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Focus
Health and Climate Change: science calls for global action

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Abstract
Climate changes affect social and environmental health determinants such as clean air, ecosystems health, safe drinking water and safe sufficient food. Globally, people at greatest risk of adverse health effects associated with climate change include children, the elderly and other vulnerable groups. Temperature-related death and illness, extreme events, polluted or stressed ecosystems represent relevant issues raising concern for both health and economic consequences. The aim of the Symposium "Health and Climate Change" (Istituto Superiore di Sanità, Rome 3-5 December 2018) was to promote an inter-sectoral and multidisciplinary approach to estimate and prevent climate change-related events as well as to call the authorities to put in place measures to reduce adverse health effects. At the end of the Symposium the Rome International Charter on Health and Climate Change was presented. It includes a series of actions and recommendations, discussed and shared by all the participants, intended to inform policy makers and all the stakeholders involved in the management of climate changes.

Key words
- climate changes
- human health
- adaptation
- innovative tools
- management policy

OVERVIEW

Climate change is an increasingly urgent issue and the application of measures and actions to mitigate the impact on the environment and human health is required at all levels, as well as adaptation measures to improve resilience of ecosystems and populations.

Climate changes affect social and environmental health determinants such as clean air, ecosystems health, safe drinking water and safe sufficient food. Globally, people at greatest risk of adverse health effects associated with climate change include children, the elderly and other vulnerable groups, and prevention is a major, largely unexploited opportunity to improve health [1].

Socio-economically disadvantaged groups and areas where infrastructure and/or social services are not efficient will fail in adaptation to climate change and related health hazards. Temperature-related death and illness, extreme events, polluted or stressed ecosystems represent relevant issues raising concern for both health and economic consequences [2].

Our health is threatened whether you live in a rural

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village, on a small island, in coastal areas or in a big city; everyone is at risk [3-5].

Over the last 130 years, the world has warmed by approximately 0.85 °C. Each of the last 3 decades has been successively warmer than any preceding decade since 1850 [6].

Extremely high air temperatures contribute directly to deaths from cardiovascular and respiratory diseases, particularly among elderly people [7]. In the heatwave of summer 2003 in Europe for example, more than 70 000 excess deaths were recorded [8]. The World Health Organization estimates that climate changes are expected to cause an additional 250 000 deaths worldwide per year between 2030 and 2050 [2, 9].

Some of the most evident impacts and consequences of climate change on human health are: 1) an increase in vector-borne diseases due to greater humidity and heat; 2) destabilization of food production by droughts and extreme weather; 3) rise in allergies and asthma caused by pollution; 4) an increase in the risk of food and water-borne diseases stemming also from warmer waters and flooding [5].

Other threats include the impact on zoonoses creating new ecological niches for vectors and wild animal species acting as reservoir for zoonotic agents, altering temporal and spatial distribution of disease [10]. This in turn will affect the prevalence of vector-borne diseases [11]. In fact, climate change was probably responsible for the expansion of important vectors in Europe such as *Aedes albopictus* (the Asian tiger mosquito), which transmits Zika, dengue and chikungunya diseases and Phlebotomus sandfly species, which transmits diseases including *Leishmaniasis* [12, 13].

Climate changes are one of the most relevant drivers of emerging risks for food safety [14, 15], which cannot be taken for granted in the future. They may have an impact on food safety at various stages of the food chain, from primary production to consumption: they must be considered, for example but not limited to, in the risk assessment of pesticides, including the secondary exposure of livestock and other environmental organisms, as for example non-target arthropods, such as bees [16]. Mycotoxins are also expected to impact significantly on food security and safety in the ongoing climate change scenarios [17].

The impacts on air quality and pollution already significantly affect health causing up to 7 million premature deaths annually with even larger numbers of hospitalization and days of sick leave. Recent research confirms an increase in the concentrations of near-surface ozone and particulate matter with associated adverse health consequences [18]. The increase in the incidence of skin cancer is also one of the most extensively studied effects of increasing ultraviolet radiation by ozone depletion [19]. The frequency of excessive heat exposures increasing acute heat strokes and heat mortality appears primarily due to effects on the cardiovascular and respiratory systems [20-23].

Furthermore, climate changes can also impact mental health causing and intensifying stress and anxiety: extreme storms or extreme heat, for example, can lead to depression, anger, and even violence [24, 25].

Climate changes can facilitate the spread of microbiological and chemical contaminants into aquatic ecosystem and increasing the risks for human health due to their transmission through the food chain [26-30].

In this context it is important to recognize that our ecosystems are closely connected with the wellbeing and health status of populations [31]. Several studies suggest that climate change could surpass habitat destruction as the greatest global threat to biodiversity over the next several decades [32]. Restoring, re-establishing and conservation of ecosystems can provide both ecological and social benefits, and contribute to prevent both climate breakdown and ecological collapse with significant benefits for human health [33].

The pressures on freshwater resources will affect water security, access to sufficient quantities of safe and acceptable drinking water, the adequate provision of water supply services, and ultimately, public health [34].

Climate change is putting at risk the achievement of all Sustainable Development Goals (SDGs), particularly health targets [35].

Climate-specific actions are necessary to protect people and the planet and are necessary across sectors and settings to promote resilience to and mitigation of climate change. The protection of human health from climate changes requires management at many levels, from the scientific assessment of the hazards and exposures for the human populations to the social, economic and policy aspects [36].

PUTTING THE CHALLENGE INTO CONTEXT

For all these reasons and urgencies a group of researchers of the Istituto Superiore di Sanità, ISS (Italian National Institute of Health) under the leadership of the President decided to organize the "First Scientific Symposium Health and Climate Change" (H&CC Symposium) in Rome, from 3 to 5 December, 2018 with the aim to promote an intersectoral and multidisciplinary approach to estimate, and to prevent, climate change-related impacts as well as to call the authorities to put in place measures to reduce adverse health effects.

The idea of hosting the conference at ISS stemmed from the fact that, besides being a leading and internationally renowned research institute, the ISS is also the technical-scientific body of the Italian Ministry of Health and therefore is a key actor in all issues related to Public Health. Furthermore, ISS provides technical-scientific support to the Italian Ministry of Environment. Thanks to these roles it was possible to involve major actors, scientists and decision makers, to discuss and illustrate the risks for human, animal and environmental health related to climate changes. The graph below summarizes the main steps leading to the organization of the Symposium.

The first step (*Figure 1*) consisted in the establishment of the working groups organized in three different levels: International Scientific Committee (ISC), Local Scientific Committee (LSC) and Local Organizing Committee (LOC).

The ISC consisted in a panel of international experts recognized worldwide for their scientific and policy contribution in relation to the protection of human,

animal and environmental health and therefore to the emerging issues related to climate change.

The LSC featured Italian researchers with wide ranging international experience. Its role was to evaluate abstracts, chair or co-chair the parallel sessions and draw up the scientific program. The LOC role was to focus on the logistics required to organize the event.

A dedicated website was created, managed and updated by LSC and LOC members (https://healthclimate2018.iss.it/).

THE CHARTER AS A TOOL TO PROMOTE ACTIONS

As far as the process regarding the Charter was concerned, the LOC sent a message to all the chairs before the symposium to explain the purpose of the symposium i.e. to draw up a document.

A three-step method was used consisting first in the analysis of the problems, followed by advocacy-building in order to reach a consensus on a set of key Messages and Measures (MMs) which would make up the Rome International Charter on Health and Climate Change (*Figure 1*). To achieve this goal a target conference audience was identified, made up of scientists, policy makers, stakeholder citizens. This work of dissemination was carried out before the Symposium by the LSC and LOC.

Analysis. Assessment of the most relevant scientific evidence related to the impact and consequences of climate change on human animal and environmental health was carried out by the ISC and LSC through an extensive search and review of the literature on the subject. This analysis revealed a series of complex and far reaching issues in the relationship between climate change and health and therefore the sessions were necessarily inter-sectoral. Selected topics for the symposium sessions were chosen to address the main issues and two chairs were appointed for each session according to their expertise on the specific subject.

Building advocacy and identifying key Measures and Messages. Before the Symposium, all chairs were asked to identify a simple and direct "Primary key MM" a sort of focus on the issue to be discussed during each session. The chairs' role was also to invite an internationally relevant speaker on the subject. After having heard the selected oral presentations and having shared and discussed the Primary key MMs with speakers and attendees, the chairs were invited to send the updated version of the key MM of their sessions to the LSC and LOC. The latter two collected all key MMs in order to draw up a first draft of the Charter to be presented in the final plenary session of the Symposium and disseminated to the media.

After the Symposium, this draft circulated among the ISC and session chairs for further comments and improvements so that each message could be read as a concise, clear, convincing, everyday language call for action incorporating both the problem and the evidence-based measure to deal with it [37].

SYMPOSIUM OUTPUTS

Approximately 500 researchers from 27 countries gathered in the H&CC Symposium (*Figure 2*) to discuss the far ranging impacts climate changes have and will increasingly have on human health and reach a consensus on a set of key actions required to face the risks and threats (available online as *Supplementary Material*).

This number of participants is particularly relevant considering that The Global Climate UN – COP24, where global political decisions are made, was taking place in the same days in Katowice, Poland. Many events have been organized on the issue of Health and Climate Change but this event in Rome was characterized by the wide variety of scientific aspects covered over the three days and presented and discussed by highly recognized experts in each field.

The H&CC Symposium was opened by Walter Ricciardi, at the time President of the Istituto Superiore di Sanità who provided a brief overview of the state of the art of the science of Climate Change. This was prepared together with Eric Chivian who was unable to attend. This was followed by greetings, speeches and presentations from various national and international authorities: World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO), World Organisation for Animal Health (OIE), European Environment Agency (EEA), European Centre for Disease Prevention and Control (ECDC), European Food Safety Authority (EFSA) and International Agency for Research on Cancer (IARC). The first plenary session featured three keynote lectures by Philip Landrigan, Howard Frumkin and Tamer S. Rabie focussing respectively on the widespread risks linked to pol-

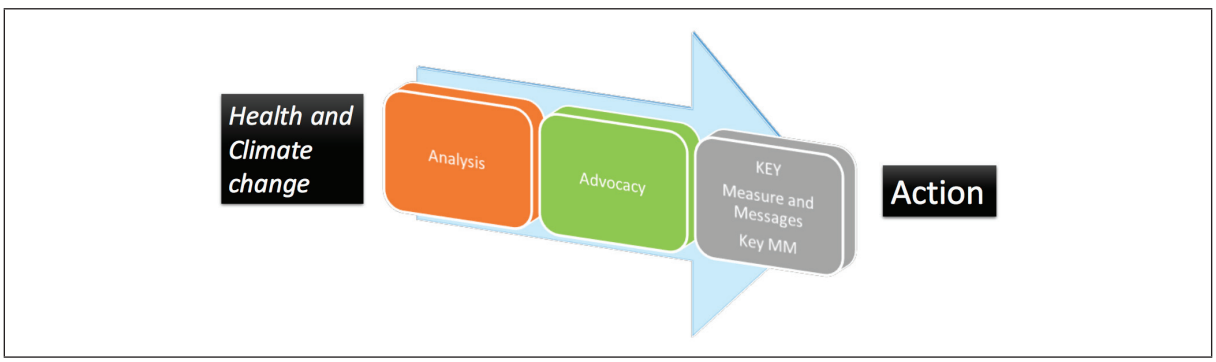

Figure 1
The three step approach adopted to draw up the Rome International Charter on Health and Climate Change.

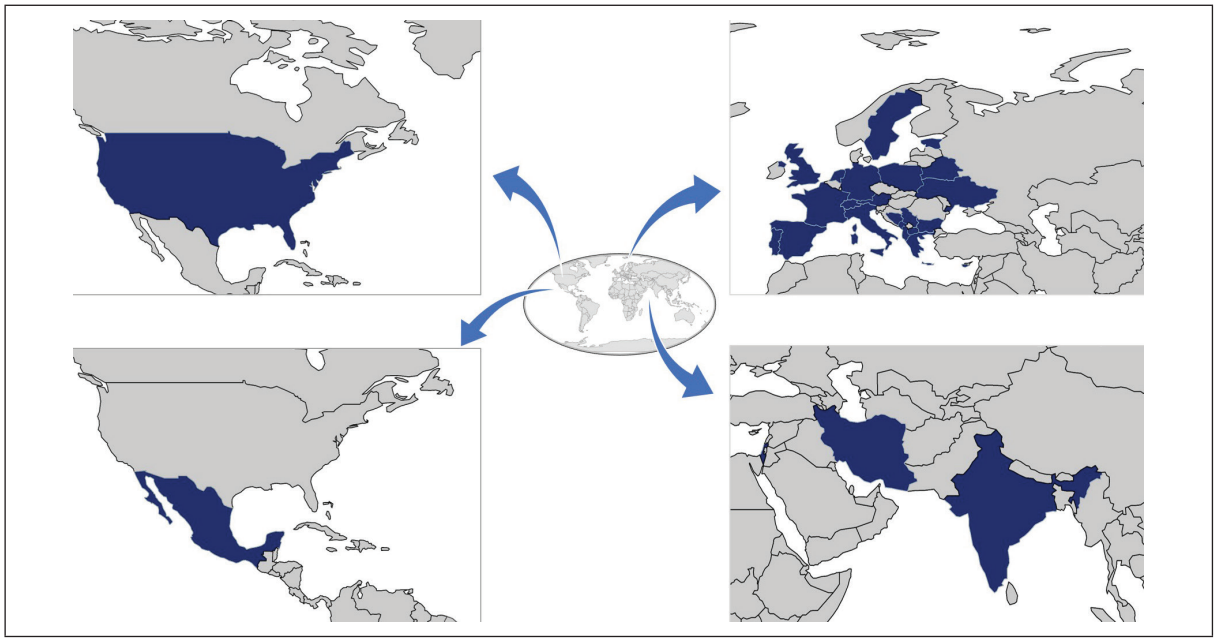

Figure 2
The 27 countries of the 500 participants in the Health and Climate Change Symposium.

lution, the need to adopt a planetary health approach and the importance of shifting towards a low carbon, resilient, climate-smart healthcare system [38].

Following the opening addresses, participants had the opportunity to choose to take part in specific topics through dedicated sessions chaired by distinguished experts in the field (available on line as *Supplementary Material*).

Some very interesting abstracts received did not fall within the scope of any of the planned sessions and so a miscellaneous session was established called "Everything else on health and climate change" which, among others, hosted oral presentations such as global warming and its effect on biotic modifications like skeletal anomalies in fishes [39]; the effect of droughts on the benthic invertebrate communities structures [40]; the role of cetaceans in the detection of zoonotic and terrestrial pathogens in marine environment [41].

One hundred and thirty-six abstracts were submitted before the Symposium and 68 of these were selected as oral presentations which would have contributed to better define the key statements of the specific session. The criteria for abstract selection were based on the general quality of the research presented, including aspects such as: 1) clarity of objectives; 2) appropriateness and explanation of methodology; 3) presentation and discussion of results; 4) clarity of conclusions. The abstracts selected as poster presentations were grouped into three sessions according to the oral sessions and e-poster exhibitions took place each day of the symposium.

Of the 68 posters exhibited in the three daily sessions, eight posters were shortlisted for Poster awards and were presented by the authors during the dedicated session (December 5) chaired by M. Manganelli, S. Marcheggiani, M. Carere. Further criteria for the "best poster" were defined during the Symposium: poster layout appropriateness, effectiveness in reinforcing presentation; use of progressive disclosure; overall layout and clarity, oral delivery (poster corner), indication of good preparation, clarity of speech, for the subject and/or ability to engage attendees. The three best posters for scientific relevance, clarity of communication and graphic layout received an award during the "Final Plenary session" (available on line as *Supplementary Material*).

The last day also featured two plenary sessions. The first hosted three keynote lectures, one by Timothy Bouley (former World Bank), devoted to the subject of how science may be translated into innovative tools in tackling the many issues linked to Climate Change: the second by Alberto Contri (Pubblicità Progresso) focused on communication and how the change in consumer attitudes is slowly bringing about a shift towards corporate social responsibility; the third by Isabel Annesi Maesano (INSERM) discussed the impact of climate change on the health of migrants both as a cause for displacement and as a vulnerable population.

The final plenary session of the Symposium hosted two lectures aimed at linking three of the main actors on the stage of the health-related effects of climate change: science, politics, economics. Ake Bergmann (Stockholm University) advocated putting real human needs as the central goal of human endeavours whatever the field of action. Giorgina Nigro (CNH Industrial) discussed how manufacturers are increasingly committing themselves to ever more sustainable processes and products and how this can be, at the same time, compatible with their medium and long-term economic interests. Walter Ricciardi and Andy Haines closed the Symposium awarding the winners of the poster sessions and presenting the first draft of the Rome International Charter on Health and Climate Change. The date and location of the Second International Symposium was also announced thanks to Philip Landrigan's offer to host it in Boston in September 2019.

ROME INTERNATIONAL CHARTER ON HEALTH AND CLIMATE CHANGE

The most important output was the Rome International Charter on Health and Climate Change which summarized the main messages and measures deriving from the results of the presentations and discussions carried out within the single sessions.

The scientific community is united in declaring that climate change effects on health, whether direct or indirect, are the most urgent public health problem which needs to be faced now. One of the concerns shared by many which, among others, inspired the idea of organizing the symposium was how to increase the attention of policy makers to health in relation to climate change. Integrating health concerns and benefits into all policies related to climate change whether they focus on mitigation or adaptation means to strengthen the call for and scope of climate action.

The Rome International Charter on Health and Climate Change (*Table 1*) summarizes the results of each

Table1
Rome International Charter on Health and Climate Change

Health is climate-dependent, so is our future	
	Measures and Messages
Environment and health	Adopt climate change mitigation measures to reduce the environmental burden of pollutants and related human diseases
Climate change and zoonoses	Promote a one-health approach (animal-human-environment) in both research and management programs.
Climate changes scenario	Adopt vigorous adaptation and mitigation measures to reduce the role of climate change as a multiplier of stressors and accelerating conflicts and societal fragmentation
Climate change and children health	Recognize parks and protected areas as a vital source of health and well-being and pivotal in reconnecting children to nature and in mitigating the effects of climate change.
Healthier cities	Connect science to politics and the population and provide health and climate change education for healthier cities.
Mental health and climate change	Monitor fragility and resilience both at mental and psychosocial level and promote interventions.
Blue and green space	Provide education about, management of, and access to blue and green spaces to sustain and improve the physical and mental health and well-being of individuals and communities, particularly to overcome socio-economic inequalities.
Water, sanitation and climate change	Adopt an holistic approach in policy, research and management to strengthen climate adaptation and the resilience of water and sanitation systems, based on risk analysis and through water and sanitation safety plan management approaches.
Communicable disease and climate change	Monitor epidemic precursors of disease (human infections, climatic-, environmental-, vector-, social-, animal-, food-related, etc) through a continuum of surveillance across sectors for the early detection of unusual patterns and for the improvement of prevention and control
Health and Climate Change. Joint Action for Sustainable Development	Consider externalities (calculations and embedding into prices), goods and services to reduce carbon hotspots, social and financial return on investment of sustainable health systems, (i.e. sustainability beyond economic, including social and environmental aspects, too)
Air quality, low carbon policy health and climatic change	Place protection and promotion of health at the centre of the climate change agenda, ensuring that policies to accelerate progress towards the zero -carbon economy capitalize on the health and wider economic benefits and to communicate those benefits to the public and policymakers Develop well designed policies to reduce the emissions of carbon dioxide and short lived climate pollutants in sectors such as transport, energy, housing, urban design, health care, and food and agriculture.
Ecosystem and health	Link ecosystem management with sustainable livelihoods and development to avoid the sixth mass extinction.
Global health and climate change	Interrupt the vicious circle between climate change and air pollution by addressing its impact on chronic non-communicable diseases and on cardiovascular and respiratory diseases in particular.
Tools and needs	Develop tools that inform people and engage them with the issues Empower people to take action at a personal level to undertake targeted intervention both for their own health and the environment.
From the environment friendly green to the healthy hospital	Make smart green technology available in hospitals, health centers and in health care systems to respond to disasters related to climate change Reduce the impact of clinical effects to improve resilience of affected citizens and to advocate for a persistent better health of the global population
Food security - food safety and climate change	Adopt holistic approaches to food security, food safety and climate change Promote interconnectivity and cooperation (connect-collaborate-co-design) to build resilience to the effects of climate changes, harnessing disruption rather than being passively subjected to it
Stakeholders	Encourage mindful, responsible and effective transfer of scientific data on climate change and its effects among stakeholders to promote global and local health and well-being and to reduce vulnerability through education, training and information/communication

session of the Symposium. One of the most relevant results of this Symposium was to bring together scientists, policy makers, and stakeholders to present their work and discuss their findings with their colleagues, to reach a consensus on priorities and produce key messages concerning measures and actions decision makers are called on to implement (available on line as *Supplementary Material*). It is interesting to note that one of the key focuses, cross-sectoral among the sessions, concerned information, education and empowerment of citizens as an effective means to contribute to the mitigation of the effects of climate change on health and at the same time enable adaptation by fostering resilience of the single and of communities.

These key MM need to be translated into action by decision makers and administrators to reduce the impact of climate change on health and foster adaptation and resilience. We hope they may contribute to the growing momentum surrounding the subject worldwide. The event also received the medal of the President of the Italian Republic.

Author contributions

WR, SM, CP, MC, TS, FG, ED, LM, equally conceived and contributed to writing the manuscript. UA, EA, LB, PDC, SG, PM, GR, ET SV have read and approved the manuscript.

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Conflict of interest statement

The authors declare no conflict of interest.

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