WHO European Region. Offers some data at the subnational level.
ECDC	TESSy	The European Surveillance System
Meteorology		
Host/Sponsor	Database	Description
24 European National Meteorological Services	EUMETNET www.eumetnet.eu.org/	EUMETNET is a network grouping 24 European National Meteorological Services. EUMETNET provides a framework to organise co-operative programmes between the Members in the various fields of basic meteorological activities such as observing systems, data processing, basic forecasting products, research and development, training. The site provides links for national meteorological services of Europe.
Intergovernmental organisation	EUMETSAT www.eumetsat.int/	The main purpose of the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) is to deliver weather and climate-related satellite data, images and products– 24 hours a day, 365 days a year. This information is supplied to the National Meteorological Services of the organisation’s intergovernmental organisation member and cooperating states in Europe, as well as other users world-wide. EUMETSAT is an intergovernmental organisation and was founded in 1986.

International organisation supported by 31 countries.	ECMWF (The European Centre for Medium-Range Weather Forecasts) www.ecmwf.int/	ECMWF provides a range of services for WMO (World Meteorological Organization) Members, which can be accessed via the website. Please read the conditions for data provision.
Entomology		
Host/Sponsor	Database	Description
Scientific/educational, not-for-profit public service association operating under the corporation laws of the state of New Jersey	American Mosquito Control Association www.mosquito.org/	Mosquito information, also provides link to world-wide entomological sources.
Iowa State	Iowa State Entomology Index of Internet Resources www.ent.iastate.edu/LIST/	The directory and search engine of insect-related resources on the internet.
Water Quality		
Host/Sponsor	Database	Description
DG Environment, EEA, Joint Research Centre, Eurostat	Water Information System for Europe http://water.europa.eu/ content/view/20/36/lang, en/	Compiles a number of data and information collected at EU level by various institutions or bodies which have either not been available or only been fragmented over many places.
Environment (general)		
EEA	http://www.eea.europa.eu/products	All the reports produced by the EEA. It includes state of the environment reports, thematic and technical reports, briefings and corporate documents.
Air Quality		
Host/Sponsor	Database	Description
EEA	Ozone Net http://www.eea.europa.eu/maps/ozone/map or http://www.eea.europa.eu/themes/air/airbase	Provides real-time information on Ozone pollution in Europe and information on Ozone reduction, or on air pollution in general.
JRC/IES	EDGAR (Emissions Database on Global Atmospheric Research) http://www.rivm.nl/edgar/	Provides global past and present day anthropogenic emissions of greenhouse gases and air pollutants by country and on 0.1x0.1 grid. A joint project of the European Commission DG JRC and the Netherlands Environmental Assessment Agency (MNP).
EEA	EIONET (European Information and Observation Network) http://www.eionet.europa.eu/	EEA core set indicators, assessments and data services are available at www.eea.europa.eu. Links to several data sources, such as: Air-base (Air Quality monitoring information); Water-base/WISE; Ozone.
Cambridge Environmental Research Consultants Ltd (CERC)	AIRTEXT http://www.airtext.info/	Air pollution forecasts for different regions
Flora		
Host/Sponsor	Database: to be determined	Description not yet available
Fauna		
Host/Sponsor	Database: to be determined	Description not yet available
Geology		
Host/Sponsor	Database: to be determined	Description not yet available
Satellite Data		
Host/Sponsor	Database	Description
ESA (European Space Agency)	ESA (European Space Agency)–Space for Health http://www.esa.int/SPECIALS/Space_ for_health/index.html	Health-related satellite data and services.

ESA (European Space Agency)	Epidemiology http://www.epidemio.info/	The scope of this ESA project is to demonstrate and use the potential of Earth Observation for a new service which supplies new types of environmental information for epidemiology.
SES Data		
Host/Sponsor	Database: to be determined	Description not yet available
Agriculture		
Host/Sponsor	Database: to be determined	Description not yet available
Land Use		
Host/Sponsor	Database	Description
EEA	SEBI 2010 (Streamlining European 2010 Biodiversity Indicators) http://biodiversity-chm.eea.europa.eu/ information/indicator/F1090245995	Launched in 2004 to develop a European set of biodiversity indicators for assessing and informing about progress in halting biodiversity loss. Provides a detailed description of each of the indicators, complete with methodological data.
DG ENV, DG JRC, ESTAT, EEA	European Soil Data Centre http://eusoils.jrc.ec.europa.eu/ library/esdac/index.html	The European Soil Data Centre (ESDAC) is the thematic centre for soil-related data in Europe and has been established according to a decision taken among the European Commission's DG ENV, DG JRC, ESTAT and the European Environment Agency. Currently it contains soil data and information at European scale and will link in the future to similar datacentres at global and national level.
EEA	CORINE Land Cover http://reports.eea.europa.eu/COR0-landcover/en	Land cover data for Europe.
Health Databases		
WHO Europe	Health For All Database Europe www.euro.who.int/HFADB	Contains data on about 600 health indicators, including basic demographic and socioeconomic indicators; some lifestyle- and environment-related indicators; mortality, morbidity and disability; hospital discharges; and healthcare resources, utilisation and expenditure.
Multi-purpose databases		
United Nations Environment Programme	United Nations Environment Programme – Global Environment Outlook – The GEO Data portal http://geodata.grid.unep.ch/	Online database holds more than 450 different variables, as national, sub-regional, regional and global statistics or as geospatial datasets (maps), covering themes like Freshwater, Population, Forests, Emissions, Climate, Disasters, Health and GDP.
EDEN	EDEN http://www.eden-fp6project.net/ , http://www.edendatasite.com/	The project develops and co-coordinates a set of generic methods, tools and skills such as predictive models, early warning and monitoring tools which can be used by decision makers for risk assessment, decision support for intervention and public health policies.

EC, EEA	Shared Environmental Information System http://ec.europa.eu/environment /seis/index.htm	The Shared Environmental Information System (SEIS) is a collaborative initiative of the European Commission and the European Environment Agency (EEA) to establish together with the Member States an integrated and shared EU-wide environmental information system.
EPA	Global Earth Observation System of Systems (GEOSS) http://www.epa.gov/geoss/	GEOSS is envisioned as a large national and international cooperative effort to bring together existing and new hardware and software, making it all compatible in order to supply data and information at no cost. The US and developed nations have a unique role in developing and maintaining the system, collecting data, enhancing data distribution, and providing models to help all of the world's nations. EPA has a strong commitment to the GEOSS initiative.
EC	Global Monitoring for Environment and Security (GMES) http://www.gmes.info/ index.php?id=home	The 'Global Monitoring for Environment and Security' (GMES) represents a concerted effort to bring data and information providers together with users, so they can better understand each other and make environmental and security-related information available to the people who need it through enhanced or new services.
European Commission	Eurostat	Principal EU source for demographic, population, economic data.
Multiple	INDEPTH www.indepth-network.org	INDEPTH will be an international platform of sentinel demographic sites that provides health and demographic data and research to enable developing countries to set health priorities and policies based on longitudinal evidence.
WHO/DG SANCO	ENHIS http://www.enhis.org/object_class/ enhis_home_tab.html	Not focused on infectious disease, but has developed environmental health indicators for numerous other fields (e.g. air quality, food safety, water & sanitation, housing, chemical safety, etc.).
European Commission	The INSPIRE Community Geoportal http://www.inspire-geoportal.eu/	Europe's internet access point to a collection of geographic data and services within the framework of the Infrastructure for Spatial Information in Europe (INSPIRE) Directive.

ANNEX 4: LINKS TO DATABASES

United Nations Environment Programme — Global Environment Outlook

The GEO data portal: http://geodata.grid.unep.ch/

The EDEN project: http://www.eden-fp6project.net/, http://www.edendatasite.com/

ESA (European Space Agency) — Space for Health:
http://www.esa.int/SPECIALS/Space_for_health/index.html

The European Environment and Health Information System (ENHIS):
http://www.enhis.org/object_class/enhis_home_tab.html

Epidemio — EO in Epidemiology: http://www.epidemio.info/

AirText — Air pollution forecasts and alert: http://www.airtext.info/

CORINE Land Cover (EEA): http://reports.eea.europa.eu/COR0-landcover/en

Eionet — European Environment Information and Observation Network:
http://www.eionet.europa.eu/

INSPIRE Community Geoportal: http://www.inspire-geoportal.eu/

SEIS: Shared Environmental Information System:
http://ec.europa.eu/environment/seis/index.htm

European Soil Data Center: http://eusoils.jrc.ec.europa.eu/library/esdac/index.html

Global Earth Observation System of Systems (GEOSS): http://www.epa.gov/geoss/

Global Monitoring for Environment and Security: http://www.gmes.info/index.php?id=home

SEBI2010 — Streamlining European 2010 Biodiversity Indicators: http://biodiversity-chm.eea.europa.eu/information/indicator/F1090245995

EURECA — European Ecosystem Assessment: http://biodiversity-chm.eea.europa.eu/information/F1051869800/fol818985

WISE — Water Information System for Europe:
http://water.europa.eu/content/view/20/36/lang, en/

Ozone-net: http://www.eea.europa.eu/maps/ozone/welcome

ANNEX 5: LIST OF PARTICIPANTS

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ANNEX 6: WORKSHOP PROGRAMME

Workshop on Linking Environmental and Infectious Disease Data

28-29 May, 2008, Sigtuna

Day 1

Wednesday, May 28, 2008

08:30 – 09:30	Registration and Introduction
08:30 – 09:15	Registration
09:15 – 09:30	Opening remarks: Zsuszanna Jakab, ECDC
09:30 – 13:00	Session 1: Environmental Change and Infectious Disease. Chair: TBA
09:30 – 10:00	Environmental determinants of infectious disease: Bettina Menne, WHO Regional Office for Europe
10:00 – 10:30	Monitoring environmental change and infectious disease: Jan Semenza, ECDC
10:30 – 11:00	Coffee
11:00 – 11:30	EDEN: Successes and Challenges: Renaud Lancelot, CIRAD
11:30 – 12:00	Environment and Health in Europe: The ENHIS System: Dalfina Dalbokova, WHO
12:00 – 13:00	LUNCH
13:00 – 17:30	Session 2: Group Work on Prioritising Environmental Determinants of Infectious Diseases
13:00 – 13:15	Introduction to Group Assignments. Jaap Koot, Public Health Consultants
13:15 – 16:00	Group Assignment: Identifying Environmental and Epidemiological Datasets for Linking

Group A: Food- and Waterborne Diseases. Chair: Paul Sockett

Group B: Vector-Borne Diseases. Chair: Elisabet Lindgren

(Coffee break during group assignments at 15:00)

16:00 – 17:15	Plenary presentations on group work and discussion. Chair: Martin Ceen, Trnavskej Univerzity
17:15 – 17:30	Wrap, day 1. Jan Semenza, ECDC
19:00	Dinner. TBA

Day 2

Thursday, May 29, 2008

09:00 – 10:45	Session 3: Linking Environmental and Epidemiological Information Systems. Chair: David Stanners, EEA
09:00 – 09:30	Selecting and linking datasets: EDEN experience: Guy Hendricks, AVIA GIS
09:30 – 10:00	Managing environmental data: The UNEP GEO Data Portal: Stefan Schwarzer, UNEP
10:00 – 10:30	EEA Activities Linking Environmental & Health Data: Dorota Jarosinska, EEA
10:30 – 11:00	Coffee
11:00 – 11:30	Public Health Mapping and GIS: Jason Pickering, WHO
11:30 – 12:00	Remote Sensing for Public Health Risk Mapping: Didier Schmitt, ESA
12:00 – 13:00	Lunch
13:00 – 15:00	Session 4: Group Work on Action Planning
13:00 – 13:10	Introduction to Group Assignments: Jaap Koot, Public Health Consultants
13:10 – 15:00	Group Assignment: Environmental and Epidemiological Data Availability for Linking

Group A: Surveillance and Epidemic Intelligence Data. Chair: Andrea Ammon

Group B: Environmental Data. Chair: David Stanners

15:00 – 15:15	Coffee
15:15 – 16:00	Plenary presentations on group work, discussion and closing remarks. Chair: Jan Semenza, ECDC