HERA-COVID-19
Research needs on Covid-19/Environment & Health nexus
Contribution of HERA

Background

The COVID-19 pandemic is challenging the world's economic and health care systems. It exemplifies the degree of global dependencies and the need of preparedness for global health threats. The emergence of a new global pandemic had been predicted. It was a question of when rather than if or how it would occur, given the increased understanding of how habitat disruption, the live animal trade and intensive livestock farming increase risk of zoonotic pathogens from wild animals. These human activities, compounded by the increase in international air travel and weakened public health systems particularly for infectious diseases, created ideal conditions for the emergence and rapid transmission of a new virus. Previous warnings went largely unheeded. As the pandemic unfolds, most societies find themselves unprepared and paying extraordinary costs in terms of lives, overwhelmed health systems, contracting economies and increasing social and economic inequalities.
In response to the pandemic, we observe unprecedented levels of cooperation and radically changed individual behaviour to address this collective crisis. This critical inflection point opens a window of opportunity to take urgent, coordinated action to protect human and planetary health. Hopefully, the resurgence from the COVID-19 crisis causing vast human suffering and having profound social and economic impacts will help us build a more resilient, sustainable and equitable future.

Objectives

While several aspects of global challenges are addressed in the HERA interim agenda on the environment, climate and health nexus[1], the unprecedented and totally new implications that the COVID-19 pandemic will have on global societies were not included. We present here the research priorities to be addressed to better understand the links between the COVID-19 pandemic and environment, climate change and health. In this report we identify research needs that should be tackled rapidly to develop policies promoting health. We discuss priorities for protecting public health in the face of the COVID-19 pandemic and its consequences, including the impact of social/physical distancing and confinement measures. We will prepare a second more complete report that will address knowledge gaps on the critically important interlinkages between global environmental change and the emergence of the COVID-19 pandemic and their relevance to the implementation of the SDGs.

Proposals are grouped into three major Research Goals.

Research goal 1: Environmental drivers of SARS-cov2 emergence and spread

1.1 Drivers of the SARS-CoV-2 emergence. Understanding the SARS-CoV-2 life cycle (where, when and why it circulates) is a question that requires additional research. While this will also appear in the medium/long term research needs, it seems important to better understand the contribution of animal/human proximity urgently to take appropriate action for example on land use, food system, including agriculture, intensive farming and live animal markets, on contacts between human and both wild, domestic animals and pets, etc. Understanding how human activities, environmental change/disturbances and animal

[1] https://www.heraresearcheu.eu/hera-2030-agenda

behaviour facilitate SARS-CoV-2 infection requires a joint effort between health, ecological and social sciences.

1.2 Drivers of the SARS-CoV-2 spread. The impact of climate and seasonality on the coronavirus is not definitely known. The initial spread of the virus was primarily in countries of the northern temperate climates, but it appears that it can also effectively spread more globally, including in warm and humid climates. So this important question still needs to be addressed. Furthermore, the role of different media in viral spread should be better assessed: transmission through aerosols and air particles; behaviour and virulence of SARS-CoV-2 in water (freshwater, marine water, wastewater), soils and wastes. These media could be reservoirs of virus particularly in cities. Short term research is needed to mitigate transmission of the virus through these media.

1.3 Improved modelling of virus spread including impact of mitigation and exit strategies. Robust open models are needed by the public authorities, and reducing uncertainties is an important objective. It is important to explore how environmental conditions (temperature, relative humidity, wind, UV light, etc.) affect the virus and its survival, which may affect the spread significantly. Models should now take into account the new tools that are foreseen for mitigation such as contact tracing (including technologies such as apps for mobile phones, artificial intelligence and immunological tests). A modelling effort is required on the one hand to take control measures that limit transmission and to evaluate/validate their effectiveness, and on the other hand to prevent a possible evolution of SARS-CoV-2 towards better transmitted or more virulent genetic variants. Evaluation of spread, severity, immunity and persistence of immunity is most likely modified by environmental conditions. Therefore, models need to be optimized for taking such conditions into account.

Research goal 2: Health impact of COVID-19 and environmental stressors

2.1 Understanding the population burden and identifying populations at risk - Harmonizing cohort studies and surveys across the EU. Many countries are basing their assessments on clinical case series and *ad hoc* data collection. They are also considering using available cohorts as well as new survey panels. It is critical to harmonize the studies to ensure comparability between various contexts. Large consortia or population and patient cohorts in the EU will have the potential to evaluate the effects of the environment on COVID-19, identify susceptible groups and examine the interaction between the pandemic and the response to the pandemic with health effects related to environmental exposures. Large new studies or existing cohorts may have the capacity to allow estimation of the associations between COVID-19 incidence/prevalence, underlying chronic diseases and long term exposures in previous years that may be related to cardiometabolic and/or pulmonary health including air pollution, lifestyle (e.g. smoking, diet, physical activity, mobility), indoor pollution, green/blue spaces, noise, chemicals, contaminants in drinking water, as well as policy approaches and intervention strategies chosen in various countries. The assessment of sero-prevalence and host genetics allows to study the impact of environmental exposures in modulating immune responses during the pandemic. From a larger medical perspective, an important issue to consider is the delay in prevention (including, but not only, medical prevention such as routine vaccinations, cancer screening programmes), diagnosis and therapy for other diseases during the crisis and the public health implications.

2.2 COVID-19 and Climate change impacts. Short term studies are needed to address the possible impacts of combined COVID-19 and heat waves. It is unclear at this stage whether co-occurrence of heat waves and active COVID-19 epidemic is possible, but if this happens, the stress on the health system could be severe. The impact of spatial and temporal variation of temperature, humidity, UV radiation and COVID-19 on morbidity and mortality should be evaluated, as well as the impact of control measures during heat waves. The vulnerability of the health system is a major point.

2.3 COVID-19 and air pollution. Rapid communications have highlighted relevant and potentially controversial aspects that need systematic scientific assessments: link between highly polluted areas and virus spread and impact; synergistic health impacts of air pollution and COVID-19 and severity of the disease; impacts of air pollutants on virus entry and pathogenesis (e.g. NO_2, O_3, particles); role of

allergens; contribution of agricultural practices. All these issues are relevant and require short term validation to support public action.

2.4 COVID-19 and toxicants. Higher burdens of exogenous toxicants can alter immune response, metabolism during stress or shock, and adversely impact cardiometabolic and respiratory function, all of which are relevant to this pandemic. Little is known about the possible contribution of chemicals which target the immune and vascular systems to the severity of the disease. Such evidence should expedite action limiting exposure to the most relevant chemicals.

2.5 Social economic and psychological impacts of COVID-19. There are several research needs that can be best examined through the harmonization of cohort studies described in 2.1, specifically the impact of COVID-19 and associated countermeasures and consequences (loss of movement, loss of livelihood, uncertainties and mixed messages) on anxiety and mental health, on social interactions and quality of life taking into consideration cultural differences and social and health inequalities. This includes also development and validation of strategies to mitigate these effects and build resilience in affected populations and society in general. Many of these aspects are related to disasters in general, thus the importance of drawing from the lessons and experience of other disaster situations (natural and technological) in the process..

2.6 Integrated Health and social Impact modelling and assessment of COVID-19 and related intervention strategies, confinement, improved environmental conditions (e.g. air quality), economic crisis and its social/health implications, environmental health inequalities and inequalities in access to environmental goods (such as parks, private garden, etc.). Improved assessment could guide political decisions for the post-crisis period.

2.7 Coordination of health and environmental impact prediction capacities across the EU. A coordinated effort at the EU level would be very helpful to enable and support effectively public interventions and enhance preparedness with quantitative evidence and state-of-the-art harmonized computational capacities, methodologies and tools. This could lead in the medium/long term to a sustainable infrastructure or network, but a short term coordination is helpful to improve the methodologies and harmonize the scientific support to public decisions.

Research goal 3: Integrated socio-economic, political and health implications of COVID-19 and intervention strategies

3.1 Impacts of intervention strategies and physical distancing, including cultural and social value aspects, as well as behavioural, lifestyle, economic and ethical aspects (e.g. conflicts between generations). The aim would be to estimate changes in environmental, lifestyle (physical activity, change in diet) and socio-economic factors (uncertainties, mixed messages from authorities in different media) due to COVID-19, during control measures/confinement and post-confinement, and effects on health including impact on social and health inequalities, focusing in particular on the most vulnerable population groups. Several objectives are relevant: evaluate or compare the impact of intervention strategies on post-traumatic stress and mental health and behaviour and their precursors of loneliness and isolation, depression and anxiety which undermine healthy and active lifestyles; evaluate impacts of intervention strategies on domestic violence; evaluate interventions that support resilience and recovery of citizens, communities and societies in the short-, medium- and long-term (e.g. extension of safer public spaces, green infrastructures, cycling lanes, local shops); assess the communication between affected populations, health professionals and authorities and the level and type of citizen engagement which is critical for the exit strategies.

3.2 Interaction between COVID-19 and the built environment. There are still uncertainties on how COVID-19 pandemic will reshape the urban built environment and how the built environment influences the occurrence and severity of the disease. What has been the role of cities structure in transmission and impact of the disease? Specific questions are: evaluate transport modes in the post-confinement period; explore the role of urban density by e.g. assessing average person-to-person distance in different city

structures and lay-outs as well as various urban settings; how to redesign public spaces to enable safe outdoor physical and social activities for all while mitigating climate change (green/blue space); focus on the interaction between built environment, COVID-19 and vulnerable populations including the elderly and the maternal and child health and wellbeing.

3.3 COVID-19 and the work environment. The objective is to examine short term risks particularly infection, stress and burnout and develop evidence-based protocols for the prevention of those risks taking into account engineering, administrative/organisational approaches and use of personal protective equipment (PPE). Another objective is to assess and evaluate long term effects of the COVID-19 pandemic and the post-pandemic period on new economic settings, including types of employment, working patterns and unemployment.

3.4 Implementation research of integrated social, economic, and environmental policies. In many cases discussed in this paper, scientific knowledge is available, but the implementation of decisions for successfully managing health risk is not straightforward. Therefore, implementation research is relevant as a cross-cutting proposal and several suggestions are discussed here. One direction would be to support the creation, synthesis, and application of interdisciplinary knowledge to strengthen research on implementation with a focus on integrated social, economic, and environmental policies. Implementation research should integrate small scale experimental settings as well as large scale cohorts mapping the Europe-wide setting and integrating ongoing long-term efforts across Europe to understand health impact related to COVID-19 and societal responses in populations and patients. Research should develop and examine novel concepts to integrate the continuum from wellbeing to therapeutic successes as potential outcomes and measures of healthy urban and rural environments. Implementation research is needed to guide future interventions and novel technological developments especially for mitigation of undesired effects of social/physical distancing and confinement measures. Research should focus on technologies, knowledge and stakeholder involvement to deliver win–win solutions and co-benefits, and rapid scale-up facilitated through research on implementation of potential solutions.

3.5 Political implications balancing economic and environmental strategies. A major question is how to "steer" the economy towards a sustainable path during recovery, to avoid "rebound" of production and consumption harmful to public health and the environment. Other implications are to collect and assess the lessons learned from the COVID-19 crisis for the climate crisis and assess the factors that triggered a different response to the COVID-19 pandemic compared to the climate or other environmental crises. Research is needed to support the following objectives: to communicate urgency and uncertainty (incl. the precautionary principle) and to assess the role of scientists and experts, citizens and local authorities; to implement and evaluate intervention measures and define the conditions for public acceptance notably through citizen involvement in design and/or evaluation; to communicate science to the public, media and politicians (discuss role of scientists and experts); to balance between imposed changes though policies and laws and incentives and voluntary changes in informed and engaged populations; to implement sustainable changes and to promote triple wins - health, equity and environmental sustainability in policies and measures; to balance between health and environmental protection versus economic needs and interests; to achieve protection of vulnerable groups and reduction of social inequalities (vulnerability, exposure, cost of mitigation action, "leave no one behind").

Research goals on the interlinkages of global environmental change and the emergence and impact of the COVID-19 pandemic

These goals will be fully discussed and a report will be completed in the coming months. The following text is indicative of the areas of current discussion

There are still many knowledge gaps on interlinkages between global environmental change and the emergence of the COVID-19 pandemic. Addressing most of these gaps requires long-term follow-up studies. However, this

does not mean that this research should not start now and many of the short-term proposals will have to be pursued for a longer time.

The ecological parameters that influenced the emergence and the spread of the new coronavirus pandemic are still incompletely understood. Research should address the role of biodiversity loss in the emergence and spread of this new virus, and more broadly the role of global environmental changes on the emergence and transmission of SARS-CoV-2 and similar infectious agents. Relevant parameters include land use change and invasion of natural habitats, food and feed production and food systems including international trade and transport, climate change, which lead to habitat destruction/fragmentation, deforestation and contacts between humans and wildlife. Another important aspect will be to understand the genetic mechanism through which SARS-CoV-2 evolved and became infectious to humans (host shift), and to identify the ecological drivers that favoured this evolution.

Furthermore, the COVID-19 pandemic presents new opportunities and challenges for resetting the economy, meeting the SDGs and accelerating progress towards more sustainable societies. There are many questions that need to be addressed: how to support and promote transformational change processes to build a more sustainable future, taking into account a planetary health perspective; how to strengthen governance at all scales to foster agreement and coordination in finding solutions to these problems; how to better identify the win-wins and trade-offs in terms of environmental protection and prevention of and response to emerging infections, including a wider public health perspective. This requires mainstreaming environment, climate change and health aspects and integrating inter- and transdisciplinary research and co-creation with stakeholders, including policy, practice and citizens. This approach will contribute to the societal impact of the lessons learned.