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One Health and global security into the future

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Global health, broadly, is an organising framework through which the effects of identity, social position, policies, institutional practices and geography of multiple populations of people intersect with the health of animals and our changing environments. This framework, best reflected in the Manhattan Principles, was developed in 2004 at the Wildlife Conservation Society's meeting on 'One World, One Health: building interdisciplinary bridges to health in a globalized world' (Cook, Karesh and Osofsky 2004). The 12 principles (Box 2.1) recognise that human, animal, and environmental health are not mutually exclusive. Each is shaped by the relationships between them.

The principles recognise that decision-making processes are integral to maintaining the integrity of biodiversity, food supplies and economies and acknowledge the impact of decisions on relationships between ecosystem resilience and patterns of disease emergence and spread. The principles also embed global disease prevention, surveillance, monitoring, control and mitigation in biodiversity conservation work and call for holistic, integrative and ethical approaches to minimise social inequity. They acknowledge the overlapping agendas linking human, environmental and animal health, and call on the global community to unite on global security. Since 2004, EcoHealth and One Health scientists and advocates have been

lobbying investors and collaborators to address emerging threats to human health, food security, animal populations and environments.

The challenges for this century are multi-factorial and traverse human, animal and environmental health imperatives, driven by rapid social, cultural and ecological change. We need to understand the impact of these factors as well as the need to enhance global human and animal health surveillance with clear, timely information sharing, taking language barriers into account. Improved coordination of responses among government and non-government agencies, public and private sectors, local and Indigenous people, animal health institutions, vaccine/pharmaceutical manufacturers, and other stakeholders are prerequisites. In addition to co-ordination, deep understanding of the principles of complexity and diversity is required if programs are to be effective. The development of early warning systems, appropriate engagement, and knowledge translation and dissemination strategies are all required core competencies.

Many groups and organisations (see Table 2.1) have embraced the continuity of human, animal and environmental health as a reality for 21st-century thinking and action, and employ practical and theoretical resources to tackle challenges to global security. The principal difference between these groups is the primacy given to either the environment, human beings, animals or the earth system that binds them together.

This chapter describes these different groups: their origins, distinctiveness and how their overlapping agendas intersect. Their distinction is as important as their convergence – each group has an explicit way of articulating thought, speech, aesthetic appreciation, judgements and approaches for addressing current threats and creating future opportunities for global security. Looking into the future, however, is as much about understanding our historical capacity for living in natural systems as it is about future megatrends, including digital immersion. In this chapter, we explore how these groups can collaborate as a rallying point for inter-sectoral reform and future collaborations for the next generation of researchers, policy makers, educators and practitioners.

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Acronym	Full title of organisation
ACCAHZ	ASEAN Coordinating Centre for Animal Health and Zoonoses
CDC	Centers for Disease Control and Prevention
EC	European Council
FAO	Food and Agriculture Organization
IAEH	International Association for Ecology and Health
IDRC	International Development Research Centre of Canada
IMCAPI	International Ministerial Conference on Avian Pandemic Influenza
OHC	One Health Commission
OHCEA	One Health Central and Eastern Africa
OHI	One Health Initiative
OHP	One Health Platform
OIE	Office International des Epizooties (World Organization for Animal Health)
PHA	Planetary Health Alliance
PMSEIC	Australian Prime Minister's Science, Engineering and Innovation Council
UNICEF	United Nations International Children's Emergency Fund
UNSC	United Nations System Influenza Coordination
USAID	United States Agency of International Development
WB	World Bank
WHO	World Health Organization

Table 2.1: Organisations and their acronyms.

The One Health world

At the start of the 21st century, One Health experienced a revival with the spread of zoonotic diseases, in particular the 2003 SARS pandemic and the spread of highly pathogenic avian influenza (HPAI) H5N1 outbreaks (Mackenzie, McKinnon and Jeggo 2014). The Manhattan

Principles were devised around this time (Cook, Karesh and Osofsky 2004), leading to One Medicine and One World continuing under the banner One Health (Zinstag et al. 2005). The movement grew internationally under a tripartite agreement between the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the World Organization for Animal Health (OIE) in 2010 (WHO 2010). Commitment to a One Health approach in managing zoonotic diseases is evident worldwide with the creation of specific One Health entities both nationally and regionally (Mackenzie et al. 2013; Mackenzie, McKinnon and Jeggo 2014). Many countries now recognise the importance of a One Health approach to combat the rise of antimicrobial resistance (AMR), and ensure food safety.

A number of seminal activities over the past decade have shaped One Health, none more so than the publication of the Manhattan Principles, which has enhanced the uptake of One Health and EcoHealth thinking internationally. Concern about the potential risks to human and animal health of emerging zoonotic diseases and especially the possibility of an influenza pandemic, has also been a critical factor. These concerns underpin the development of national and regional One Health centres now established in many countries. The strategies to translate One Health concepts into practice originate from two meetings in 2009 – the first, ‘One World, One Health: from ideas to action’ (Public Health Agency of Canada 2009), was organised by the Public Health Agency of Canada, and the second, ‘Operationalizing “One Health”: a policy perspective – taking stock and shaping an implementation roadmap’ (CDC 2010), was organised by the Centers for Disease Control and Prevention (CDC). A number of One Health groups associated with promotion, governance and information activities provide the mechanisms for unifying the One Health community, including sharing concepts and activities and giving support through co-ordinating roles such as that provided by the One Health Commission (OHC) in the US, the One Health Initiative (OHI), and the One Health Platform (OHP). Finally, and most relevant for sustainability, the inclusion of One Health concepts into medical and veterinary education is essential for breaking down silos and ensuring that knowledge of One Health is explicit in the education of the next generation of veterinarians, clinicians, and relevant biological disciplines.

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Box 2.1: The Manhattan Principles

1. Recognizing the link between human, domestic animal, and wildlife health, and the threat disease poses to people, their food supplies and economies, and the biodiversity essential to maintaining the healthy environments and functioning ecosystems we all require.
2. Recognizing that decisions regarding land and water use have real implications for health. Alterations in the resilience of ecosystems and shifts in patterns of disease emergence and spread manifest themselves when we fail to recognize this relationship.
3. Including wildlife health science as an essential component of global disease prevention, surveillance, monitoring, control, and mitigation.
4. Recognizing that human health programs can greatly contribute to conservation efforts.
5. Devising adaptive, holistic, and forward-looking approaches to the prevention, surveillance, monitoring, control, and mitigation of emerging and resurging diseases that fully account for the complex interconnections among species.
6. Seeking opportunities to fully integrate biodiversity conservation perspectives and human needs (including those related to domestic animal health) when developing solutions to infectious disease threats.
7. Reducing demand for and better regulating the international live wildlife and bush meat trade, not only to protect wildlife populations but to lessen the risks of disease movement, cross-species transmission, and the development of novel pathogen–host relationships. The costs of this worldwide trade in terms of impacts on public health, agriculture, and conservation are enormous, and the global community must address this trade as the real threat it is to global socio-economic security.
8. Restricting the mass culling of free-ranging wildlife species for disease control to situations where there is a multidisciplinary, international scientific consensus that a wildlife population poses an urgent, significant threat to human health, food security, or wildlife health more broadly.
9. Increasing investment in the global human and animal health infrastructure commensurate with the serious nature of emerging and resurging disease threats to people, domestic animals and wildlife. Enhanced capacity for global human and animal health surveillance and for clear, timely information sharing (that takes language barriers into account) can only help improve

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coordination of responses among governmental and non-governmental agencies, public and animal health institutions, vaccine/pharmaceutical manufacturers, and other stakeholders.

10. Forming collaborative relationships among governments, local people, and the private and public (i.e. non-profit) sectors to meet the challenges of global health and biodiversity conservation.

11. Providing adequate resources and support for global wildlife health surveillance networks that exchange disease information with the public health and agricultural animal health communities as part of early warning systems for the emergence and resurgence of disease threats.

12. Investing in educating and raising awareness among the world's people and in influencing the policy process to increase recognition that we must better understand the relationships between health and ecosystem integrity to succeed in improving prospects for a healthier planet.

Cook, Karesh and Osofsky (2004b)

Emerging diseases as a driver of One Health

Among global health security issues, the emergence and spread of epidemic-prone infectious diseases (EIDs) is a major international concern and plays a pivotal role in the development of One Health – not least because of the significant economic impact of outbreaks (Forum on Microbial Threats 2015; Institute of Medicine (US) Committee on Emerging Microbial Threats to Health in the 21st Century 2003). The term 'EIDs' has become synonymous with previously unknown infectious diseases, such as the Nipah virus in Malaysia in 1999 (Field et al. 2001) and SARS, which appeared suddenly in South Asia in 2003 (Forum on Microbial Threats 2004), and with known infections that are either increasing in incidence and geographic spread as exemplified by dengue and West Nile viruses (Mackenzie, Gubler and Petersen 2004), or expanding their host range as demonstrated by H5N1 avian influenza (Beato and Capau 2011). Evidence indicates increased risks from EIDs to humans, to animals and to the environment. Such diseases require national and international approaches for effective management.

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Factors contributing to disease emergence include travel and the movement of people (particularly by air), international trade in live animals and fresh animal products, changes in land use and agricultural production, developments in technology capable of detecting new diseases, and the spread of exotic vectors to colonise new habitats thereby making new areas receptive to the spread of infections. The greatest challenge for the 21st century may well be climate change, which will have as yet uncharacterised effects on disease patterns and emergence, through its impact on the ecology of hosts, vectors and pathogens (Lafferty and Mordecai 2016; McMichael 2015) as well as the need to provide food and safe water to an ever-increasing world population.

In an effort to define EID threats to Australia, an expert working group of the Australian Prime Minister's Science, Engineering and Innovation Council (PMSEIC) was formed in 2009 to advise about epidemics. Their 2009 report concluded that 'it is a matter of when, not if, a lethally catastrophic epidemic will happen' and recommended 'the Government establish cross-portfolio arrangements essential for effective implementation ... as a matter of immediate priority' (PMSEIC 2009).

The role of One Health in managing risks from infectious diseases is now widely accepted in the United States, the European Community, and by the World Bank and WHO (Direction Générale de la Mondialisation, du Développement et des Partenariats 2011; Institute of Medicine 2012; World Bank 2010; WHO 2014). All agree that effective global surveillance is an essential ingredient for detecting EIDs, and is best achieved by a global alliance of networks established by the WHO, FAO and the OIE – such networks provide early detection of, and enable early response to, EIDs (Vallat 2009; WHO 2010). Notwithstanding these collaborative efforts, major gaps still exist in the surveillance of wildlife diseases where surveillance, if it exists, is devoid of depth or detail, with most outbreaks recognised by occasional widespread deaths among particular species.

The One Health approach was accelerated by the global threat of an avian influenza pandemic caused by pathogenic influenza A virus H5N1 (HPAI H5N1) and the risks such a pandemic would pose to human health. The United Nations, in collaboration with the FAO, OIE, WHO, United Nations System Influenza Coordination (UNSIC),

United Nations International Children's Emergency Fund (UNICEF), the World Bank and other international and national agencies, instigated a series of International Ministerial Conferences on Avian and Pandemic Influenza (IMCAPI) to discuss the spread, transmission and possible containment of HPAI H5N1. While these conferences were directed primarily at HPAI H5N1, by 2008 it was clear that the intention was to extend to the wider context of EIDs as evidenced by the IMCAPI held in Sharm el-Sheikh, Egypt, in October 2008, where the 'Strategic framework for reducing risks of infectious diseases at the animal–human–ecosystems interface' was developed (IMCAPI 2010). The framework documented the necessity of a holistic One Health approach in response to HPAI H5N1 and other zoonotic disease emergencies to manage risks and minimise the global impact of epidemics and pandemics. A spirit of collaboration developed in the international community, resulting in part from IMCAPI and the cross-sectoral leadership shown by the WHO, FAO and OIE when they published their tripartite concept note 'Sharing responsibilities and coordinating global activities to address health risks at the animal–human–ecosystems interfaces', which aligned strategies and streamlined resources (WHO 2010). The 2010 IMCAPI in Hanoi, shortly after the publication of the concept note, concluded with the Hanoi Declaration, which proposed a multi-sector array of national measures to detect new diseases that might cross from animals to humans. Agreement was also reached to promote international surveillance, diagnosis and rapid response – noting that country strategies should be aligned nationally and regionally (IMCAPI 2010).

One Health: food safety and antimicrobial resistance

The risks from food contaminated with pathogenic microorganisms are well established. Early One Health approaches managed risks after the product had left the farm (post-farm gate), applying detection processes for infectious agents and chemical contamination linked to food production processes. However, the increasing impact of food-borne pathogens such as *Escherichia coli*, *Salmonella spp.*, and *Clostridium difficile*, along with the risks associated with bovine

spongiform encephalopathy (mad cow disease), have led to a number of whole-of-food-production-chain approaches. Appreciating the risks of these food-borne pathogens to humans and the need to manage them in animals (or plants) has necessitated a One Health approach (Lammie and Hughes 2016; Silva, Calva and Maloy 2014).

Mitigating risks for humans, animals and environments has not been without controversy, particularly in the use of antibiotics and the subsequent increase in AMR. The One Health approach has polarised rather than unified debate between human and animal health experts as to the underlying cause(s) of the growing microbial resistance that has persisted over many years. Influenced by the significant value of antibiotics as growth promoters in intensive livestock production systems, it was some time before the underlying issues were recognised and addressed, establishing a clear nexus between AMR, food safety, and agriculture (Review on Antimicrobial Resistance 2015). Had the One Health framework been used earlier, the nexus might have been identified through systems of political and scientific decision-making underpinned by a collectivist approach to disease emergence.

National and international activities promoting the One Health paradigm

National and international organisations proactively support One Health approaches to pandemic and emerging zoonotic disease threats. A number of initiatives have been supported by the World Bank, particularly in the avian and human influenza arena through its report *People, pathogens, and our planet* (World Bank 2010). The European Community supports One Health in the Asian area, through the European External Action Service's Asia and Pacific Department (European Union 2016). In addition, regional groups operate across Africa and Asia, such as the Southern African Centre for Infectious Disease Surveillance's One Health Virtual Centre Model (Rweyemamu et al. 2013), the One Health Central and East Africa network (OHCEA 2016), the One Health Network South Asia, and the recently announced ASEAN Coordinating Centre for Animal Health and Zoonoses (ACCAHZ) (Association of South East Asian Nations 2016).

The One Health Network South Asia, initiated by Massey University, comprises a network of hubs in different South Asian countries; each hub is a national network led by a government institution and together they form the 'Hubnet' with all hubs connected by a secure online platform (One Health Network South Asia 2014). In 2018 most nations are developing or have already developed their own action plans and coordinated approaches instigated by public health and veterinarian groups, governments or universities. In the Asia–Pacific region, a wide range of national activities, networks and national organisations operate with particular emphasis on the importance of the animal–human interface, and of the need for a strong cross-sectorial response (Coghlan and Hall 2013; Gongal 2013).

One Health organisations concerned with governance, information and educational activities

The following organisations promote and coordinate One Health activities:

One Health Commission

The OHC is a global organisation dedicated to promoting the improved health of people, domestic animals, wildlife, plants and the environment (OHC 2016). The organisation was chartered in Washington DC in 2009 as a not-for-profit entity with eight founding institutional members and is headquartered in the Research Triangle Park region of central North Carolina. Its primary aim is to inform audiences about the need to transcend institutional and disciplinary boundaries, and transform the way that human, animal, plant and ecosystem health professionals, and their related disciplines, work together to improve the health of all living things and the environment. The OHC seeks to connect One Health advocates, to create networks and teams that work together across disciplines, and to educate about One Health and One Health issues. Its charter informs professionals and students from all disciplines, the lay public, policy- and law-makers, healthcare providers from human and animal domains, and

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those in the agricultural and food production sectors, about the One Health approach. It aims to train and prepare the next generation of One Health leaders and professionals.

One Health Initiative

The OHI is a worldwide strategy for expanding interdisciplinary collaboration and communication in all aspects of healthcare for humans, animals and the environment. This synergism advances healthcare by accelerating biomedical research discoveries, enhancing public health efficacy, expeditiously expanding the scientific knowledge base, and improving medical education and clinical care.

The OHI autonomous team was co-founded by physician Laura H. Kahn, veterinarian Bruce Kaplan and physician Thomas P. Monath in 2007 with the sole purpose of promoting One Health concepts nationally and internationally (OHI 2016). An Honorary Advisory Board was established in 2010, and now consists of One Health advocates worldwide.

The OHI team's purpose and goals centre on educating international multidisciplinary scientific communities, political and government leaders, the news media and people everywhere about One Health. They promote One Health worldwide by their website and national and international publications, including the journal *One Health*. For the last decade, the OHI team has worked closely with the widely read online *One Health Newsletter* produced by the University of Florida's Emerging Pathogens Institute. All reputable One Health organisations, and individuals worldwide, are welcomed as supporters and advocates. The OHI team works pro bono and requires no fees from participating organisations and individuals.

One Health Platform

The OHP was established in 2015 in Belgium as a charitable foundation (OHP 2015). It provides a strategic forum for researchers, early-career investigators, governmental and non-governmental institutions, international organisations and companies to foster cross-sectoral collaborations. Its major objectives are to:

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- Provide a strategic forum for researchers, early-career investigators, governmental and non-governmental institutions, international organisations, and companies to foster cross-sectoral collaborations;
- Identify and prioritise research gaps in the fields of zoonoses, emerging infectious diseases and antimicrobial resistance, including the ecological and environmental factors that impact on these diseases, and advocate the resulting scientific research agenda – on both a scientific and policy level;
- Create synergies and facilitate the sharing of data between researchers and research groups to fill the research gaps, and translate the data to anyone who might benefit;
- Disseminate the results and insights of existing and new research projects on zoonoses, emerging infectious diseases and antimicrobial resistance, including the ecological and environmental factors which impact on these diseases;
- Establish an information reference centre for the One Health community; and
- Enhance awareness of the value of the One Health approach through communication, facilitation of interactions between stakeholder groups, education and training, and specific efforts to convince ‘non-believers’, in both the research community and in the policy arena (OHP 2015).

The platform publishes an occasional newsletter, *One Health Communicator*, and supports the electronic journal, *One Health*, published by Elsevier. From 2018, the platform will organise future One Health Congresses, with the 5th Congress held in 2018 in Saskatoon, Canada.

One Health Foundation

The One Health Foundation (OHF), established in 2010 in Zurich, focuses on improving human and livestock health by addressing issues including zoonotic diseases, food safety, and environmental pollution. It remains a small entity in this increasingly crowded space (OHF 2015).

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One Health Global Network

In recognition of the number of One Health groups and networks established around the world, and others in the process of development, the One Health Global Network was created – following the CDC Stone Mountain meeting in 2010 – to act as a ‘network of networks’ facilitating coordination and offering linkages that provide a global geographic dimension and optimal complementarity between initiatives.

One Health conferences and congresses

One Health conferences and congresses are now commonplace, both regionally and globally. One Health conferences in Africa organised by the Southern African Centre for Infectious Disease Surveillance, the OHCEA One Health conferences, and the 2016 One Health European Interregional Conference in Bucharest, Romania, are some regional examples.

Since 2011 five ‘International One Health Congresses’ have been held (Melbourne in 2011, Bangkok in 2013, Amsterdam in 2015, Melbourne in 2016 and Saskatoon in 2018). Other international meetings include the ‘Global Conferences in One Health’, organised by the World Veterinary Association and World Medical Association (the first meeting was held in Madrid in 2015 and the second in Fukuoka in 2016), and the Global Risk Forums on One Health in Davos, Switzerland (2012, 2013 and 2015).

Educational developments in support of One Health

An essential aspect of One Health development is educating professionals – veterinarians, medical practitioners, biomedical scientists, wildlife biologists, and others – to better understand a One Health approach through improved communication and cooperation across the disciplines and across a wide range of subjects, such as responding to known or new zoonotic diseases, detecting and tracking the origins of antibiotic resistance, ensuring food security and food safety, and mitigating the effects of climate change. Breaking down the disciplinary silos is an essential component of One Health education.

The One Health Masters course for students in the Asia–Pacific region, established with the support of the World Bank, the European Commission and Massey University in New Zealand (One Health at Massey 2016; Vink et al. 2013), is a good example of multidisciplinary learning. Other examples include the One Health Institute at the University of California at Davis, the One Health Center of Excellence at the University of Florida, the Center of One Health Research at the University of Washington, and the One Health Center Illinois at the University of Illinois. The University of Edinburgh, the Royal Veterinary College in London, Ross University School of Veterinary Medicine, the University of Hokkaido, Duke University and the University of Saskatchewan have all established graduate courses in One Health. There are others.

The most important and sustainable training developments occur when medical and veterinary programs introduce One Health concepts into their undergraduate as well as postgraduate degree courses. Many universities do this, with many more planning to do it, especially those with faculties of veterinary medicine, but the effects of this may not be visible until future clinicians and veterinarians enter their professional careers.

‘One Health’ has become a *lingua franca* in global terms. Nevertheless, while it professes to be the intersection of human, animal and ecosystems health, it is understood by many to focus mainly on the animal–human interface, irrespective of whether the subject is disease emergence, zoonoses, food safety, AMR, or climate change. In the past, environmental factors were seen only in relation to human or animal health rather than as substantial components of the health of our environment. This is where EcoHealth has been preeminent and filled the void.

The EcoHealth world: what is it and where did it come from?

EcoHealth and One Health share a holistic approach but EcoHealth is broader, incorporating the earth’s ecosystems and their impact on human health. EcoHealth examines changes in the biological, physical, social and economic environments and relates these changes to human

health. The modern EcoHealth concept emerged with the founding of the EcoHealth Alliance in 1971 by British naturalist Gerard Durrell, in collaboration with local and international conservation partners. With close links to conservation medicine, EcoHealth grew during the 1990s, supported by the International Development Research Centre of Canada (IDRC) (Lebel 2003). At its core is an appreciation that environmental health, human and animal health, and the social and political context in which they exist, make up a complex system – the ecosystem. EcoHealth supports a systems approach to tackling complex problems, rather than the more reductionist approach taken by scientists working in individual health specialties or ‘silos’ (i.e. human health, veterinary medicine, ecology, social science, politics).

The ecosystem approach to human health is a union of ecological approaches to public health and ecosystem health from environmental management. The IDRC, a long-time advocate of ecosystem health, first introduced the EcoHealth research program in 1996. In 2004, the IDRC founded the *EcoHealth* journal, merging two previous journals – *Ecosystem Health* and *Global Change and Human Health*. The IDRC established the International Association for Ecology and Health (IAEH) in 2006, in part to fill the *EcoHealth* publisher’s need to have the financial backing of a society; but more relevantly to address the need to organise the EcoHealth movement globally as well as to curate the journal.

EcoHealth was shaped by the sustainable development movement of the 1980s espousing the principles in the seminal Brundtland Report of 1987 (United Nations 1987), which articulated the movement’s goals in terms of social justice, participation, and equity across and between generations. These principles, and the holistic spirit of the Brundtland Report, continue to inform current EcoHealth thinking and practice, and are evident in global and local initiatives that give primacy to the health and wellbeing of humans in healthy environments and systems.

The IAEH is a scholarly organisation that supports EcoHealth activities, with members from all continents (IAEH 2015). Committed to fostering the health of humans, animals and ecosystems, IAEH members conduct research and help scholars and field-based practitioners to recognise the inextricable linkages between the health of all species and their environments. A basic tenet in EcoHealth is

that health and wellbeing cannot be sustained in a resource-depleted, polluted and socially unstable planet. EcoHealth members engage in integrated systemic approaches to health by seeking to sustain ecosystem health services, foster social stability and promote the peaceful coexistence of humans, animals and environments.

EcoHealth objectives include serving a diverse international community of scientists, educators, policy makers and practitioners, and providing mechanisms and forums to facilitate international and interdisciplinary discourse. This is achieved through the journal *EcoHealth*, biennial conferences, promotional activities in line with the mission, by encouraging the development of transdisciplinary teaching, research and problem solving that cuts across many fields of scholarship (including natural, social and health sciences and the humanities), and by fostering intercultural knowledge exchange, validating holistic knowledge and creating conditions that sponsor creativity among diverse groups of people.

EcoHealth focuses on interdisciplinary, transdisciplinary and collective social learning processes in which the environment is regarded in the broadest sense. Maintaining healthy environments in which all members of a system can flourish is a primary goal.

Conservation and equity (of gender, resources and opportunity) are critical issues, coupled with a strong appreciation of the need to engage with everyone about problems and solutions. EcoHealth scholars are conscious of the limitations in the way that we think, and recognise that solutions can emerge not only from compartmentalised interests, but also from collaborative contributions. EcoHealth is engaged with factors affecting health and wellbeing in their own right, and as interconnected, making this approach multidimensional, complex and reflective of the diversity within the ecosystems of concern.

Originally, the IDRC EcoHealth program was based on three methodological pillars of transdisciplinarity, participation, and equity. These were subsequently expanded to six key principles: systems thinking, knowledge to action, transdisciplinarity, participation, equity and sustainability (Parkes 2011). These principles are dependent on, and fully expressed through, the four interacting areas of society, economics, politics and ecology. This appreciation for complex systems underpins the ecosystems approach to achieving health and wellbeing

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for people, animals and environments. Those working under the banner of EcoHealth are ethically driven to make positive long-lasting changes, leading to sustainability through environmentally sound processes and the promotion of durable and equitable social change.

EcoHealth studies differ from traditional, single-discipline studies. A traditional epidemiological study, for example, may show increasing rates of malaria in a region, but not address how or why those rates are increasing. An environmental health study may recommend spraying a pesticide in certain areas to reduce spread, while an economic analysis may calculate the cost and effectiveness of every dollar spent on such a program.

An EcoHealth study brings multiple specialist disciplines together with members of the affected community *before* the study begins. Through pre-study meetings, the group shares knowledge, adopts a common language and develops a shared vision for the outcome of their work. These pre-study meetings often lead to creative and novel approaches and more 'socially robust' solutions.

Transdisciplinarity differentiates this field from other multidisciplinary studies. EcoHealth studies value the participation of all groups, even those with radically different and sometimes opposing views. Transdisciplinarity values and harnesses the knowledge of all the disciplines, placing equal value on contributions from decision makers, artists, philosophers, scientists, inventors, citizen activists and community leaders. It recognises all elements such as good quality air and waterways, healthy wetlands and river systems, nutrient-rich, fertile topsoil and native flora and fauna.

The principle of equality of diversity underpins EcoHealth: everything is different but equal. Equity (between genders, socioeconomic classes, age brackets and even species) is not a desired outcome in itself; rather it is a field of practice, a part of the process and a way of comprehending and contributing to the problem being studied, and the consequences that might come from resolving it.

After a decade of international conferences in North America and Australia, under the more contentious umbrella of ecosystem health, the first 'ecosystem approach to human health' forum was held in Montreal in 2003. This was followed by conferences and forums in

Wisconsin, US, and Mérida, Mexico – all with major support from the IDRC. Since then the IAEH and the linked journal *EcoHealth* confirm the field as a legitimate scholarly and development activity. The EcoHealth movement is aligned with the Ottawa Charter, Rio Declaration, International Panel on Climate Change, and the Millennium Ecosystem Assessment, with new initiatives such as the Resilience Alliance continually emerging and gaining traction.

Planetary Health Alliance

The Planetary Health Alliance (PHA), formed in December 2015, is an alliance of universities, NGOs and other organisations dedicated to increasing understanding of the human health impacts of accelerating global environmental change; to building an educational platform that enables the teaching of planetary health topics in classrooms around the world, and to ensuring growing understanding of these topics is applied to real-world natural resource management and policy making. Ultimately, it envisages a global public educated about the connection between human health and our management of earth's natural systems, and policy makers who are able to calculate the human health costs and benefits of their resource management decisions. Planetary health is 'the health of human civilization and the state of the natural systems on which it depends' (PHA 2016).

The PHA is hosted by Harvard University's Center for the Environment and the T.H. Chan School of Public Health, and seeks to draw together like-minded organisations and individuals. The alliance's products are publicly accessible, with the intention that Harvard's faculty will be housed in universities and other organisations around the world. The Steering Committee includes international senior faculty, scientists and policy makers. The PHA aims to be a unifying and integrating force by engaging with other organisations, groups, and individuals around the world to support them in developing a robust field of planetary health.

The PHA also aims to establish a community of practice across a variety of disciplines by generating common ground and stimulating the growth of the field through educational materials, shared literature,

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common sources of communication about new scientific findings, alerts regarding job opportunities and meetings, shared methodologies, protocols and datasets, and an online journal club. A robust research effort investigating and quantifying the human health impacts of global environmental change is the engine at the heart of building a discipline of planetary health and policy. Although the PHA does not carry out research itself, it exists within a rich research environment where numerous planetary health-related research activities are ongoing.

The PHA supports training in planetary health topics, using relevant datasets and research methodologies. It also makes announcements about new research and job opportunities and sponsors an annual research meeting with the ambition of providing a cadre of young investigators with the capacity and motivation to break new ground in this field. In addition, the PHA awards full-time research positions to postdoctoral candidates with outstanding track records within their disciplines and strong capacity to step out of their disciplinary experience, and engage in transdisciplinary, planetary health research with the PHA-associated faculty.

Although the PHA recognises that funding for this approach is limited, it plans to stimulate growth in the planetary health field through its support of US government agencies – such as the National Institutes of Health, National Science Foundation, and USAID – to create programs focused on planetary health. Without funding sources, universities will be unable to develop and promote faculty work, and civil society and other stakeholders will be unable to take action based upon the science and evidence-based policies.

The commissioners on the Rockefeller Foundation–Lancet Commission on Planetary Health believe that degradation of ecosystems can lead to negative public health impacts. Until these impacts are proven and quantified in actionable ways, they remain vague externalities that are not factored into decisions about public health or natural resource management. The emergent field of planetary health is poised to deliver powerful new and convincing arguments that demonstrate the range of critical relationships between the state of natural systems and health.

Where are we currently?

The 'all-inclusive' view of health, or One Health, is the systematic understanding and management of health within a sociopolitical and ecological framework (Zinsstag et al. 2011). There are social and ecological drivers for the emergence of disease in humans, animals and plants. Impaired human, animal and plant health has social and ecological consequences, which create new socioecological drivers. Effective intervention strategies require an understanding of the socioecological drivers of disease, along with the sociopolitical and ecological factors determining intervention (equity) effectiveness and consequences.

Although One Health is the accepted term that represents all this, and the organisations under this umbrella seek to take a multidisciplinary and cross-sectorial (health, environment, agriculture) approach, they each have varying degrees of focus on particular aspects. EcoHealth has an emphasis on the health of the environment with an ecosystems approach, while the One Health Platform highlights infectious diseases with a focus on the health both of humans and animals as well as issues around food security and safety. This diversity may be valuable and provide a rich tapestry of approaches to global health, but it may also have drawbacks, and a range of issues within this context need to be considered (Zinsstag 2012).

Organisational issues

The following five structured organisations purport to represent the new order of One Health: EcoHealth, the One Health Platform, One Health Foundation, One Health Initiative, and the One Health Commission. They each have mandates and missions linked to objectives and outcomes, and varying membership arrangements and management or governance approaches. Most seek funding through these arrangements and have a call out for membership. While this provides choice, it is also confusing, competitive and divisive. This fragmentation sends a message to governments and funding bodies of complexity and uncertainty about the organisations' longevity, which impedes serious investment or attention by traditional groups or silos

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that have dominated health in the past. The essence of the problem – a lack of cross-sectorial collaboration and thinking – is hardly helped by this multi-organisational approach to One Health concepts and solutions.

But organisation and structure are essential building blocks. For a time One Health advocates believed that by sharing ideas, encouraging collaboration and expounding multidisciplinary approaches to complex issues, the desired One Health approach would be successful (Gibbs and Gibbs 2013). It was not, and many examples are testimony to this. At the national level and international levels, One Health entities within the Mongolian and Laotian governments and within regions such as Asia–Pacific Economic Cooperation and the African Union are the only ones demonstrating progress.

Would not a single international One Health organisation be better? One established through a union of these existing bodies? Each entity has its own organisational culture, which has both refined its thinking and contributions but at the same time compartmentalised shared interests, resulting in intense competition for resources. Each entity understands its capacity to solve real-life threats to global security, but to the exclusion of others. Taken together, these factors have created within each of these agencies a sense of legitimacy, singularity and purpose. This development has created conditions for competition rather than convergence, resulting in divisions that have crept into our accepted understanding of the nature of the world, even though they are humanly constructed (Brown 2008). While solutions can emerge from within these separate knowledge systems, little consideration is given to how these different contributions fit together, even though each has made, or could make, a major contribution in its own right. It appears that unifying under a single entity may be easier said than done.

Financial issues

Two major financial problems beset the One Health arena. First, none of the organisations are financially secure, having to rely upon subscriptions and donations. Only relatively small cohorts of researchers and advocates work in this space, making it unlikely to

have sufficient capacity to sustain current engagement. While each of the entities described has a favoured funding or resource base, a better and more sustainable solution would be to unify competing cells into a single entity representing One Health.

Secondly, One Health research has no identified champion or patron. Most national or international bodies fund through a specific One Health sector, for example, human health, agriculture, the environment. Finding a single financial source for a One Health project is still a substantial challenge – with the exception of the Bill and Melinda Gates Foundation and the Wellcome Trust, which support One Health. Progress is slow and much of One Health research exists within a sector that should only be partially funding the work. Having a single international One Health organisation might provide an opportunity to seek serious funding specifically for One Health research.

Communication and publishing issues

The journal *EcoHealth*, now more than nine years old, has an impact factor of 2.48. It publishes on a broad range of topics, including the environment, ecology, diseases and health. Editorials and forum pieces provide views on a range of One Health and EcoHealth issues as well as a reading focus for EcoHealth and One Health researchers and advocates. A further three journals have begun publishing in the One Health area including the One Health Platform–linked *One Health* journal. This diversity of publishing opportunities is valuable, but is not without challenges, such as identifying the most appropriate journal to publish research. The journals face simultaneous demands to maintain their impact factor, readership and subscription figures.

Congresses and conferences

The first EcoHealth conference was held in Madison, Wisconsin, in 2006. A legacy of this conference, and all future ones, has been the Conference Statement, outlining an agenda for EcoHealth around the world. Since the first One Health International Congress in Australia in 2011, a plethora of One Health conferences and meetings have been held, leaving a confusing set of agendas. Most noticeable was the

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attempt by the city of Davos in Switzerland to establish an annual One Health Conference along similar lines to the Davos Economic Forum. Despite diminishing attendees and presentations in the last five years, it continues to compete with other One Health conferences.

In 2016 a joint congress between EcoHealth (6th Biennial Conference) and One Health (4th International Congress) was held in Melbourne. But the challenges of finance, membership and scope experienced in organising this conference make it unlikely to be repeated in two years. These conferences are vital for boosting the One Health agenda, sharing research and ideas across disciplines and sectors, continents and cultures, and for social and political advocacy beyond that of the scientific papers. The plethora of meetings and conferences dilutes the trans-sectorial and multidisciplinary approaches One Health strives for and weakens the opportunities for messaging and lobbying for resources and attention.

What should the future be?

The scientific approach for the past 200 years has been primarily reductionist in nature and increasingly specialised, driven largely by complexities in understanding the basics and developing workable solutions to scientific problems. This is also the case in healthcare. Specialisation in human health, agriculture, and environmental management, has created sub-specialties with a large number of disciplines, with their own methods, modes of inquiry, languages, professional bodies, qualifications, and professional support in the form of journals, conferences and educational initiatives.

The start of this century, with so many intractable global and local concerns, casts doubt on whether conventional approaches will work. Rittel and Webber (1973) termed a class of issues facing our current planetary dilemmas as 'wicked problems': that defy complete definition and for which there is unlikely to be a final solution. Brown (OHP 2015) saw wicked problems as part of the community that generates them, meaning that any resolution requires changes in that society (governance or way of living), or changes in the 'thought' community (novel approaches to research methods and to actions and decisions

based on that research). The authors cautioned against rejecting the powerful tools that enabled reductions in diseases or increased world food production (Brown 2010). They suggested that an alternative to a limited focus on any single avenue of enquiry is a requirement that current and future researchers and decision makers be receptive to new ideas and directions – matching that of the times.

Today, the deleterious manner in which centuries of human activity have devastated the natural systems on Earth is acknowledged and recognised. The disruption of the functional integrity of the planet by human activity, and at the same time accepting that the processes underlying this integrity are intrinsically linked, is in itself a difficult problem for scientists and thought leaders. Although we are yet to fully understand these links, a viable future founded on life-sustaining solutions cannot be achieved without a more holistic and systems-oriented approach to local and global matters.

One Health viewpoints recognise the imperative of whole-of-system and ecosystem analyses, noting that the social and political changes required are beyond discipline-based approaches. However, these disciplines remain powerful, and fragmentation and diversification continues. People engaged in these disciplinary traditions have strong membership identities; the power of those identities is a significant motivating factor for maintaining the status quo. Identification as a member of a particular group is narrow, and often too socially or politically exclusionary to facilitate finding the solutions required. The benefits that these entities might bring are often lost due to the narrowness of the allegiance they inspire.

The multiple shared views of these specialty and sub-specialty groups could inspire a shared identity – offering both motivation and universality – sharing effort, resources and support. In this way, we could maintain identity through a singular entity (EcoHealth practitioner, One Health scientist, parks ranger) as well as participate in a shared identity that includes other voices. The new generations of scholars, scientists, decision makers and policy advisers will need to facilitate shared platforms.

The issue of scale: is a regional rather than global approach more realistic?

While these issues of identity vex global efforts to come together, the future of One Health entities might be better approached using a regional model – one that makes sense ecologically. Regionalisation is an effective spatial framework for systems research and protects the biological, linguistic and cultural diversity specific to each region. Regional initiatives may provide the greatest opportunity for engagement, knowledge exchange and the development of integrative practices that draw on all the knowledge domains.

In 2012, EcoHealth scholars based in Oceania discussed regional initiatives at the 4th Biennial Conference of the International Association for Ecology and Health (IAEH) in Kunming, China, and made a commitment to ensure voices, concerns and ideas of the region would be heard in global forums. The IAEH can establish regional chapters using a constitutional trigger. (This was activated at an Oceania-focused forum in December 2013.) The specific mandate of the Oceania EcoHealth Chapter is to consult and engage with IAEH members and advocate for local and regional issues that represent the diversity of the region and the mission of the international organisation (Arabena and Kingsley 2016). With foundational principles of co-creation, collaboration and relationship building, the chapter has facilitated regional activities, demonstrations, short courses, student activities, and social media and place-based strategic engagement across institutions, entity representatives and Indigenous communities. However, as inspiring as this might be, the viability of this initiative depends on the enthusiasm of its members and leadership.

A missing link: custodianship

Despite treaties, statements, manifestos and congresses, billions of people have not been convinced that environmental issues are serious and myriad, and that cooperative action is essential to survive. We have failed to unite people to act. Communication strategies have either failed to engage at an individual level and/or do not provide

information about how to get from point A (the problem) to point B (a sensible alternative or different code to live by). People invested in modern societies are left with a sense of inevitability about the destruction left for future generations.

The Oceania Chapter's path mentioned above examines the historical knowledge of local and Indigenous peoples in various regions and, in particular, draws on their knowledge about 'how to live in place'. Knowledge systems have sustained populations over thousands of years without destroying the integrity of their environments. Evidence from studies on hunting, herding, fishing and gathering from across Australia, Micronesia, and the Pacific Islands demonstrates that local communities are able to 'marshal powerful emotional resources' (Anderson 2014), and societal strength from their cultures, which are closely linked to, and informed by, their connection to land and sea.

These studies critically highlight connection to Country, working from the premise that ecosystem approaches are far more than a biophysical focus on health. Rather, they incorporate a holistic way of understanding environmental issues by drawing on interconnections between culture, identity and wellbeing, and a deep appreciation for environments as a life-source – a non-negotiable foundation for all life (Parkes 2010). This theme, explored in a special issue of *EcoHealth*, coincided with the adoption of the United Nations Declaration on the Rights of Indigenous Peoples (Stephens, Parkes and Chang 2007; United Nations 2007). These traditional and local cultures and societies show us how to devise practical strategies for environmental management, in the context of land being a non-negotiable life-source, and uniting people to act on these strategies. Custodianship of the environment and the biological systems it supports has been embraced by Aboriginal and Torres Strait Islander peoples for over 60,000 years, and supported with irreversible frameworks of cultural obligations that underpin this sustainable approach (Arabena 2015).

Combining united disciplinary knowledge with a custodianship framework has the potential to refocus learning and knowledge, in a way that includes the views of people whose knowledge systems have been linked for thousands of years. This will require all knowledge, ideologies and future initiatives to adopt, in a real sense, the principles of tolerance, diversity, reciprocity and solidarity. These must be at the

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core of all custodial relationships and are essential for the future of One Health and EcoHealth platforms.

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