

CNR Environment and Health Inter-departmental Project: present knowledge and prospects for future research

INTRODUCTION

The World Health Organization states that the environment influences our health in many ways through the exposure to physical, chemical and biological risks, and through the changes that our behavior operates in response to those factors. This is what is commonly addressed as the “Environment and Health issue” (EH), which has gained an increasing attention at local, national and international level.

There is a growing political support to the implementation of concrete actions, as well as an ever increasing knowledge of these issues. The need has been recognized to jointly tackle these issues with the aim of producing more detailed and focused studies and planning actions to reduce the negative impacts of some human activities on the environment. Several international initiatives addressed this issue in the last years.

The environment and health issue in the European Union

Since the turn of the century, when the Lisbon Strategy was launched “to stimulate growth and create more and better jobs, while making the economy greener and more innovative”, the European Union has been playing a leading role in addressing the Environment and Health issue. Following the Lisbon Strategy, the 2001 Gothenburg Council established sustainable development as an overall objective for the EU development, taking responsibility to ensure that future generations will not be forced to live in worse conditions than the present one. An European Environment and Health Strategy has been promoted in 2004, paving the way to the coordinated initiatives and joint efforts of the enlarged European Union, and an Action Plan was produced to implement it.

In 2004, the European Commission issued the Environment and Health Action Plan designed to combine information on environment, the ecosystem and human health so to assess with greater effectiveness the overall impact of environment on human health.

The ultimate goal of the EU strategy is to set a cause-effect framework on environment and health and provide the necessary information for the drafting of a EU policy on pollution sources and the impact pathways of stress factors on health. The Action Plan is based on some fundamental aspects: 1) to understand the relation between pollution sources and health effects through the development of environment and health indicators and integrated monitoring systems to assess human exposure and bio-monitoring systems; 2) to enhance research and thus identify potential hazards to human health and develop methodologies to analyse the environment-health relation; 3) to better inform the population and improve risk communication systems.

In the European Union, several other initiatives have been active in the environment and health sector: the Sixth Environmental Action Programme 2002-2010 contains specific indicators measuring the reduction of health risks posed by the environment; the Public Health Programme 2008-2013 adopts specific measures to reduce environment-related health risks; the 6th and 7th Research and Development Framework Programme contains a section on environment and health research initiatives. A number of other laws regarding environment, energy production, infrastructures, territorial management, agriculture,

have a direct impact on health: for this reason a unified Strategy and a surveillance system is necessary and welcomed at the EU level.

The Environment and health issue for the United Nations and the World Health Organisation

One of the initiatives that can be considered as a milestone in the environment and health sector is the list of the eight benchmarks provided by the United Nations Development Programme in 2000, to be fulfilled within 2015: the Millennium Development Goals.(1) All these Goals have in fact crucial implications for both the environment and health. The setting up of a monitoring skill, with relevant indicators to be checked over the time by each country Member of the UN, shall also be considered as an added value to this initiative.

On environment and health, however, the World Health Organisation (WHO) is the leading international actor, whose paramount mission has always been to raise awareness on health issues in all international Fora. In this context, it is important to point out that the WHO uses a definition of the environment that is somewhat broader than the one utilised by the European Commission in its Environment and Health Strategy; the WHO definition includes socio-economic factors such as poverty and the lack of infrastructures, whereas the Commission focuses on chemical and biological pollution. It seems desirable that the EU new Constitutional Treaty could fill this gap and change the current scope of its Articles 152 and 174.

In 1989, the WHO Office for Europe promoted the Environment and Health Process, ‘to raise awareness and start collaboration between sectors, particularly the health and environment sectors’. The First Ministerial Conference on Environment and Health was held in Frankfurt in 1989, gathering together the relevant public institutions of the 52 countries of the WHO European Region. The Second Conference was held in Helsinki in 1994, the Third in London in 1999.

The most recent Conference, held in Budapest in June 2004, launched the Children’s Environment and Health Action Plan for Europe to improve the protection of future generations. During this Conference, the European Commission presented the EU Environment and Health Strategy and a specific Action Plan to implement it.

The Fourth Ministerial Conference on Environment and Health in Budapest 2004

The National Research Council of Italy (Italian acronym: CNR) was part of the Italian delegation, led by the Ministry of the Environment, at the Budapest Conference. The Italian representatives, in partnership with the Regional Environmental Centre for Central and Eastern Europe (REC), proposed and organised awareness-raising initiatives - called ‘breathing days’ and focused on air pollution - in some Budapest schools, to underline the active role that younger citizens could play in driving positive change.

CNR also participated in the workshop “Environment and Health in EU Structural Funds Technical Assistance”, organised as a side event during the WHO Conference. The workshop was a first opportunity to discuss the recent Italian developments with partners from the large WHO-EU Region and to present all the coordination efforts made by Italy to an international audience. Experiences developed in the 52 countries are undoubtedly different and their analysis can be useful to plan future developments and actions.

The Authorities responsible of the use of the EU Structural Funds Technical Assistance in Objective-1 Italian Regions (areas lagging behind in their development), gave to the environment and health issue a relevance in the 2000-2006 planning period. CNR worked together with the Ministries of the Environment and Health and the National Health Institute, to establish an network of experts to analyse the specific issues of each territory and address crucial environmental and health factors.

In Italy, the core competencies in environment and health are given to Regional Authorities, and during the mentioned 2000-2006 planning period the European Union allocated funds to the Ministry of the Environment for the establishment of Regional Environmental Authorities to perform surveillance and monitoring activities; and to the Ministry of Health to assist Regional Epidemiological Observatories.

In the framework of their technical assistance activities in seven Italian regions, the Ministry of the Environment and the Ministry of Health joined their efforts to support Regional Agencies for the Protection of the Environment and Regional Epidemiological Observatories. The research on highly polluted sites has been selected as the first issue to be developed. Polluted sites are in fact considered a priority in the agendas of regional bodies and for the public opinion, and therefore these bodies had to be trained to develop their environmental epidemiology competences, methodologies and tools. The technical assistance of the two Ministries helped to implement activities and promoted a culture of collaboration among the different regional bodies in charge of environment and health protection, where the environmental epidemiology had the role of supplying a common framework to experiment and develop such cooperation.

The Italian National Research Council (CNR)

The Italian National Research Council (CNR) competence on both the environment and health is well established. The activities of the Department of Earth and Environment (Italian acronym: DTA) are carried out by 13 research Institutes. DTA delivers independent research, survey, technologies and knowledge transfer in the earth and environmental sciences to advance knowledge on the planet as a complex and interacting system. Research activities cover the full range of the Earth science, including atmospheric, terrestrial and aquatic issues. The mission of DTA is to gather knowledge and predict the behaviour of the earth system and its resources to help design a sustainable future for the planet and mankind.

The Department of Medicine includes twelve institutes performing clinical and epidemiological researches, both autonomously and by interacting with the National Health System structures. Research and health activities include clinical and epidemiological studies in cardiology, pneumology, oncology, neurology, immunology, infectious diseases, genetics and molecular medicine. Innovation and technology transfer in medicine and Education and the training of personnel and NHS are the other main activity areas.

The CNR report on areas presenting environmental hazards for health (2006)

In late 2006, the President of CNR and two Directors of Departments were asked to refer to a Chamber of Deputies Public Hearing in the framework of the “discovery investigation to evaluate the environmental impact of urban pollution, waste disposal and high risk areas”. On that occasion, CNR delivered a complete report called “State of knowledge

review on environment and health in high risk areas in Italy”.

The report includes the research activities carried out by the CNR Institutes in the 54 areas identified as Reclamation Sites of National Interest, (Italian acronym: RSNI) directly managed by the Ministry of the Environment for the remediation activities. The research activities were developed by 17 CNR Institutes, belonging to the following Departments: Earth and Environment, Medicine, Materials and Devices, Molecular Design, Information Communication Technology, Agrofood.

To give an idea of the size of this problem, it suffices to say that the population affected by the impact of polluted areas is estimated in 6.4 million (but this number increases up to 8.6 million if all the residents in the Municipalities of Milan and Turin, whose territories are however only partly affected by RSNI, are included), living in the 54 RSNI that stretch themselves over the territory of 311 municipalities. These blunt figures are important to assess the size (or – to help make a guess of the impact) of health adverse effects that can be caused by substances recognised as hazardous and released in the environment.

In fact, even modest risk increases, when acting on such large figures, can determine very serious impacts in terms of the development of diseases, symptoms of indisposition, mortality rates. Besides, since the residents of polluted areas are not equally exposed and include socio-economically vulnerable people, or more susceptible people due to a genetic predisposition or co-morbidities, the impact assessments are crucial. The size of the exposed population and the risk intensity are the main criteria to assess the health impact and, more in general, the impact on the public health service: in terms of possible scenarios, the two extremes are represented by a situation in which very aggressive factors act on limited groups of people (particularly exposed workers or small communities), or by situations where risk factors have a weak action but act on a large number of exposed people.

The areas included in the RSNI sites are former industrial areas, caves, landfills; in those cases the remediation procedures are long lasting and often very difficult to undertake from a technical viewpoint; in the case of productive areas, remediation can be implemented when an economic advantage exists, a change in production is required or strong pressure from the public and administrators is exerted.

CNR activities covered a wide range of research sectors: monitoring, pollution characterisation, remediation, epidemiology, planning.

The identification of pollution is the first step, carried out through different monitoring devices in soil, sub-soil, fresh and sea water, indoor and outdoor air.

The pollution characterisation requires the use of devices such as a radioactive tracer and mass spectrometry. In sea water environment, the characterisation is based upon the assessment of the presence and conditions of the fish population, micro-organisms, phytoplankton, sediments.

As concerns emissions into the atmosphere, the research includes studies on climate and modelling, and studies on the relationship between indoor and outdoor pollution.

The removal of pollutants urges on the analyses of the remediation potential for water and soil pollution, including bioremediation, phytoremediation and soil washing.

Emerging fields of research are represented by electromagnetic remote sensing, electromagnetic diagnostics, passive remote sensing in optics, and methodologies for

automatic interpretation and integration in Geographic Information Systems (GIS), Global Positioning System (GPS) and georeferencing systems.

Indicators to monitor environmental health effects need a wide range of data searching, analysis and testing; epidemiological research can help to identify the existence of environmental pressures, also using environmental data and GIS. Personal exposure can be monitored using portable personal devices.

Health Impact Assessment procedures and experiences are finally presented in the Report as a tool to be used for evaluation and public participation building in highly polluted areas.

The Environment and Health Inter-departmental Project of CNR-PIAS

The CNR experience described above paved the way to build a multi-disciplinary programme, to promote and coordinate collaborative research and joint actions on environment and health.

Following the said report, the Earth and Environment and the Medicine Departments launched a call for project ideas and proposals on environment and health research activities to the whole network of CNR Institutes, taking as reference international priorities and recent European developments.

130 proposals from 37 Institutes (from the Departments of Earth and Environment, Medicine, Materials and Devices, Molecular Design, Information Communication Technology, Agrofood, Energy and Transport) were submitted in few months, with a cost estimation of approximately 30 million Euro.

In mid 2007, a project named Environment and Health Inter-departmental Project (Italian acronym: PIAS-CNR) was presented to the CNR Board.

Objectives

The actions and objectives planned in the PIAS have been selected taking into account the EU and WHO Action Plans, the work presently carried out by European experts groups, the indications found in national strategic documents and plans, the excellence of CNR and the scientific and institutional collaborations that could be involved. The deliverables to be accomplished in the framework of PIAS have also been planned accordingly to an evolving real financial support.

The Environment and Health Project has the overall objective of promoting an integrated research between these two scientific sectors, and of developing, in particular:

- knowledge of pollution sources and their consequent negative effects on health
- instruments and methods to analyse environment and health interactions
- instruments and methods to be used in managing complex situations.

On the base of the allocation of available funds to PIAS, the activities have been divided into: start-up phase (phase 1) and research development phase (phase 2).

They will fulfil the following specific objectives:

1. To promote collaboration activities on environment and health among CNR researchers;
 - 1a. to establish a database of the running projects promoted or implemented by CNR Departments or in collaboration with other Institutions;
 - 1b. to promote the creation of think thanks and project development groups;

- 1c. to promote training workshops.
2. To facilitate the participation of CNR researchers in international experts' Working Groups on environment and health:
 - 2a. to help disseminate information and to support the CNR participation in EU Commission Working Tables on Environment and Health Strategy of the 7th Research Framework Programme;
 - 2b. to help disseminate information and to support the CNR participation in the WHO work on Environment and Health, preparatory to the realisation of the Fifth Inter-ministerial Conference on Environment and Health to be held in Italy in 2009.
3. To support the access to the funding schemes of the EU 7th Research Framework Programme on Environment and Health:
 - 3a. to help disseminate information and project drafting to get access to the EU 7th Research Framework Programme on Environment and Health;
 - 3b. to help disseminate information and project drafting to get access to other international and national funding schemes, including Structural Funds 2007-2013.
4. To develop the present CNR competences on Environment and Health Research:
 - 4a. To strengthen the research by selecting pilot projects on issues where collaborations and competences of the various Institutes are more advanced and consolidated, and whose results are considered as feasible with the available financial resources.

In the research development phase, the following scientific objectives must be achieved:

- to promote the transfer of research results to the production system;
- to promote the transfer of research results to the decision makers;
- to promote the experience of Health Impact Assessment, HIA, on present planning instruments (including the Strategic Environmental Assessment, SEA) and the production of methodological handbooks;
- to produce transferable results for the development of Environment and Health supervision and monitoring systems;
- to test and validate environment and health indicators suggested by EU and the WHO, supported by suitable information systems;
- to test and validate the use of georeferentiation tools (GIS) for a joint evaluation of territorial health and environmental data;
- to test and validate instruments and methods of risk reporting in different frameworks and to produce guidelines.

Project development

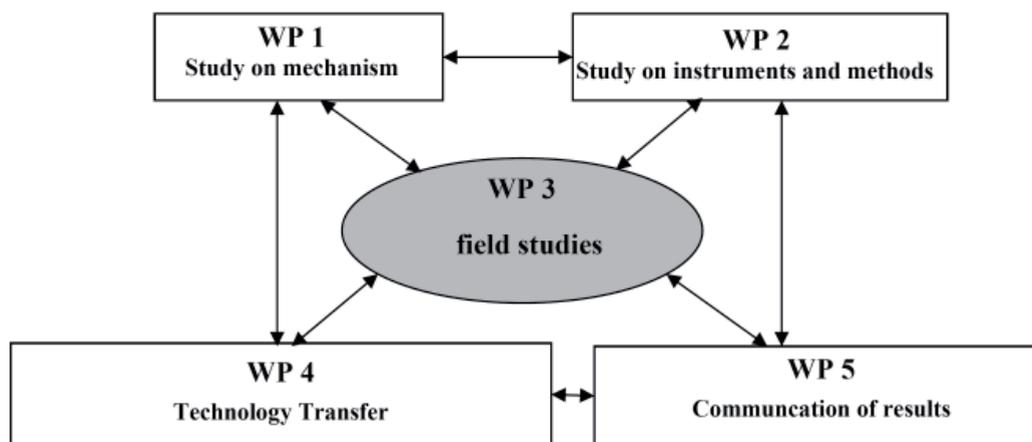
PIAS will be implemented through accurate and exhaustive examinations, development of methods and field applications. It will take advantage of the network of scientific partner institutes and a network of sites or areas in which studies and field research have been carried out or are presently underway. The sample areas are selected as those which show the most relevant health and environment impact issues (urban, rural, waste disposal, reclamation areas, etc.).

This project is based upon multidisciplinary Working Packages (WP) and Organisation Units (OU) in which CNR researchers, mainly from the Medicine and the Earth and Environment Departments participate. Researchers from other Institutes with which CNR

collaborates (for instance, the WHO, the National Institute of Health (ISS), the National Institute for Occupational Safety and Prevention (ISPELS), the Institute for Environmental Protection and Research (ISPRA), the ENEA; Universities, the National Health System, the Ministry of the Environment and Territory, the Ministry of Health, some Regional Agencies for Environment Protection, ARPAs and Regional Epidemiological Observatories are also involved in the PIAS.

The project is formed by two methodological modules for knowledge development (WP1, WP2), an operative module representing the “engine” of the project (WP3), an interface module to transfer technology innovation and industrial development results (WP4) and an interface module to transfer communication, information and training results (WP5). The OUs can operate in just one WP or in two or more WPs.

Structure



(Research areas, WP division, work orders, etc.)

Overall project structure and working packages (WP)

The relevance of the issue and the multidisciplinary research involved in the study of mechanisms and methods as well as in technology application and development, make this a project of primary interest not only for a national research council, but also for the Ministries, such as the Research, the Health and the Environment ones, as well as for other public and private Institutions.

Research Areas

1. Studies on environmental fate, biological perturbation mechanisms and health (WP1); it is the basic module for the development of the necessary knowledge to produce results to be tested in WP3.
 - 1.1. Environmental quality assessment
 - Lifecycle and the environmental fate of pollutants
 - Chemical, physical and toxicological characterization of sub-systems
 - Risks for ecosystems and human and animal health
 - Detection of risk thresholds and effective health control levels

- Exposure assessment and identification of exposed people
2. Analytical and methodological tools to meet the new environment and health challenges (WP2); this is the basic module to develop the necessary methodologies and tools to carry out the tests foreseen in WP3.
- 2.1. Monitoring and assessment tools
- 2.1.1 Environment-health indicators
- Bio-indicators of environmental quality, with reference to health risks;
 - Bio-markers of exposure, physiological reaction, early damage of people's biological tissues, substances indicating health risk;
 - Indicators of health consequences, diseases or conditions indicating adverse effects associated to known or suspected environmental risk exposure
 - Assessment indicators of actions/programmes/measures impacting the primary interest effect classes.
- 2.1.2. Health impact assessment, cost-benefit analysis and other evaluation and decision-making tools.
- 2.2. Measuring, supervision and recovery tools
- 2.2.1 Assessment and mitigation of health-impacting environmental effects;
- 2.2.2 Monitoring on environmental health indicators, *ex-ante* and *ex-post* evaluations;
- 2.2.3 Instruments to measure, control and recover/improve the environment and health. With particular reference to instruments measuring the exposure dose (individual and environmental dosimetry) especially in the case of combined exposure to different potentially hazardous agents.

3. Field surveys (WP3)

This is the core module, the “engine” of the project, oriented towards the field experimentation of the outputs of the previous two working packages (WP1 and WP2), focused on the development of knowledge and methodologies, and the preparation of useful results for technological development and communication management as foreseen in the subsequent packages (WP4 and WP5).

Another objective of the WP3 is the *feed-back* through knowledge development packages, in particular the WP2, to produce materials, methods and tools for the development of application research and to provide inputs to the WP4 and WP5.

The WP3 main objective is the assessment of the exposure, risks and effects on areas and sites of primary interest for environmental health impact (urban, rural, industrial, waste processing, reclamation areas, etc.). This package is structured in two different, parallel and interconnected activity sectors dealing with knowledge implementation and the experimentation of specific methods on the environment-health relation, starting from the study of hazardous environmental factors or from the study of environmentally sensitive diseases.

3.1 Environmental contamination that produces health effects

- inhaled fine particulate matter (PM_{10}), ($PM_{2.5}$) and ultrafine or nano particles ($PM_{0.1}$)
- heavy metals
- asbestos
- radon

- dioxins and PCB (polychlorinated biphenyl)
- endocrine disruptors
- organic pollutants
- electromagnetic fields, with particular reference to extremely low frequency electromagnetic fields (ELF); mobile telephone systems and occupational exposure
- relations between external and internal air pollutants

3.2 Environmentally sensitive diseases

- respiratory diseases, in vulnerable groups (children, senior citizens) and in urban population
- bronchial asthma associated to the interaction of climatic and oxidizing pollutant factors (NO_x, O₃)
- neurological development diseases
- adverse reproductive events and child and paediatric tumours
- effects of endocrine disruptors
- cardiovascular diseases as a consequence of air pollution exposure
- tumours and other diseases in adults as a consequence of environmental exposure in uterus and early life
- genetic sensibility and gene-environment interaction

4. Technological and industrial development (WP4)

This is a *cross-interface* module for all project activities, used to provide technological development for the outputs from previous modules.

4.1 Environmental monitoring

4.2 Reclamations

4.3 Biotechnologies

5. Information, communication and training (WP5)

This is a *cross-interface* module for project activities, used to communicate the outputs from previous modules

5.1 Risk perception methods and tools

5.2 Risk communication methods and tools

5.3 Governance strengthening instruments (including regulatory suggestions)

5.4 Instruments to promote public accountability

5.5 Information and training methods and tools

PIAS implementation

PIAS implementation is closely linked to the funds available at each stage: the first phase, now completed, allowed to explore the potentialities of a collaborative work, and to conceive project developments, as described in the following chapters.

The implementation is based on a voluntary project agreement among the CNR Institutes interested to work together on the topics identified as relevant. Working Groups and Pilot Studies Groups have been identified after the call for project ideas and proposals.

Six Working Groups (WGs) were defined to study this complex chain, starting from the environmental pollution to the emergence of illness. Several CNR Institutes are involved in each WG, together with University and Public Bodies, where relevant.

WG1 – The fate of pollutants in soil (the chain of pollution from emission to human

exposure)

WG2 - Water and soil monitoring for the protection of environment and human health (specific monitoring for the pollutants identified as dangerous for health)

WG3 - Role of atmospheric pollution on harmful health effects (the relation of outdoor with indoor pollution, the molecular mechanisms of disease promotion)

WG4 - Human biomonitoring (biomarkers of exposure and early damage, the relations among epidemiological studies, research in toxicology, in vivo and in vitro experiments)

WG5 – Environment and health surveillance systems (to develop a protocol for high risk hot spots and selected areas)

WG6 – Monitoring contaminants in food chain and their impact on human health (the pollution chain from the emission to the food chain, the pollution of animal feed)

Two Pilot Studies(PSs) are in progress. They focus on well-established issues, and are in charge of drafting a feasibility project to apply for EU-FP7 or other call for proposals. Several CNR Institutes are involved in each PS, together with the University and Public Bodies, where relevant.

The Pilot Studies deals with the following challenging fields:

PS1 – Endocrine Disruptors and health effects

PS2 – Ultrafine particles and cardiopulmonary effects

WGs deliverables include: a workshop to put together experts and building capacities; intermediate documents and working reports to share and discuss; a middle term national workshop for WGs and PSGs together; a summary document including all the activities and prospects for future research (this publication); a conclusive document including the operational proposals and the pre-feasibility projects addressed to the CNR Board of Directors; an international workshop, to be organised in late 2010.

One young researcher was hired as assistant for each WG, whereas PSG are operating to advance research and define pre-feasibility projects.

The national PIAS workshop to compare and discuss the advancements after one year of activity was held in June 2009 and it is now available on line, with video and audio streaming at <http://media.src.cnr.it/Filmati.php?evento=72&scheda=>

National projects and international collaborations

The National Institute of Health (ISS) coordinates a Strategic Environment and Health Programme, now in its second year of activity. The Programme is divided into six projects for a total of 41 units and covers the health impact associated with living in polluted sites, in areas affected by waste disposal/incineration facilities, and the exposure to air pollution in urban areas. CNR researchers, together with other Institutions, participate in the Programme implementation. The Programme included the following Projects: The role of ultrafine particles in the pathogenic mechanisms of cardio-respiratory effects produced by an urban pollution; Possible health effects of waste disposal in populations living near disposal/incineration plants and comparative evaluation of the applied technologies; Short-term effects of air pollution in urban areas: effects of gases and fine and ultrafine particles, pollution-temperature interaction, individual susceptibility; long term effects of air pollution: cohort studies in adults and children; Meteo-climatic conditions and health: definition and identification of risk, effects measurement, the evaluation of intervention

effectiveness on epidemiologically relevant pathologies; Health risk in polluted sites: exposure estimation, bio-monitoring, epidemiological characterisation.

The Institute for Environmental Protection and Research (ISPRA) is involved in several activities concerning the environment and health, such as the dissemination of information on environmental monitoring, novel risks and the promotion of Health in All Policies. ISPRA is also part of the ERA-ENVHEALTH network.

The ERA-ENVHEALTH is one of the European Union network initiatives of the ERA-NET 'family'. The project started in September 2008, and put together managers from 16 environment and health research programmes from 10 countries with the coordination of AFSSET, the French Agency for Environmental and Occupational Health Safety. ERA-ENVHEALTH strategic objectives are: to establish a network of programme managers and financiers to share information and expertise on research; to define opportunities for research cooperation and coordination; to identify priority areas for multinational research; to develop coherent joint activities at the EU level; to implement joint multinational calls for specific research proposals on environment and health; to provide policy support for the implementation of the Environment and Health Action Plan (2004-2010) and other EU policies concerning the environment and health issue. The originality of the ERA-ENVHEALTH resides in the promotion of a trans-national joint call in order to experiment joint funding and to fully assess the implementation. The ERA-ENVHEALTH fosters the use of environment and health research results to support policy development, and supports the early identification of critical issues having a public impact.

The NRC and the Institute for Environmental Protection and Research are the Italian partners of the Project, whereas the Environmental Protection Agency of the Tuscany region (ARPAT) and the Regional Agency for Prevention and the Environment of the Emilia-Romagna region (ARPA-ER) are Consultative organisations and collaborate to spread information and to seek the participation of the scientific community.

The Environment and Health Inter-departmental Project of CNR (PIAS) promotes interdisciplinary research on the interaction between environment and health.

PIAS established a network for collaboration and joint activities among researchers coming from different research institutes, that traditionally operate separately in environment sciences or in health disciplines, and to bridge the gap towards an interdisciplinary approach.

The project implementation confirmed the soundness of the original design. PIAS, with its advances in knowledge and its results, represents now a valuable and durable platform to start a broader research programme focused on field investigations and basic research on environment and health, including studies on mechanisms, research on methods and tools, risk communication and innovation for technology transfer.

The successful establishment of the PIAS Working Groups can be now considered as the framework to evaluate several proposals and action plans to be implemented.

Its documented high scientific level, coordination ability and resources attraction, competitive attitude, capacity building and networking have made it possible to complete the priority-setting stage.

The consolidation and strengthening of the existing collaborations in the European and international networks is one of the main goals of the PIAS Project to guarantee a top level research and to offer advanced competences and instruments at the national level.

THE CONTRIBUTION OF PIAS WORKING GROUPS (WGs) AND PILOT STUDY (PSs): SUMMARY OF ACTIVITIES.

The fate of pollutants in soil (WG1)

Since the soil has several functions directly related to human health, such as the production of food as well as a filter action for groundwater, the preservation of its functionality from any possible threat caused by human and natural events is clearly important. The fate of contaminants in soil has to be addressed in order to evaluate the potential exposure of people, taking into account the complexity of pathways, the interactions with soil surfaces, the changes in the chemical and biological conditions of soil environment. The study of soil environment can thus provide a basis for the assessment of human exposure and health adverse effects. Research activities such as the dietary uptake of vegetables grown in polluted soils, accidental soil ingestion, bio-accessibility and bioavailability must be analysed. The case study of Gela (Sicily) industrial allowed a progress in our knowledge of specific contamination sources (such as landfills or industrial sites) and vulnerable groups, the latter studied on the basis of their place of residence, work activity or dietary habits. Pollution pathways are strongly influenced by the chemical and physical nature of soil, by its equilibrium in a thermodynamically open multiphase system. The identification and understanding of the mechanisms linking soil quality and health is proposed through an integrated approach.

Seven CNR Institutes plus one University Department are directly involved in the PIAS Working Group.

Water and soil monitoring for the protection of the environment and human health (WG2)

Current water and soil monitoring programmes are based on the sampling and laboratory analysis of chemical and microbiological variables. Different methods to measure effects, directly applied on living organisms, both at individual and at community level, have been integrated into monitoring plans. Emerging problems are related to new classes of pollutants, not yet regulated by legislation. The CNR Institutes carry out research on several emerging environmental issues, such as engineered nanoparticles and perfluorinated compounds in water environments, that have been chosen as case studies. An innovative monitoring approach, ranging from the measurement of the effects to the identification of causal molecular agents, is discussed. “Toxicity Identification and Evaluation” (TIE) and “Effect Directed Analysis” (EDA) monitoring procedures were reviewed. In parallel to “traditional” in-vitro tests, the development of the “omics” disciplines is fundamental to study the relationships between the genome or protein structure and the activity and biological effects of exogenous agents. Methods to identify the activity of dioxin-like compounds as the cause of a specific adverse effect on river organisms are presented and discussed. Applications and perspectives of investigative monitoring were examined (in the case of an unknown agent or source for toxic or other biological effects) and of screening (for risk assessment of specific pollution sources). All the above mentioned activities are crucial for an effective management of the territory to safeguard human and environmental health.

Seven CNR Institutes are directly involved in the PIAS Working Group.

The role of atmospheric pollution on harmful health effects (WG3)

Gaseous and particulate species in outdoor and indoor air play a key role in increasing the morbidity or mortality observed in many clinical studies. The knowledge of the main toxicity patterns of atmospheric pollutants needs to be improved, especially as concerns particulate species. This is mainly due to the varying size-distribution, chemical composition and different mechanisms of toxicity of fine and ultrafine particles (UFPs). Recent findings on toxicity routes attributable to gases and particulate matter (PM) species (i.e. the water-soluble organic fraction (WSOC) studied for the strong oxidative potential to biological tissues) are reviewed. Toxicity routes are discussed to hypothesize the relationships among sources, diffusion pathways, receptor sites and susceptible populations. Strategic aspects are underlined, to be further developed in the 'Feasibility study for the assessment of the health effects of the chemical composition of ultrafine particles', presently in progress. The nature and role of aerosol particles and gaseous mixtures are major research issues, due to their potential hazard for human health; the connection of the toxicological and epidemiological impacts of atmospheric particulate matter to its chemical composition is of paramount importance to assess effective pollution abatement strategies. During a number of field experiments, state-of-the-art instruments have been used for aerosol characterization.

Two CNR Institutes are directly involved in the PIAS Working Group.

Human Biomonitoring (WG4)

Human Biomonitoring (HBM) aims at identifying biomarkers useful to measure environmental exposure, at monitoring its biological effects and the causal relationship with pathological conditions, and at defining, where possible, the genetic susceptibility of the overall population. The search of reliable biomarkers, i.e. objectively measured and validated as health or disease indicators, requires the expertise of scientists with different specializations, able to tackle increasingly complex problems through a multidisciplinary approach. The PIAS work-package aims at promoting a scientific strategy to develop and validate effect, exposure and susceptibility biomarkers. The chapter presents a knowledge review, both in the basic and applied research, as well as future perspectives and developments. Two main HBM objectives have been examined: i) the determination of the levels of toxicants in biological fluids in the overall population; ii) the search for new exposure, effect and susceptibility biomarkers. Four crucial points have been tackled: the management of environment and health issues through a multidisciplinary approach, the combination of medical tools with a biological approach based on biochemistry, biophysics, cell and molecular biology, bioinformatics, molecular genetics and genomics; the validation of conventional/new exposure biomarkers; the validation of conventional/new effect biomarkers; the identification of genetic susceptibility markers in the Italian population. The purposes of modern HBM have expanded beyond their origin in occupational medicine to cover a wide variety of diagnostic procedures and assessments of environmental pollution, leading to the identification of potentially hazardous exposure before the evidence of adverse health effects. The definition of exposure limits to minimize the likelihood of significant health outcome appears as the final goal.

Four CNR Institutes plus one National Public Research Institute (ISPESL), one Scientific

Foundation and one Hospital are directly involved in the PIAS Working Group.

Environment and health surveillance systems (WG5)

An integrated environmental and health surveillance system is the systematic, ongoing collection and analysis of information related to disease and the environment (indicators) and its dissemination to individuals and institutions. It is a scientific tool for the implementation and evaluation of policies aimed at preventing, controlling and protecting health and the environment. Different analytical approaches to classify environmental and health indicators have been examined and discussed. A protocol to be tested in areas with different environmental risks has been developed, in order to monitor environment and health indicators and to provide useful tools for primary prevention programmes and communication. The goal is to select a set of environmental and health indicators to be assessed for their utility and availability in time and space.

Five CNR Institutes plus two Departments of the National Institute of Health, two Regional Environment Protection Agencies and one Local Health Unit are directly involved in the PIAS Working Group.

Monitoring the contaminants in the food chain and their impact on human health (WG6)

A growing attention is paid in Europe to food safety and to the relation between diet and consumer's health. Changes in lifestyle, modification in food production and distribution determine the eating habits of Western populations. Data from the annual report of the European Commission Rapid Alert System for Food and Feed (RASFF), summarizing notifications on food contaminations occurred in different countries, are useful to plan efficient food control programmes. In this context, the PIAS working group studied how specific classes of environmental contaminants (e.g. pesticides, metals, dioxins) may affect human health through the food chain. Issues of major interest in this sector are, for instance, the determination of heavy metals and dioxins in food matrixes and biological samples; the existing experimental models to assess the harmful effects of contaminants on human reproduction; the role played by the cytochrome P450 in the xenobiotics metabolism. Finally, a research programme based on a holistic approach has been defined. The proposal, whose target is the young population, aims at identifying the cause-effect relationship between the presence of contaminants in the diet, their accumulation in humans and the risk of developing chronic diseases. A discussion on the bioavailability and adaptive response is presented, to suggest a possible functional link (at molecular level) between the onset of specific diseases and the concentrations of contaminants measured in food. An integrated approach to assess the impact of food contamination on human health can increase our scientific knowledge and build consumers' trust and confidence.

Three CNR Institutes plus one Public Research Agency are directly involved in the PIAS Working Group.

The Pilot Study on 'Endocrine Disruptors and health effects' (PSI)

The pilot study focuses on the relationships among exposure to endocrine disruptors and some selected diseases and the identification of how the environment and the diet

synergistically operate in promoting some severe pathologies in wildlife and humans. Several experimental studies reported that also very low doses of endocrine disruptors can affect the endocrine system, causing diseases and altering the development of mammalian (humans included) and non-mammalian species. Cancer, cardiovascular risk, modulation of adrenal, gonad and thyroid functions, and endometriosis are some of the diseases that cause alarm in the citizens, associated to the exposure to endocrine disruptors. Research activity focuses on three lines: i) the possible relationship among the levels of toxic pollutants in biological fluids and the risk or occurrence of cardiovascular diseases, as well as the alteration of thyroid, gonad and adrenal functions in the population of Gela (an high environmental risk area); ii) *in vivo* experimental studies on endometriosis using mice exposed to Bisphenol A, iii) measurements of endocrine disruptors concentration in fish used for human consumption in the selected area.

Three CNR Institutes in collaboration with the Italian Endometriosis Foundation are directly involved in the PIAS Working Group.

Pilot Study on 'Ultrafine air particle and cardiopulmonary effects' (PS2)

It aims at combining the results of two advanced activities in the identification of the composition of atmospheric ultrafine particles and those of the health studies exploring short-term effects of air pollutants exposure in subjects with selected diseases. Five work-packages focus on the improvement of knowledge in: i) the chemical composition of ultrafine particles and their variability in urban and rural sites in Italy, based on available multi-stage impact data and on initial measurements using Aerosol Mass Spectrometers, ii) the methodologies to measure the oxidative potential of the water-soluble organic fraction (WSOC) of the aerosol, iii) the short-term effects of exposure to air pollutants in subjects with pre-existent arrhythmia, iv) the short-term effects of exposure to air pollutants in subjects with pre-existent lung diseases, finally v) results are to be evaluated to design an integrated Italian research activity for projects to be presented in the framework of the available EU projects call for proposal.

Four CNR Institutes plus one University Department, one Regional Environment Protection Agency and one Local Health Unit are directly involved in the PIAS Working Group.

On the whole, eighty-six researchers belonging to nineteen CNR Institutes and other twelve Public Research Bodies are directly involved in the PIAS project and have been collaborating at the preparation of the present publication.

Fabrizio Bianchi

PIAS Coordinator, CNR - Institute of Clinical Physiology

fabriepi@ifc.cnr.it

Liliana Cori

PIAS Scientific Support, CNR - Institute of Clinical Physiology

liliana.cori@ifc.cnr.it

Pier Francesco Moretti

CNR - Department of Earth and Environment

pierfrancesco.moretti@cnr.it