Outcomes from the First European Planetary Health Congress at ARTIS in Amsterdam

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Abstract: The First European Planetary Health Congress, held from 5 to 7 July 2023 at ARTIS in Amsterdam, represented a significant milestone in the global movement of Planetary Health. The event brought together 121 attendees from academia and the private sector dedicated to addressing the impact of human disruptions to natural systems on the well-being of life on Earth. Co-organized by *Natura Artis Magistra* (ARTIS) and the European Hub of the Planetary Health Alliance (PHA), the Congress featured five workshops: The Future of Planetary Health Cities, Impact through Synergy, Planetary Health Education, Movement Building, and Food and Microbes. Oral presentations addressed the theme of how human health and the health of human civilization depend on the natural environment, including subthemes on Earth, Water, and Food. Additionally, the subtheme of Humans reflected on how humanity can thrive within Planetary Boundaries and how to imagine a prosperous future for all life on Earth. The First European Planetary Health Congress offered a platform for fostering sustainable, just, and equitable societies within ecological limits. Accordingly, ARTIS and the European Hub aim to shape a hopeful future for generations to come.

Keywords: planetary health; social justice; transdisciplinary research; biodiversity loss; climate change

1. Introduction

The First European Planetary Health Congress held at ARTIS in Amsterdam in July 2023, builds upon the foundational principles of Planetary Health, which is defined as the pursuit of the highest achievable standard of global health, well-being, and equity, achieved through deliberate consideration of the political, economic, and social systems that influence humanity's future, as well as the natural systems of Earth that establish safe environmental boundaries for human flourishing [1]. This integrated science, which is rapidly being embraced by numerous universities, NGOs, government agencies, and UN bodies, calls for interdisciplinary collaboration to tackle global challenges.

This calls for a reevaluation of governance, implementation, and a more imaginative approach among scientists and practitioners, aiming to redefine human progress, reinvent possibilities for cooperation and science, rejuvenate efforts for habitat restoration, and foster innovative thinking. The European Hub of the Planetary Health Alliance, guided by its mission, addresses critical priorities, such as planetary habitability, health emergencies, climate, and social justice. Through strategic alliances, education, and organizing Planetary Health meetings, the Hub aims to drive transformative change for sustainable societies within ecological limits. Supported by key initiatives, such as the European Green Deal [2] and the Health Environment Research Agenda for Europe [3], the Hub is well-positioned to catalyze impactful actions.

The First European Planetary Health Congress, which followed the first formal in-person convening in Amsterdam in September 2022 [4], co-organized by ARTIS and the European Planetary Health Hub [5], provided a platform to explore the multifaceted challenges of Planetary Health and reinforce existing connections, building upon previously formed Working Groups focusing on: (i) education, (ii) research, (iii) policy, and (iv) movement-building. These Working Groups addressed pressing challenges, including resource overuse, climate disasters, food insecurity, and loss of biodiversity, highlighting the transdisciplinary nature of Planetary Health [4]. The First European Planetary Health Congress also emphasized the importance of science in addressing societal issues and advocated for a strengthened Planetary Health network (for the complete program, see Supplemental File S1). The events at the Congress concluded with a public Planetary Health Festival [6], promoting awareness of human dependence on the planet's natural systems and the responsibility that comes with it.

2. Oral Presentations

The extreme overuse of Earth's resources has thrown the natural systems off balance. Systems on which we rely for drinkable water, breathable air, and healthy food. In the

coming century, we are expected to face some of the greatest threats to human safety and health. The most vulnerable groups are strongly affected by climate disasters, emerging diseases, widespread pollution, and food insecurity. Finding solutions to these challenges is incredibly complex and can feel overwhelming. The speakers at the congress provided insight and inspiration on how the solutions-oriented planetary health perspective can be applied in different fields to develop holistic, equitable, and long-lasting solutions that respect the boundaries of the planet. The oral presentations, which were held along the subthemes of Earth, Water, Food, and Humans (Figures 1–4), illustrate the inherent transdisciplinary nature of Planetary Health (Supplemental File S2).

2.1. Setting the Stage

2.1.1. Planetary Health: A New Paradigm That Combines the Health of the People and the Planet

Josep M. Antó (Barcelona Institute for Global Health (ISGlobal), Barcelona, 08036, Spain).

We are currently living in the Anthropocene, a new epoch characterized by significant disturbances caused to Earth's natural systems by industrial societies. This has resulted in unprecedented threats to humans and countless other species. In response, the concept of Planetary Health has emerged as an interdisciplinary and transdisciplinary approach aimed at understanding and addressing the impacts of human activities on natural systems, as well as the consequences on human health and the health of other species [7,8]. Planetary Health draws upon the science of complex systems to analyze the intricate interactions between social and natural systems. Its goal is to propose solutions that preserve the well-being of humans and other species within the sustainable limits of our planet. Ethical considerations are at the core of Planetary Health, as they emphasize the identification of winners and losers in the face of global environmental change. This also underscores the importance of protecting vulnerable populations and future generations. Given the urgency of the current transgression of planetary boundaries, Planetary Health advocates for the prompt implementation of transformative mitigation and adaptation strategies. These measures are crucial for addressing the pressing challenges we face and securing a sustainable future.

2.1.2. From Global Health Security to Planetary Health Solidarity

Alexandre Robert [1,2], Fabio Balli [3,2], Nadja Moser [4,2], and Nadine Henschel [5,2] ([1] Alliance Santé Planétaire, France; [2] Festival 'taking care together', Switzerland; [3] Concordia University, Canada; [4] Charité Universitätsmedizin Berlin, German; [5] Science Po Paris, France).

Systemic transformations are required to prevent the consequences of human-led damage to Earth's ecosystems. The history of imperialism, colonization, slavery, and globalization of trade is intertwined with the history of the cross-border management of infectious diseases such as plague, cholera, yellow fever, and influenza. Intensifying in the 18th century, it is contemporary with the phenomenon of the Great Acceleration. This shows that social advances and progress in human development over the last century have been very unevenly distributed and based on the over-exploitation of living organisms and ecosystems. We have reached and exceeded certain planetary boundaries necessary to preserve the conditions of human life on Earth.

The last half century has been marked by the (re)emergence of new pathogens, leading to rapidly spreading pandemics in a densely populated and globalized world. The (re)emergence of pandemic-prone zoonotic diseases in the 21st century led to a revision of the international health regulations in 2005, which aimed to move from a focus on three epidemic diseases (cholera, plague, and yellow fever) to the inclusion of public health events and framing of the concept of global health security [9–11].

From the 2014 to 2015 West Africa Ebola epidemic to the COVID-19 pandemic, One Health has grown as an integrated approach to improving human, animal, and environ-

mental health. The COVID-19 crisis and its management have disrupted every aspect of human life, from personal freedom to global economic exchange. This has led to ongoing negotiations for a Pandemic Treaty at the World Health Organization [12]. The current focus is primarily on the conventional approach to global health security. It lacks an integrated, people-led approach to planetary health governance that promotes coherence across life-preserving initiatives and agreements.

To ensure holistic and sustainable implementation, One Health needs to move beyond global health security and its excluding funding mechanism and become an essential part of the implementation of equitable global health policy. Wars, global pollution, biodiversity destruction, and climate change are increasingly being recognized as the biggest threats to global health. These are covered by Planetary Health concepts [7]. Building on the current implementation of the One Health approach, it is more necessary than ever to move from Global health security to Planetary health solidarity [13].

In contrast to the state-led approach to global health security, a planetary health solidarity initiative takes a cross-border and transdisciplinary approach led by citizens across the globe. It emphasizes a sovereign, cosmo-local valuation of well-being and health, and relies on building trust and confidence to foster collective and individual resilience. This should, by design, increase embodied solidarity between humans and other living beings and foster the cohabitation of multiple perspectives and practices. A coalition of diverse people from around the world is committed to promoting Planetary Health, co-elaborating a bottom-up proposal called Planetary Health Solidarity [13]. Rather than relying solely on governmental or institutional actors to lead the way, this initiative seeks to harness the commons, collective knowledge, creativity, and the energy of converging local community networks.

2.2. Theme: Earth

Figure 1. The artwork, 'Theme Earth', sketched by the 'Beeldvormers' for the First European Planetary Health Congress.

2.2.1. Two Sides of the Rewilding Coin: Necessity of Ecological and Human Rewilding

Koen Arts (Forest and Nature Conservation Policy Group, Wageningen University and Research, Wageningen, The Netherlands).

Rewilding is usually interpreted as an activity primarily concerned with the ecological dimensions of environmental management. This idea has not fundamentally changed since the three C's summary 25 years ago [14]. Cores stand for robust, relatively intact, natural areas; corridors stand for ecological connection zones between these areas. Carnivores highlight the important role that predators and other keystone species play. In such 'ecological rewilding' approaches, humans are generally seen as bystanders; they may initiate a rewilding project, financially benefit from it through ecosystem services, or recreate it in a rewilded area. For all the valuable ecological and social consequences such rewilding approaches may have [15], they are often remedial acts of restoration, providing a type of symptomatic relief. They fail to go to the core of what causes environmental degradation in the first place: the disconnection between humans and their natural environment [16,17]. By positing the concept of 'human rewilding', I argue that rewilding should include humans much more prominently and radically. Indeed, human rewilding is a crucial process in restoring the broken relationship between humans and nature at both individual and societal levels.

Conceptually, I approach human rewilding as a set of visions and practices that acknowledge human evolutionary history within the contemporary context of life on Earth [18]. The suggestion is that human rewilding may focus on a relational approach to nature experience and nurture qualities of technique over technology, deceleration over acceleration, and immersion over short-lived experiences. Considering what human rewilding could mean in practice, I present two case studies. The first is the rewilding of daily life, based on a personal yearlong experiment of living outside, and a straightforward research question: in a land without wilderness [19], is it possible to find wildness in everyday life? The second is the rewilding of education, specifically through establishing a new Wageningen University module that challenges traditional didactic frameworks and approaches at the institute. Ultimately, I argue that human rewilding is a necessary, complementary component to ecological rewilding efforts. Together, they offer a nature-based ethic that considers consumption patterns and structures, daily life choices, and inclusive nature conservation practices in the context of global environmental crises. Indeed, they suggest a human-inclusive, integrated pathway to Planetary Health.

2.2.2. Towards a Sustainable, Dynamic, and Biodiverse Peat Landscape for the Farmer, Nature Manager, and Citizen

Matty P. Berg [1]**, Mark Koetse** [2]**, Marjoleine van der Meij** [3] ([1] Amsterdam Institute for Life and Environment (A-LIFE), section Ecology and Evolution, Vrije Universiteit Amsterdam, De Boelelaan 1085, 1081 HV, Amsterdam, The Netherlands; [2] Institute for Environmental studies, Environmental Economics section, Vrije Universiteit Amsterdam, De Boelelaan 1111, 1081 HV, Amsterdam, The Netherlands; [3] Athena Institute, Vrije Universiteit Amsterdam, De Boelelaan 1085, 1081 HV, Amsterdam, The Netherlands).

Biodiversity in our characteristic peat meadow landscape has declined sharply due to agricultural intensification, drainage, and climate change. In addition to biodiversity loss, intensive land use has resulted in soil subsidence, nutrient enrichment, and greenhouse gas emissions. The key to improvement lies in increasing the sustainability of current activities in the area, implying a transformation to a form of land use that leads to biodiversity restoration, halts peat degradation, maintains profitable business operations for landowners, and creates an inspiring landscape for the citizens. VeenVitaal, a collaboration of scientists, nature managers, farmers, and many other actors, is a Living Lab project in the peat-meadow area surrounding Metropole Amsterdam [20].

The VeenVitaal project aims to:

- Investigate which interventions in the landscape are effective in restoring biodiversity and essential ecosystem functions and services of peat meadows.
- Contribute new knowledge through the integration and analysis of existing and new biodiversity and ecosystem (services) data.

- Underpin, develop, and validate an integrated set of objective, simple, and reliable indicators (KPIs) that quantify the degree of recovery and monitor the transition to sustainable peat meadows.
- Link ecological and socioeconomic systems by assessing both existing and alternative business models of key actors in the agriculture value chain, with explicit roles for payments based on biodiversity and ecosystem services from the market and society.
- Organize all its activities using a Living Lab approach, with Responsible Research and Innovation and citizen and multi-actor involvement as core values. Through this approach, a wide variety of societal partners are explicitly involved in all project stages, and the impacts of cooperation and the use of findings in practice are maximized.
- Link relevant policy areas and scientific disciplines to existing practices and current initiatives in the region and contribute to the Delta Plan on Biodiversity.
- Exchange lessons learned from multi-stakeholder co-creation and action for other projects with a Living Lab approach.

2.3. Theme: Water

Figure 2. The artwork, 'Theme Water', sketched by the 'Beeldvormers' for the First European Planetary Health Congress.

2.3.1. Listen to the Oceans: They Have Never Been Quiet, but Can Only Persist When They Remain Audible

Hans Slabbekoorn (Institute of Biology Leiden (IBL), Faculty of Science, Leiden University, The Netherlands).

The natural world has always been filled with sounds of abiotic origin, like wind, rain, thunder, and waves. In addition, sounds of biotic origin have been around for evolutionary time periods, as many animals make sounds. The impact of humans on natural soundscapes has grown gradually with human population growth on Earth [21,22]. The industrial revolution and the rise in the use of machines have led to an almost continuous presence of anthropogenic noise worldwide. The growth in noise pollution levels in the oceans is primarily related to a steady increase in international trade and the associated global shipping activity. Seismic exploration for geophysical surveys has been around for approximately a century, while pile driving for wind turbines at sea in coastal areas has become a recent growth sector in the last decade. Sounds are particularly important

for aquatic animals when underwater visibility is low. Animals may communicate with vocalizations to find group members and potential mates, find prey through passive acoustics, or actively find prey through echolocation. They may also use sound to detect predators or find their way through so-called soundscape orientation. There is considerable taxonomic variation in the frequencies at which different species are able to hear. Most invertebrates and fishes are only sensitive to low frequencies up to 1 kHz, or exceptionally up to 4 kHz or higher, whereas marine mammals vary extensively, with large baleen whales being sensitive to very low frequencies and smaller dolphins being sensitive to very high frequencies (bats of the sea).

As sound can be important to aquatic animals, and almost all of them can hear, anthropogenic noise can be harmful to individuals and populations [23,24]. Anthropogenic noise can induce deterrence, disturbance, and distraction, whereas elevated ambient levels can mask relevant signals and cues, undermining critical auditory functions. Animals may habituate to noisy conditions and become skilled at extracting biologically relevant sounds from a familiar background of irrelevant sounds. However, masking problems that render relevant sounds undetectable do not fade over time. Furthermore, not all animal species may be equally able to cope with noisy conditions, and we may end up with the same 'happy few' in large parts of the urbanized underwater world. Not only animals have to rely on sound underwater. Humans also have difficulties in seeing what is going on with marine and aquatic biodiversity. Consequently, the first and most important thing to do is "listen to the oceans." Due to the global spread and taxonomically wide impact of noise pollution, it is reasonable to speak about acoustic climate change. Therefore, the impact on threatened animals and vulnerable populations, species interactions, and ecosystem health should be investigated. Only through awareness, knowledge, and insights about the beauty and acoustic sensitivity of the underwater world will we be able to convince people to make less noise or to time and locate their noisy activities wisely. In this way, we protect what has never been a silent world, which can persist only when it remains audible.

2.3.2. Climate Change and the Aquatic Microorganisms of Lakes and Oceans

Jef Huisman (Department of Freshwater and Marine Ecology, University of Amsterdam).

In the current era, the Anthropocene, climate change will impact most life on Earth. Despite their small size, microorganisms support the existence of all higher life forms. To understand how life on Earth will respond to climate change, it is therefore vital to improve our understanding of the microbial 'unseen majority' [25]. We must learn how microorganisms affect climate change through their role in the production and consumption of greenhouse gases, as well as how microorganisms are affected by climate change and other human activities. In this lecture, I will focus on cyanobacteria and eukaryotic phytoplankton in lakes and oceans, which are responsible for approximately half of the global primary production. I will discuss their contribution to global CO_2 fixation, their responses to global warming and ocean acidification, and the impact of climate change on the proliferation of toxic algal blooms [26].

2.3.3. Rights for the Waddensea

Jessica den Outer (JEDO Consultancy, Amsterdam, The Netherlands).

Jessica den Outer introduced us to the concept of the Rights of Nature and specifically, the rights of the Waddensea, as part of the Water theme addressed at this Congress. It may sound bizarre, but it is really happening all over the world; the rights of mountains, rivers, and forests are recognized. After the legal emancipation of women and enslaved people, it is time for the next evolution in law: the Rights of Nature. This legal concept forces us to place ourselves in the perspective of nature. Den Outer wrote a book on the Rights for Nature [27]. During this oral presentation, she introduces examples from around the world, focusing on the Rights for Nature previously obtained for the Whanganui River in New Zealand [28] and the heavily polluted saltwater lagoon, Mar Menor, in Spain [29]. These cases are compared to the Dutch situation of the Waddensea. What rights should the

Waddensea have and how will this change our perspective on the Waddensea? Rights of Nature is considered the fastest growing legal movement of the twenty-first century, and Den Outer predicts this will become a popular theme in the years to come.

2.4. Theme: Food

Figure 3. The artwork, 'Food', sketched by the 'Beeldvormers' for the First European Planetary Health Congress.

2.4.1. Creating a Healthy and Sustainable Food System

Jaap Seidell (Faculty of Science, Amsterdam Public Health—Health Behaviors & Chronic Diseases, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands).

The global food system currently faces significant challenges related to health, sustainability, and equity. To address these challenges, the concept of healthy and sustainable food systems has attracted increasing attention in recent years. I will share ideas about promoting and implementing strategies to achieve a healthier and more sustainable food system. A healthy and sustainable food system encompasses various aspects, including production, distribution, consumption, and waste management. I will stress the importance of adopting a holistic approach that considers the entire lifecycle of food, from farm to fork. By doing so, we can address the interconnected issues of malnutrition, chronic diseases, environmental degradation, and social inequality [30].

One aspect of our current food system is the impact of unhealthy diets on public health. I will particularly focus on the rising prevalence of diet-related diseases, such as obesity and diabetes, and their significant burden on healthcare systems worldwide. I will emphasize the need to promote healthier eating patterns, including increased consumption of fruits, vegetables, whole grains, and plant-based proteins, while reducing the intake of processed foods, added sugars, and unhealthy fats. In addition to focusing on individual behavioral changes, I will emphasize the importance of transforming the food environment [31]. There is a need for advocacy for policies that support sustainable agriculture, promote local food production, and increase access to nutritious foods, particularly in underserved communities. For instance, it has been demonstrated that improving food environments, such as creating food hubs or farmers' markets, can positively influence dietary choices and improve health outcomes.

In my opinion, it is necessary for public health scientists to actively engage with policy-makers, industry leaders, and community organizations to drive change. There is an urgent need for multi-stakeholder collaborations to develop innovative solutions and implement evidence-based interventions [32]. By bringing together diverse perspectives, we can create a food system that prioritizes health, sustainability, and social justice. Furthermore, there is an urgent need to reduce food waste and mitigate the environmental impact of food production. Our food systems lead to a staggering amount of food being wasted globally and associated greenhouse gas emissions. I will advocate for strategies that promote food waste reduction, such as improved storage and distribution systems, consumer education, and repurposing of surplus food.

In conclusion, I will stress the importance of adopting a comprehensive approach that encompasses individual behavioral changes, policy interventions, and systemic transformations. By embracing these insights, we can strive towards a future where everyone has access to nutritious and sustainably produced food, promoting the well-being of individuals and the planet alike.

2.4.2. The Transition to a Sustainable Food System

Frederike Praasterink (HAS University of Applied Sciences, 's-Hertogenbosch, The Netherlands).

The Netherlands, a small country famous for its highly productive agri-food sector, ranks as the first exporter of agri-food products in the EU and the second worldwide. However, we are at a global tipping point. The way food is produced and consumed has a critical negative impact on diverse dimensions of social, ecological, and economic sustainability [33]. It is not enough to make the current agri-food system 'less bad.' We must also work on innovating the system itself to transition to a sustainable food system that addresses and restores ecological exploitation and social inequality (concentration of power on the one hand and food insecurity and exclusion on the other). This requires radically different ways of working by using a systems approach that not only focuses on symptom management, but also transforms the underlying patterns, structures, and paradigm of the system that make unsustainable symptoms happen repeatedly. This means shifting the current paradigm of productivity and economic growth to a new system goal that emphasizes the health and wellbeing of the planet, animals, and people. Fortunately, many innovative entrepreneurs and innovators in the Netherlands have actively worked on this transition. They use agroecological farming to restore (soil) biodiversity, produce plant-based proteins, work on true pricing, reconnect consumers through short supply chains, and upcycle waste streams into bio-based materials. Increasingly, groups are collaborating to upscale these system innovations. All of this helps foster collective learning on redesigning the food system to act *within* social and planetary boundaries, aiming for it to be regenerative, inclusive, circular, and equitable. However, the transition is going too slowly relative to the urgency of global challenges.

A Dutch transdisciplinary consortium [34] is working on an acceleration agenda for the transition to a sustainable food system. One of the subprojects is focused on assessing the 'state of food transition in the Netherlands.' The X-curve framework of transitions [35] was used through a participatory process to identify patterns of build-up and phase-out. Examples on the protein transition and regenerative agriculture were presented, as they are visible in both the acceleration phase of small scale 'niches' and in the destabilization phase of big 'regime' players. Although the analysis of the 'state' is a work in progress, transitions seem to stagnate during the phases of emergence and institutionalization. To speed up the transition in the agri-food system, interventions may include developing a positive vision for a sustainable food system in the Netherlands with clear choices on what needs to be phased out and what needs to be built up. Deliberate decline of unsustainable practices and shaping the associated 'mourning process', along with active support, financial incentives, and R&I for alternatives (e.g., payments for ecosystem services by farmers, true pricing, and transparency) are important elements for transition. Some 'ingredients' for a future

food system were presented, including the EAT Lancet planetary health diet, which inspires a much more plant-based diet [36]. Brave leadership is needed, especially in policy-making, to place societal challenges before the economy, shift financial flows in favor of sustainability, and support social innovation to change the 'normal', for instance, to a planetary health diet. All of us can contribute by what we choose to eat.

2.4.3. Urban Food Hubs as Catalysts for Healthy Cities for Humans and Non-Humans

Marian Stuiver (Wageningen University and Research, Wageningen, The Netherlands).

We need healthy cities where humans have access to healthy food produced through the regenerative use of resources, by utilizing nature-friendly agricultural practices. The pathway to building healthy cities requires a catalyst that stimulates each of these factors. Urban food hubs have proven to be such catalysts. In urban food hubs, nutritious, healthy, and safe foods are produced and consumed within the region, using nature-inclusive farming practices [37]. Active community engagement is encouraged in the process, which further creates opportunities for earning extra income and effectively spending leisure time. Furthermore, urban food hubs help build a balanced ecosystem by restoring resources, conserving nature, and enhancing biodiversity [38]. Therefore, urban food hubs are essential elements to be incorporated into urban design. In this oral presentation on urban food hubs, information is presented using real-world examples. Data were gathered from multiple sources, including websites, literature, and research on several food hubs in the United States and Europe [38,39].

Food hubs consist of four integrated components: Food Production, Food Preparation, Food Distribution, and the Recovery phase [37]. During food production, environmentally friendly agricultural practices should be implemented, and the preparation of nutritious, safe, and value-added food should take place in the second component. Food is then distributed to local markets and restaurants, or sold on-site. During the recovery phase, waste and water should be recovered through composting, water reuse, or other nature-friendly practices [39]. Various forms of food hubs have emerged, each with unique characteristics and benefits. Food forests imitate natural processes, promote biodiversity via permaculture, and require limited maintenance [40]. Large-scale food sheds encompass the territory around urban areas, aiming to create resilient food systems by shortening supply chains [41]. Neighborhood-based food hubs focus on improving access to fresh and locally sourced food within a community and fostering community engagement and resilience [38]. Finally, indoor farming systems utilize innovative methods such as hydroponics and aquaponics to produce food without soil, offering benefits such as a reduced environmental footprint, year-round production, and enhanced food security.

Food hubs are crucial for improving food provisioning in cities and shortening food chains. They provide diverse fresh food options and enhance nutritious choices for urban residents. Community-based food gardens and farms, like 'Kaskantine Amsterdam' [38] or 'Voedselpark Amsterdam' [42], strengthen social bonds among urban residents and can enhance the economic possibilities of the urban population. Furthermore, food hubs contribute to plant and animal diversity, promoting biodiversity in urban communities, as observed in studies on biodiversity richness in food forests [40]. Based on the adopted practices, food hubs can improve air, soil, and water quality and enhance urban resilience by regulating floods, or mitigating heat stress in communities. Food forests and gardens contribute to climate change mitigation through carbon sequestration. However, there is work to be done, as a recent study indicated that in the United States of America, social benefits of Urban Food Hubs are easier to achieve compared with environmental benefits [39]. Further research needs to be conducted to address how to increase sustainability benefits in urban environments.

Food hubs are threatened by the lack of land, integrated food policies, funding possibilities, stakeholder cooperation, partnerships, expertise, and localized experience. They are based on an alternative economic model and are vulnerable within present economic models. Citizens, producers, and institutional stakeholders need to move closer together

based on an economy that embraces planetary health, the regeneration of natural resources, and local economic opportunities. It is important to emphasize the multiple benefits of food hubs and integrate them into public policies. These policies should address land use conflicts and focus on long-term benefits instead of short-term economic costs. Municipalities play a central role in enabling food hubs to become a part of the urban economy. On one hand, community engagement is crucial for identifying local food needs and promoting citizen participation. On the other hand, governments must embrace and work together with communities that want to develop food hubs and actively help overcome obstacles. Finally, education and research, for instance into nature-based urban farming, alternative economic models, and healthy nutrition and lifestyles, can help promote urban food hubs.

Urban food hubs are crucial components in building healthy cities through sustainable food production, community engagement, soil regeneration, and ecosystem balance. They provide diverse food provisions, strengthen social bonds, enhance biodiversity, and contribute to urban resilience and climate mitigation. Overcoming transformation challenges, such as policy and funding gaps, requires collaboration, community involvement, and research. By embracing food hubs, cities can create healthier, more sustainable food systems.

2.5. Theme: Humans

Figure 4. The artwork, 'Humans', sketched by the 'Beeldvormers' for the First European Planetary Health Congress.

2.5.1. The Need for Safe and Just Earth System Boundaries

Joyeeta Gupta (Amsterdam Institute for Social Science Research, University of Amsterdam, Amsterdam, The Netherlands).

Since 2009, scientists have argued that planetary boundaries exist, beyond which various Earth systems have become unstable. They identified nine domains, for which targets were identified for three domains. Six years later, another target was identified. The question these boundaries raise is: should we not also have boundaries that prevent major injustices to people and ecosystems? When Future Earth and the Global Commons Alliance set up the Earth Commission, this was a question that we debated. We then decided to build an Earth System Justice framework based on existing scholarship. We also decided to identify safe and just boundaries. The third step was to assess what meeting the basic needs of all people would imply, in terms of extra pressure on biophysical domains. Our methods

included literature reviews, modelling, consultations with others, and expert judgement. The details are provided in the Supplementary Materials of our studies [43–46].

Our Earth System Governance Framework builds on lessons learned from the diverse literature on justice. This is a framework that builds on recognition and epistemic justice. It calls for balancing interspecies justice, Earth System Stability (I1), intergenerational justice (I2), and intragenerational justice (I3). It includes procedural and substantive justice; the latter covers access to minimum resources and services, and the allocation of the remaining resources, risks, and responsibilities. This framework is then applied in terms of ends and means. Two critical ends are: (a) safe and just boundaries and (b) access to minimum needs. The means address: (i) underlying causes of environmental degradation and poverty, (ii) allocation of the remaining resources once access to minimum needs is met, (iii) allocation of risks/harm, and (iv) allocation of responsibilities between countries.

We identified five domains (water, biosphere, nutrients, climate, and air) and eight targets (two each for water, the biosphere, and nutrients). We identified safe targets and, using our framework, assessed whether they were just. This has led to more stringent targets for climate change, aerosols, and nitrogen. We also complemented some targets with locally relevant targets, such as those for air pollution. Moreover, we provided suggestions on how to achieve some of these targets. Our results showed that we crossed seven out of eight targets at the global level, and more than half of the land area crossed at least two boundaries. This is worrying.

This implies that any additional activity would further degrade the environment. Nevertheless, we calculated the impact of meeting the basic needs of people below the minimum on food, water, energy, and infrastructure for the environment, and we show in quantitative terms what the impact would be. This implies that meeting these minimum needs, as required by the SDGs within the Earth System Boundaries, is only possible if we radically transform our existing system. Such a transformation would also need to be done in as just a manner as possible to make it acceptable and feasible.

2.5.2. (Public) Planetary Health (Stack)—Artistic Research and Perspectives

Marleen Stikker [1,2], **Zoénie Liwen Deng** [1], **Lucas Evers** [1] ([1]Waag Futurelab, Amsterdam, The Netherlands, [2] Amsterdam University of Applied Sciences, Amsterdam, The Netherlands).

Waag Futurelab is a transdisciplinary public research organization that critically engages with and reflects on technology and society. The approach of public research and art-science is key in Waag's efforts. At Waag, some research labs and their various projects address matters related to planetary health. There are cases of artistic research and perspectives that engage with matters of concern, such as the planet as a sensorium, planetary imaginaries, how to relate to and care for the more-than-human, the rights of nature, and ecological regeneration.

At the Smart Citizens Lab, 'Hollandse Luchten' (Dutch Skies) is a citizen science project where citizens are involved in measuring air quality in their environment in the Province of North Holland. The Urban Ecology Lab, working with artists such as Esmee Geerken, explores research questions such as: how do we relate to other animals, plants, soil, air, and micro-organisms—in other words, to the "more-than-human"? What answers do they offer to major issues, such as adaptation, resilience, and mental and physical well-being? [47] In Open Wetlab's European project, Art4Med, within the framework of open science, collaborative efforts between artists and health and biomedical researchers are carried out to address the exclusion of marginalized groups from healthcare, global migrations, collapses in environmental health, and the need for radical care during the pandemic [48]. In the More-than-Planet project at Space Lab, we aim to facilitate collaborative, transdisciplinary (artistic) research on planetary imaginaries, how they influence the way humans relate to the more-than-human and the planet, and how we can treat planetary health as a matter-of-concern [49] and matter-of-care [50].

Planetary Public Stack grows out of the More-than-Planet project, in which Miha Tušič, the lab lead of Space Lab, develops a model that explores the different layers of planetary imaginaries: foundation, design layer, technological layer, interface, and public layer. This model can be used in the context of planetary health. Waag works with artists whose art projects explore how to relate to and account for the planet and the more-than-human as the sensorium, matters-of-concern, and matters-of-care. Waag's artist-in-residency, Špela Petrič's PL'AI (2021), a project that embraces the notion of play as an ontological condition of all living bodies, including plants; Creator Doctus Femke Herregraven's Twenty Birds Inside Her Chest (2021) explores the aquatic voice and the watery commons as a site of resistance in times of planetary catastrophe to counter "discourses of doom." Other important projects are Ocean in Transformation (2022) by Territorial Agency, Broken Spectre (2022) by Richard Mosse, Pollinator Pathmaker (2021) by Alexandra Daisy Ginsberg, and initiatives such as Ambassade van de Noordzee, Zoöp, and biocultural corridor.

2.5.3. An Entangled Life with Animals and the Planet

Pim Martens (System Earth Science Institute, Maastricht University, Maastricht, The Netherlands).

Our current socioeconomic and political systems have become decoupled from the larger ecology of life. Our relationship with the natural environment and animals has changed dramatically over time. More respect for animals and nature is key to a planetary healthy society. When we respect our planet, we respect life, and, in turn, we respect ourselves. Learning from indigenous people all over the world about our relationship with animals and our planet may be a way to address the planetary challenges we see today. We, as humans, have affected the health of our Earth to such an extent in recent years that not only nature but also our health is suffering. If the COVID-19 crisis was not a clear enough signal that we are not on the right track, this certainly is: if we do nothing and continue with a 'business-as-usual' lifestyle, we will undoubtedly see further consequences in the future. Instead, we, as humans, need to rebuild, restore, and regenerate holistically. We need to realize that humans are part of nature, not separate from it, and that we all have a positive role to play. We must realize at our very core that human health is the planet's health and everything on it, and vice versa.

For example, animals are hardly or not at all discussed in discussions about a sustainable future, and if they are, it is as an economic product or as a cause of climate change. Because we increasingly realize that everything that lives on Earth is interconnected and that humans certainly do not have a unique position in this, 'sustainability' is an outdated concept. If we want to keep the Earth habitable, we must take into account the needs, feelings, and intrinsic values of everything that lives, including other animals: 'sustanimalism.' Sustanimalism goes much further than sustainability in the sense that animal interests and respect for all animals (not just humans) and their natural environment are paramount here. Sustanimalism requires a new vision of our relationship with the living (and non-living) nature around us [51,52]. The next logical step, after the step from sustainability to sustanimalism, is planetary health [53].

We can also learn from many ancient indigenous cultures on our planet and, through them, gain a better understanding of what a "planetary healthy" society could entail today [54]. In traditional cultures, humans are viewed as a part of nature. Equality, reciprocity, and co-evolution are considered guiding principles in the evolution and development of a society. Animals and plants are sometimes considered relatives. For example, indigenous people and local communities play an important role in the management, conservation, and sustainable use of biodiversity and nature [55]. Many indigenous communities live in areas of high biodiversity, and living in harmony with nature is essential for their survival. These communities have strong ties to their territory and apply indigenous knowledge to protect, manage, and utilize the natural resources in these areas. It has been shown that the ecosystems and species in areas managed by indigenous peoples are often less threatened than in other areas. This is just one example in which we can learn from indigenous knowledge.

3. Workshops

Each workshop at the Congress pointed out a different discipline of Planetary Health or illuminated a specific relationship between planetary ecosystems, living organisms, and human health (Supplemental File S3). The workshops aimed to encourage interactive learning, facilitate interdisciplinary collaboration, and stimulate solution-oriented thinking. The diverse collection of topics matched a broad range of interests and offered something for everyone. The workshop 'The Future of Planetary Health Cities' focused on strengthening cooperation between Planetary Health initiatives and political leaders at the city level and identified what hurdles should be overcome to achieve narrow collaboration and secure a future for Planetary Health Cities (Figure 5). The Education Working Group shared the experience of implementing planetary health education at different education levels and created an environment in which participants could discuss ideas and inspire each other. The Movement Building Working Group held a workshop focused on (re)connecting actors in the developing field of Planetary Health to strengthen the movement and encourage joint action. At the same time, the Impact Through Synergy (ITS) workshop emphasized why connecting actors and cross-project collaboration is of paramount importance to, in this specific case, improve food-health-living environment science, innovation, and implementation projects. The workshop, Food and Microbes, clarified the hygiene hypothesis and explained the health risks of 'dysbiotic' microbiota due to our changing lifestyle and environment. Additionally, this workshop shed light on the correlation between dietary microbial intake and health outcomes. This raises the question of whether we should consume more live microbes. Participants who directly wanted to align their actions with their words joined 'The Wonderful World of Fermentation', where a leading fermentation expert illuminated the importance of microbes in our diet and dived into the wonderful world of fermentation. The workshops demonstrated that, as we are willing to incorporate the Planetary Health paradigm into, among other things, political decision-making, business strategies, education, and lifestyle, practicable solutions are available for the complex problems we encounter; solutions that contribute to restoring planetary balance and promoting the health of the planet and all life that lives on it.
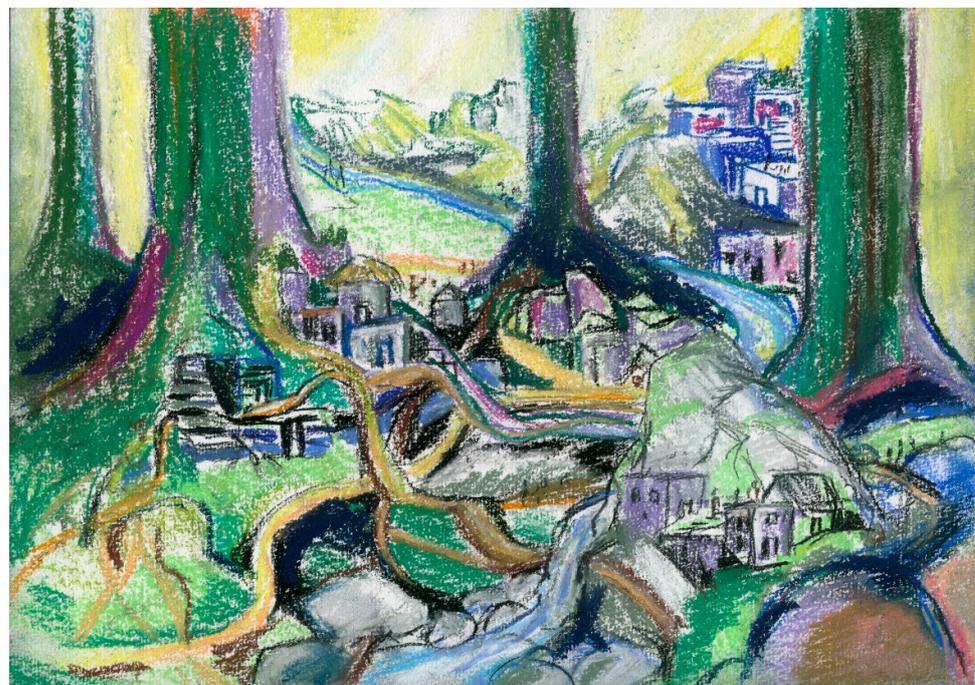
Figure 5. The artwork, 'The future of Planetary Health cities', sketched by the 'Beeldvormers' for the First European Planetary Health Congress.

3.1. The Future of Planetary Health Cities—The Role of Political Leadership

Ralf Klemens Stappen [1], **Josep M. Antó** [2], **Remco Kort** [3,4], **Tulsi Modi** [5], **Marju Prass** [6], **Alexandre Robert** [7] ([1] University Witten-Herdecke, Germany; [2] IS Global-Barcelona, Spain; [3] Vrije Universiteit Amsterdam, [4] ARTIS, Amsterdam, The Netherlands; [5] Planetary Health Alliance, USA; [6] Lahti University Campus and University of Helsinki, Finland; [7] Alliance Santé Planétaire, Paris, France).

The workshop was conceived as a starting point for the Cities Working Group of the Planetary Health Alliance, to work together with experts, mayors, administrators, physicians, and scientists to develop initial goals and images for Planetary Health Cities until 2050 (Supplemental File S4). The focus was on the challenge of strengthening political leadership capacities at the city level in Planetary Health, elaborate on different angles, and address the following key questions: does the Planetary Health paradigm communicate well with political leaders? Are the links between human health and the planet's health relevant to political discourse? What are the political hurdles to driving transformative challenges in PH (e.g., political costs of trade-offs)? How does the urgency scale in Planetary Health fit short-term political agendas? What are the risks of working closely with political leaders in the Planetary Health approach? Would the European Hub of the Planetary Health Alliance benefit from formal support and the advancement of a group of political leaders? What trends will cities face by 2050? What are the implications for health? How can cities be prepared for this purpose? How can the future UN framework (post-SDG phase) be designed to enable this?

The discussion was based on five presentations: The Future for Planetary Health Cities—The role of political leadership, Ralf Klemens Stappen, Witten/Herdecke University; Planetary Health Cities towards Climate Neutrality until 2050—The example of the City of Rome, Edoardo Zanchini from the City of Rome; Lahti's Step to Nature approach—Marju Prass, NatureStep Program, Lathti University Camus; The Symbiotic City—Marian Stuiver, Programme Leader Green Cities, Wageningen University; and Barcelona experience to green transition, Josep Antó IS Global, Barcelona.

During the workshop discussions, participants agreed that Planetary Health Cities will not only focus on climate change but also on biodiversity, new economies, and air pollution across all areas of life. The global importance of cities and municipalities for Planetary Health lies in the fact that over 70% of all Planetary Health interventions occur at this level. Cities require a transformational systemic approach for all determinants of health, well-being, and sustainability. The distinctive feature of the Planetary Health approach lies in strengthening the synergies of sustainability and health, especially via an integrated methodology, methods, and digital techniques that increase problem-solving capacity. During the workshop of this new working group in the European Hub, a first consensus was reached on ten principles as a first step towards an Amsterdam Charta for Planetary Health Cities 2024, outlined below (Box 1). The preliminary Amsterdam Charta for Planetary Health Cities was offered at the First European Planetary Health Congress to the Mayor of Amsterdam on 5 July 2023.

Box 1. Towards the Amsterdam Charta for Planetary Health Cities. Initial Draft of the Planetary Health Congress 2023, Amsterdam, 6 July 2023.

Principle 1—Towards Exceptional Planetary Health Solutions
In an extraordinary moment in human history, Planetary Health is dedicated to exceptional solutions with a focus of the interactions between the health of the planet and its people. We are responsible and committed to protecting and regenerating the health of our Earth and humanity locally, where everything is interconnected and has dignity—from oceans, ecosystems, microbes, insects, plants, animals, and humans to our whole living Earth, which is our common home.

Box 1. *Cont.*

Principle 2—Human Right to a Healthy Environment for All

We are convinced that healthy, happy living and well-being are imperative and possible for all people on Earth. The implementation of the human right to a safe, clean, healthy, and sustainable environment is an obligation for all cities and municipalities. Healthy urban environments must be achieved—cities should be built in symbiosis with nature, enabling ecological footprints and providing natural spaces accessible for all while caring for urban nature.

Principle 3—Transformations to Healthy Structures

Imagining a healthy future for the world—a future built on health and wellbeing for all, living with planetary boundaries—gives us hope. We are convinced that only a fundamental change in our civilization, consumption, and values towards true sustainability and health can secure our existence. Local governments have the responsibility to ensure the transformation of healthy structures (health, water, energy, food, housing, education, security, mobility, etc.) for us, the citizens.

Principle 4—Healthy Living for a Healthy Planet

How we eat, move, live, work, and spend our leisure time—all these aspects of life affect our health and have consequences for the health of the planet. We appeal to all governments, businesses, and relevant stakeholders to create the political, economic, and social conditions for healthy and sustainable behavioral patterns. Changes in behavior can also be profoundly inspired by us citizens and communities who, with their wise decisions and values, give hope on the way for a healthy Earth and uphold the rights of future generations.

Principle 5—Localization of the Paris Agreement

We are convinced that local governments, and we, citizens, are the driving force for healthy living on a healthy planet. All cities must become resilient to protect them from extreme weather events and changing environments, to reduce risks from climate change and biodiversity loss. The implementation of the Paris Agreement through the NDCs requires localizations for all cities for effective climate protection, adaptation, and the transformation of all energy sectors to Net-Zero, including the integration of public and planetary health needs.

Principle 6—Strong Political Leadership and Governance

We need strong political leadership, governance, and resources to enter into a process for Planetary Health Cities worldwide to anchor health and "all policies for planetary health" as a basic principle for urban and municipal development. We urge all leaders and executives of all levels to include the health of our Earth and humanity (Planetary Health) as a basic principle in all international legal regulations, agreements, and their governance, especially for the Post-Agenda 2030, and to secure the needed financial resources.

Principle 7—Planetary Health Partnerships and Cooperations

We are convinced that Planetary Health requires the involvement and cooperation of the entire local government and all sectors, whether in urban or rural communities. We will work together with citizens, universities, and research institutions, all networks, organizations, businesses, faith-based, indigenous and marginalized communities in transdisciplinary partnerships, to overcome the existential challenge of the 21st century.

Principle 8—Local Planetary Health Actions and Operations

We will use advanced tools and digital systems to transform the entire city towards sustainability and health, harmonize all planning and decision-making with planetary health imperatives, and prepare cities for extreme challenges (heat plans, etc.). For this, we will create knowledge, processes, and skills (Manuals) for the Planetary Health City and Municipality Framework (human, administrative, digital, strategic, and operational) for local administrations. Also, we will develop local Planetary Health Operations Plans, which build on and optimize existing frameworks such as urban development, climate protection, sustainability strategies, etc. The evidence-based enabling of Planetary Health Cities should be supported by world-class Planetary Health Standard processes (including new ISO Standards for Planetary Health).

Principle 9—Planetary Health Professionals and Operational Research

We are convinced that Planetary Health requires specific qualifications, skills, tools, instruments, and know-do competencies. For this, one Planetary Health Professional must be trained for every 10,000 inhabitants of the planet by 2050. Missing knowledge must be generated through transdisciplinary research to close know-do gaps to effectively implement the actions and operations.

Box 1. *Cont.*

Principle 10—The Urgency for Planetary Health Solutions
We are facing a great crisis where millions are already suffering daily—the urgency is now. We are aware that the implementation of the Charta will require extraordinary resources, finances, good governance, and effective legislation from the states. It must be ensured, in the sense of inter- and intragenerational justice, that all cities and citizens (including those in the south) receive all necessary support (financial, human, operational, etc.), and especially, fair compensation for losses and damages due to climate-related extreme weather. We hope that the responsible executives at all levels will be wise enough to ensure this.

The Way Forward to the Final Charta

This is the first draft of a European Charta. A broad consensus, clarification, and deepening for this initial draft, prepared, and adopted by the Planetary Health Congress 2023 in Amsterdam, are to be found until June 2024. In addition, the aim is to identify actions, new partnerships, and resources for implementation, especially how cities, states, foundations, donors, other world regions (Charta for other regions), and the Planetary Health Alliance can enable this worldwide. The new City and Municipality Working Group of the European Hub of the Planetary Health Alliance will take over the further coordination.

The results of the workshop were presented digitally to the parallel congress (auditorium) "One Sustainable Health for All" (Lyon, France). Parallel to the ARTIS conference, further principles were developed based on the current state of research and discussions in Amsterdam. Eleven new principles were added, so that the Charter 2024 will be based on 21 principles. Long-term implementation (until 2050) can only be realized with new partnerships and resources for implementation from states, foundations, the private sector, and donors. For global coordination, a Planetary Health City Working Group of the Planetary Health Alliance is planned for 2025.

3.2. Planetary Health Education Working Group

Jennifer Cole [1], Cristina O'Callaghan Gordo [2], Marju Prass [3] ([1] Royal Holloway, University of London, UK, [2] Barcelona Institute for Global Health, [3] Lahti University Campus and University of Helsinki, Finland)

The Education Working Group of the European Hub of the Planetary Heath Alliance [4] held a progress and future planning session on Friday, 7 July 2023, at ARTIS in Amsterdam during the 2023 Planetary Health Congress [6]. Approximately 40 members of the European Planetary Health Hub attended the session, representing all levels of education, from school and university to continued professional development. During the first half of the session, members gave presentations on the recent Postgraduate Planetary Health Meeting in Barcelona [56], the integration of art into planetary health [57], and their experiences in planning and developing planetary health education at different levels (high school, undergraduate, and postgraduate [58]). During the second half of the session, attendees engaged in two interactive exercises: mapping educational activities across Europe and listing topics that should be included in the planetary health curriculum.

The presentations generated lively discussions on planetary health education at different levels and across disciplines. Interactive exercises resulted in knowledge capture across several large whiteboard sheets. These discussions showed that a substantial body of planetary health educational materials and courses exists across Europe, various educational levels, and diverse disciplines. The strong heterogeneity of approaches is embedded in the awareness and application of the Planetary Health Educational Framework [59]. Some gaps in education provision, particularly at the pre-university level and in disciplines other than medicine and public health, were recorded and noted. Planetary Health education is gradually being disseminated beyond medical schools and public health, particularly in the arts and humanities, and is attracting students interested in environmental issues and the impact of climate change.

The presentations and interactive sessions raised some issues that had not been previously discussed within the European Hub, including the need for clear advice to pre-university educators on how to provide emotional support to schoolchildren who may be frightened and anxious due to climate emergencies. So far, the issue of what to teach has been considered within the Planetary Health field, but not necessarily how to teach it. This finding warrants further investigation. Considerations of curriculum content placed a strong emphasis on policy influence and complex adaptive systems (CAS) theory in planetary health, neither of which are typical components of medical and public health courses. The incorporation of additional topics into current institutional curricula may, in the short term, benefit from a pool of planetary health experts who can be made available to institutions as visiting lecturers to cover gaps, coordinated by the European Hub or the PHA more centrally. This aspect should be explored further in future studies.

In conclusion, Planetary Health education is growing across Europe, particularly at the higher education level. Interest at the school level is increasing, and there is an awareness that Continued Professional Development and training for policymakers and practitioners are also needed. The Education Working Group of the European Planetary Health Hub will address these issues going forward.

3.3. Movement Building Working Group

Jopke Janmaat [1,2], Juliette Mattijsen [2,3,4] ([1] CO$_2$-assistent, [2] Planetary Health Hub NL, [3] Dutch Green Health Alliance, [4] Act4Health-IFMSA, The Netherlands).

The European Hub of the Planetary Health Alliance aims to inspire, promote, and develop interactions and synergies among actors in the field of Planetary Health [4]. Consequently, the July 2023 Congress lunch workshop of the Movement Building Working Group focused on (re)connecting, community building, and moving to action. In this report, we share a summary of the session elements and the most important reflections, insights, and conclusions.

To foster planetary stewardship that connects and speaks to the heart, attendants were invited to have a conversation while listening actively, using a conversation exercise based on Active Hope [60]. To experience our interconnections with nature, participants were encouraged to walk and talk outdoors in ARTIS Park.

A plenary, interactive introduction to theory and learning from past and present movements was guided by questions, including: what makes people act for societal challenges? What is the difference between mobilization and a movement? What roles can be identified during the transition to Planetary Health? How to tell a story? Four lessons can be derived from the theoretical elements of the session. First, a sense of community is vital for a community to move towards a shared goal. This sense of community can be vitalized by cultivating a feeling of membership, influence, integration, fulfillment of needs, and a shared emotional connection [61]. Aiding elements can be celebrations of successes and lowering barriers to engagement. Second, different and diverse roles within a movement must be appreciated to build a community, even when a role may seem small at first glance. Third, the importance of learning from the history and role of civil society in social movements should not be underestimated. Fourth, knowing that stories can be powerful vehicles for change, the art of storytelling was touched upon. An example that was given is the Green Futures—University of Exeter's project 'We Still Have a Chance' [57].

To move from theory to practice, the session concluded with a brainstorm on the current and future movement. Several subsequent steps could be identified, both for individuals, organizations, and the European Planetary Health Hub, providing a basis for the continuation of conversations and collaborative actions. However, the brainstorm remained abstract.

During the discussion, the majority of participants felt that their activism was revived after the Active Hope conversations and a reflection on what activism means. Shared insights were that the first steps towards engagement coalesced with a feeling of being overwhelmed by the many challenges and ensuing tasks. The dialogue evolved around

the hope and meaning of communities and collaborations within the Planetary Health movement. Knowing that each actor does not stand alone means that we can focus on one of these many challenges. As a movement, the voices of the few can be strengthened, thus strengthening our actions. We conclude that building strong networks and further connections is crucial. The next steps also lie in engaging civil society, as underrepresentation of this group was observed during this academic Congress.

The social Planetary Health movement is growing. We invite everyone to collaborate to strengthen the movement and help it flourish. As one member of the Planetary Health Hub once stated, 'Where to start? Exactly where you are.'

3.4. Workshop Impact through Synergy

Wouter Spek, Michiel Roelse (NL-Top Sector Horticulture, The Netherlands)

The purpose of this first Impact through Synergy (ITS[©]) workshop was for the Top Sectors Horticulture, Life Science & Health, and Agri & Food to bring together major EU-funded projects related to Food, Health, and Living Environment (FHLE) for research and innovation purposes, to identify obstacles, and develop potential solutions (Supplemental File S5). In addition, the workshop aimed to identify cross-project collaboration opportunities and propose actions to improve FHLE science, innovation, and implementation. It is evident that it is timely to address the issue of synergy and convergence in the FHLE continuum to tackle the socio-economic challenges that we face today. In the first step, participants identified several action lines to be further developed and deployed in 2023, involving compiling factsheets and designing a fundraising and communication strategy.

ITS Workshop Conclusions

The Continuum of the Food, Health, and Living Environment (FHLE)

The workshop recognized the inherent interconnections between food, health, and the living environment. It acknowledges that the health of the environmental ecosystem directly affects human health and that unsustainable human activities have detrimental consequences.

Human Health Impacts

The workshop highlighted the profound health impacts of environmental degradation and climate change. It identifies a range of health concerns, including the increased incidence of infectious diseases, respiratory disorders, mental health issues, malnutrition, and displacement due to natural disasters.

Socioeconomic Status (SES)

The workshop highlighted the linkages between food systems, socioeconomic factors, and health outcomes. It acknowledges that disparities in access to healthy and affordable food as well as inequities in living environments contribute to health inequalities among different populations. This underscores the need for inclusive, equitable solutions.

Ecological Sustainability

The workshop emphasizes the need for the transition to more sustainable and regenerative agricultural practices. It recognizes the importance of preserving biodiversity, improving soil health, conserving water resources, and reducing greenhouse gas emissions to ensure long-term ecological sustainability.

Food Systems Impact

The workshop acknowledged that current food systems, including agricultural practices, food production, distribution, and waste management, have significant environmental impacts. These impacts contribute to climate change, biodiversity loss, soil degradation, water pollution, and other environmental challenges.

3.5. Food and Microbes

3.5.1. Recommended Daily Allowance for Microbes

Colin Hill (APC Microbiome Ireland and School of Microbiology, University College Cork, Ireland).

Humans have consumed large numbers of live microbes in their diets throughout evolutionary history. Until now! In recent decades, better hygiene and increased food processing have led to a decline in microbial exposure, particularly in the gut. This coincides with an increase in chronic gut-related diseases such as IBS, IBD, and diabetes; the lack of exposure to microbes in the diet can be linked to these health issues [62]. We can confidently expect that our immune systems, particularly the gut immune system, evolved to 'expect' daily exposure to large numbers of microbes. It is not surprising that a highly sophisticated immune system with a vast array of receptors designed to recognize microbial molecules is located in the gastrointestinal tract, and that our gastrointestinal immune system plays an important role in eliminating beneficial or harmless food microbes from pathogens targeted for destruction. At some point in evolution, we also discovered the benefits of drying, salting, sugaring, and pickling foods, while in more recent times, the development of effective food processing tools such as pasteurization, canning, refrigeration, freezing, aseptic packaging, food preservatives, water treatment, and washing fruits and vegetables before consumption has inevitably reduced our exposure to microbes. Of course, these more recent advances have happened in much too short a timeframe for our immune systems to evolve and adapt to this significant reduction in microbial intake.

It must be acknowledged and stressed that these food and water processing strategies have certainly reduced the morbidity and mortality associated with food- and water-borne infections, and thus play a vital role in protecting human health. I am not advocating for a return to unhygienic food and water practices, since this would be devastating to human health, particularly in a modern world where many people with compromised immune systems live long and productive lives. We do not want to return to an age where infectious disease claimed so many lives, and only the 'fittest' or 'fortunate' survived into adulthood. However, it is possible that these advances in food processing have come at a price in terms of losing daily contact with dietary microbes.

We have conducted some of the first studies to define the number of microbes in a typical Western (US) diet, with some interesting outcomes [63]. Over 9000 foods listed in the US National Health and Nutrition Examination Survey (NHANES) were assigned to one of three categories in terms of their microbial loads: high, medium, and low. It is striking that only 20% of US adults (covering almost 50,000 individuals during the period we investigated) regularly eat foods in the high-microbe category. We sought to determine whether there was an association between dietary microbial intake and health outcomes. Statistical analysis confirmed a correlation between the number of microbes consumed and various health indices [64]. These effect sizes are small but may be important at the population level.

While there are many confounders (such as whether the consumption of fermented foods is a proxy for lifestyle, wealth, and more diverse diets), there is sufficient evidence to warrant further investigation. Will future dietary guidelines include recommendations to consume more live microbes in the form of fermented foods, fruit, and uncooked vegetables?

3.5.2. Microbes and the Old Friends Hypothesis

Bruno Pot [1,2] ([1] Yakult Europe BV; Shutsluisweg 1, 1332 EN Almere, Netherlands, [2] Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium).

In 2001, the "hygiene hypothesis" was put forward again by J-F Bach [64], stating that contact with pathogens at an early life stage was necessary to fully mature our immune system. This hypothesis was revisited [65,66], acknowledging the importance of *commensal* microbiota in training the immune system of newborns. Today, more insight has been gained into the importance of a diverse gut microbiota in maintaining health, offering a higher degree of resilience against possible insults, and preventing different types of diseases.

Microbiota insults, leading to a disturbed or 'dysbiotic' microbiota, can be manyfold and have been linked to lifestyle factors, such as diet, stress, age, traveling, smoking,

or medical interventions such as treatment with antibiotics, chemotherapeutics, proton pump inhibitors, or other drugs. A 'dysbiotic' microbiota is increasingly linked to specific health-risk conditions such as obesity, diabetes, allergies, autoimmune diseases, as well as different types of neural disorders such as anxiety, autism spectrum disorder, Parkinson's disease, and Alzheimer's disease. Currently however, the crucial cause or consequence question often remains unsolved. Correlation does not necessarily indicate causation in many diseases, and more in-depth research is needed to solve these links. Often, because of the huge variation in individual microbiota compositions, a 'healthy' microbiota is almost impossible to define, making this type of research challenging.

In 2014, Erica and Justin Sonnenburg published a paper titled "Starving our Microbial Self: The Deleterious Consequences of a Diet Deficient in Microbiota-Accessible Carbohydrates" [67], in which they hypothesized that during human evolution, we lost a large part of the microbial diversity in the gut, mostly linked to changes in the diet (change from hunter-gatherer to agriculture, industrial revolution, mass food production, food processing, antibiotic use, etc.), leading to a reduced intake of fermentable carbohydrates as well as live microorganisms. In the meantime, several studies, albeit rather small, have shown that diet is indeed able to positively impact diversity and related immune factors. To investigate the hypothesis put forward by Erica and Justin Sonnenburg, the same research group showed that increased intake of fermented foods during a period of six weeks had the potential to increase the diversity of the gut microbiota as well as change multiple immune parameters, shifting the immune system towards a more tolerant phenotype [68]. However, increased intake of fermentable carbohydrates did not have the same significant effects. These and many other fascinating studies have shown that diet can impact the quality of our microbiota and, therefore, maintain many aspects of health.

3.5.3. The Wonderful World of Fermentation

Christian Weij (ProefTuin Ede, Ede, The Netherlands).

At the 'Food and Microbes' workshop, Christian Weij, a leading expert in the field of fermentation, gave an in-depth presentation on the importance of microbes in the history of our diet. The lecture emphasized the interplay of science, culture, and culinary art that comes together in the wonderful world of fermentation. Weij started his lecture by taking the audience on a journey through time, during which our ancestors discovered and perfected the techniques of fermentation. Without the aid of modern scientific tools or even a basic understanding of microorganisms, our ancestors took the first step toward what is now a global culinary tradition. They discovered that fermentation not only preserved food, increasing their chances of survival in difficult times but also enriched the flavors and textures of their food.

The benefits of fermentation have been acknowledged since ancient times. While our ancestors were ignorant of the biological and chemical processes occurring in their food, they recognized their benefits. They were aware that fermented foods had a longer shelf life and were often safer to eat. However, they did not know that the compounds produced by beneficial bacteria were active in suppressing harmful pathogens. They understood that the fermentation process also produced deep, umami-rich flavors, making their dishes more complex and satisfying. During the lecture, participants were treated with a range of fermented delicacies, showcasing the diversity and richness of fermented foods worldwide. Detailed information was provided for each item, from origin and history to the specific microbes responsible for the transformation. By tasting the products, participants immediately experienced the power of fermentation, which had a profound influence on our culinary world.

Another important aspect emphasized by Weij was the accessibility of fermentation to the public. Although some techniques may seem intimidating, he argued that the basics of fermentation are simple and can be easily learned by anyone interested. It is not only a way to preserve food but also a way to stimulate creativity and innovation in the kitchen. To conclude his lecture, Weij emphasized the importance of knowledge transfer and education.

He pointed to his book as a comprehensive resource for those interested in exploring the world of fermentation further [29]. This work serves as a bridge between traditional knowledge and modern science, allowing readers to understand both the 'how' and 'why' of fermentation.

4. Other Contributions to the Congress

In addition to the above-mentioned program of lectures and workshops, other initiatives of paramount importance for the development of the Planetary Health field were pointed out. The Summary of the KNAW Advisory Report, 'Planetary Health: An emerging field to be developed' showed that science can play a pivotal role in tackling societal challenges. During the European Hub of the Planetary Health Alliance meeting, participants could discuss, inspire, and share ideas. A practical example illustrated the importance of strengthening the Planetary Health network. To bring the congress to a close, participants were taken on a musical journey to discover the importance of restoring contact with microbes and nature as a whole, within and outside our bodies. The spread of Planetary Health knowledge and experiences must not be bound to congress and should be available to everyone. Therefore, the first Planetary Health Festival open to the public was held during the summer of 2023. The event contributed to raising awareness among the public about the interdependence, vulnerability, and responsibility of our planet and all life on it.

4.1. Summary of the KNAW Advisory Report: 'Planetary Health: An Emerging Field to Be Developed'

Pim Martens (Maastricht University, Maastricht, The Netherlands)

As everyone realizes today, the conditions for life on Earth are profoundly changing. The climate crisis is causing frequent forest fires, heat waves, floods, and extreme droughts. Biodiversity is rapidly declining, environmental pollution has reached every corner of the Earth, nitrogen is accumulating in nature, deforestation and erosion continue at an alarming rate, and freshwater sources are drying up. The Royal Netherlands Academy of Arts and Sciences (KNAW) believes that science can play an indispensable role in tackling societal challenges of this kind by establishing and analyzing facts and finding solutions. This belief prompted the Academy to set up a Planetary Health Committee. The Committee's remit was to explore this field, which is twofold: (1) to survey the situation: what is the current state of scientific knowledge regarding Planetary Health, what is already happening in the Netherlands and elsewhere in this field, and what knowledge gaps are apparent? and (2) to draw up an ambitious agenda for knowledge development in the Netherlands in the field of Planetary Health: what opportunities are there for this field of science, both in terms of scientific content and with regard to facilities and cooperation (national and international), and how should these be prioritized? For practical reasons, the committee has focused mainly on human health, which has thus far been the subject of most research (after much discussion).

The link between human and Planetary Health

The scientific literature clearly shows that global environmental change, in addition to other detrimental effects, has potentially negative effects on human health. Current trends in the global environment point to the possibility of long-term disastrous effects on human health worldwide. Global environmental changes, for which negative effects on human health are likely, include climate change, biodiversity loss, global pollution of air, water, and soils, altered nitrogen and phosphorous cycles, changes in land use and land cover, and depletion of freshwater and arable land. Although we lack quantitative estimates of the future impacts of global environmental changes on human health (with the exception of climate change), the risks certainly appear to be considerable. Some of these pathways are partially known, with food production, consumption, and infection playing a crucial role in the human health effects of several environmental changes.

The development of the Dutch Research Agenda for Planetary Health

First, we compiled a long list of research priorities by combining four existing reports in the Planetary Health field [7]. Second, we reviewed the draft longlist. Experts were asked to review parts of the longlist (depending on their expertise) and suggest improvements by adding missing research questions, rephrasing or removing research questions, or restructuring the list. Third, we set priorities for the Dutch research agenda on Planetary Health. We invited a selection of experts to contribute to in-depth discussions in a specific sub-area. Six thematic groups were established: (1) climate change and health, (2) biodiversity and health, (3) food production and consumption, (4) infectious diseases, (5) health care and public health, and (6) behavioral change and governance. These experts were asked to rate longlist items on two criteria: (1) relevance for policy, that is, the degree to which research into the knowledge gap is necessary before effective policies can be pursued, and (2) the time necessary to conduct research and obtain actionable results. They were also asked to rate the capacity of the Dutch research community to address the knowledge gap in terms of expertise and available technology. This expert consultation was conducted in a 'semi-Delphi' setup, in which experts first completed a written questionnaire individually and then participated in a group session in which they discussed summaries of the scores and their variation and were given the opportunity to adapt their scores in light of arguments put forward by peers. Fourth, we developed a list of conclusions and recommendations using interviews with several experts in the field. The topics addressed during the interviews were opportunities for international collaboration and funding, options for the organization of interdisciplinary collaboration, ways to encourage researchers to include Planetary Health topics in their studies, and funding options and funding needs to carry out the research agenda. Further input was sought by organizing a Planetary Health Conference in Amsterdam on 7 November 2022. This meeting was attended by 56 invited participants.

Our literature review clearly shows that climate change and other global environmental changes pose serious threats to human health. In line with the relatively well-developed evidence regarding the long-term effects of climate change, an overwhelming majority of the experts we consulted rated these effects as 'potentially disastrous for human health' worldwide in the year 2100 in the absence of effective countermeasures. Most experts also rated the potential future impact on human health due to other global environmental changes, such as freshwater scarcity, biodiversity loss, and global air, water, and soil pollution; however, many indicated that it was difficult to rank these because of the interconnectedness of all environmental changes.

4.2. The Planetary Health European Hub: An Expanding and Diversifying Network

Martine Veenman (Maastricht University, Maastricht, The Netherlands)

The secretariat for the European Planetary Health Hub was established in the Netherlands at the beginning of 2023 as one of the outcomes of the first Planetary Health Alliance European Hub Convening [4]. As a community of practice [69], the Hub's secretariat facilitated the collaboration of European professionals in the field of Planetary Health. From June onwards, a monthly online meeting takes place, communicated via the Hub's LinkedIn profile [5]. This meeting is open to everyone interested in the Hub's activities. During the ARTIS Planetary Health Congress in July 2023 at ARTIS in Amsterdam, the Netherlands, the Hub was represented by Juliette Mattijsen and Martine Veenman (operational coordinators within the Hub's secretariat). After the congress program, an informal Hub event took place at ARTIS, aiming to strengthen the network within the Hub and thus, strengthen the community. The second aim was to welcome new members to diversify the Hub concerning both professions and nationalities. During the event, the need for this diversification of the Hub became clear. However, most professionals from (public) healthcare were represented. Creative and spiritual professions have not yet been involved. The arts, as well as our human spiritual connection to the natural world around us, are of vital importance for a healthy and sustainable future. Moreover, the encouragement of open-mindedness and normalizing creative and more emotion-centered approaches

appear to play an important role [70]. The third aim of this informal event was to explore network expansion opportunities as a Hub. Thanks to the active involvement of attending members, a mapping overview of Planetary Health initiatives throughout Europe was created. The Hub's secretariat will explore these potential synergies in the second part of 2023. In October 2023, an online Hub meeting will take place, in which the four Working Groups share updates and learn from each other's best practices. In November, another in-person Hub event will take place at Utrecht, the Netherlands, immediately before the start of the European Congress on Global Health (ECTMIH).

4.3. Public Planetary Health Festival

Tomás van Gorp, Evanne Nowak (ARTIS, Amsterdam, The Netherlands).

In the summer of 2023, ARTIS marked a significant milestone by hosting its inaugural Planetary Health Festival, which is expected to return annually. This event transformed ARTIS Park, including its museums, into a platform for exploring the interdependence, vulnerability, and shared responsibility of all life on Earth. Engaging speakers presented Planetary Health-related topics in an interactive format, reaching out to both returning and first-time ARTIS visitors.

The Planetary Health Experience Walk provided visitors with a unique, sensory journey through ARTIS Park, offering fresh perspectives on our collective role in promoting a healthier planet. Over the course of more than two months, forward-thinking experts shared their insights, shedding light on practical steps towards a more sustainable future. Guided walks, led by members of the ARTIS Animal Collection, Nature Conservation Team, and ARTIS Gardeners, provided immersive experiences. These experiences prompted visitors to reflect on various aspects, including what humans can learn from the dietary habits of herbivores, the crucial need for clean rivers, responsible citizenship, recent advancements in nature conservation at ARTIS, the vital role of healthy soil, the significance of amplifying youth voices in climate conversation, and the importance of granting rights to the natural world.

ARTIS serves as a conduit for translating scientific knowledge into accessible understanding, extending an open invitation to individuals of all ages to uncover the profound interconnection between our own well-being and that of our cherished planet Earth.

4.4. Symbiosis

Remco Kort [1], Maya Fridman [2], Milo Grootjen [1], Wim van Egmond [3], and Gustavo Trujillo Delgado [2] ([1] ARTIS, 1018CZ Amsterdam, The Netherlands; [2] Conservatorium van Amsterdam/Amsterdam University of the Arts, 1011 DL Amsterdam, The Netherlands, [3] Wim van Egmond Microphotography, 2627 AB Delft, The Netherlands).

In this one-hour musical and visual performance in the dome of the ARTIS-Planetarium, it becomes clear that all macroscopic life forms, including humans, have evolved in a world of microbes. The most fascinating dependencies have developed over millions of years of coexistence. Plants, animals, and humans cannot exist without microbes. For over 100,000 years, mankind has lived as hunter-gatherers—a lifestyle that, in terms of microbial exposure, is in strong contrast to that of modern man in today's industrialized society [71]. As a result of the decline in contact with nature, intake of processed foods, and overuse of antibiotics, many microbes in our bodies have disappeared, resulting in increased risks of adverse immune and metabolic health outcomes [66,72]. How do we restore this contact, how do we maintain microbial biodiversity outside and within our bodies, and how do we undergo a transformation to become one with nature again—a most urgent appeal (Supplemental File S6).

5. Conclusions

Rooted in a science of interdependence and connectedness, Planetary Health emphasizes the importance of fostering connections in all aspects of our lives, starting with the connection with one another. The First European Planetary Health Congress at ARTIS in

Amsterdam not only laid the foundation for an effective transdisciplinary network necessary to address the multifaceted challenges of Planetary Health but is also uniquely suited to build on existing connections. This initiative provides a European platform for contributing to local, regional, national, and global transformations that promote sustainable, just, and equitable societies, while respecting the limits of our ecosystems. In anticipation of future collaboration and growth, we anticipate the inclusion of new members and our collective efforts to pave the way for a hopeful future for generations to come.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/challe14040049/s1, Supplemental File S1: Program of the First European Planetary Health Congress; Supplemental File S2: Speakers of the First European Planetary Health Congress; Supplemental File S3: Overview of the lunch workshops at the First European Planetary Health Congress; Supplemental File S4: Workshop on the future of Planetary Health cities; Supplemental File S5: Schematic overview of the EU-funded projects related to Food, Health, and Living Environment (FHLE) relevant for the Impact through Synergy Workshop; Supplemental File S6: The musical and visual performance: 'Symbiosis'.

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