One health and the prevention of Pathogens' spillover

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*Ginevra Le Moli**

1 Introduction

Whereas, over the past century, viruses have been found in humans at an approximate uniform rate of two novel species every year,[1] as of today, a higher number of spillover events lead to larger and more frequent outbreaks.[2] In particular, emerging zoonoses constitute one of the major threats to human health.[3] Even though the list of all known pathogens is only a small part of the total number of potential pathogens that exist,[4] this scenario means that pandemics will be more recurrent and that preventing the risk of spillover

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1 Mark E.J. Woolhouse, Richard Howey, Eleanor Gaunt, Liam Reilly et al., 'Temporal trends in the discovery of human viruses' (2008) 275 Proceedings of the Royal Society – Series Biological Sciences, 2111–2115.

2 Aaron S. Bernstein, Amy W. Ando, Ted Loch-Temzelides, Mariana M. Vale et al., 'The costs and benefits of primary prevention of zoonotic pandemics' (2022) 8 Science Advances, 1–13, 2.

3 World Bank, 'People, Pathogens, and Our Planet', Vol. 1: Towards a One Health Approach for Controlling Zoonotic Diseases (1 January 2010); Sarah Cleaveland, M. Karen Laurenson and Louise H. Taylor, 'Diseases of humans and their domestic mammals: pathogen characteristics, host range and the risk of emergence' (2001) 356 Philosophical Transactions of the Royal Society – Series Biological Sciences, 991–999; Peter Daszak, Andrew A. Cunningham and Alex D. Hyatt, 'Emerging infectious diseases of wildlife – threats to biodiversity and human health' (2000) 287 Science, 443–449; Kate E. Jones, Nikkita G. Patel, Marc A. Levy, Adam Storeygard, et al., 'Global trends in emerging infectious diseases (2008) 451 Nature, 990–993; Mark E.J. Woolhouse and Sonya Gowtage-Sequeria, 'Host range and emerging and reemerging pathogens' (2005) 11 Emerging Infectious Diseases, 1842–1847; Mark Woolhouse and Eleanor Gaunt, 'Ecological origins of novel human pathogens' (2007) 33 Critical Reviews in Microbiology, 231–242; Louise H. Taylor, Sophia M. Latham and Mark E.J. Woolhouse, 'Risk factors for human disease emergence' (2001) 356 Philosophical Transactions of the Royal Society – Series Biological Sciences, 983–989.

4 Simon J. Anthony, Jonathan H. Epstein, Kris A. Murray, Isamara Navarrete-Macias et al., 'A strategy to estimate unknown viral diversity in mammals' (2013) mBio 4, e00598-13; Daniel P. Bebber, Francis H.C. Marriott, Kevin J. Gaston, Stephen A. Harris and Robert W. Scotland, 'Predicting unknown species numbers using discovery curves' (2007) 274 Proceedings of the Royal Society – Series Biological Sciences, 1651–1658.

currently constitutes one of the legal and policy priorities in the international agenda. The COVID-19 pandemic, despite being predictable, was not prevented. It in fact exposed an inherent blind-spot of the international health law system, namely that, to address future pandemic risks, the envisaged approach is by way of detection and containment of emerging zoonotic threats[5] (or, in other words, action is required only once the outbreak has occurred),[6] rather than also by way of prevention of pathogens' spillover (also defined as 'deep prevention').[7] The latter regulatory target is in fact not regulated in the current international legal architecture, even though it should be part of the prevention strategy. More specifically, the threat posed by unknown pathogens calls for an enhanced pathogen detection network grounded on One Health principles in order to prevent, at its inception, a pandemic resulting from a zoonotic agent.

Importantly, among emerging infectious diseases (EIDS), up to 75 percent result from pathogens of animal origin that can subsequently spread among humans.[8] Various systemic changes have increased contact (and conflicts) among humans, animals, wildlife, and their habitats, with a direct impact on spillover risk.[9] Few examples are population growth, increasing (and higher) food demand as well as environmental degradation, with effects on land use. The recent West Africa Ebola outbreak or the COVID-19 pandemic, which most likely had its origins in a zoonotic event,[10] have increased the urgency of a

5 Jorge Viñuales, Suerie Moon, Ginevra Le Moli and Gian Luca Burci, 'A global pandemic treaty should aim for deep prevention' (2021) 397 The Lancet, 1791, 1791–1792; Ginevra Le Moli, Jorge Viñuales, Gian Luca Burci, Adam Strobeyko and Suerie Moon, 'The Deep Prevention of Future Pandemics through a One Health Approach: What Role for a Pandemic Instrument?' (2022, Global Health Centre-CEENRG) 9–10. See also Bernstein, Ando, Loch-Temzelides, Vale et al. (n 2) 1–2.

6 On detection and containment as the best ways to address pandemic risks, see Christopher Elias, John N. Nkengasong and Firdausi Qadri, 'Emerging infectious diseases – Learning from the past and looking to the future' (2021) 384 The New England Journal of Medicine, 1181–1184. As relevant illustrations, see World Health Organization (WHO) and World Bank, 'A world in disorder: Global Preparedness Monitoring Board Annual Report 2020' (2020); G20, Progress Note of the G20 High-Level Independent Panel on Financing the Global Commons for Pandemic Preparedness and Response (2021).

7 Viñuales, Moon, Le Moli and Burci (n 5).

8 Taylor, Latham, Woolhouse (n 3).

9 Food and Agriculture Organization (FAO), 'One Health: Food and Agriculture of the United Nations Strategic Action Plan' (2011) <http://www.fao.org/3/al868e/al868e00.pdf>, last accessed (as any subsequent URL) on 10 April 2022.

10 Edward C. Holmes, Stephen A. Goldstein, Angela L. Rasmussen, David L. Robertson et al., 'The origins of SARS-CoV-2: A critical review' (2021) 184 Cell, 4848–4856.

better understanding of how human behaviours may impact interactions with animal reservoirs and their pathogens.

As this study will discuss, the One Health approach recognizes that the health of all living organisms is interdependent and is the result of connections among humans, animals and the shared environment.[11] The importance of these inter-connections has become evident not only with the COVID-19 pandemic and other EIDs, but also in light of endemic zoonoses and the continuing threat of Antimicrobial Resistance (AMR).[12] A One Health Approach thus urges to holistically address human, animal, and environmental health challenges and to tackle spillover prevention in order to reduce the risk of outbreaks and, in turn, of pandemics. Whereas various ideas have been put forward on what could be done to prevent future pandemics,[13] and the inefficiencies shown by the international response to the COVID-19 pandemic have built the momentum for international initiatives,[14] this study focuses on One Health approach as a way to operationalise such a goal. To do so, it first examines two of the main drivers of pathogen risk emergence, namely deforestation and wildlife trade and hunting. It then addresses the value of a One Health approach, as a legal and policy paradigm for addressing public and environmental health risks. It then concludes, outlining challenges and possible approaches to incorporate One Health in legal frameworks and to address pathogens' spillover prevention.

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11 Joint Tripartite – FAO, 'World Organization for Animal Health (OIE) WHO – and UNEP Statement, Tripartite and UNEP support OHHLEP's definition of 'One Health'', FAO, OIE, WHO and UNEP, 2021, <https://wedocs.unep.org/bitstream/handle/20.500.11822/37600/JTFOWU.pdf>.

12 D.G. Joakim Larsson and Carl-Fredrik Flach, 'Antibiotic resistance in the environment' (2021) Nature Reviews Microbiology, <https://www.nature.com/articles/s41579-021-00649-x.pdf?origin=ppub>; David W. Graham, Gilles Bergeron, Megan W. Bourassa, James Dickson et al., 'Complexities in understanding antimicrobial resistance across domesticated animal, human, and environmental systems' (2019) 1441 Annals of the New York Academy of Sciences, 17–30.

13 Andrew P. Dobson, Stuart L. Pimm, Lee Hannah, Les Kaufman et al., 'Ecology and economics for pandemic prevention' (2020) Science, 369, 379–381; Peter Daszak, Kevin J. Olival and Hongying Li, 'A strategy to prevent future epidemics similar to the 2019-nCoV outbreak' (2020) 427 Biosafety and Health, 2, 6–8; Viñuales, Moon, Le Moli and Burci (n 5); Pedro A. Villareal, 'Pandemic Risk and International Law: Laying the Foundations for Proactive State Obligations' (2020) 3 Yearbook of International Disaster Law, 154–179.

14 WHO, 'Strengthening the International Health Regulations (2005): a process for their revision through potential amendment' EB150(3) (26 January 2022); World Health Assembly (WHA) Decision SSA2(5) 'The World Together: Establishment of an Intergovernmental Negotiating Body to Strengthen Pandemic Prevention, Preparedness and Response', WHA74(16), 1 December 2021.

2 Deforestation, Wildlife Trade and Zoonotic Diseases

Zoonoses constitute one of the health threats where the interconnections of human, animal and environmental health are most evident. They are diseases or infections naturally transmissible from vertebrate animals to humans.[15] The emergence or re-emergence of a pathogen can vary significantly.[16] Such variety includes, for instance,[17] cases of new (or newly detected) pathogens; the 'migration' of known pathogens to different locations, such as the shift of the Ebola virus to West Africa; cases of jumps of a pathogen into new hosts, as it was the case of H5N1 avian influenza virus' jump to humans. The concept of emergence and re-emergence further expands to the micro level, including the genomic mutations resulting in enhanced antimicrobial drug resistance.[18] Thus, the drivers of emergence can occur at different levels in our environment, even causing changes in pathogenesis that can create a new disease entity.[19] Such wide scope inevitably defines a primary challenge in identifying and detecting newly emerging zoonoses. In addition, not only biological factors play an important role. The ecology, sociology, as well as human and animal behaviour greatly impact the transmission interface and allow the spillover of a new pathogen from an animal reservoir host into the first human case – which is likely to determine the subsequent dissemination through the human population.[20]

15 WHO, 'Zoonoses', 2020, <https://www.who.int/news-room/fact-sheets/detail/zoonoses>.

16 Anneke Engering, Lenny Hogerwerf and Jan Slingenbergh, 'Pathogen-host-environment interplay and disease emergence' (2013) Emerging Microbes and Infections 2, 5.

17 Brian H. Bird and Jonna A.K. Mazet, 'Detection of Emerging Zoonotic Pathogens: An Integrated One Health Approach' (2018) 6 Annual Review of Animal Biosciences, 121–139, 122.

18 Yongfei Hu, George F. Gao and Baoli Zhu, 'The antibiotic resistome: gene flow in environments, animals and human beings' (2017) 11 Frontiers of Medicine, 161–168.

19 Abigail B. Diack, Mark W. Head, Sandra McCutcheon, Aileen Boyle et al., 'Variant CJD. 18 years of research and surveillance', (2014) Prion 8, 286–295.

20 Woolhouse and Gaunt (n 3); Nathan D. Wolfe, Claire Panosian Dunavan and Jared Diamond, 'Origins of major human infectious diseases' (2007) 447 Nature, 279–283; James O. Lloyd-Smith, Dylan George, Kim M. Pepin and Virginia E. Pitzer, 'Epidemic dynamics at the human-animal interface' (2009) 326 Science, 1362–1367; Stephen S. Morse, Jonna A.K. Mazet, Mark Woolhouse, Colin R. Parrish, Dennis Carroll et al., 'Prediction and prevention of the next pandemic zoonosis' (2012) 380 Lancet, 1956–1965; James M. Hassell, Judy M. Bettridge, Melissa J. Ward, Allan Ogendo et al., 'Socio-ecological drivers of vertebrate biodiversity and human-animal interfaces across an urban landscape' (2021) 27 Global Change Biology, 781–792.

In particular, among the main (known) drivers of emerging zoonoses,[21] it is possible to identify deforestation and domesticated and wild animal interactions but, even more, in the latter case, direct human contact with wildlife, their by-products and their meat for consumption.[22]

As regards the first, studies have recognized land use change as one of the EIDs' main drivers, since it typically involves the conversion of natural habitats to agricultural or urban ecosystems.[23] In particular, changes in the mode and the intensity of land use have worldwide and systematic effects on local zoonotic host communities.[24] Such effects are stronger for specific categories, namely rodent, bat and passerine bird zoonotic host species.[25] This is considered as one factor that lies at the basis of their recognition as main zoonotic reservoirs.[26] In particular, deforestation is arguably the leading driver of risk of pathogen emergence,[27] due to the presence of wild bats, primates, and rodents which act as reservoirs of very high proportions of zoonotic viruses.[28] By creating forest edges, deforestation facilitates human contact with these viral

21 See Bernstein, Ando, Loch-Temzelides, Vale et al. (n 2).

22 Engering, Hogerwerf and Slingenbergh (n 16); Kis Robertson, Boonlert Lumlertdacha, Richard Franka, Brett Petersen et al., 'Rabies-related knowledge and practices among persons at risk of bat exposures in Thailand' (2011) 5 PLOS Neglected Tropical Diseases, 1054; Kanokwan Suwannarong and Sydney Schuler, 'Bat consumption in Thailand' (2016) 6 Infection Ecology & Epidemiology, 29941.

23 Samuel S. Myers, Lynne Gaffikin, Christopher D. Golden, Richard S. Ostfeld et al., 'Human health impacts of ecosystem alteration' (2013) 110 PNAS USA, 18753–18760; Nicole L. Gottdenker, Daniel G. Streicker, Christina L. Faust and C. Ronald Carroll, 'Anthropogenic land use change and infectious diseases: a review of the evidence' (2014) 11 EcoHealth, 619–632.

24 Rory Gibb, David W. Redding, Kai Qing Chin, Christl A. Donnelly et al., 'Zoonotic host diversity increases in human-dominated ecosystems' (2020) 584 Nature 398; see also Richard S. Ostfeld and Kathleen LoGiudice, 'Community disassembly, biodiversity loss, and the erosion of an ecosystem service' (2003) 84 Ecology, 1421–1427; Pieter T.J. Johnson, Jason R. Rohr, Jason T. Hoverman, Esra Kellermanns et al., 'Living fast and dying of infection: host life history drives interspecific variation in infection and disease risk' (2012) 15 Ecology Letters, 235–242.

25 Gibb, Redding, Chin, Donnelly et al. (n 24) 398.

26 Christina L. Faust, Hamish I. McCallum, Laura S.P. Bloomfield, Nicole L. Gottdenker et al., 'Pathogen spillover during land conversion' (2018) Ecology Letters 21, 471–483; Toph Allen, Kris A. Murray, Carlos Zambrana-Torrelio, Stephen S. Morse et al., 'Global hotspots and correlates of emerging zoonotic diseases' (2017) 8 Nature Communications, 1124.

27 Gottdenker, Streicker, Faust and Carroll (n 23); Thomas R. Gillespie, Kate E. Jones, Andrew P. Dobson, Julie A. Clennon and Mercedes Pascual, 'COVID-Clarity demands unification of health and environmental policy' (2021) 27 Global Change Biology, 1319–1321.

28 Kevin J. Olival, Parviez R. Hosseini, Carlos Zambrana-Torrelio, Noam Ross et al., 'Host and viral traits predict zoonotic spillover from mammals' (2017) Nature 546, 646–650; Christine K. Johnson, Peta L. Hitchens, Pranav S. Pandit, Julie Rushmore et al., 'Global

reservoir hosts.[29] By way of example, deforestation in West Africa and rapid human population growth most likely played a central role in the 2013 Ebola outbreaks.[30] This is not however only a current phenomenon, as deforestation has been considered the cause of also past zoonotic diseases.[31]

Studies have illustrated the need to mitigate deforestation by focusing on the example of the Brazilian Amazon,[32] where various measures have been adopted to prevent pathogens' spillover near the forest. Among such policies, supported by science satellite monitoring and improved enforcement,[33] the following have been promoted with success: the enhancement of protected areas, recognition of indigenous lands, the adoption of market restrictions on illegal landholdings, credit restrictions on municipalities with high rates of deforestation as well as payment for programs set up to benefit small farmers.[34]

Moreover, another important driver of pathogen spillover is represented by the human demand for wild animals.[35] In particular, changes in human population mobility, practices density as well as food preferences have all had an impact on zoonotic disease emergence.[36] Human taste preferences are in fact

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shifts in mammalian population trends reveal key predictors of virus spillover risk' (2020) 287 Proceedings. Biological sciences, 20192736.

29 Maria Cristina Rulli, Monia Santini, David T.S. Hayman and Paolo D'Odorico, 'The nexus between forest fragmentation in Africa and Ebola virus disease outbreaks' (2017) 7 Science Reports 41613; Laura S.P. Bloomfield, Tayler L. McIntosh and Eric F. Lambin, 'Habitat fragmentation, livelihood behaviors, and contact between people and nonhuman primates in Africa' (2020) 35 Landscape Ecology, 985–1000.

30 Rulli, Santini, Hayman and D'Odorico (n 29).

31 Jones, Patel, Levy, Storeygard et al. (n 3).

32 A.S. Bernstein, A.W. Ando, T. Loch-Temzelides, M.M. Vale et al., 'The costs and benefits of primary prevention of zoonotic pandemics' (2022) 8 Science Advances, 1–13, 7.

33 Daniel Nepstad, David McGrath, Claudia Stickler, Ane Alencar et al., 'Slowing Amazon deforestation through public policy and interventions in beef and soy supply chains' (2014) 344 Science, 1118–1123.

34 *Ibid.*; Felipe Arias Fogliano de Souza Cunha, Jan Börner, Sven Wunder, Carlos Alberto Nunes Cosenza and André F.P. Lucena, 'The implementation costs of forest conservation policies in Brazil' (2016) 130 Ecological Economics, 209–220.

35 See Karesh, Cook, Bennett and Newcomb (n 37).

36 Ronan F. Arthur, Emily S. Gurley, Henrik Salje, Laura S.P. Bloomfield et al., 'Contact structure, mobility, environmental impact and behaviour: the importance of social forces to infectious disease dynamics and disease ecology' (2017) 372 Philosophical Transactions of the Royal Society London – Series Biological Sciences, 20160454; James M. Hassell, Michael Begon, Melissa J. Ward and Eric M. Fèvre, 'Urbanization and disease emergence: dynamics at the wildlife-livestock-human interface' (2017) 32 Trends in Ecology and Evolution, 55–67; Mary A. Rogalski, Camden D. Gowler, Clara L. Shaw, Ruth A. Hufbauer and Meghan A. Duffy, 'Human drivers of ecological and evolutionary dynamics in emerging and disappearing infectious disease systems' (2017) 372 Philosophical Transactions of the Royal Society London – Series Biological Sciences, 20160043; Nathan D. Wolfe, Peter

at the basis of the intensification of wild animal meat hunting in the so-called bushmeat trade. This creates a fertile ground for the direct contact of humans with diverse animal reservoirs of potential pathogens.[37]

The wildlife trade alone constitutes a quarter of all mammal species and includes rodents, bats, and primates.[38] Traded animals are often forced in associations with other and different species,[39] which normally also have a higher pathogen prevalence.[40] Human contact, and consequent pathogen spillover, may occur at different moments in wildlife trade, in both wildlife hunting,[41] slaughtering or consumption of wild animals.[42] This has been the case for the emergence of several known zoonoses, such as monkey-pox, SARS-CoV,

Daszak, A. Marm Kilpatrick and Donald S. Burke, 'Bushmeat hunting, deforestation, and prediction of zoonoses emergence' (2005) 11 Emerging Infectious Diseases, 1822–1827. See also Quan Liu, Biao He, Si-Yang Huang, Feng Wei and Xing-Quan Zhu, 'Severe fever with thrombocytopenia syndrome, an emerging tick-borne zoonosis' (2014) 14 Lancet Infectious Diseases, 763–772; Emmie de Wit, Neeltje van Doremalen, Darryl Falzarano and Vincent J. Munster, 'SARS and MERS: recent insights into emerging coronaviruses' (2016) 14 Nature Reviews Microbiology, 523–534.

37 Suwannarong and Schuler (n 22); William B. Karesh and Eric Noble, 'The bushmeat trade: increased opportunities for transmission of zoonotic disease' (2009) 76 Mount Sinai Journal of Medicine, 429–434; Alexandra O. Kamins, Olivier Restif, Yaa Ntiamoa-Baidu, Richard Suu-Ire et al., 'Uncovering the fruit bat bushmeat commodity chain and the true extent of fruit bat hunting in Ghana' (2011) 144 West Africa Biological Conservation, 3000–3008; Justin S. Brashares, Christopher D. Golden, Karen Z. Weinbaum, Christopher B. Barrett and Grace V. Okello, 'Economic and geographic drivers of wildlife consumption in rural Africa' (2011) PNAS 108, 13931–13936; William B. Karesh, Robert A. Cook, Elizabeth L. Bennett and James Newcomb, 'Wildlife trade and global disease emergence' (2005) 11 Emerging Infectious Diseases, 1000–1002.

38 Olival, Hosseini, Zambrana-Torrelio, Ross et al. (n 28); Brett R. Scheffers, Brunno F. Oliveira, Xieuan Lamb and David P. Edwards, 'Global wildlife trade across the tree of life' (2019) 366 Science, 71–76; Johnson, Hitchens, Pandit, Rushmore et al. (n 28).

39 Centers for Disease Control and Prevention (CDC), 'Update: Multistate outbreak of monkeypox – Illinois, Indiana, Kansas, Missouri, Ohio, and Wisconsin' (2003) Morbidity and Mortality Weekly Report (MMWR) 52, 642–646.

40 Morse, Mazet, Woolhouse, Parrish, Carroll et al. (n 20).

41 In particular, due to wildlife hunting, at least 300 species of terrestrial mammals are at risk of extinction, see William J. Ripple, Katharine Abernethy, Matthew G. Betts, Guillaume Chapron et al., 'Bushmeat hunting and extinction risk to the world's mammals' (2016) 3 Royal Society Open Science, 160498.

42 Justus Nsio, Jimmy Kapetshi, Sheila Makiala, Frederic Raymond et al., '2017 outbreak of ebola virus disease in Northern Democratic Republic of Congo' (2019) 221 Journal of Infectious Diseases, 701–706; Beatrice H. Hahn, George M. Shaw, Kevin M. De Cockand and Paul M. Sharp, 'AIDS as a zoonosis: Scientific and public health implications' (2000) 287 Science, 607–614.

as well as Ebola viruses.[43] In this context, the prevention of zoonotic disease emergence is challenged by the difficulty in the monitoring and surveillance of wildlife trade[44] as well as by unreliable data for quantitative assessments of the zoonotic risk.[45] At the international level, the secretariat for the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has explained that it is beyond its mandate to monitor pathogens (and thus, the zoonotic risk) in wildlife trade.[46] The World Organization for Animal Health (OIE), while having the authority to list diseases that threaten wildlife through environmental sources, has rarely used this power.[47]

3 Origin and Implementation of One Health

As mentioned in the introduction, pathogens' spillover from animals to humans constitutes today a major source of pandemic risk.[48] Adopting a 'One Health'

43 Isabel Ordaz-Németh, Mimi Arandjelovic, Lukas Boesch, Tsegaye Gatiso et al., 'The socio-economic drivers of bushmeat consumption during the West African Ebola crisis' (2017) PLOS Neglected Tropical Diseases 11, e0005450; Seth D. Judson, Robert Fischer, Andrew Judson and Vincent J. Munster, 'Ecological contexts of index cases and spill-over events of different ebolaviruses' (2016) 12 PLOS Pathogens, e1005780; Nathan D. Wolfe, Walid Heneine, Jean K. Carr, Albert D. Garcia et al., 'Emergence of unique primate T-lymphotropic viruses among central African bushmeat hunters' (2005) 102 PNAS, 7994–7999; Claire A. Quiner, Cynthia Moses, Benjamin P. Monroe, Yoshinori Nakazawa et al., 'Presumptive risk factors for monkeypox in rural communities in the Democratic Republic of the Congo' (2017) PLOS ONE 12, e0168664; Antoine Gessain, Réjane Rua, Edouard Betsem, Jocelyn Turpin and Renaud Mahieux, 'HTLV-3/4 and simian foamy retroviruses in humans: discovery, epidemiology, cross-species transmission and molecular virology' (2013) 435 Virology, 187–199.

44 By way of example, see Peter B. Jahrling, Thomas W. Geisbert, E.D. Johnson, C.J. Peters et al., 'Preliminary report: Isolation of Ebola virus from monkeys imported to USA' (1990) 335 Lancet, 502–505; CDC (n 39).

45 Hon-Ki Chan, Huarong Zhang, Feng Yang and Gunter Fischer, 'Improve customs systems to monitor global wildlife trade' (2015) 348 Science, 291–292.

46 Convention on International Trade in Endangered Species, CITES Secretariat's statement in relation to COVID-19 (CITES, 2021), <https://cites.org/eng/CITES_Secretariat_statement_in_relation_to_COVID19>.

47 The OIE has listed amphibian chytridiomycosis, a disease affecting amphibians which threatens their trade because of its spread in wild populations Lisa M. Schloegel, Peter Daszak, Andrew A. Cunningham, Richard Speare and Barry Hill, 'Two amphibian diseases, chytridiomycosis and ranaviral disease, are now globally notifiable to the World Organization for Animal Health (OIE): An assessment' (2010) 92 Diseases of Aquatic Organisms, 101–108.

48 See Morse, Mazet, Woolhouse, Parrish, Carroll et al (n 20); Woolhouse and Gowtage-Sequeria (n 3).

approach is critical not only to prevent spillovers and outbreaks in zoonotic diseases, but also to address and prevent environmental issues, including those related to food safety and AMR.[49] Collaborative and cross-disciplinary, a One Health approach cuts across boundaries of animal, human, and environmental health, and allows to understand the ecology of each emerging zoonotic disease to assess the risk and design measure of response and control. This section first examines the meaning and origin of One Health and it subsequently presents an overview of its recognition (or absence) in international instruments.

3.1 *Origin and Definition*

The term 'One Health' was first used in 2003–2004 and was associated with the emergence of severe acute respiratory disease (SARS) in early 2003 and, later, with the spread of avian influenza H5N1. Since 2005, as part of pandemic influenza preparedness, there have been in fact several efforts to embed One Health in institutional responses.[50] These responses are at the heart of One Health implementation and are mainly constituted by collaborations among various actors,[51] which ensure that

> policy decisions are based on accurate and shared assessments of the situation; proposed regulations, policies, and guidelines are realistic, acceptable, and implementable by all sectors; technical, human, and financial resources are effectively used and equitably shared; and gaps in infrastructure, capacity and information are identified and filled.[52]

In particular, three institutions – the WHO, FAO, World Organization for Animal Health (OIE) – have largely been at the core of these efforts. This collaborative framework, called the 'Tripartite Plus' was formally initiated in 2010 and was aimed at undertaking 'complementary work to develop normative standards

49 Alexandra L. Phelan and Lawrence O. Gostin, 'Law as a fixture between the One Health interfaces of emerging diseases', (2017) 111/6 Transactions of the Royal Society of Tropical Medicine and Hygiene 241–243.

50 Kelley Lee and Zabrina L. Brumme, 'Operationalizing the One Health approach: The global governance challenges' (2013) 28/7 Health Policy Plan, 778–85.

51 See Syed Shahid Abbas, Tim Shorten and Jonathan Rushton, 'Meanings and mechanisms of One Health partnerships: insights from a critical review of literature on cross-government collaborations' (2021) 37/3 Health Policy and Planning 385–399; Kaylee Myhre Errecaborde, Katelyn Wuebbolt Macy, Amy Pekol, Sol Perez et al., 'Factors that enable effective One Health collaborations – A scoping review of the literature' (2019) 14/12 PLoS ONE, e0224660.

52 WHO, FAO, OIE, 'Taking a multisectoral, one health approach: a tripartite guide to addressing zoonotic diseases in countries' (WHO 2019) 151.

and field programs to achieve One Health goals'.[53] It is now called the 'Quadripartite', given the involvement of the United Nations Environment Programme (UNEP), which has been formally added to the partnership in 2022.[54] The purpose of the new 2022 Quadripartite Memorandum of Understanding (MoU) is to provide a formal and legal framework for the longstanding collaboration between the four organizations to 'further their shared goals and objectives in regard to the development and implementation of multi-sectoral approaches to complex health challenges at the animal-human-ecosystem interface with particular emphasis on AMR'.[55] This framework will not only enhance a more integrated approach but also contribute to reinforce national and regional health systems and services.

Of note is that, together with other international and national organizations, including the United Nations Children's Fund (UNICEF) and the World Bank, as well as national health ministries, they set up the International Ministerial Conferences on Avian and Pandemic Influenza (IMCAPI). IMCAPI played a central role in the surveillance and response to influenza H5N1[56] and in defining a framework around a One Health approach centred on reducing the risk and the impact of epidemics and pandemics due to emerging infectious diseases.[57] Moreover, a One Health approach has also been supported at the national[58]

53 FAO, OIE, WHO, 'The FAO-OIE-WHO Collaboration – Sharing Responsibilities and Coordinating Global Activities to Address Health Risks at the Animal-Human-Ecosystems Interfaces – A Tripartite Concept Note', 2010.

54 See 'UN Environment Programme joins alliance to implement One Health approach', 18 March 2022, <https://www.who.int/news/item/18-03-2022-un-environment-programme-joins-alliance-to-implement-one-health-approach>.

55 Quadripartite Memorandum of Understanding (MoU) between FAO, WHAO, WHO and UNEP, 29 April 2022.

56 IMCAPI, 'International Ministerial Conference: Animal and Pandemic Influenza: The Way Forward', IMCAPI: Hanoi, Vietnam, 2010, <https://www.fao.org/avianflu/en/conferences/imcapi_2010.html>.

57 IMCAPI, Contributing to One World, One Health: A Strategic Framework for Risks of Infectious Disease at the Animal-Human-Ecosystems Interface, <https://www.fao.org/3/aj137e/aj137e00.pdf>.

58 See, by way of example, Bhutan: Bhutan One Health Strategic Plan 2018–2023, (2018); Burkina Faso: Burkina Faso National One Health Platform, (2019); Ethiopia: Ethiopia National One Health Strategic Plan 2018–2022, (2018); Germany: Initiative area One Health in development cooperation, (2021); Kenya: National Strategic Plan for Implementation of One Health One Health in Kenya (2012–2017), (2012); Nigeria: Nigeria One Health Strategic Plan 2019–2023, (2019); Namibia: Namibia National Action Plan for Health Security (2021–2025), (2021); South Sudan: South Sudan National Action Plan for Health Security (NAPHS) 2020–2024, (2020); Thailand: Thailand National Strategic Plan for EIDS 2017–2021, (2017); Uganda: Uganda One Health Strategic Plan (2018–2022), (2018).

and regional level.[59] In particular, the European Union has not only been a prominent supporter of the IMCAPI, but it has also integrated the approach into its policy since 2008.[60] In addition, the Association of South East Asian Nations (ASEAN) and the Asia Pacific Economic Cooperation (APEC) have promoted capacity building and preparedness for influenza pandemic response as well as One Health AMR Action Plans.[61]

While these collaborations have advanced One Health at different levels, the full operational implementation of a One Health approach has mostly been confined to "soft" instruments and policy decisions, such as principles and declarations (the Manhattan and Berlin Principles).[62] Moreover, the

59 African Union: see Africa CDC, 'One Health Framework for One Health Practice in National Public Health Institutes', (2020); Eastern Mediterranean Region of WHO, 'One Health operational framework for action for the Eastern Mediterranean Region, focusing on zoonotic diseases', (2020). Economic Community of West Africa States (ECOWAS): 'Operationalizing the ECOWAS regional one health coordination mechanism (2016–2019): Scoping review on progress, challenges and way forward', (2021); ECOWAS, 'Prioritizing zoonotic diseases using a multisectoral, One Health approach for The Economic Community of West African States (ECOWAS)', (2021); ECOWAS, 'Report on One Health Technical and Ministerial Meeting to Address Zoonotic Diseases and Related Public Health Threats', (2016); ECOWAS, 'Communiqué: One Health Ministerial Meeting To Address Zoonotic Diseases and Other Related Public Health Threats', Dakar, Senegal, 11 November 2016. Horn of Africa: One Health Units for Humans, Environment, Animals and Livelihoods (HEAL) Project, 'One Health Policy Context of Ethiopia, Somalia, and Kenya', (2019).

60 See EFSA, ECDC, 'The European Union One Health 2018 Zoonoses report' (2019) 17/12 EFSA Journal, e05926; EFSA, ECDC, 'The European Union One Health 2019 Zoonoses Report', (2021) 19/2 EFSA Journal, 6406; EFSA, ECDC, 'The European Union One Health 2020 Zoonoses report', (2021) EFSA Journal 19/12, 6971. See also EFSA, ECDC, 'The European Union Summary Report on antimicrobial resistance in zoonotic and indicator bacteria from humans, animals and food in 2017', (2019) 17/2 EFSA Journal e05598; EFSA, ECDC, 'The European Union Summary Report on Antimicrobial Resistance in zoonotic and indicator bacteria from humans, animals and food in 2017/2018', (2020) 18/3 EFSA Journal, 6007.

61 ASEAN, ASEAN Strategic Framework to Combat Antimicrobial Resistance through One Health Approach [2019–2030], (2019); ASEAN, ALD on Antimicrobial Resistance (AMR): Combating AMR through One Health Approach ASEAN, (2017); APEC, APEC One Health Action Plan, (2011).

62 The 'Manhattan Principles' considered wildlife health as a core feature of global disease prevention, surveillance, control, and mitigation, see The Manhattan Principles, 2004, at <https://oneworldonehealth.wcs.org/About-Us/Mission/The-Manhattan-Principles.aspx>; The Berlin Principles on One Health, 2019, at <https://oneworldonehealth.wcs.org/About-Us/Mission/The-2019-Berlin-Principles-on-One-Health.aspx>. See also Kim Gruetzmacher, William B. Karesh, John H. Amuasi, Adnan Arshad et al., 'The Berlin principles on one health – Bridging global health and conservation' (2021) 764 Science of the Total Environment, 142919.

FAO/OIE/WHO collaboration has led to the publication of several reports discussing the health risks at the human-animal-ecosystems interfaces,[63] including an operational guide to countries for the implementation of a One Health approach to address zoonotic diseases.[64] In December 2021, the One Health High Level Expert Panel (OHHLEP), an advisory panel convened by WHO, FAO, OIE and UNEP, provided a new operational definition of One Health. It reads as follows:

> One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent.[65]

The Panel also clarified that the One Health approach 'recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent' and that it

> mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development.[66]

Thus, the One Health approach is centred around responses and actions at the animal-human-ecosystems interfaces and its scope, as defined by the international organizations (WHO, FAO, OIE and UNEP,[67] the World

63 FAO, OIE, WHO, 'High-Level Technical Meeting to Address Health Risks at the Human-Animal-Ecosystems Interfaces' (2011); WHO, OIE, 'WHO-OIE Operational Framework for good governance at the human-animal interface: bridging WHO and OIE tools for the assessment of national capacities' (WHO-OIE 2014); FAO, OIE WHO, 'The Tripartite's Commitment. Providing multi-sectoral, collaborative leadership in addressing health challenges', 2017; FAO, OIE, WHO, '2020 Joint Risk Assessment Operational Tool' (JRA OT) 2020.

64 FAO, OIE WHO, 'Taking a multisectoral, one health approach: a tripartite guide to addressing zoonotic diseases in countries', 2019.

65 Tripartite and UNEP support OHHLEP's definition of 'One Health' (n 11).

66 *Ibid*.

67 See (n 63 and n 64). In 2020, these four organizations created the One Health High-Level Expert Council, see Presentation of the work of the Alliance for Multilateralism The One Health High-Level Expert Council and the Fight against Infodemics, Paris Peace

Bank,[68] regional organizations[69]), has been expanded to include not only emerging and endemic zoonoses, AMR[70] and food safety,[71] but also areas and factors such as ecology, land use and biodiversity.

3.2 *Surveillance, Detection and One Health*

Existing international instruments relevant in cases of pandemic risk do not directly refer to the One Health approach.[72] This is of special concern with regard to the IHRs, which constitute the main legal tool to fight human infectious disease outbreaks of potential global concern and whose effectiveness has come under question in the context of the COVID-19 pandemic.[73] The

Forum, 12 November 2020, <https://multilateralism.org/wp-content/uploads/2020/11/2020-11-11-Press-release-meeting-AfM-12-November-2020-final-version-EN.pdf>.

68 World Bank, 'World Bank Operational framework for strengthening human, animal and environmental public health systems at their interface' (2018); World Bank, 'People, Pathogens, and Our Planet, Vol. 1: Towards a One Health Approach for Controlling Zoonotic Diseases' (2010); World Bank, 'People, Pathogens and Our Planet: The Economics of One Health' (2012); World Bank, 'People, Pathogens and Our Planet, Vol. 2: The Economics of One Health' (2012).

69 EFSA, ECDC (n 60).

70 WHO-FAO-OIE-UNEP, 'Strategic framework for collaboration on antimicrobial resistance. Together for One Health' (2022); WHO-FAO-OIE, 'Monitoring and evaluation of the global action plan on antimicrobial resistance: framework and recommended indicators' (2019); WHO-FAO-OIE, 'Global Action Plan on antimicrobial resistance', 68th World Health Assembly, (2015); ASEAN Strategic Framework to Combat Antimicrobial Resistance through One Health Approach [2019–2030], (2019); ASEAN, ASEAN Leaders' Declaration on Antimicrobial Resistance (AMR), Combating AMR through One Health Approach (2017); European Commission, A European One Health Action Plan against Antimicrobial Resistance (AMR) (2017).

71 Sara N. Garcia, Bennie I. Osburn and James S. Cullora, 'A one health perspective on dairy production and dairy food safety' (2019) 7 One Health, 100086.

72 The following instruments do not include a direct reference to One Health: International Health Regulations (IHRs) WHO (2005[3]); Sendai Framework for Disaster Risk Reduction 2015–2030, adopted at the Third UN World Conference in Sendai, Japan, on 18 March 2015 ('Sendai Framework'); Convention on Biological Diversity, 1760 UNTS 79 (1992); United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, UN Doc A/AC.241/15/Rev. 7, 33 ILM 1328 (1994); Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 993 UNTS 243 (1973); Agreement on Sanitary and Phytosanitary (SPS) Measures, 1867 UNTS 493 (1994); Framework Convention on Tobacco Control (FCTC), 2302 UNTS 166 (2003).

73 See, for instance, WHO, 'WHO's work in health emergencies Strengthening preparedness for health emergencies: implementation of the International Health Regulations' (2005), 74th WHA (2021); Giulio Bartolini, 'The Failure of "Core Capacities" under the Who International Health Regulations' (2021) 70/1 International & Comparative Law Quarterly, 233–250; Lawrence O. Gostin, Benjamin Mason Meier and Barbara Stocking,

IHR-Performance of Veterinary Services (PVS) National Bridging Workshops (NBWs),[74] hosted by the WHO and OIE, have however provided a platform to discuss and identify actions to address a One Health Approach and find solutions for possible gaps with regard to core functions of the IHRs and institutional cooperation. Moreover, also other instruments have been adopted to support states' in countries' implementation of IHR core capacities, such as the Handbook for the Assessment of IHR Capacities at the Human-Animal Interface,[75] the WHO/OIE IHR-PVS National Bridging Workshops, and the OIE Performance of Veterinary Services Pathway.[76]

In particular, surveillance is an essential component of the One Health approach, mainly for the early detection of novel threats arising at the human-animal interface. There are important international surveillance networks, namely the Global Early Warning System for major animal diseases (GLEWS), developed by FAO, OIE and WHO[77] as well as the Global Alert and Response Operations (GAR) of WHO. The WHO's Global Outbreak Alert and Response Network (GOARN) was established in order to coordinate rapid outbreak response.[78] An illustration of a successful implementation of the One Health approach is represented by the 2005 OIE-FAO Joint OIE/FAO worldwide scientific network for the control of animal influenzas (OFFLU), which was expanded in 2009 to include all animal influenza – established to support veterinary services aimed at reducing risks to animal and public health from animal influenza viruses.[79]

There is however not yet a mechanism which allows early and rapid detection of potential pathogens at the human-animal interface. An illustration of

'Developing an Innovative Pandemic Treaty to Advance Global Health Security' (2021) 49/3 The Journal of Law Medicine & Ethics, 503–508.

74 Guillaume Belot, François Caya, Kaylee Myhre Errecaborde, Tieble Traore et al., 'IHR-PVS National Bridging Workshops, a tool to operationalize the collaboration between human and animal health while advancing sector-specific goals in countries' (2021) PloS One 16/6, e0245312; Stephane De La Rocque, Francois Caya, Abdeslem El Idrissi et al., 'One Health operations: a critical component in the International Health Regulations Monitoring and Evaluation Framework' (2019) 38/1 Revue scientifique et technique International Office of Epizootics, 303–314.

75 WHO, 'Handbook for the assessment of capacities at the human-animal interface' (2017).

76 De La Rocque, Caya, El Idrissi et al. (n 74).

77 GLEWS, 'Global early warning system for major animal diseases including zoonoses' (2013), <www.glews.net>.

78 WHO, 'Global Outbreak Alert and Response: Report of a WHO Meeting' (2000), WHO/CDS/CSR/2000/3; WHO, 'A Framework for Global Outbreak Alert and Response' (2000). See John S. Mackenzie, Patrick Drury, Ray R. Arthur, Michael J. Ryan, et al. 'The global outbreak alert and response network' (2014) 9/9 Global Public Health, 1023–39.

79 OFFLU, at <https://www.offlu.org>.

the need for robust detection networks is the emergence of a relatively known pathogen, namely the Ebola virus (Zaire ebolavirus), in 2013 in Guinea, Sierra Leone, and Liberia.[80] The outbreak was over 60 times larger than any previous Ebola outbreak.[81] Thus, despite advances in diagnostic technology since 1976, when the virus was discovered, the 2013 outbreak (and subsequent ones, in 2017, 2018, 2020 and 2021)[82] showed that surveillance and laboratory systems were not ready and advanced enough.

In this context, the relevance of the PREDICT program is thus quite striking. The program has been designed to detect spillovers of pathogens from wildlife through the so-called Strategic, Measurable, Adaptive, Responsive, and Targeted (SMART) surveillance method.[83] Animal disease surveillance or outbreak investigation is rather fragmentary and, thus, surveillance procedures aimed at the animal-human interface are required. To face this specific necessity, the process of pathogen discovery has been influenced by newly developed molecular diagnostic platforms[84] as well as by new procedures for targeted surveillance created through the PREDICT program. There is however no incentive for international reporting or surveillance of wildlife's diseases, since countries are merely encouraged to voluntarily take part and submit a

80 Sylvain Baize, Delphine Pannetier, Lisa Oestereich, Toni Rieger et al. 'Emergence of Zaire Ebola virus disease in Guinea' (2014) 371 New England Journal of Medicine, 1418–1425; Meredith G. Dixon and Ilana J. Schafer, 'Ebola viral disease outbreak – West Africa' (2014) 63 Morbidity and Mortality Weekly Report (MMWR) 548–551; Gytis Dudas, Luiz Max Carvalho, Trevor Bedford, Andrew J. Tatem et al., 'Virus genomes reveal factors that spread and sustained the Ebola epidemic' (2017) 544 Nature, 309–315.

81 WHO, 'Ebola haemorrhagic fever in Zaire, 1976' (1978) 56 Bulletin World Health Organization, 271–293; WHO 'Ebola haemorrhagic fever in Sudan, 1976' (1978) 56 Report of a WHO/International Study Team, Bulletin World Health Organization, 247–270; Karl M. Johnson, James V. Lange, Patricia Anne Webb and Frederick Murphy, 'Isolation and partial characterisation of a new virus causing acute haemorrhagic fever in Zaire' (1977) 1 Lancet, 569–571.

82 See CDC, 'History of Ebola Outbreaks', <https://www.cdc.gov/vhf/ebola/history/chronology.html>.

83 The SMART surveillance method is intended to early detect novel diseases with pandemic potential and specifically targets sentinel animal species at active human interfaces in specific hotspots, see Morse, Mazet, Woolhouse, Parrish, Carroll et al (n 20); PREDICT, <https://ohi.vetmed.ucdavis.edu/programs-projects/predict-project/about>; PREDICT Consortium, One Health Institute, University of California, Davis, 'Reducing pandemic risk, promoting global health' (2014); Morse, Mazet, Woolhouse, Parrish, Carroll et al. (n 20).

84 W. Ian Lipkin, 'The changing face of pathogen discovery and surveillance' (2013) 11 Nature Reviews Microbiology, 133–141.

report on non OIE-listed diseases in wildlife through the OIE World Animal Health Information System (OIE-WAHIS).[85]

Furthermore, several regional surveillance networks have been created and developed in Europe, Southern Africa, South and South-East Asia, and in the Pacific Islands. In 2010, these networks have been connected through a non-government platform, called Connecting Organizations for Regional Disease Surveillance (CORDS),[86] which has four key aims, i.e. improving capacity, advancing One Health, promoting innovation and building sustainable networks. Moreover, in South-East Asia and Western Pacific, the Asia-Pacific Strategy for Emerging Diseases (APSED) was established to support member states with implementing their core capacities, and thus comply with the 2005 IHRS, and to strengthen early detection and response to outbreaks, including zoonoses. This also incorporated a 'Guide to Establishing Collaboration between Animal and Human Health Sectors at the Country Level', which is a joint collaboration between WHO, FAO and OIE for surveillance and information sharing, response, and risk reduction.[87]

Despite these initiatives, One Health integration tools are simply available to countries on a voluntary basis.[88] It has been found that One Health issues

85 Mariana Marrana, Daniel Donachie, Jennifer Lasley, Sophie Muset et al., 'Lessons Identified From Before And During The Pandemic: How the OIE Can Support Veterinary Services to Achieve One Health Resilience' (2021) Report 88 SG/9, OIE.

86 CORDS is composed of 'six regional members networks working in 28 countries (...) to detect and contain outbreaks at source and keep communities safe from the spread of infectious diseases in animals and humans', see <http://www.cordsnetwork.org>. The latter includes the Mekong Basin Disease Surveillance (MBDS), Middle East Consortium on Infectious Disease Surveillance (MECIDS), South-East European Center for Surveillance and Control of Infectious Diseases (SECID), Asian Partnership on Emerging Infectious Disease Research (APEIR), Southern Africa Centre for Infectious Disease Surveillance (SACIDS Foundation for One Health), and East African Integrated Disease Surveillance Network (EAIDSNet).

87 WHO, 'Zoonotic diseases: a guide to establishing collaboration between animal and human health sectors at the country level', (2008) WHO South-East Asia and Western Pacific Regional Offices, Manila, 1–19.

88 Among non-binding tools with One Health relevance: a) on capacity assessment: Joint External Evaluation (JEE) for the IHR Monitoring and Evaluation Framework (WHO); Performance of Veterinary Services (PVS) Evaluations, including PVS Evaluations for Aquatic Animal Health Services (OIE); b) on audits Resources, Prioritization and Action Planning: National Action Plan for Health Security (WHO); One Health Zoonotic Disease Prioritization Tool and Workshop (CDC); PVS Gap Analysis (OIE); National Adaptation Plans (UNFCCC); National Action Plans for Disaster Risk Reduction (UNISDR and UNDP); Health Security Financing Assessment Tool (World Bank); Strategic Tool for Assessing Risk (STAR) and Vulnerability and Risk Analysis and Mapping (VRAM) (WHO); Resource Mapping tool (WHO); c) Multisectoral One Health systems improvement tools: IHR-PVS

are rarely taken into account in practice. A study on the gaps in pandemic preparedness and prevention noted that 'despite the likelihood of devastating impacts from epidemics following a spillover event from wildlife to humans, countries are failing to address the environmental components of current health threats'.[89] In particular, as regards the wildlife sector, it is rarely considered in risk assessments and health security plans.[90] This is the same for biodiversity and the link between health and the biological integrity of the planet.[91] In particular, wild animal markets are not currently regulated through any international treaty. Even though some instruments address the trade of wildlife species, such as CITES (for specific listed species), the health of wild animals lacks a specific regulation. In addition, whereas wildlife surveillance is not present in many countries, where it is, resources are low.[92] In the last years, OIE, WHO and FAO have thus increased their activities related to wildlife disease surveillance.[93] Importantly, the three organizations have recently called for the international suspension of the sale of live, wild mammals in traditional markets (or wet markets),[94] clarifying that such environments facilitate pathogens' spillover events.[95]

National Bridging Workshops (WHO and OIE); One Health Systems Mapping and Analysis Resource Tool Kit (OH-SMART) (University of Minnesota and US Department of Agriculture); One Health Assessment for Planning and Performance (OH-APP), Multisectoral Coordination Mechanism Self-Assessment Tool (USAID Preparedness & Response project and DAI Global Health); Joint Risk Assessment Operational Tool (Tripartite). See Arne Ruckert, Carlos Gonçalo das Neves, John Amuasi, Suzanne Hindmarch et al., 'One Health as a Pillar for a transformative Pandemic Treaty' (2021) 1 Global Health Centre Policy Brief, 7–12.

89 Catherine Machalaba, Marcela Uhart, Marie-Pierre Ryser-Degiorgis and William B. Karesh, 'Gaps in health security related to wildlife and environment affecting pandemic prevention and preparedness, 2007–2020' (2021) 99/5 Bulletin World Health Organization, 342–350.

90 *Ibid*.

91 IPBES, 'Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services' (2020) IPBES secretariat ('IPBES 2020 Report'). With a focus on the African continent, see also Akaninyene Otu, Emmanuel Effa, Clement Meseko, Simeon Cadmus, Chinwe Ochu et al. 'Africa needs to prioritize One Health approaches that focus on the environment, animal health and human health' (2021) 27 Nature Medicine, 943–946.

92 In Australia, the Wildlife Health Australia, <https://wildlifehealthaustralia.com.au/Home.aspx>; in Canada, the Canadian Wildlife Health Cooperative, <http://www.cwhc-rcsf.ca/>; and, in France, The SAGIR Network, <https://www.ofb.gouv.fr/le-reseau-sagir>.

93 As regards OIE, see OIE, 'Terrestrial animal code' (2021); OIE, 'Training manual on wildlife diseases and surveillance', (2010); OIE, 'The OIE worldwide monitoring system for wild animal diseases' (2014).

94 WHO, OIE, UNEP, 'Reducing public health risks associated with the sale of live wild animals of mammalian species in traditional food markets: interim guidance' (2021).

95 IPBES 2020 Report (n 91).

Thus, despite various institutional efforts, the global health legal framework is currently missing specific instruments that comprehensively address pathogens' spillover and, in turn, prevention of zoonotic diseases, also through institutional coordination.

3.3 *One Health and Disaster Risk Reduction*

The Sendai Framework marked the transition from the regulation of the management of the impact of disasters to the regulation of the management and reduction of risks that lead to disasters, i.e. a shift from reaction to prevention.[96] Even though the Sendai Framework does not include a direct reference to One Health, one of the most significant changes it introduced compared to its predecessor, the Hyogo Framework for Action (HFA) 2005–2015,[97] is indeed a goal focused on preventing new risk. More specifically, whereas it intends to achieve '[t]he substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries',[98] the Sendai Framework establishes, as the main goal, to:

> Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience.[99]

To achieve this objective, it requires the enhancement of the implementation capacity and capability of developing countries[100] and calls for multisectoral collaboration, which is seen as crucial in disaster response and for building people-centred, multi-hazard forecasting and early warning systems.[101] In particular, paragraph 31f notes that it is important 'strengthen and promote collaboration and capacity-building for the protection of productive assets,

96 Mami Mizutori, 'Reflections on the Sendai Framework for Disaster Risk Reduction: Five Years Since Its Adoption' (2020) 11 International Journal of Disaster Risk Science, 147–151, 147.

97 United Nations Office for Disaster Risk Reduction, 2005, Hyogo Framework for Action 2005–2015: Building the resilience of nations and communities to disasters.

98 See Sendai Framework, para. 16.

99 *Ibid*., para. 17.

100 *Ibid*.

101 *Ibid*., paras. 7 and 27. See also Hajime Kanamori, Hiroaki Baba and David J. Weber, 'Rethinking One Health approach in the challenging era of COVID-19 pandemic and natural disasters', (2021) 11/1 Infection Ecology & Epidemiology, 1852681.

including livestock, working animals, tools and seeds', which may be relevant to One Health. The Bangkok Principles for the implementation of the health aspects of the Sendai Framework place strengthened coordination at the heart of efforts to reduce risk from biological hazards. They set a blueprint for integrating health into disaster risk management planning and disaster management into health planning.[102] In the Principles, it is noted that health emergencies have many common features with natural hazards and should be addressed through risk assessments, surveillance, early warning systems, resilient infrastructure and coordinated incident management across national borders.[103] Whereas some have argued for a more open approach with regard to the sharing and management of information,[104] an integrated One Health surveillance system could contain data outlining risk factors for disease emergence in wildlife, livestock, animals, the environment, and humans.[105]

Thus, to prevent the emergence of zoonotic diseases, such as COVID-19, which are linked to the transformation of ecosystems and biodiversity, the wide scope of hazards of the Sendai Framework (biological, technological and environmental hazards) should be taken into account in disaster risk governance.[106] As noted in the Global Assessment Report on Disaster Risk Reduction (2022), the COVID-19 pandemic has demonstrated the need 'to recognize that planetary

102 The Bangkok Principles were adopted by the International Conference on the Implementation of the Health Aspects of the Sendai Framework for Disaster Risk Reduction 2015–2030. See also UNDRR, 'Fact sheet: Health in the Context of the Sendai Framework for Disaster Risk Reduction' (UNDRR, 2015); Amina Aitsi-Selmi, Virginia Murray, David Heymann et al., 'Reducing risks to health and wellbeing at mass gatherings: the role of the sendai framework for disaster risk reduction' (2016) 47 International Journal of Infectious Diseases, 101–104.

103 See also Economic and Social Commission for Asia and the Pacific Committee on Disaster Risk Reduction, 'Scaling up cooperation frameworks to manage cascading risks', ESCAP/CDR/2021/2, 21 June 2021, 3; Global Assessment Report, 'Our World at Risk: Transforming Governance for a Resilient Future 2022, Summary for Policymakers' (UNDRR 2022) 2–3 and 19–22 [GAR 2022]; Catherine Machalaba, 'Health Emergencies: A Role for Risk Reduction' (UNDRR 2017).

104 Marco Toscano-Rivalta, 'Disaster Risk Reduction in Light of the COVID-19 Crisis: Policy and Legal Considerations' (2020) QIL – Zoom-Out 70, 37–57; Katja L.H. Samuel and Rosalind J. Cornforth, 'Disaster Risk Reduction, Early Warning Systems, and Global Health: Critiquing the Current System-Based Approach' in Katja L.H. Samuel, Marie Aronsson-Storrier and Kirsten N. Bookmiller (eds), The Cambridge Handbook of Disaster Risk Reduction and International Law (CUP 2019) 373–404.

105 Ruckert et al. (n 88).

106 See Final Concept Note 1, Seventh Session of the Global Platform for Disaster Risk Reduction (GP2022), From Risk to Resilience: Towards Sustainable Development for All in a COVID-19 Transformed World 23–28 May 2022, Bali, Indonesia, at 7.

and human systems are interdependent, and that risk knowledge systems need to become more flexible'.[107]

4 One Health as a Key for Pathogens' Spillover Risk Prevention

Prevention is at the heart of a One Health approach. It requires to take into consideration risk factors at the human-animal-environment interface and at the origin of zoonotic disease outbreaks[108] and to enhance, from a legal perspective, the coherence between environmental treaties and the IHRs and animal health regulations, to build a more effective system.[109] A One Health approach supporting and protecting animal and environment health also enhances biosecurity in food production and, in turn, human and animal health by reducing the risk of pathogens' spillover.[110] At present, various initiatives seem to be advancing the international agenda in the direction of recognizing the importance of addressing prevention and adopting a One Health approach to do so.

During a special session of the WHA held in December 2021, member states of the WHO agreed to start negotiations on an international instrument on pandemic prevention and set up an intergovernmental negotiating body (INB) for such end, with the final outcome to be presented at the 77th WHA in 2024.[111] At the occasion of the 2021 WHA Special Session, New Zealand, the Group of Friends of a Pandemic Treaty and the EU advanced proposals defined three important needs of a new international legal instrument to address pandemic prevention and the human health, animal health and environment nexus:[112] first, the adoption of a cross-sectoral approach, nationally and internationally, giving account of the animal-human-environment interface; second, the importance of adopting upstream preventive measures to strengthen the surveillance system, of improving the flow of information and data and of

107 GAR 2022, 3.

108 See Rory Gibb, David W. Redding, Kai Qing Chin, Christl A. Donnelly et al., 'Zoonotic host diversity increases in human-dominated ecosystems' (2020) 584/7821 Nature, 398–402.

109 Viñuales, Moon, Le Moli and Burci (n 5) 1791–1792.

110 Hans-Otto Pörtner, Robert J. Scholes, John Agard, Emma Archer et al., 'IPBES-IPCC co-sponsored workshop report on biodiversity and climate change' (2021); IPBES 2020 Report (n 91); Joachim Otte, David Roland-Holst, Dirk U. Pfeiffer, Ricardo Soares Magalhaes et al., 'Industrial Livestock Production and Global Health Risks' (2007) FAO PPLPI.

111 WHA Decision SSA2(5) (n 14).

112 See Ana Beatriz Balcazar Moreno, Gian Luca Burci and Adam Strobejko, 'Taxonomy of Substantive Proposals for A new Instrument on Pandemic Prevention, Preparedness and Response' (2022) Global Health Centre, 16–17.

regulating domestic animal markets as well as illicit wildlife traffic and wet markets; lastly, the need of coordination and partnerships between international organizations. During the WHA special session, various members supported the proposal to include in the new instrument provisions on One Health approach and animal-human-environment interface,[113] on solid preventive measures, prompt detection and notification of risks[114] and, lastly, on cross-sectoral approaches to the work of authorities in health-related areas.[115]

Moreover, in January 2022, the WHO Executive Board urged Member States 'to take all appropriate measures to consider potential amendments' to the IHRs.[116] The inefficiencies shown by the international response to the COVID-19 pandemic had clearly built the momentum for such initiatives by WHO member states.[117] It remains to be seen whether these processes will ultimately result in a new international instrument or in amendments to the IHRs addressing spillover prevention.

More recently, in February 2022, the agenda of the second segment of the fifth UN Environment Assembly (UNEA-5.2), held in Nairobi, discussed the connections between ecosystem health and human health. The concluding Ministerial Declaration recognized the risk for future pandemics if patterns of the interaction human-nature are not addressed through a holistic approach such as One Health. In particular, two draft resolutions are of relevance: first, a resolution on animal welfare, which recognizes that 'animal welfare can contribute to addressing environmental challenges, promoting the "One Health" approach and achieving the Sustainable Development Goals';[118] and, secondly,

113 Namely, WPRO members, Belgium, India, Lebanon, Mexico, Morocco, Spain, EU, see *ibid*., 16.

114 Namely, Belgium, Botswana, Fiji, India, Kenya, Spain, and Suriname, see *ibid*.

115 Namely, WPRO members, Guatemala, and Mexico, see *ibid*., 17.

116 WHO, 'Strengthening the International Health Regulations (2005): a process for their revision through potential amendment' EB150(3) (26 January 2022). The United States delegation will lead a series of 'informal' member state negotiations to reach consensus on an IHRs reform resolution for approval at the 2022 75th WHA.

117 WHA, Resolution WHA73.1, Seventy-Third World Health Assembly, 19 May 2020; Review Committee on the functioning of the IHR (2005) during the COVID-19 response, Report, 30 April 2021. See also Council of the European Union, Council Decision (EU) 2021/1101 on the position to be taken on behalf of the European Union in the seventy-fourth session of the World Health Assembly of 20 May 2021 (2021) 238 Official Journal of the European Union, 79–80; Statement by the President of the European Council, Charles Michel, at the Special Session of the General Assembly in Response to the Coronavirus Disease (COVID-19) Pandemic, New York (3 December 2020).

118 Draft resolution on the animal welfare-environment-sustainable development nexus, UNEP/EA.5/L.10/Rev.1, 26 February 2022, Preamble, draft at <https://wedocs.unep.org/bitstream/handle/20.500.11822/38632/L.10.REV.1%20-%20Draft%20resolution%20on%20

a resolution on biodiversity and health, which invites Member States to 'mainstream and integrate the concept of One Health in their sectoral policies and implement it (…) as a method for preventing as well as responding to zoonotic disease outbreaks and pandemics (…) in order to preserve human and ecosystems health'.[119] The draft resolution also calls on Member states to 'reduce risks for public health which are associated with the selling of living wild mammals' and to 'suspend their commerce including the closing of sections in food markets which are selling living wild mammals'.[120]

Thus, these developments and growing attention to implementing a One Health approach demonstrate the institutional recognition of its critical importance in reducing complex health problems, also defying a sectoral approach. These discussions also provide an opportunity to reflect on the role that One Health principles must play in predicting and preventing future pandemics, by embedding One Health in the global health security architecture for pandemic prevention, preparedness, and response activities at the human-animal-environment interface.

In the context of One Health, technical cooperation and assistance has a central role in reaching equitable outcomes, which constitutes one of the core considerations in the debates towards a new international agreement.[121] In order to address this specific goal, states could build upon existing "soft" instruments, such as the Sendai Framework, which includes a set of principles on technical cooperation in the context of risk reduction that would provide an approach to better integrate One Health.[122]

More generally, however, there are two complex dimensions in the operationalisation of the One Health approach in the form of a new international agreement.[123] They concern the interplay, first, between such agreement and

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the%20animal%20welfare-environment-%20sustainable%20development%20nexus%20-%20English.pdf?sequence=1&isAllowed=y>.

119 Draft resolution on biodiversity and health, UNEP/EA.5/L.11/Rev.1, 26 February 2022, OP5, draft at <https://wedocs.unep.org/bitstream/handle/20.500.11822/37753/African%20Group%20Draft%20Resolution%20on%20Biodiversity%20and%20Health.pdf?sequence=1&isAllowed=y>.

120 *Ibid*., OP6.

121 AFRO members, Argentina, Azerbaijan, Belgium, Botswana, Chile, Cuba, El Salvador, EMRO members, EU, GoF, Haiti, India, Kenya, Lebanon, Madagascar, Malaysia, Maldives, Mali, Mexico, New Zealand, SEARO members, Slovakia, Southern African countries, Suriname, United States of America, Venezuela, WPRO members. See Balcazar Moreno, Burci, Strobeyko (n 112).

122 Bartolini (n 73) 249; Adam Strobeyko, 'Disaster Preparedness and Response in International Law: Implications for a Prospective Pandemic Treaty', Global Health Centre, 2021.

123 This analysis relies on Le Moli, Viñuales, Burci, Strobeyko and Moon (n 5) 9.

the 2005 IHRS and, second, between the agreement and the IHRS, on one hand, and a range of multilateral environmental agreements, on the other hand. Clarifying such interrelations is important for several reasons, including avoidance of overlaps, maximisation of synergies, identification of possible gaps in the coverage and, more generally, mapping the main inter-institutional relations that would be involved in implementing a One Health-based set of measures. It is, indeed, important to move from the encompassing characterisation of One Health offered by the Advisory Board OHHLEP, to the needs highlighted by some States at the WHA Special Session, and finally to a concrete design strategy based on a clear understanding of where and how a new international agreement would fit.

Thus, in order to approach the matter,[124] it would be necessary to draw the interlinkages between health and environmental instruments first. Here, the starting point is the differing understanding of 'prevention', as a policy goal, in the contexts of public health (infectious diseases) and environmental policy. In the former context, the term prevention is adopted to define public health measures that prevent the spread of disease, i.e. measures to contain the disease. Differently, in the context of environmental policy, prevention refers to preventing the harmful event from occurring in the first place. Such 'deep prevention'[125] can be reached "upstream" by addressing the drivers of the problem (as it is done, in the health context, for non-communicable diseases) or "midstream" by reducing the likelihood of a harmful event. The containment of disease spread, under a deep prevention lens, implies managing "downstream" a harmful event which has already happened – whether the pathogen spillover itself or a disease outbreak.

In particular, at the level of regulatory focus, "drivers" can be identified and regulated at distinct levels. In the environmental policy context, the most important activities, from a One Health perspective, tend to be defined at a "macro-level", such as land-use change, greenhouse gas emissions causing climate change and associated impacts such as pathogen, species and disease-vector redistribution, activities leading to desertification, but also at "finer-grained levels", such as trade in specific endangered species. As regards instead "events", at least three regulatory targets could direct the focus of an instrument, namely disease emergence or re-emergence (including pathogen spillover), disease outbreaks (whether of emerging or existing diseases) and 'disease spread'. The IHRS are focused on detecting and reporting disease outbreaks and containing disease spread and do not clearly regulate, even in

124 *Ibid.*, 12–18.

125 Viñuales, Moon, Le Moli and Burci (n 5).

their provisions on 'core capacities', the prevention (rather than the detection and reporting) of the outbreak itself or the prevention of the (re-)emergence (including pathogen spillover).

Between the "upstream" regulation of macro and micro-drivers and the "downstream" detection and reporting of disease outbreaks and containment of their spread, there is a wide regulatory area which is not sufficiently regulated by international instruments. Its core is 'deep prevention', mainly 'midstream' (regulation of events) but also, to some extent, 'upstream' (regulation of drivers). The prevention of pathogen spillover or pathogen mutation could be approached through the regulation of specific zones and areas, such as farms, wildlife markets or research facilities, in order to guarantee practices that decrease the risk of pathogen spillover or pathogen mutation. Moreover, the regulation of such places could also extend to those activities driving pathogen spillover and pathogen mutation, such as host species management, wildlife trade, farming and feeding techniques, or wildlife consumption, in order to reduce their epidemic risks. The midstream deep prevention of disease outbreaks could rely on the strengthening of national health infrastructures.

Thus, in order to address pathogens' spillover prevention and management of emerging infection outbreak risks, an integrated One Health approach is warranted and the regulatory focus should thus be on 'midstream' deep prevention. Through specific legal and governance measures,[126] this approach will bring a novel and necessary dimension, based on inter-trans-disciplinary and multi-intersectoral collaboration, that is currently not sufficiently accounted for by legal frameworks.[127]

126 See Le Moli, Viñuales, Burci, Strobeyko and Moon (n 5) 12–18.

127 See also Anne Peters, 'COVID-19 as a Catalyst for the (Re-)Constitutionalisation of International Law One Health One Welfare' in Jean D'Aspremont and Makane M. Mbengue (eds), Crisis Narratives in International Law (Brill 2022) 85–99, 94–99.