

# Setting research priorities in environment and health

Report of a meeting in  
Bonn, Germany  
30 November–1 December 2017





**World Health  
Organization**

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REGIONAL OFFICE FOR **Europe**

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## ABSTRACT

Establishing priorities in environment and health research is a complex challenge. Human impact on the environment occurs at a faster pace than research; therefore, improvements should be made in research aimed at anticipating human health impacts. More action-oriented research is needed in this respect, namely on the effectiveness of interventions. Innovation and creativity are key elements, both for novel research and for extracting value from existing knowledge and evidence. Investment is needed in research methodologies that allow for complexity in risk assessment, system assessments and economic assessments. Investments should be made in new research methods that strengthen causal inferences but at the same time, as uncertainty is often an issue, do not hamper or delay policy action in environment and health. The development of effective governance systems for environment and health research is also a priority, with attention to values, ethics and conflict of interest. Improvements in the accessibility and uptake of research findings beyond the academic community, along with educational research programs and good communication, are necessary for optimal use of research findings. Conflicts of interest must be identified to protect research impartiality and, consequently, promote effective prevention.

### Keywords

RESEARCH  
ENVIRONMENT  
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## Abbreviations

AIDS	Acquired Immunodeficiency Syndrome
AMR	Antimicrobial resistance
AOP	Adverse outcome pathways
CAP	Climate active pollutants
DALY	Disability Adjusted Life-Years
DPSEEA	Driving force, Pressure, State, Exposure and Effect
EC	European Commission
EEA	European Environment Agency
EH	Environment and health
EU	European Union
FP	Framework Programme for Research and Innovation
GATHER	Guidelines for Accurate and Transparent Health Estimates Reporting
GBD	Global Burden of Disease
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HBM4EU	European Human Biomonitoring Initiative
HIV	Human Immunodeficiency Virus
IARC	International Agency for Research on Cancer
IT	Information technology
JRC	Joint Research Centre
miRNA	micro ribonucleic acid
NCDs	Noncommunicable diseases
NEC	National Emission Ceiling
NGO	Nongovernmental organization
PM	Particulate matter
SDG	Sustainable Development Goals
SC	Societal challenge
SEE	South Eastern Europe
SES	Socioeconomic status
WASH	Water, Sanitation and Hygiene

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## Introduction

Research in environment and health (EH) is of crucial strategic importance to contemporary society to effectively prevent risks from environmental exposures and to identify environmental conditions optimally supporting health. It is becoming even more critical given the increasingly fast pace of environmental changes, opportunities and threats. Input from research is also essential for the World Health Organization (WHO) to fulfil its mandate of supporting Member States on environment and health matters, as part of a commitment to strengthening the use of evidence, information and research for policy-making in the WHO European Region.<sup>1</sup> As EH research utilizes substantial human and financial resources, it is imperative that society at large stands to gain from it.

The WHO Regional Office for Europe has undertaken a project to identify contemporary EH research needs and priorities, in light of the evolving understanding of the complexity of connections and interactions in environment and health. A first meeting, held in Cascais, Portugal, on 27-28 April 2017 and organized in collaboration with the Portuguese Ministry of Health, took stock of previous efforts and developed an updated set of criteria for establishing EH research priorities, which included public health relevance, distribution, policy relevance, innovation and novelty.

The meeting “Setting research priorities in environment and health”, convened in Bonn on 30 November – 1 December 2017, built on the outcomes of the Cascais meeting and of the 6th Ministerial Conference on Environment and Health, held on 13–15 June 2017 in Ostrava, Czechia, where Member States identified priority areas of interest and action in EH. The overall goal of this meeting was to use the newly developed criteria and apply them to specific EH domains, including those of the Ostrava Declaration: air pollution, water and sanitation, chemicals, waste management and contaminated sites, climate change, cities, and health systems sustainability. Also, considering the fast-evolving contemporary EH landscape, the meeting aimed to determine how to establish dynamic, flexible and responsive mechanisms and institutional arrangements for maximizing the benefits of EH research in Europe. Specific objectives of this meeting included:

- identifying research priorities which would lead to fulfilment of the Ostrava agenda;
- identifying further priority topical areas and cross-cutting issues for EH research;
- analyzing current and emerging research implementation frameworks and mechanisms, such as the European Union’s Environment and Health Action Plan;
- identifying incentives for supporting more innovative, “high-risk” type of EH research; and
- addressing relevant cross-cutting issues such as uncertainty, conflict of interest, and

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<sup>1</sup> Action plan to strengthen the use of evidence, information and research for policy-making in the WHO European Region. <http://www.euro.who.int/en/about-us/governance/regional-committee-for-europe/66th-session/documentation/working-documents/eurrc6612-action-plan-to-strengthen-the-use-of-evidence,-information- and-research-for-policy-making-in-the-who-european-region> 11  
SEP



dissemination needs in EH research.

The meeting convened experts from the EH research community and involved relevant stakeholders, including funding agencies and national government agencies. The meeting programme, list of participants and background document can be found in the annexes.

## **Strategic perspectives in environment and health research**

### **The Ostrava agenda**

The Ostrava agenda includes seven main priorities: water, air, chemicals (mainly relating to exposures), cities (relating to locations), health systems, climate change, waste and contaminated sites (relating to complex systems). To address such challenging themes, public health research on environmental determinants of health, their burden of disease and the final health impact on people is needed, focusing on the whole population. Research should be designed so as to facilitate translation of knowledge into action.

Implementation of the Ostrava agenda is indeed complex: it requires intersectoral action, and evidence and research should be made available to different audiences and stakeholders at different stages of risk management. The right questions need to be asked, and such questions need to be properly framed.

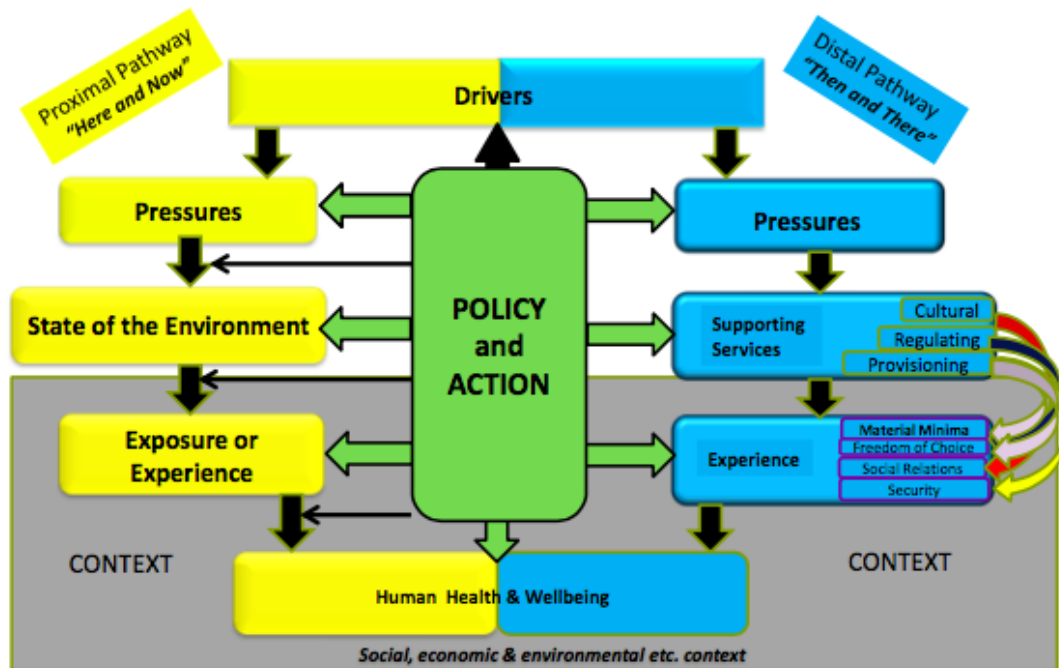
### **The contemporary research agenda**

EH research faces a number of challenges related to prioritization: ensuring that the relevant issues are brought to the table and adopting a sensible and defensible approach to prioritize among the different topics.

Society cannot deliver health, well-being and health care in an equitable way without a substantial rethink and the ability to act on a vastly extended temporal and spatial scale. Such an approach seems to be especially needed in order to meet the goals articulated by the existing, mutually supportive policy frameworks, of Health 2020, the European EH process, the New Urban Agenda and the 2030 Sustainable Development agenda and its Goals. With regard to the latter, environmental action can directly contribute to good health and well-being (SDG 3) and to virtually every other SDG. A logical conceptualization of the whole public health project, if it is to progress, is an environmental conceptualization. Two pathways can be considered: a proximal pathway (“here and now”) and a distal pathway (“then and there”).

The Ecosystems Enriched DPSEEA Model (Driving force, Pressure, State, Exposure and Effect) illustrated in Figure 1 incorporates both social and ecosystem dimensions and represents a viable basis for identifying relevant research.

Figure 1. The Ecosystems enriched DPSEEA model



Source: G Morris, presented at meeting

Contemporary EH research, in some cases, is arguably overly narrow, linear, compartmentalized and hazard focused. Not uncommonly, stakeholder engagement is insufficient, and a focus on the proximal effects often makes research of limited use to policy-makers. Establishing research priorities can hardly be accomplished at a single moment in time; rather, it is a process that requires discussion and building of consensus.

A useful, if possibly over simplistic, distinction can be drawn between regulatory research and academic research, as shown in Table 1.

Table 1. Regulatory research versus academic research

<b>Research aspects</b>	<b>Regulatory research</b>	<b>Academic research</b>
Initiators	Government	Scientists
Institutional affiliation	Regulatory Agencies	Universities, public and private research facilities
Goals	"truths" relevant to policy	"truth" of originality and significance
Motivation	Policy-driven	Curiosity-driven
Timeframe	Statutory deadlines, political pressure, or pressure of imminent danger	Open-ended
Audience	Policy-makers, affected industries, courts, media, consumers	Scientific community
Level of conflict	Often high because of competing interests	Low, conflicts stay inside the academic community

In order to move the contemporary research agenda forward, horizon scanning and meaningful stakeholder engagement are necessary, along with a balance between regulatory and academic research.

Conflicts of interest, including those in industry-funded research, represent a potentially large source of bias and should be rigorously monitored. This is for example well illustrated in the recent glyphosate case, where some of the research was funded by entities with connections to manufacturers of glyphosate and products containing it, and whose findings contradict other independent assessments (1).

All in all, prioritization among academic research topics is likely to remain very challenging, while regulatory research seems to be more amenable to application of prioritization criteria and explicitly developed approaches.

## **Needs and hurdles for integration of EH research**

EH research consists of various heterogeneous fields and involves many different areas of expertise. Integration of such a broad spectrum is desirable, if relevant knowledge on complex phenomena like globalisation, or climate change and their health implications, is sought. Globalization brings a large number of positive and negative changes in health. For example, the

globalization of business and the technological changes in food production, including larger farms and intensification of agriculture, have multiple impacts on climate change and health (2). When investigating implications of alternative policies for fostering a shift in diet and consumption, not only should one consider the implications for nutrition but also for the emission of greenhouse gases: the CO<sub>2</sub> equivalent per gram of protein ruminant meat, for example, is up to 250 times higher than for legumes.

The exposome is an example of an approach to integration of several aspects in EH research, and can be defined as the science of multi-factoriality, allowing, *inter alia*, the study of mixtures and low doses.(3) Research on mitochondrial ribonucleic acid (miRNA) changes in relation to air pollution, for example, showed that air pollutants impact several pathways via miRNA activation that are relevant to the multi-organ toxicity of air pollution.(4) It is particularly promising to investigate the connections between exposures and epigenetic mechanisms. Also, evidence has been growing that shows that investments in early life, in terms of reduction in exposures to environmental factors, can pay dividends later in life. However, the understanding of the life-course health determinants also requires integration over many EH research areas.

Such integration faces many challenges, for example when combining natural and social sciences. As risk is a social and cultural construct, it is not always perceived equally by different stakeholders. A study on the association of social economic status (SES) with age acceleration has shown that socioeconomic deprivation is associated with epigenetic aging. Individuals who experience SES improvement through the life course have intermediate age acceleration, suggesting that the effect can be at least partially reversed (5). More often than not, there is not a single exposure, and socio-economic status is often treated as a confounder, which is not always appropriate. These questions are part of the complex interface between policy and evidence. Current policy is often not based on robust empirical evidence, whilst research is also not always set up in order to help address policy questions, as noted by a Joint Research Centre (JRC) document.(6)

## **The European perspective on EH Research**

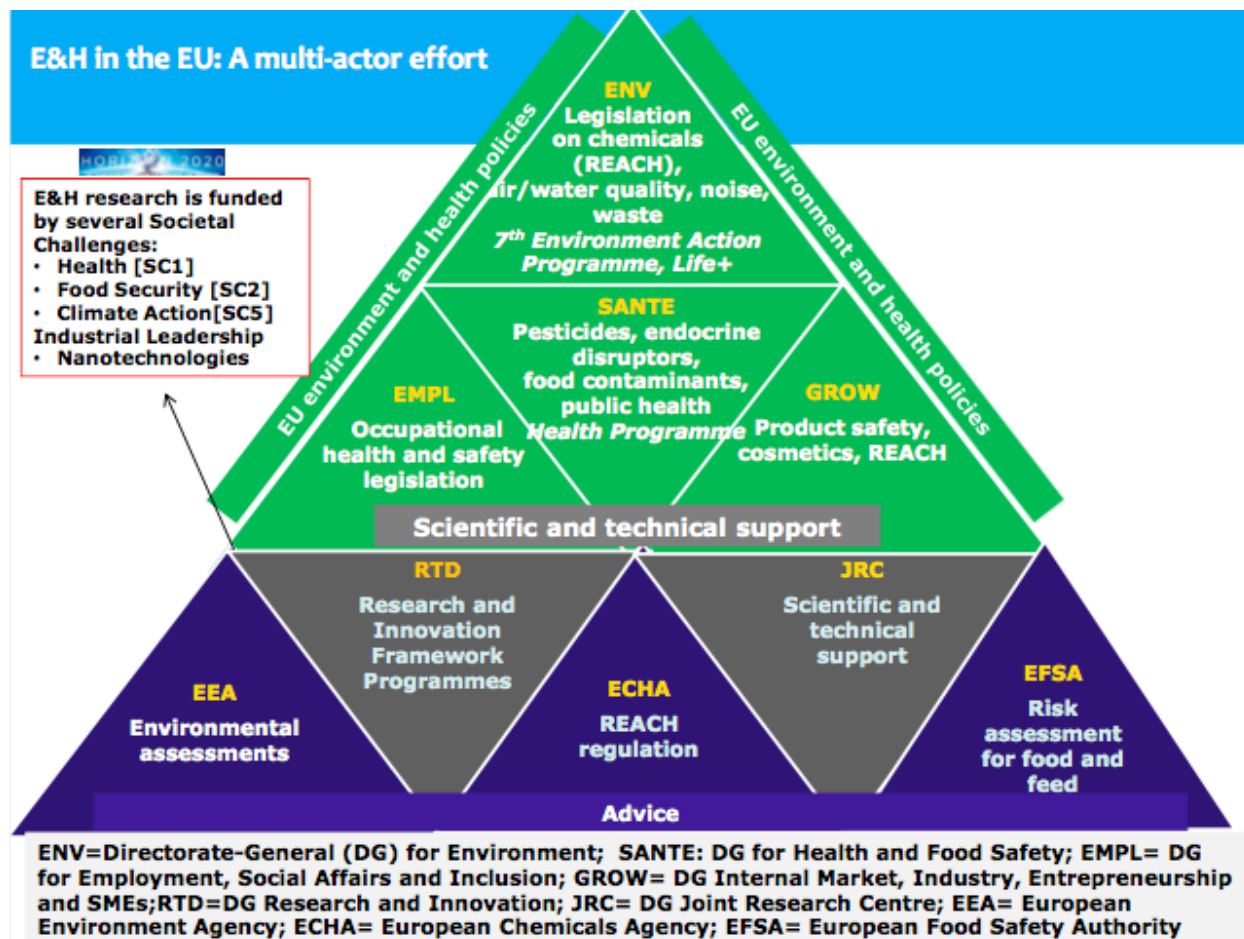
Addressing questions on EH in the European Union (EU) requires a multistakeholder effort, involving actors who work on policy, research and those who provide advice, as illustrated in Figure 2. Since the early 2000s, the EU has seen an increase in its funding for research on the environment and on its impact on human health. Starting at less than €10 million per year in the year 2000, the spending reached close to €120 million in 2017. Over 300 multinational research projects and other actions such as coordination and support actions have been funded, mainly focusing on health related issues of exposures to specific environmental factors such as air pollution, noise or particular groups of chemicals such as endocrine disruptors. Funding has been provided mostly through the Framework Programmes for Research and Technological Development, also called Framework Programmes (FP), the current one being Horizon 2020 (2014-2020). The funded projects aim to respond to societal and policy needs in the EU and beyond. These activities will set the stage for the next framework programme (FP) for research and innovation – the 9th – which is foreseen to run between 2020 and 2027. Scientific support would contribute to the implementation of the Ostrava agenda for each of the priority areas. Table 2 summarizes the different topics for which scientific support is available per area, with

the five societal challenges (SC): Health (SC1), Food security (SC2), Secure, clean and efficient energy (SC3), Smart, Green and Integrated Transport (SC4) and Climate action (SC5).

Table 2. Scientific support for possible actions to advance the implementation of the Ostrava Declaration

Priority area	Topics
Improving indoor and outdoor air quality	The Human Exposome (SC1) InCo flagship reduction of transport impact on air quality (SC4)
Safe drinking water	EU-India water co-operation (SC5)
Adverse effects of chemicals	Screening and testing methods for endocrine disruptors (SC1) Integrated health approaches and alternatives to pesticide use (SC2) Nanotechnology topics (Industrial Leadership)
Waste and contaminated sites	Waste mentioned as a case study in the exposome topic Several topics under SC5 on waste reduction
Climate change-related health risks	Climate impacts on health in Europe (SC5) Setting priorities for a European environment, climate and health research agenda (SC1)
Healthier, more inclusive, safer, resilient and sustainable cities	Visionary and integrated solutions to improve well-being and health in cities (SC5) InCo flagship on reduction of transport impact on air quality (SC4)
Environmental sustainability of health systems	Several topics under SC1

Figure 2. EH in the EU: a multistakeholder effort



Source: T Karjalainen, presented at meeting

## The Ostrava declaration themes

### Air quality

The relationships between urban and transport planning, environmental exposures and health and other factors are complex. As air pollution levels have been decreasing in many countries over the last decades and fewer and fewer people are exposed to concentrations above the values set by the EU and also by the WHO Air Quality Guidelines (AQG). The AQG were last updated in 2005 and a revision process is ongoing. Therefore, health impact assessments and cost-benefit analyses, as well as insights into health effects of low-level exposures are possible research directions which would help establish new standards and evaluate benefits of further pollution reduction.

Most of the global population, and a part of the population in the WHO European Region, is still exposed to relatively high air pollution levels. Therefore, support for epidemiology studies at the high end of the concentration range of air pollutants is urgently needed. Understanding the

contribution of air pollution to multi-morbidity late in life, and the impacts on underlying and contributing causes of death, is also of utmost importance for a comprehensive GBD estimation. More generally, a life-course approach to studying health effects of air pollution is needed. Better research is also needed into the combined effects of air pollution, noise, built environment and physical activity.

The health effects of NO<sub>2</sub> and traffic-generated pollution mixtures represented by NO<sub>2</sub> have come under intense scrutiny, partly because of the well-known problems related to emissions testing procedures, but also because of the changing traffic pollution mixture as a result of the widespread application of soot filters on diesel powered vehicles. With the expected widespread introduction of electric vehicles in addition to the aforementioned reductions of emissions from combustion engines, the relative importance of non-regulated, non-tailpipe emissions is growing. Few studies have addressed the health effects of non-tailpipe emissions, which are a complex mixture dominated by tire wear, brake wear, road surface wear, engine wear and re-suspended crustal and street dust particles. Road traffic-related ultrafine particles, while probably also reduced by particle filters, also remain an understudied element from a health point of view.

Evidence is mounting that at sizable distances from airport runways, populations are exposed to high levels of ultrafine particles from engine exhaust of aircraft. These exposures occur in the absence of clear increases in black carbon and nitrogen oxides, providing a unique opportunity to study health effects of ultrafine particles in relative isolation. Such investigations should include detailed assessments of the size distribution in the 0-100 nm range, and of the chemical composition of the ultrafine particles.

Ammonia emissions from agriculture have become a dominant cause of secondary fine particle formation. Yet the EU-mandated National Emission Ceiling (NEC) directive is less ambitious than those for most other contributors to fine particulate matter (PM) concentrations. Thorough investigation of the (ways to minimize) contributions of agricultural ammonia to secondary PM and the associated health effects is needed.

## **Water and sanitation**

Over the last century, considerable investments in water research have substantially improved the safety of drinking water in the European Region and brought about many improvements to sanitation. However, such improvements are far from universal or equitably distributed. The provision of safe drinking water and the management of water re(uses) need to be more solidly based on available science and supported by long-term anticipatory vision allowing for adaptation to climate change. This includes criteria, practices and methods for assessing and adapting drinking water chain and sanitation systems to hydro-climatic extreme events, particularly droughts and floods, embracing both security of water systems and water quality.

A significant share of wastewater is still discharged into the environment without treatment, affecting human health, the environment and the economy. There is still no universal and equitable access to affordable and safely managed Water, Sanitation and Hygiene (WASH) services. At the same time, it is necessary to ensure resilience to emerging and future challenges originating from water overuse, pollution and climate change by expanding the focus to include integrated approaches to foster sustainable management of water resources, including safe management of wastewater discharge and reuse to protect public health and the environment. Research on emerging or neglected water contaminants with regards to their potential EH impacts, including early-warning systems and online technologies to detect and monitor



pathogens and chemical contaminants, would contribute to optimal management of water resources. In addition, developing health criteria and methodologies to underpin water reuse and recycling energy and materials from wastewater treatment, based on risk analysis (sanitation safety planning), could also contribute. To ensure sustainability, investment in research on the use of alternative energy sources for water treatment should be supported.

There is growing public health concern over the emergence of antimicrobial resistance (AMR), including the release of antimicrobial residues and resistant bacteria in sewage that pass into the environment (water and soil), as sewage treatment systems are not yet fully functional or do not use the most appropriate technologies. Building knowledge on antibiotic presence in aquatic environments, including water treatment efficiency in antibiotic removal is key, along with improving knowledge on WASH practices and their effectiveness to cope with AMR. The influence of climate change in AMR and in antibiotic presence in water is also an issue which needs to be further investigated.

## **Chemical safety**

The 6<sup>th</sup> Ministerial Conference on EH chemical safety recommended the minimization of the adverse effects of chemicals on human health and the environment by replacing hazardous chemicals with safer alternatives; reducing exposures of vulnerable groups to hazardous chemicals, particularly during early stages of development; and strengthening capacities for risk assessment and research to secure a better understanding of human exposure to chemicals and the associated burden of disease.

There is a growing need to build reliable and broad datasets on chemical exposures, which will allow for better characterization of chemical exposure levels and trends at individual and population level. When researching chemical exposures, accounting for genetic disposition, lifestyle, age, pre-existing illnesses and nutrition is also of importance. The study of environmentally-caused features in specific diseases, allowing a detailed mechanistic, biological and pathological knowledge is important. Such research should enable distinguishing the burden arising from environmental causes from other causes.

Uncertainty is an issue in epidemiological studies focusing on all exposures in EH research. Reducing uncertainty in epidemiological studies on specific chemicals could be achieved by investing in better measures of exposure, which will lead to more accurate interpretation of risk and improved stratification of populations. In addition, improving exposure and outcome measures and their linkages would contribute to improving the quality of epidemiological studies on chemical exposures.

## **Climate and global change**

The response to climate change requires transformative changes in almost every sector of the economy. What needs to be achieved is already broadly mapped out, and includes rapid reduction in the emissions of climate active pollutants (CAP) to limit the magnitude of climate change, and the implementation of measures to adapt to climate change. Across a large research agenda to support such action, there are three particular challenges.

First is developing evidence to help accelerate actions to achieve change at the required pace and scale. The aspiration arising from the Paris conference to limit the global mean temperature rise

to no more than 1.5C is extremely ambitious. Under reasonable assumptions, it implies that global emissions of CAPs must start to decline rapidly by 2020 to achieve very low levels within a decade or so. However, despite increasing leadership from city networks and others, few specific strategies for change match these ambitions at population level. The quantification of the consequences for health and well-being of climate policies is a potentially important element in helping to motivate action. In many settings, therefore, evidence is needed to support decision-makers both on the contribution of specific policies and interventions to the attainment of climate goals and on their consequences for health.

A second challenge is the need to develop evidence on the effects of integrated actions across sectors. There is increasing recognition that well-chosen policies have the potential to achieve multiple benefits for the environment and health, such as the impact on climate change, air pollution and physical activity of policies that reduce dependence on petrol and diesel vehicles and promote active travel. Yet, it remains rare for policy development to be informed by the integrated assessment of multiple impacts.

A third challenge is designing infrastructure and other changes to reduce vulnerability to climate change while avoiding unintended adverse consequences. For example, energy efficiency improvements for housing may carry a number of health benefits but, under some circumstances, can have a negative effect on indoor air quality and increase the risk of overheating. Given the complexity and scale of climate policies, careful evaluation of their impacts on health and other outcomes is therefore important.

## **Cities**

Cities are the places “where it all comes together”, a dynamic context, constantly reshaped by multiple and simultaneous drivers: economic development, urbanization, demographic change, migration and climate and environmental changes, among others. The global policy frameworks present opportunities for action in cities, including the SDGs, particularly SDG 11 (make cities and human settlements inclusive, safe, resilient and sustainable), the New Urban Agenda and the Global Covenant of Mayors for Climate and Energy.

Two areas of greatest impact and concern emerged from the Ostrava agenda: health within sustainable urban planning, and transport and mobility. Health and sustainable urban planning is a primary tool to ensure local quality of life and equitable access to environmental resources such as green spaces, public services and healthy housing. Transport and mobility are also important determinants of health and well-being and should be considered in urban planning.

An observational study including stakeholders from national and local government, the third sector (i.e., non-governmental and non-profit) and academia found that transport specialists tended to emphasise the importance of whether something has been done before and worked elsewhere, while health specialists were concerned with the rigour and synthesis of research evidence. Therefore, multisectoral research, practice and policy-making requires the ability and capacity to locate, understand and communicate complex evidence from a variety of disciplines, and integrate different types of evidence into clear business cases beyond sectoral boundaries.(7)

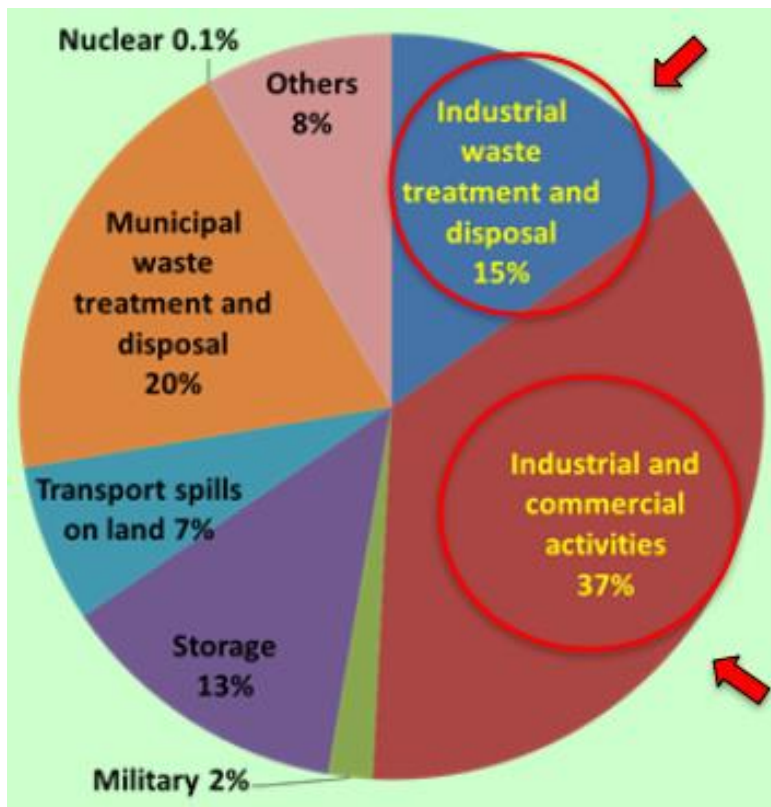
Understanding the effectiveness of interventions in complex environments, by amplifying the existing quantitative information and by conducting health impact assessments is a priority. Climate change related actions can be used as a strategic entry point, as mitigation leads to health

co-benefits, and adaptation leads to more resilience. As in other areas linked with EH research, developing mechanisms to embrace and synthesize evidence from different disciplines and sectors is crucial when conducting EH research in cities.

## Waste and contaminated sites

Past and current industrial activities have left a legacy of areas contaminated by a large variety of hazardous agents posing a mix of risks to human populations. These areas represent the expression of a development model rarely committed to sustainability, and are of high EH concern at local, regional and global level. Industrial activities including industrial waste treatment and disposal are those mostly contributing to soil contamination in Europe, as shown in Figure 4.

Figure 4. Sources of contamination in European contaminated sites requiring clean-up



Source: Progress in the Management of Contaminated Sites in Europe. Report EUR 26376. EC-JRC-2014.

The Ostrava declaration identified two actions which could help to advance the agenda in this area: identify priority sites for remediation/phasing out based on health impacts, starting from national inventories of landfills, obsolete waste facilities and contaminated sites; and enhance capacities at national and subnational levels to assess impacts and manage health risks from waste, contaminated sites and improperly recycled materials.

Special attention should be given to addressing social inequalities when conducting EH research in waste and contaminated sites. SES should not be regarded as a confounder in contaminated areas, rather it should be evaluated in terms of its ability to modify the hazardous exposures and their effect on population health. In order to identify preventive public health actions there is a need to assess the impact of environmental pollution in different deprivation scenarios in

populations living in contaminated areas rather than producing average risk estimates. Epidemiological research has therefore a key role in addressing inequalities and in securing great environmental sustainability.

EH research needs tools and sound methodologies able to integrate toxicological, epidemiological and other evidences under the guidance of multidisciplinary and inter-sectoral approaches, in order to analyse the mixes of exposures linked to waste and contaminated sites. A focus on children's health as a sentinel even in complex exposure scenarios is also an approach to explore further.

Conditions should be created for undertaking comparable health impact assessments in critical sites involving complex exposure scenarios in Europe, so as to develop guidance on primary prevention actions, considering the best available technological and policy options.

## **Challenges in processing and integrating evidence**

### **Evidence based EH**

For virtually all the above domains, human exposures to environmental factors are often complex, cumulative and difficult to quantify. Diseases are often multifactorial with long latencies, and data is often patchy, approximate or absent. Toxicity testing in population based studies in environmental health, a key building block, is also difficult to perform.

There are flaws in each type of study that can be applied in EH. Experimental studies are often not feasible or ethically challenging. Epidemiological retrospective studies may suffer from exposure assessment uncertainty, which tends to bias risk estimates towards the null. Prospective studies, on the other hand, can be very expensive, as they typically require following a cohort of individuals for years or decades to assess health effects over time. Cross-sectional studies, which assess both exposure and health status at the same point in time, can be useful for generating hypotheses for future research, but are vulnerable to confounding by multiple variables, and are weak when it comes to demonstrating a cause-effect relationship. Research methods are, however, improving, profiting from progress in environmental modelling and monitoring, which facilitates exposure assessment, as well as from the emergence of health data covering large populations. Causal inference should also be strengthened, using methods such as triangulation.

EH research would profit from a combination of various types of studies, with a focus on integration of data.<sup>(8)</sup> Several fields of knowledge should be integrated when producing evidence, including from the sectors where exposures occur, such as agriculture, industry, and transportation.

Systematic reviews are essential for synthesizing the evidence on a particular issue, but they are feasible only if there is already evidence available. Good reporting practices for studies that calculate health effects estimates, thus facilitating systematic reviews, are set out in the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER). There are several approaches to evidence integration, including expert review, guided expert judgement, structured approaches and quantitative approaches. Various organizations have adopted systems to assess the quality of evidence and remaining uncertainties. The Intergovernmental Panel on

Climate Change has dealt with causality, and uncertainty on causality, developing probability weighting for ranges of scenarios, as shown on Table 3.

Table 3. Confidence level and its interpretation with regards to probability of causation

<b>Confidence level</b>	<b>Interpretation</b>
Very high	90-100% probability of causation
High	70-89% probability of causation
Medium	40-69% probability of causation
Low	20-39% probability of causation
Very low	0-19% probability of causation

Source: IPCC

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) scheme is also increasingly used to evaluate scientific evidence in the presence of uncertainty.

Focussing on hazard identification, the monographs of the International Agency for Research on Cancer (IARC) were launched in 1971 and are written according to published guidelines and criteria on data eligibility, review of human, animal and mechanistic evidence, decision process for overall evaluation and participant selection, conflict of interest and stakeholder involvement. IARC classifications refer to the strength of evidence, not to the magnitude of carcinogenic risk. Table 4 shows how evidence from human and animal experiments is integrated in IARC monographs.

Table 4. Integrating human and animal evidence in IARC monographs

<b>Evidence in humans</b>	<b>Evidence in experimental animals</b>		
	Sufficient	Limited	Inadequate
Sufficient	Group 1 (carcinogenic to humans)		
Limited	Group 2A (probably carcinogenic)	Group 2B (possibly carcinogenic) (exceptionally, Group 2A)	
Inadequate	Group 2B (possibly carcinogenic)	Group 3 (not classifiable)	

Source: IARC

National and international health agencies have used these classifications as a basis for cancer prevention policy and to control exposure to known or suspected carcinogens. However, IARC does not set standards or make policy recommendations, leaving this to national and other international agencies. Using IARC classifications, risk assessments can be performed to help understand the level of risk with exposure in different settings and to determine public health action to limit exposure to workers or the general public.

## **Assessing the burden of disease and the economic costs**

Assessment of the burden of disease requires sufficient epidemiological and toxicological evidence to allow the quantification of an impact following an exposure, also allowing quantification of an effect that could be avoided.

More studies with designs that are eligible for evidence synthesis are needed, as many studies do not meet the standards required for meta-analyses and subsequent burden of disease assessments. While guidance on the standards for quality of study designs exist, they are not systematically used.

A major issue in burden of disease assessments is transferability and generalizability of evidence between various areas and populations. Studies performed in highly polluted areas often concern low income or otherwise disadvantaged populations. Applicability of this information in high income countries might be questioned. Most of the evidence on health effects of air pollution comes from relatively less polluted high income countries resulting in some uncertainty in the impact assessments of numerous more polluted regions worldwide. In this area, there is little international coordination of research and research needs.

There are few studies documenting impacts of specific policies or policy change on health. Examples of areas in which such information is needed include transport policies, air pollution policies and energy policies. Such evidence would provide direct support to design and implementation of policies facilitating proper consideration of population health.

Recent estimates of the Institute for Health Metrics and Evaluation have shown that 11.3% of lost Disability Adjusted Life-Years (DALYs) are due to environmental and occupational risks (half of it in interaction with behavioural or metabolic risks).(9) WHO has estimated it at 24%, with 85 diseases reasonably attributable to modifiable environmental factors.(10) This divergence can be explained by differences in methodology applied in various studies, including causality criteria, inclusion of subclinical effects and data availability but can be confusing to a non-specialist. A standardization of the presentation of burden of disease calculation focussed on environmental factors, including main assumptions and methods used, would facilitate communication with a broader public audience and policy-makers, and improve the application of such results in risk management.

Childhood exposure to lead illustrates the difficulties in evaluating subclinical effects of exposures. The Global Burden of Disease (GBD) report estimated the global costs at 449,000 lost DALYs because of increases in mild mental retardation (\$22.5 billion globally). However, this estimate does not consider IQ losses within the normal range, while the literature documents substantial change in lifetime economic productivity for each IQ point lost. Thus, this estimate fails to capture the large societal losses to those children who are not shifted into the subnormal range of cognitive function.

## **Environment and health research for public policy: embracing complexity**

### **The environmental health research agenda**

Some general questions are of particular interest as they have a great relevance for the policy debate in environment and health: the boundary between risk assessment and risk management, system assessment and economic assessment. With regards to risk assessment, detailed evaluation for single stressors and precautionary response models in light of uncertainty are needed, as is risk assessment for multiple stressors, to address more realistic exposure patterns and inform environmental disease burden assessment. Systems assessment methodology should also be developed, for example, to elucidate the health dimension of production and consumption patterns, including pressures along the value chain and impacts of circular material use, including shifts to bio-materials. The obvious importance of the economic dimension means that the EH community must be prepared to develop and/or consider monetary evaluations of health impacts, the internalisation of external costs, valuation of ecosystem services and cost-effectiveness of both policy measures and inaction.

### **Research for precision prevention**

Adverse health outcomes are the result of a combination of environmental, lifestyle and genetic factors. So-called “precision prevention” (prevention at the individual level) requires an accurate assessment of individual vulnerabilities and susceptibilities, which in turn allows for accurate individualized cumulative exposure profiles and identification of vulnerabilities to exposure based on sociodemographic parameters, thus allowing for SES differences. In addition, understanding both the genetic susceptibilities that predispose people to adverse outcomes from environmental stressors, and the development of molecular markers of exposure associated with preclinical markers of effect, is crucial for effective precision prevention.

The exposome approach is a powerful tool for understanding this complex interplay. Functional integration of advanced personal exposure assessment methods with data fusion coupled with multi-omics techniques supported by advanced bioinformatics provides a way to process and integrate the large amounts of data that underlie these assessments.

These approaches aim to embrace complexity and use mechanistic information to arrive at simple interpretations- the concept of so-called simplicity in EH science and risk assessment. The concept’s ultimate goal is to understand how multiple stressors interact with human physiology and to identify simple strategies for addressing adverse outcomes, targeting the critical issues in the biological and metabolic regulatory networks.

However, several challenges arise in precision prevention in EH, of a technical and ethical nature. One is ensuring the completeness and quality of information; another is defining who bears moral and material responsibility for a healthy life. Further ethical concerns relate to social justice, including possible stigmatization and group harm, and to normative implications of different forms of prevention that concern or involve genetic traits.

These challenges also come with several opportunities. One is to target precise groups and communities and macro-environmental differences between communities. This allows for the design of public health risk reduction strategies by stratification. There is also an opportunity to

bring social determinants of health to the foreground of public health genomics research and practice.

## **Stakeholder involvement**

Involving and dealing with stakeholders is often advocated in EH, but the practice poses several challenges both in public policy and in research. The heterogeneity and complexity of EH research results in difficulties of interpretation, potentially impacting the motivation and the ability of stakeholders to use EH research. There are also growing expectations from the public which must be managed. Participation needs a transparent approach that builds trust and ensures that the different interests, values and opinions (of the public, producers, and policy-makers) are taken into account. Researchers and policy-makers need to collaborate and to be prepared for different questions, priorities, perceptions and willingness to participate. Science needs to support this process, by adapting its role towards different stakeholders, including citizens, by studying how regulatory and academic science can complement each other. Mobilization of society, along with including a vision based on societal needs, is also of importance.

Stakeholders need to be involved in setting up research priorities from the early stages. Youth organizations and early career professionals should join EH research from the projects' outset and be made aware of the broader picture. Communication tools and the use of information technology (IT) and social media should link to research actions and dissemination as an open process. Research and policy-making should be more interrelated to clarify evidence for change of policy measures for sustainable cities and regions.

## **The role of big data**

EH analyses require accurate estimates of exposures with comprehensive coverage. In addition, the increase in data availability may be utilized. For example, in air pollution, satellite remote sensing, chemical transport models and land use information are all valuable for assessing health implications. Health data from large administrative or insurance systems enable studies of millions of individual records. EH research also requires methods for combining information from multiple data sources, and to account for biases, missing data and measures of uncertainty. There is a rapid increase in number and variety of data sources, and more complex models based on realistic assumption and estimates are increasingly available. In addition, data may be used by EH research for reasons other than those for which it was intended, including non-standard sampling designs and preferential sampling.

## **Challenges for EH research in south-east European countries**

The Memorandum of Understanding on the Future of the South-eastern Europe Health Network in the framework of the South East European Co-operation Process, signed by the network's ministers of health in April 2009, outlines the importance and role of the Regional Health Development Centers (RHDCs) to transform regional projects into long-term programmes of cooperation and development. Since June 2011, several RHDCs have been created but none on EH, and no intentions for such have been expressed.

Several challenges in EH exist in the Region. As other issues such as non-communicable diseases (NCDs), HIV/AIDS and drugs, are of higher priority in the Region's agenda, EH risks are not a very high priority for research, and there is insufficient funding and trained human



resources. This affects capacity for EH risk management. Therefore, there is a recognized need to improve national capacities in EH in South-eastern Europe, and provision of adequate training is a priority. There seems to be a need to raise more awareness of EH issues, namely through improved advocacy on EH.

The Region needs to continue working with different stakeholders to identify and implement the most effective set of policies and interventions for improving health, particularly in issues linked with EH.

## **“Moon shots”**

The post-2020 EU research and investigation programme aims at addressing global societal challenges through a limited number of large-scale research and innovation missions, or so-called moon-shots. These missions should be clearly communicated, capturing public involvement and inducing action across disciplines, sectors and institutional silos. They represent a breakthrough and have a large transformative potential for science, technology, industry and society. It should be possible, within an appropriate timeframe, to ascertain to what extent a mission has been accomplished. Given the ambitious goals, failure should be allowed, but equally, unexpected spill-over of benefits should be encouraged.

Table 5 shows a few examples of potential missions for the post-2020 EU research and investigation programme, the first 5 being from the Lamy report.(11)

Table 5. Examples of potential missions for the post-2020 EU research and investigation programme – first 5 from the Lamy report

Achieving a plastic litter-free Europe by 2030
Understanding and enhancing the brain by 2030
Producing steel with zero carbon in Europe by 2030
Making 3 out of 4 patients survive cancer by 2035
Building and operating the first quantum computer in Europe
Improve and speed the diagnosis of dementia
Reduce obesity by 90%
Fitting oceans with high-speed internet

Several of the topics from Table 5 may include EH aspects. For example, it would be interesting to evaluate health benefits of a Europe free of plastic litter and the role of environmental improvements in brain enhancement or obesity reduction.

## **Promoting creative and accountable research in EH**

Creativity in science is difficult to plan and organize, as it mainly arises from individual talent. Nevertheless, creativity can be promoted. Evidence demonstrates that “open countries have strong science”(12). Technological innovation, coupled with a long-term and global perspective and attention to differences within a broader context can promote creativity.

When evaluating research, several criteria can be used, such as novelty, importance to people, impact on policy and technical innovation and development. In addition, systematic evaluation of successes and failures in EH research over time allows for progress and cements the ground

for creativity. Examples of successes include collaborative research in air pollution, green spaces and urban health issues and occupational exposures and diseases.

Multi-disciplinary collaboration in research on intervention is needed, as it can provide a contribution to identifying the conditions of effective intervention (including social and environmental characteristics of the target population), designing optimal interventions from the public health perspective, monitoring the actual effects of the intervention, and ultimately fostering policy support for effective and sustainable interventions.

Establishing priorities in environmental health research is a complex and ongoing process, which requires the involvement of a wide range of stakeholders and civil society. There is a need of more action-oriented research and of more investment in methodologies and approaches, which embrace complexity. Accessibility and uptake of research on policy also need to be improved, coupled with better governance in environment and health.

## **Next steps**

To ensure implementation of the Ostrava and the SDG agendas, high quality EH research is needed, with a special attention on cities and local level governance, inequalities, including in health, and institutional collaboration with other agencies and stakeholders. This meeting provided valuable input for EH research priority setting, and an opportunity to discuss challenging issues in this area.

The possible next steps after the meeting include drafting a position paper on the priorities in EH research, addressing the challenges that this field has to overcome. There is a wide range and rich variety of EH research, both academic and regulatory, both with their own particularities. Given the current societal and scientific challenges in EH, a “quantum leap” of the EH research community towards more action-oriented research may be desirable, by:

- investing in research methodologies and approaches that embrace complexity,
- supporting the development of effective governance systems for EH, and
- improving accessibility and uptake of research findings beyond the academic community.

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## Annex 1: Meeting programme

### Thursday 30 November 2017

9:00 – 09.30	<i>Registration – welcome coffee</i>
09.30 – 10:45	<b>Opening, introductions</b> Welcome addresses (E Paunovic) Appointment of chairperson and rapporteur Background, rationale and goals of the meeting (E Paunovic, M Martuzzi) Outcome of Cascais meeting (C Portier) The Ostrava agenda: implications for EH research (S Matic)
10.45 – 11.15	<i>Coffee break</i>
11.15 – 13:00	<b>EH research: strategic perspectives</b> Research for the contemporary EH agenda (G Morris) Needs and hurdles for integration of EH research (P Vineis) Research on Environment and Health – EU Perspectives (T Karjalainen) Discussion
13.00 – 14.00	<i>Lunch break</i>
14.00 – 16:00	<b>The Ostrava themes – I</b> Air quality (B Brunekreef) Water and sanitation (L Lucentini) Chemical safety (R Duarte) Discussion
16.00 – 16.30	<i>Coffee break</i>
16.30 – 18:00	<b>Processing evidence</b> Evidence based environmental health? (A Vaz Carneiro) Burden of disease assessments (A Prüss-Ustün) EH economics (L Trasande) Integrating evidence in cancer research (D Loomis)
18:00 – 18:30	<b>Wrap-up day 1: discussion and close</b>
18:30	<i>Drinks reception</i>

**Friday 1 December 2017**

09.00 – 10:30	<b>The Ostrava themes – II</b> Climate and global change (P Wilkinson) Cities (F Racioppi) Waste and contaminated sites (I Iavarone)
10:45 – 11.15	<i>Coffee break</i>
11.15 – 13:00	<b>EH research for public policy: embracing complexity</b> The environmental research agenda (Y Hoogeveen) Research for “Precision prevention” (D Sarigiannis) Involving the right stakeholders (P van den Hazel) Tools for stakeholder involvement in research (E Csobod) Challenges for EH research in south-east European countries (P Dimitrov) Big data (G Shaddick)
13:00 – 14:00	<i>Lunch break</i>
14:00 – 16:00	<b>Way forward – next steps</b> Harmonising disciplines: toxicology and epidemiology (R Barouki) EH science for policy and governance (M Krzyzanowski) Promoting creative research in EH (M Kogevinas)
16:00	<i>Closure of meeting</i>

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