Review

# One Health governance: theory, practice and ethics

Yinling Zhou [a], Roger Frutos [b,c], Issam Bennis [d], Mayumi D. Wakimoto [e,*]

[a] Wuhan University Institute of International Law/Wuhan University Academy of International Law and Global Governance, Wuhan 430071, Hubei, China
[b] Cirad, Intertryp, Montpellier 34070, France
[c] Faculty of Medicine-Ramathibodi Hospital, Mahidol University, Bangkok, Thailand
[d] Mohammed VI International School of Public Health at Mohammed VI University of Sciences and Health, Morocco
[e] Evandro Chagas National Institute of Infectious Diseases, Oswaldo Cruz Foundation, Rio de Janeiro, Brazil

## ARTICLE INFO

## ABSTRACT

One Health approach is a global public good (GPG) that invites governance to maximize the health of humans, animals, and the environment by shaping interdisciplinary and cross-sectoral collaboration. This paper explores the theoretical foundations, practical applications, and ethical considerations of the One Health governance architecture. At the theoretical level, One Health governance invites systems thinking and involves collaborative efforts among multiple stakeholders, applying across multi-layered scenarios and requires public-private partnership (PPP). This governance architecture transcends traditional anthropocentrism and shifts towards eco-centrism, highlighting the integrity of ecosystems and the deep prevention of diseases. Selected case studies illustrate the implementation of One Health initiatives, such as shared water resources, disease surveillance programmes, and sustainable environmental health interventions, demonstrating the added value of a collaborative efforts across sectors and regions. Ethical considerations are integral to decision-making and actions of One Health governance, with a focus on equity, inclusivity and accountability, providing moral guidelines to prioritize the health of vulnerable populations and ecosystems. Through these efforts, One Health governance is expected to improve public health globally, promote sustainable development, and achieve a harmonious coexistence of human, animal, and environmental health.

## 1. Introduction

There has been wide-ranging commitment to the One Health concept to enhance pandemic prevention, preparedness, readiness and response, while its operationalization has so far proven challenging [1–3]. Meanwhile, ethical issues may arise during One Health implementation as it is central to accountability, strategic planning, and effective health programmes [4,5]. To address these challenges, we first discuss the theories by exploring characteristics and architecture of One Health governance. Second, we employ some practical cases to explore its complex challenges and effort direction towards an effective One Health governance. Finally, we present the ethics and ethical functions of One Health governance.

This paper addresses the research question: "How can One Health governance be effectively theorized, practiced, and ethically implemented to enhance pandemic prevention, preparedness, and response?"

## 2. Methodology

### 2.1. Scope and selection criteria

A comprehensive literature review was conducted to explore theoretical frameworks, practical applications, and ethical considerations of One Health governance based on effective practical cases well documenting these concepts.

Databases searched included PubMed, Scopus, and Web of Science. Keywords used were a combination of "One Health governance",

"systems thinking", "ethical considerations", "public-private partnerships", "case studies", and "policy integration".

Moreover, information for each case study was collected from official reports, academic articles, and credible news sources. Data sources included reports from international organizations [e.g., Food and Agriculture Organization of the United Nations (FAO), and World Health Organization (WHO)], peer-reviewed journals, and governmental publications.

Inclusion criteria encompassed peer-reviewed articles, official reports, and relevant case studies published in English from 2000 to September 2024. Exclusion criteria were articles not focused on governance aspects of One Health or lacking substantial empirical data.

### 2.2. Analytical framework

The analysis of the case practical studies was guided by systems thinking and the principles of good governance drawing on frameworks provided by Meadows (2008) [6] for systems thinking and Graham et al. (2003) [7] for good governance principles.

The targeted components included multi-disciplinary collaboration, policy integration, stakeholder engagement and ethical considerations. Indeed, systems thinking was applied to identify components, interactions, and feedback loops within One Health governance. By analyzing relationships between human health, animal health, and environmental factors, the approach helped illustrate how changes in one component can affect others.

In addition, the public-private partnership (PPP) of One Health governance was assessed with regard to a previously published framework, allowing to cover a wide variety of potential cooperative arrangements [8] (Fig. 1).

### 2.3. Data analysis

A qualitative thematic analysis was employed to synthesize information from the selected case studies and the literature following the approach outlined by Braun and Clarke (2006) [9].

The analysis focused on identifying key themes related to the characteristics, architecture, practical applications, and ethical functions of One Health governance. This involved coding data, identifying patterns, and interpreting findings in relation to the research question.

Three practical case studies were selected for their relevance in demonstrating One Health governance challenges and applications.

(1) Shared water resources in the Lake Chad Basin [10];
(2) Crisis of superimposed desert locust plague and COVID-19 outbreaks in Sub-Saharan Africa and South-West Asia (2019–2020) [10];
(3) China's mycorrhizal technology contributions to sustainable development in Africa [11].

These cases were chosen because they exemplify the complexities of implementing One Health governance in different contexts and highlight the importance of collaborative efforts across sectors and regions.

### 3. Theories of One Health governance

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 broader environment (including ecosystems) as closely linked and interdependent [12]. Therefore, there exists a One Health approach for optimal governance structure in addressing the global challenges concerning human health, diseases and health related issues affecting animals and the ecosystems so as to help foster cooperation between different sectors.

Since One Health approach is a global public good (GPG), One Health governance requires collaborative efforts among multiple stakeholders and must be applied across multi-layered scenarios and necessitating PPP. According to the GPG theory, a "good" is one that is rational for a group of nations to produce for universal consumption, and from which it
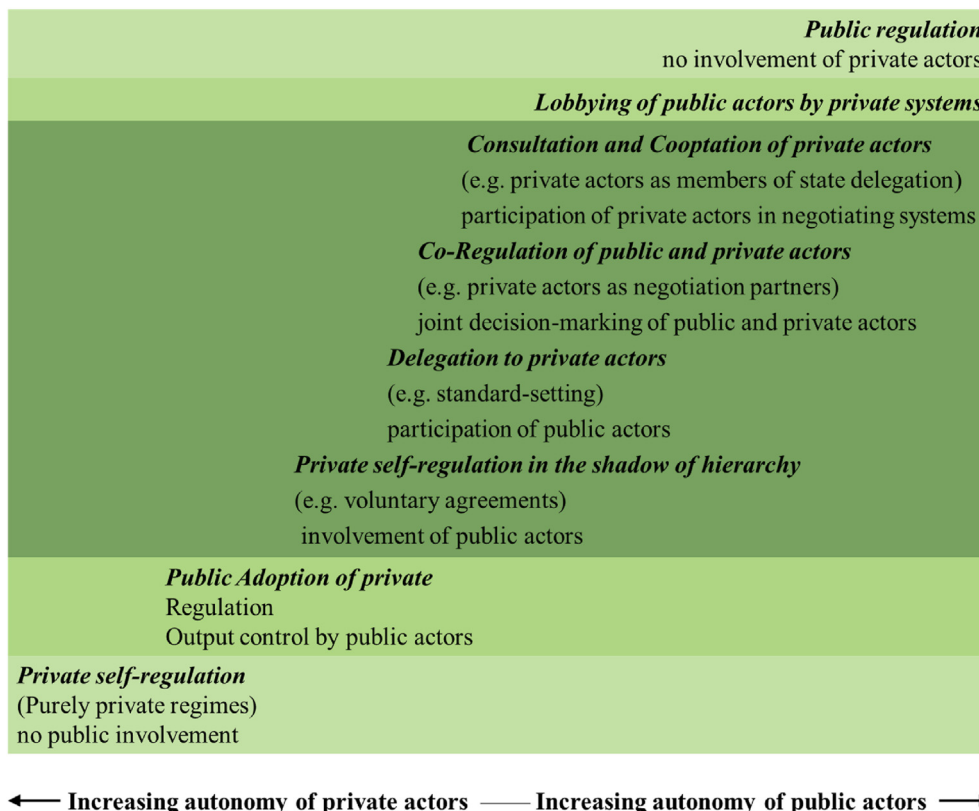


**Fig. 1.** The realms of public-private partnerships in One Health governance architecture [8].

is irrational to exclude any individual nation from consuming [13]. One Health principles align well with a key component of GPG theory: the promotion of international collective action [13]. One Health governance encourage approaches to deal with health challenges, as seen in the international response, incorporating broader philosophies and more holistic approaches to health outside of crisis situations.

Besides, systems thinking may also act as a lens for further exploring the characteristics and architecture of One Health governance. Systems thinking stems from complexity theory, analyses interactions between systems' components to explain how and why they give rise to observed system outcomes and behaviours [14]. Systems thinking facilitates an in-depth exploration of One Health governance, as it requires broader stakeholder engagement and more coordinated work across multiple building blocks. By involving non-linear relationships and feed-back loops between components of complex entities at different scales [15], systems thinking thus helps identify the relationships between different health determinants and multiple stakeholders of One Health governance. Furthermore, applied systems thinking may be fully and equally appreciated in policymaking and practice [14], strengthening long-term One Health collaborations and health systems in low- and middle-income countries (LMICs) in particular.

### 3.1. Characteristics of One Health governance

#### 3.1.1. Multi-disciplinary and multi-sectoral collaboration

One Health governance integrates the knowledge and expertise of multiple disciplines, including public health, veterinary science, ecology, environmental science, etc., while fostering collaboration among government departments, international organisations, the private sector, and academia to address complex health issues [13,16–20].

#### 3.1.2. Integrative view of health and a precautionary approach

One Health governance takes an integrative approach to the interconnections between human, animal and environmental health, emphasising the importance of preventative measures to reduce threats to human and animal health and to protect the environment [21,22].

#### 3.1.3. Policy integration, shared responsibility and evidence-based decision-making

One Health governance facilitates consistency between disparate policies and legal frameworks [23], enables all relevant parties to be involved in health management and policy implementation, which is based on rationality, while ensuring that people who make decisions and policies are responsible for their actions.

There is a strong relationship between good governance [24] and One Health governance (Table 1).

This set of principles of good governance constitutes the theoretical approach and backbone of One Health governance to ensure that it is efficient, responsive, equitable and inclusive, participatory, transparent, and cost-effective. As principles of good governance are applied, One Health governance enhances the capacity to deal with complex health challenges and safeguard the health of populations and ecosystems. One Health approaches offer good governance and are achieved through treaties, coordination mechanisms, collaborative plans of action, multi-sectoral integrated risk management strategies, collaborative science initiatives, and integrated funding.

Through partnerships, coordination of joint action plans, collaboration across disciplines and sectors, integrated risk assessment strategies, joint research initiatives and streamlined financing, One Health approaches provide a sound basis for good governance [25].

### 3.2. One Health governance architecture

A multi-disciplinary, multi-sectoral and cross-sectoral approach to governance is usually adopted, which emphasises cross-disciplinary,

**Table 1**
Difference between good governance and One Health governance.

| Contact point | Good governance | One Health governance |
|---|---|---|
| Transparency and accountability | Emphasises transparency and accountability, ensuring that decision-making processes are open and decision-makers are held accountable for their decisions | Requires transparency and accountability to ensure that interdisciplinary and cross-sectoral cooperation is effective and that resources are allocated appropriately |
| Participation and inclusivity | Promote broad stakeholder participation and inclusiveness to ensure that the voices of diverse groups are heard | Requires the involvement of multiple sectors and stakeholders, including public health, veterinary medicine, environmental science, etc., as well as government, the private sector and communities |
| Rule of law and legality | Based on the principle of the rule of law and ensuring that all acts are in accordance with the law | Needs to operate within the legal framework to ensure the legitimacy of cross-sectoral cooperation and the implementation of policies |
| Efficiency and effectiveness | Pursuing effective and efficient use of public resources | Aims to increase the efficiency and effectiveness of health interventions and reduce wasted resources through cross-sectoral collaboration |
| Capacity building and sustainable development | Emphasises capacity-building to improve public administration and service delivery | Capacity building is needed so that experts in different fields can work together to achieve sustainable development for human, animal and environmental health |
| Policy integration and coordination | Promotes coherence and coordination between different policies | Integrating between human, animal and environmental health policies to ensure that policy objectives are mutually supportive |
| Preventive and forward looking | Taking preventive measures to avoid problems rather than just responding to problems | Preventing the spread of disease among humans, animals and the environment through surveillance and early intervention |

cross-sectoral and cross-field cooperation, as well as the participation of different levels of government, non-governmental organizations (NGOs), the private sector, communities and citizens. One Health governance should seek to maximize the creativity and initiative of the public in terms of their participation and, within the coordinated framework of the government, make use of various types of local self-governing associations, grassroots organisations, community volunteer groups, etc., to build up a system, which is comprehensive and muti-vector of social governance.

#### 3.2.1. Multiple stakeholders of One Health governance

Effective governance mechanisms are essential for facilitating collaboration and coordination among stakeholders involved in One Health initiatives [22].

A One Health governance model emphasises collaboration and communication between these subjects to address complex challenges involving human, animal and environmental health through building partnerships. This model requires mutual respect, shared resources, coordinated action, and shared responsibility among the subjects. The stakeholders of One Health governance involve multiple levels and types of organisations and individuals [26,27], including government sector, international organisations, NGOs, private sector, academic and research institutions, communities and citizens. Other stakeholders, e.g. the media, play a role in information dissemination and public education [28]. Financing institutions, e.g. World Bank, Asian Development Bank,

etc., provide financial support. Policy makers and legislators formulate and revise relevant laws and policies [13,16,29] (Table 2).

### 3.2.2. Three scenarios applied with One Health governance

The scenarios of One Health governance refer to the specific areas or contexts in which the concept of One Health is applied to practice, which involve the intersection of human, animal and environmental health. This requires that One Health practice be characterized by comprehensiveness, whole domain, entire process and all personnel. Comprehensiveness means that health governance should cover all health-related domains, including physical health, mental health, social health and environmental health. This involves health care, disease prevention, health education, nutrition, environmental health, occupational health and other aspects. Whole domain means that health governance should cross different geographic areas and administrative levels, including urban, rural and remote areas, as well as the participation of governments and social organisations at all levels, including national, provincial, municipal, county, township and village. Entire process means that One Health governance should run through the entire cycle of policy formulation, implementation, monitoring, evaluation and feedback. In order to sustain One Health at all its level, it requires continuous attention and management from problem identification, policy formulation, implementation, policy effects evaluation to policy adjustment. All personnel suggests that health governance should foster the involvement of many relevant actors and their networks including government officials, health professionals, community workers, educators, enterprises, citizens and so on. This calls for broad and deep collaboration across

**Table 2**
Multiple stakeholders of One Health governance.

| Stakeholder Type | Role | Examples |
|---|---|---|
| Government sector | Implement risk reduction measures, respond to zoonotic diseases, plan and coordinate | Health sector, agriculture sector, environmental protection departments, other relevant departments |
| International organisations | Global and regional health and environmental affairs | WHO, WOAH, UNEP, FAO, IFRC, as well as other regional and international organisations for health and the environment |
| NGOs | Advocate for issues and provide professional support | Environmental NGOs, public health NGOs, animal welfare NGOs, professional associations, academic groups, etc. |
| Private sector | Focus on policy implementation and continuity, may implement risk reduction measures to avoid production and economic losses | Healthcare companies, veterinary drug and vaccine manufacturers, food and agribusinesses, environmental service companies, scientific research organisations, consulting firms |
| Academic and research institutions | Provide expertise for disease diagnosis, data analysis, and specialized technical activities; train human resources | Universities, independent research institutes, medical and veterinary colleges |
| Communities and citizens | Promote community participation in policy and activity implementation | Community leaders, grassroots health workers, volunteers, general public, consumers |
| Other stakeholders | Information dissemination; public education; financial support; policy and law formulation | Media, financing institutions (e.g., world bank, Asian development bank), policy makers, legislators |

Abbreviations: NGOs, non-governmental organizations; WHO, World Health Organization; WOAH, World Organisation for Animal Health; UNEP, Uited Nations Environment Programme; FAO, the Food and Agriculture Organization of the United Nations; IFRC, the International Federation of Red Cross and Red Crescent Societies.

sectors, disciplines and levels. Thus, the One Health arena can be categorized into three arenas: global, regional and national [2] (Table 3).

### 3.2.3. PPP of One Health governance

The essential definition of the term PPP in governance of One Health feels incomplete without other sectors' involvement, that is private sector, academic, NGOs, community and other bodies, to tackle the complex problem of human, animal and ecosystem health [13]. PPP of One Health governance covers a wide variety of potential cooperative arrangements [8]. The following requirements need to be considered when implementing a PPP model. Firstly, there needs to be a common goal and coordination: PPPs are usually coordinated around common health goals, such as controlling infectious diseases, improving food safety or protecting the environment. Secondly, there is a need to meet resource-sharing objectives: partners share resources, including funding, expertise, technology, equipment and human resources. Thirdly, shared risks and responsibilities: with regard to public-private partnership, all parties share the risks and responsibilities of project implementation, thus relieving any single party from too much burden. Fourthly, the concerted policy formulation and implementation: government institutions have a responsibility to devise strategies, while the private sector and other organisations may become active in applying such policies, offering creativity and adaptability.

The most relevant scenarios of One Health governance through a PPP model are as follows. (1) Research and surveillance: public institutions partner with universities and private research organisations for disease surveillance, epidemiological studies and vaccine's research. (2) Health interventions: department of public health partner with pharmaceutical companies and NGOs in undertaking vaccination activities, disease prevention and control. (3) Capacity building: state collaborates with professional bodies and educational institutions to offer recruitment and professional upgrading for public health and veterinary practitioners. Training should be provided to community health workers, program managers, and policymakers on the critical social determinants that must be addressed to effectively influence zoonotic disease interventions within the nation. (4) Infrastructure development: public health resources including laboratories, disease surveillance systems, and sanitation facilities are provided, construced or improved by governments in cooperation with the private sector. (5) Policies and regulations: standards of food safety, environmental protection and animal welfare policies are formulated and enforced with the governments, industry and consumers together. The above mentioned measures are accomplished in conjunction with social scientists (sociologists, anthropologists, demographers, etc.) engaged in designing, implementing and evaluating of policies, programs, research and training courses, to devise communication strategies that respond to gender, indigenous and ethnic minorities, and diverse cultural practices.

The One Health approach societal governance of PPP models must centre several societal aspects: leadership and governance structures, which clarifies the roles and responsibilities of all parties, and establishes effective decision-making and management structures [27]; communication and transparency, which ensures open communication among partners and maintains project transparency to build trust; sustainability and flexibility, which designs partnerships for long-term sustainability and maintains flexibility to adapt to changes; evaluation and monitoring, which establishes monitoring mechanisms to ensure that goals are met and continuous improvement is achieved. By effectively managing these aspects, PPPs can help tackle complex health challenges, leverage the strengths of all parties, and achieve broader social and economic benefits.

## 4. Practice cases of One Health governance

The effects of a One Health approach are complex and many are indirect, or not immediately visible to policymakers. Collaboration during outbreaks was positive but not sustained. Mechanism for enhanced collaboration should be developed for endemic and outbreak situations.

**Table 3**
Three scenarios applied with One Health governance.

| Level | Roles | Domains | Activities | Examples |
|---|---|---|---|---|
| Global | (1) Consolidating One Health surveillance through international treaties; (2) Funding of capacities should be prioritized; (3) Strengthening environmental dimension through regular reports and risk assessments | Global health security and disease surveillance<br><br>Global environment and ecosystems protection<br><br>Global food safety and nutrition scene | Coordination through mechanisms; international health response measures<br><br>Reducing pollution; protecting biodiversity; addressing health impacts of climate change<br><br>Promoting food safety standards and nutrition policies; improving sustainability of food systems | (1) The ongoing pandemic treaty; (2) Convention on biological diversity; (3) The joint action plan for global health (2022–2026); (4) Global Outbreak Alert and Response Network (GOARN); (5) Global Virus Network (GVN); (6) The aquatic animal health code |
| Regional | (1) Influencing One Health implementation at a downstream level through trade standards or bans; (2) Incenting regional grouping countries to research and development, and to mitigate risks | Disease surveillance and control<br>Food safety<br><br>Antimicrobial resistance management<br><br>Ecosystem protection | Establishing cross-border data sharing and early warning systems<br>Sharing latest technologies for monitoring and controlling pathogens in food<br>Developing policies and sharing best practices for the rational use of antimicrobials<br><br>Managing impacts of human activities on wildlife habitats | (1) One Health network South East Asia; (2) Southeast Asia One Health University Network (SEAOHUN); (3) One Health Alliance of South Asia (OHASA); (4) The One Health Action Commission (OHAC) |
| National | (1) Stronger institutionalized cooperation between government departments; (2) Transferring One Health approaches to government action | National level domains | Legislation and standard setting; policy development; resource cooperation and allocation; public health promotion | (1) Implement measures such as travel restrictions, epidemic reporting systems to control the cross-border zoonotic diseases; (2) Establish a team composed of health, agriculture, and environment department to jointly formulate epidemic response strategies; (3) Inter-departmental coordination, construction of monitoring and early warning platforms |
| | | Provincial application domains | Formulate specific prevention and control measures according to national policies; share epidemic information with veterinary departments; collaborative research on epidemic prevention and control technologies with local universities, research institutions, enterprises; encourage community participation | (1) Close live poultry markets and implement vaccination; (2) Jointly carry out epidemiological investigations and laboratory testing; (3) The global health institute of the tropical disease research center at Shanghai Jiao Tong University released the world's first One Health index; (4) Organize volunteers to promote knowledge of avian influenza prevention and control in community |
| | | Community scenario analysis | Health education; disease prevention; waste management; livestock management; local monitoring empowerment | (1) Conduct lectures on disease prevention; (2) Promote safe drinking water, toilet facilities, and regularly deworming pets; (3) Establish garbage collection and disposal system; (4) Guide scientific feeding methods to reduce livestock infection risk |

Countries would benefit from capacity-building efforts to support One Health governance at the global, regional and national levels.

### 4.1. Shared water resources in the Lake Chad Basin

The Lake Chad Basin is located in north–central Africa and Lake Chad provides livelihoods for over 30 million people in four neighboring countries (Chad, Cameroon, Niger and Nigeria). Once affected by severe droughts, Lake Chad now faces increased pressure on its resources due to population migration, poorly planned upstream hydrological and agricultural projects, climate change and increasing militarization. It is estimated that some 107 million people in the region are in need of humanitarian assistance and 5 million people face severe food insecurity. Joint management of water resources therefore remains crucial for regional health security [10,30].

The Lake Chad Basin Commission (LCBC), established in 1964 with a membership of the four countries mentioned above and later expanded to include the Central African Republic, Libya and four observer countries (Sudan, Egypt, Republic of the Congo and the Democratic Republic of the Congo), works to coordinate access to, and the use of, the resources in and around Lake Chad [30–32]. In 2012, the member countries acceded to the legally binding Water Charter [30], which aims to equitably address water management issues, establish rules for surrounding wetlands and fish populations, maintain water quality, prevent water-related diseases and ecological hazards, coordinate monitoring, evaluation and communication tools, and support civil society participation in the above objectives. Failure to comply with the Water Charter can lead to political and legal consequences.

However, LCBC has faced political and technical constraints and need to cope with competing economic interests and resource shortages [10]. Nigeria, as the most influential member, has a key role to play in policies and solutions, for example, by supporting the Ubangi Interbasin Water Transfer Project and thereby replenishing Lake Chad. The climate change has led to pastoralist-farmer conflicts, exacerbating food and water shortages. Failure of state services, weak social trust, corruption and human rights violations affect the legitimacy of governance. Basin commissions are unable to provide climate-sensitive economic packages and require the intervention of national ministries or regional economic institutions. Basin commissions seek to address long-term recovery and resilience in the regional stabilization strategy. In 2019, the United Nations Development Program raised $60 million for the strategy, with better cost-effectiveness and co-benefits [10]. In particular, integrated interventions focusing on One Health integrated water resources management, climate adaptation, social cohesion and peace building contribute to improved food, health care and basic human rights, and reduce conflict and insecurity expenditures.

The case of shared water resources in the Lake Chad Basin indicates that an effective One Health governance requires long-term institutional approaches, legal and policy process as well as regional actor-networks.

### 4.2. Crisis of superimposed desert locust plague and COVID-19 outbreaks in Sub-Saharan Africa and South-West Asia, 2019–2020

The 2019–2020 desert locust plague in East Africa and South-West Asia destroys large areas of rangeland and farmland. Although locusts do not harm humans or animals, a single swarm of locusts of up to 1 square kilometer in size can destroy an area of crops that would otherwise feed 35,000 people. As a result, locust infestations have led to a severe nutritional emergency that threatens the food security of 25 million people in West Africa, the Sahel, the Greater Horn of Africa and South-West Asia.

For many years, the Food and Agriculture Organization of the United Nations (FAO) Desert Locust Information Service (DLSIS), in cooperation with national locust information officers, has taken rigorous monitoring measures for countries on the front line of locust invasion epidemics, including the production of daily bulletins and six-weekly forecasts and the operation of the Desert Locust Early Warning System (DLEWS). However, climate change has led to successive swarms of locusts forming and breeding from 2018 onwards, migrating westwards from Asia to Africa. This has also led to the continuation of crises, shortening the recovery time between locust swarms and making previously consistent forecasts highly unpredictable. In countries such as Kenya and Pakistan, the locust plague was the first outbreak in decades [10]. Extreme weather events continue to jeopardize harvesting, fishing and livestock farming in these areas. This additional challenge stems from the persistent global health security risks in these regions, including child malnutrition, infectious diseases (such as meningitis and malaria in the African meningitis belt region), armed conflict and natural disasters. In the East African region, where the desert locust is less common, the surge in migratory flows has put pressure on already fragile countries, most of which are ill-prepared and underfunded to access biopesticide control.

In addition, the ability to contain this crisis has been weakened by the demands of social distancing and movement restrictions that have disrupted the flow of migrant agricultural labour, supplies of pesticide products and even humanitarian aid. As countries shifted the focus of their foreign assistance to epidemic control, the epidemic further weakened the availability of funds to respond to such shocks. The impact of economic stagnation and recession, including massive unemployment, reduced the purchasing power and crisis resilience of individuals and countries. Massive crop losses further exacerbated malnutrition, hunger, soaring food prices and conflicts over natural resources.

The UN World Food Program estimates that long-term recovery costs could exceed $1 billion. The World Bank's conservative estimate of locust damage in the Horn of Africa is also as high as $8.5 billion. While the World Bank has approved $500 million for projects aimed at securing livelihoods and promoting recovery, this financing has a low capacity to mitigate the long-term damage caused by overlapping crises [33,34]. It is worth mentioning that some local governments have experimented with innovative measures to preserve the integrity of the food supply chain in the short term. For instance, a successful pilot project has been approved by the Pakistani government in June 2020, which paid local farmers to collect locusts overnight and then make them into chicken feed [10]. The project has been replicated by a private start-up in Kenya [10]. However, these initiatives remain small-scale because they cannot rely on locusts collected from areas where pesticides have been used, and because national authorities are cash-strapped and do not have sufficient funds to compensate collectors [10]. If these initiatives become the only way to provide financial support to poor people in times of famine or food shortages, they may also become perverse triggers for ongoing crises. The secondary consequences of conditional financing should be considered in the long term, and they should not impede "One Health" innovations aimed at multi-functionality and cross-sectorality [10]. At the same time,

there is growing evidence of the value of direct cash transfers to socio-economically marginalized households, which can be used with flexibility and dignity, and which should be emphasised to donors to ensure that local populations have access to basic commodities. Response financing should go beyond donor targets or predetermined thresholds set by proprietary modelling software.

This case indicates the added challenge that requires detection of disease containment strategies as well as a long-term and global political commitment for dealing with the "root causes" of outbreaks [35]. In other words, despite enhancing the early warning systems, improving funding capacities, in particular creating incentives of capacity building should also be in priority.

### 4.3. China's mycorrhizal technology contributes to sustainable development in Africa

Mycorrhizal technology solves the world problem of "cutting down trees for edible fungi production" by cultivating edible fungi with "grass instead of wood". Mycorrhiza is a pioneering plant for ecological management. It has a well-developed root system, high photosynthetic efficiency, wide adaptability, drought resistance, salinity resistance, barrenness resistance, strong resistance, water retention and soil retention. Among them, giant fungus grass which can reach a height of 7 m, is rich in endogenous nitrogen-fixing bacteria, can grow rapidly on slopes, sandy land, saline and alkaline land, and can effectively improve saline and alkaline land. Fungus grass has a wide range of uses. In addition to the cultivation of mushrooms, crop compost, it can also be used as livestock feed [11].

The One Health approach is one of collaborative priorities among China–Africa collaboration in health development [36]. China–Africa mycorrhiza exchanges and cooperation have been ongoing for nearly 30 years, exploring a variety of cooperative forms [37], such as organizing mycorrhizal tech training for Africa, establishing demo bases and centres, sending experts for long-term tech localization and promotion, and partnering with UN departments to host seminars for African mycorrhizal industry experience sharing.

Mycorrhizal technology can help counter the effects of soil erosion and desertification and provide solutions for dealing with land degradation, better supporting food production and farmers' livelihoods in African countries. In Rwanda, planting giant mycorrhizal grassland reduces soil erosion by 97.05–98.9 percent and water loss by 80–91.9 percent compared to planting maize, and mycorrhizal ecological management has been listed as a key national erosion management project in Rwanda. According to statistics, 64 % of the arable land in the southern region of Lesotho has serious soil erosion [11]. Local scholars believe that cooperating with China in planting mycorrhizal grass will be conducive to the maintenance and restoration of the existing arable land, water conservation, windbreaks and sand fixation, and the enhancement of crop yields.

In Rwanda, more than 35,000 farmers have received training in mycorrhizal technology, and more than 3800 families and 50 companies and cooperatives are engaged in related businesses. In South Africa, the Sidra Research and Training Centre for Mycorrhizal Technology has provided more than 200 permanent jobs for local farmers, trained 507 trainees, and benefited more than 10,000 families. In Lesotho, the "10-square-metre mushroom cultivation model" has been promoted, enabling land-deficit farmers to produce 1.2 tons of fresh mushrooms on 10 square metres of land annually, which has greatly improved the livelihoods of the local people. In Madagascar, mycorrhizal technology has played an important role in alleviating the shortage of fodder in some localities and in promoting the development of the animal husbandry industry [11].

This case indicates the need for sustainable environmental health interventions, providing direction for effective One Health governance.

## 5. Ethics and ethical functions of One Health governance

Ethics, derived from the Greek word "*ethos*", meaning "behaviour", is concerned with questions about right versus wrong conduct, the

justificatory basis for such questions, and the reconciliation of situations involving conflicting values (e.g. ethical dilemmas) [38]. It helps health professionals, policy makers and researchers to make ethically sound decisions by providing guidance for action in situations of conflicting values [39]. One Health governance processes reflect a gradual shift from anthropocentrism to ecocentrism [4]; however, ethical challenges such as resource allocation, animal welfare, and environmental protection may be encountered [40,41]. Assessments of ethical solutions regarding, for example, zoonotic diseases that significantly affect animal well-being but do not pose serious health risks to humans, or the culling of healthy animals as a safety measure, can and will differ considerably [42]. In particular, it's crucial to be vigilant against three potential negative outcomes: the increasing health inequalities [5,43–45], imperialistic attitudes [44,46] and ethical accountability.

### 5.1. Addressing the challenge of inequality in One Health implementation

Implementing a One Health approach at the national level implies the need for: (1) advanced knowledge, including trained scientists trained and appropriate scientific and health infrastructure [35,47]; (2) economic resources for research and health care [23,47]; and (3) policymakers' willingness to adopt the approach and establish structural health policies [3,26,47]. In the absence of these elements, it is difficult for a country to make progress in implementing a One Health approach.

These elements can be challenging for less developed countries, making it harder for them to implement costly policies with medium-to-long-term benefits, especially when immediate political returns are not guaranteed. i.e., investments in resources that do not bring immediate returns and may be unpopular from the viewpoint of the political consensus of the leadership group, as is often the case with environmental policies in their initial stages. This could lead to a disparity where some regions benefit from a One Health approach while others lag, exacerbating health inequalities globally.

### 5.2. Guarding against imperialist attitudes

The implementation of One Health requires incentives to guard against excessive political pressure on other countries. On the one hand, a One Health approach can constitute a form of international co-operation and assistance that can benefit all participants in the process, especially those with limited resources. On the other hand, One Health implementation cannot be undertaken externally only, but should take into account the traditions, beliefs, social practices and customs of the populations concerned [44]. For instance, live poultry or wet markets in developing countries are old and deeply rooted parts of popular culture [48], and bans on all food practices associated with them may be difficult to eliminate, and short-lived bans may be quickly repealed. Furthermore, a blind ban will push people to resort to underground market. Social equity and livelihoods must be taken into account when managing wet markets (including those involving the legal consumption of wild meat for additional regulation [49,50]. A ban should be strictly regulated and enforced but alternatives (from rearing) should be offered. Some countries face many competing interests, such as hunger, malnutrition, food insecurity and socio-political instability. Some populations may be overly dependent on these protein sources to meet their food security needs. There is limited access to services and a lack of resources in these countries. While these populations may be more vulnerable to disease events, the implementation of drastic regulatory reforms in these areas could face strong resistance, potentially reducing compliance with One Health approaches.

### 5.3. Making stakeholders accountable

Legal accountability in global health has been problematic. WHO and other intergovernmental organisations are officially accountable to their Member States, but they often lack detailed and realistic targets for health outcomes or for the intermediate actions they take to promote health; States themselves tend to enter into voluntary, rather than binding commitments towards health, making it difficult to hold them accountable under such weak mechanisms. Other actors, such as civil society, foundations and corporations, report to an array of different interest groups and are hard to be held accountable for their failures or shortcomings [51].

Ethical accountability is thus more significant for effective One Health governance, ensuring that ethical considerations are integrated in decision-making and actions, and that the interests of all stakeholders are respected [24]. Accreditation bodies are increasingly emphasizing the importance of ethical accountability at the highest level of health organisations, paying greater attention to defining the moral attributes and competencies of ethical leadership, and developing standards to monitor and evaluate ethical performance of these health organisations [38].

Greater transparency seems to facilitate more accountable decision-making and actions in One Health governance, as it requires that citizens be fully informed about the procedures, criteria and evidence underlying decision-making. The digital age has introduced a number of new technologies that can enhance the visibility of public and private activities. However, the design and effectiveness of transparency systems are contested [52]. Two questions are particularly pertinent here. First, who controls the information made accessible through transparency and traceability schemes; and second, how and by whom is this information used?

The One Health Joint Plan of Action emphasises data sharing [47], which is crucial for bolstering the scientific evidence base and translating knowledge into data for evidence-based decision-making. However, these tools might largely be developed as proprietary "risk assessment algorithms" by corporate "data science for impact" programs, for-profit global health firms and non-profit organisations, similar to those used in the development of pandemic insurance programs or comparable analytics [53]. Without appropriate governance, the countries with the highest burden of zoonotic emergence might find their own data (repackaged in an analytic format) sold back to them at a premium by corporations from high-income countries [53,54]. Another example in Cambodia indicated that research priorities are set by the granting agencies and laboratories from developed countries based on the benefits they can have from publications in big journals or tackling scientifically important issues but not on health priorities in developing countries [55]. Therefore, concerted efforts are needed to govern data sharing accountability and prevent the monopolization of critical health data.

## 6. Conclusion

There is a general consensus that the idea of One Health shapes governance and ethics to achieve synergistic protection of human, animal, and environmental health. Governance facilitates the implementation of One Health policies, while ethics provides moral guidance for these actions. The convergence of these two domains not only assists in solving present health problems, but also establishes a firm basis for building a more sustainable and healthy future.

**Credit authorship contribution statement**

**Yinling Zhou:** Writing – original draft, Resources, Formal analysis. **Roger Frutos:** Writing – review & editing, Formal analysis, Conceptualization. **Issam Bennis:** Writing – review & editing, Conceptualization. **Mayumi D. Wakimoto:** Writing – review & editing, Supervision, Resources, Methodology, Conceptualization.

**Funding**

## Declaration of competing interest

All authors disclosed no relevant relationships.

## References

[1] X.X. Zhang, Z. Lederman, L.F. Han, J.M. Schurer, L.H. Xiao, Z.B. Zhang, et al., Towards an actionable One Health approach, Infect. Dis. Poverty 13 (1) (2024) 28, https://doi.org/10.1186/s40249-024-01198-0.

[2] M. Bayerlein, P.A. Villarreal, "One Health" and Global Health Governance: Design and Implementation at the International, European, and German Levels, 2023. https://www.swp-berlin.org/publications/products/comments/2023C43_OneHealth_EN.pdf. (Accessed 4 August 2024).

[3] K. Lee, Z.L. Brumme, Operationalizing the One Health approach: the global governance challenges, Health Pol. Plann. 28 (7) (2012) 778–785, https://doi.org/10.1093/heapol/czs127.

[4] B. Capps, One health ethics, Bioethics 36 (4) (2021) 348–355, https://doi.org/10.1111/bioe.12984.

[5] O.J. Mujica, C.E. Brown, C.G. Victora, P.O. Goldblatt, J. Barbosa da Silva Jr., Health inequity focus in pandemic preparedness and response plans, Bull. World Health Organ. 100 (2) (2022) 91, https://doi.org/10.2471/BLT.21.287580.

[6] J. Graham, B. Amos, T. Plumptre, Principles for Good Governance in the 21st Century, Institute on Governance, 2003.

[7] D.H. Meadows, Thinking in Systems: A Primer, Chelsea Green Publishing, New York, 2008.

[8] T.A. Börzel, T. Risse, Public private partnerships:effective and legitimate tools of transnational governance ?, in: L.W.P. Edgar Grande (Ed.), Complex Sovereignty: On the Reconstitution of Political Authority in the 21st Century, De Gruyter, Berlin, 2004.

[9] V. Braun, V. Clarke, Using thematic analysis in psychology, Qual, Res. Psychol. 3 (2) (2006) 77–101, https://doi.org/10.1191/1478088706qp063oa.

[10] A. Elnaiem, O. Mohamed-Ahmed, A. Zumla, J. Mecaskey, N. Charron, M.F. Abakar, et al., Global and regional governance of One Health and implications for global health security, Lancet 401 (10377) (2023) 688–704, https://doi.org/10.1016/S0140-6736(22)01597-5.

[11] China News, What Is the Story of 'Chinese Grass' Grown in Africa?, 2024. https://www.chinanews.com.cn/dxw/2024/09-05/10280814.shtml. (Accessed 4 August 2024).

[12] One Health High-Level Expert Panel (OHHLEP), One Health: a new definition for a sustainable and healthy future, PLoS Pathog 18 (6) (2022) e1010537, https://doi.org/10.1371/journal.ppat.1010537.

[13] J. Zinsstag, E. Schelling, L. Crump, M. Whittaker, M. Tanner, C. Stephen, One Health: The Theory and Practice of Integrated Health Approaches, 2nd Edition, CABI Books, Oxfordshire, 2015.

[14] A. Kwamie, S. Ha, A. Ghaffar, Applied systems thinking: unlocking theory, evidence and practice for health policy and systems research, Health Pol. Plann. 36 (10) (2021) 1715–1717, https://doi.org/10.1093/heapol/czab062.

[15] J. Zinsstag, E. Schelling, D. Waltner-Toews, M. Tanner, From "one medicine" to "one health" and systemic approaches to health and well-being, Prev. Vet. Med. 101 (3–4) (2011) 148–156, https://doi.org/10.1016/j.prevetmed.2010.07.003.

[16] WHO, Taking a Multisectoral, One Health Approach: A Tripartite Guide to Addressing Zoonotic Diseases in Countries, 2019. https://iris.who.int/bitstream/handle/10665/325620/9789241514934-eng.pdf?sequence=1. (Accessed 4 August 2024).

[17] S.S. Abbas, T. Shorten, J. Rushton, Meanings and mechanisms of one health partnerships: insights from a critical review of literature on cross-government collaborations, Health Pol. Plann. 37 (3) (2022) 385–399, https://doi.org/10.1093/heapol/czab134.

[18] M. Palkovits, S.R. Van Katwyk, S.J. Hoffman, Embed multisectoral governance mechanisms in the pandemic instrument for one health action, J. Law Med. Ethics 50 (S2) (2023) 71–81, https://doi.org/10.1017/jme.2023.30.

[19] A.A. Aguirre, V.R. Beasley, T. Augspurger, W.H. Benson, J. Whaley, N. Basu, One health—transdisciplinary opportunities for SETAC leadership in integrating and improving the health of people, animals, and the environment, Environ. Toxicol. Chem. 35 (10) (2016) 2383–2391, https://doi.org/10.1002/etc.3557.

[20] F.C.J. Berthe, T. Bouley, W.B. Karesh, I.C. Legall, C.C. Machalaba, C.A. Plante, et al., One Health Operational Framework for Strengthening Human, Animal, and Environmental Public Health Systems at Their Interface, 2018. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/961101524657708673/one-health-operational-framework-for-strengthening-human-animal-and-environmental-public-health-systems-at-their-interface. (Accessed 4 August 2024).

[21] J. Vinuales, S. Moon, G. Le Moli, G.L. Burci, A global pandemic treaty should aim for deep prevention, Lancet 397 (10287) (2021) 1791–1792, https://doi.org/10.1016/S0140-6736(21)00948-X.

[22] S.A. Faijue Dd, A.O. Segui, K. Shringarpure, A. Razavi, N. Hasan, O. Dar, et al., Constructing a One Health governance architecture: a systematic review and analysis of governance mechanisms for One Health, Eur. J. Publ. Health (2024) ckae124, https://doi.org/10.1093/eurpub/ckae124.

[23] K.K. Mwacalimba, J. Green, One health' and development priorities in resource-constrained countries: policy lessons from avian and pandemic influenza

[24] preparedness in Zambia, Health Pol. Plann. 30 (2) (2015) 215–222, https://doi.org/10.1093/heapol/czu001.

[24] UNDP, Good Governance in Education, 2010. https://info.undp.org/docs/pdc/Documents/MKD/00049939_Good%20governance%20in%20Education%20-%20English%20_final%20corrected_.pdf. (Accessed 4 August 2024).

[25] J. Landford, M. Nunn, Good governance in 'one health' approaches, Scientific & Technical Review 31 (2) (2012) 561–575.

[26] OHHLEP, One Health Theory of Change, 2022. https://www.who.int/publications/m/item/one-health-theory-of-change. (Accessed 4 August 2024).

[27] C. Stephen, B. Stemshorn, Leadership, governance and partnerships are essential One Health competencies, One Health 2 (2016) 161–163, https://doi.org/10.1016/j.onehlt.2016.10.002.

[28] R. Amelia, H. Wijaya, P. Eyanoer, Y. Yunanda, A. Wahyuni, I. Fujiati, et al., Education and socialization of mosquito nest erradication with 3M plus movement to students and teachers at SMA Negeri 1 Binjai district, Langkat district, North Sumatera, Indonesia, ABDIMAS TALENTA: Jurnal Pengabdian Kepada Masyarakat 9 (1) (2024) 85–89, https://doi.org/10.32734/abdimastalenta.v9i1.17177.

[29] O. Moneer, G. Igihozo, L. Wotton, One Health approaches require community engagement, education, and international collaborations—a lesson from Rwanda, Nat. Med. 27 (6) (2021) 940–943, https://doi.org/10.1038/s41591-021-01350-5.

[30] UNESCO, The United Nations World Water Development Report 2024: Water for Prosperity and Peace, 2024. https://unesdoc.unesco.org/ark:/48223/pf0000388948. (Accessed 4 August 2024).

[31] Britannica, African agency, Lake Chad Basin Commission. https://www.britannica.com/topic/Lake-Chad-Basin-Commission. (Accessed 4 August 2024).

[32] IMF, Lake Chad Basin Commission (LCBC), 2002. https://www.imf.org/external/np/sec/decdo/lcbc.htm. (Accessed 4 August 2024).

[33] DLSIS, Greater Horn of Africa and Yemen – Desert Locust Crisis Appeal, January–December2020, Rapid Response and Sustained Action, 2020. https://openknowledge.fao.org/server/api/core/bitstreams/95049dad-8a9e-40f1-83b2-4607607ab2a3/content. (Accessed 4 May 2024).

[34] S.L. Erikson, L. Johnson, Will financial innovation transform pandemic response? Lancet Infect. Dis. 20 (5) (2020) 529–530, https://doi.org/10.1016/S1473-3099(20)30150-X.

[35] J. Connolly, Governing towards 'one health': establishing knowledge integration in global health security governance, Glob. Policy 8 (4) (2017) 483–494, https://doi.org/10.1111/1758-5899.12505.

[36] E. Tambo, S. Tang, L. Ai, X.N. Zhou, The value of China-Africa health development initiatives in strengthening "One Health" strategy, Global Health Journal 1 (1) (2017) 33–46, https://doi.org/10.1016/S2414-6447(19)30062-4.

[37] W. Cuimei, China's foreign technical assistance under new paradigm of symbiotic international development cooperation: taking juncao technology assistance as example, Journal of International Economic Cooperation 1 (2024) 59–72.

[38] WHO, Global Health Ethics, Key Issues, 2015. https://iris.who.int/handle/10665/164576. (Accessed 4 May 2024).

[39] WHO, Bridging the Gap between Ethics and Decision-Making in Pandemics: Report of the WHO Pandemic Ethics and Policy Summit, 2022. https://iris.who.int/handle/10665/365374. (Accessed 14 September 2024).

[40] S. Coghlan, B.J. Coghlan, A. Capon, P. Singer, A bolder One Health: expanding the moral circle to optimize health for all, One Health Outlook 3 (1) (2021) 21, https://doi.org/10.1186/s42522-021-00053-8.

[41] J. van Herten, B. Bovenkerk, M. Verweij, One Health as a moral dilemma: towards a socially responsible zoonotic disease control, Zoonoses and Public Health 66 (1) (2018) 26–34, https://doi.org/10.1111/zph.12536.

[42] F. Selter, S. Salloch, Whose health and which health? Two theoretical flaws in the One Health paradigm, Bioethics 37 (7) (2023) 674–682, https://doi.org/10.1111/bioe.13192.

[43] I. Kawachi, S.V. Subramanian, N. Almeida-Filho, A glossary for health inequalities, J. Epidemiol. Community Health 56 (9) (2002) 647–652, https://doi.org/10.1136/jech.56.9.647.

[44] V.A. Sironi, S. Inglese, A. Lavazza, The "One Health" approach in the face of Covid-19: how radical should it be? Philos. Ethics Humanit. Med. 17 (1) (2022) 3, https://doi.org/10.1186/s13010-022-00116-2.

[45] E.S. Eliakimu, L. Mans, Addressing inequalities toward inclusive governance for achieving one health: a rapid review, Front. Public Health 9 (2022) 755285, https://doi.org/10.3389/fpubh.2021.755285.

[46] J. Levich, The gates foundation, Ebola, and global health imperialism, Am. J. Econ. Sociol. 74 (4) (2015) 704–742, https://doi.org/10.1111/AJES.12110.

[47] WHO, A Guide to Implementing the One Health Joint Plan of Action at National Level, 2023. https://www.who.int/publications/i/item/9789240082069. (Accessed 4 September 2024).

[48] E.L. Mumford, D.J. Martinez, K. Tyance-Hassell, A. Cook, G.R. Hansen, R. Labonté,et, et al., Evolution and expansion of the One Health approach to promote sustainable and resilient health and well-being: a call to action, Front. Public Health 10 (2023) 1–13, https://doi.org/10.3389/fpubh.2022.1056459.

[49] The Lancet, One Health:a call for ecological equity, Lancet 402 (2023) 169, https://doi.org/10.1016/S0140-6736(23)00090-9.

[50] Nuture Food, Exploring wet markets, Nat. Food 1 (5) (2020) 241, https://doi.org/10.1038/s43016-020-0090-1.

[51] L.O. Gostin, E.A. Mok, Grand challenges in global health governance, Br. Med. Bull. 90 (1) (2009) 7–18, https://doi.org/10.1093/bmb/ldp014.

[52] A. Gupta, I. Boas, P. Oosterveer, Transparency in global sustainability governance: to what effect? J. Environ. Pol. Plann. 22 (1) (2020) 84–97, https://doi.org/10.1080/1523908X.2020.1709281.

[53] C.J. Carlson, M.J. Farrell, Z. Grange, B.A. Han, N. Mollentze, A.L. Phelan, The future of zoonotic risk prediction, Phil. Trans. Biol. Sci. 376 (1837) (2021) 20200358, https://doi.org/10.1098/rstb.2020.0358.

[54] E. Missoni, Global health, planetary health, One Health: conceptual and ethical challenges and concerns, Theor. Med. Bioeth. 45 (3) (2024) 241–250, https://doi.org/10.1007/s11017-024-09670-6.

[55] S. Goyet, S. Touch, P. Ir, S. SamAn, T. Fassier, R. Frutos, et al., Gaps between research and public health priorities in low income countries: evidence from a systematic literature review focused on Cambodia, Implement. Sci. 10 (1) (2015) 32, https://doi.org/10.1186/s13012-015-0217-1.