THE WORLD BANK

People, Pathogens and Our Planet

Volume 1: Towards a One Health Approach for Controlling Zoonotic Diseases

REPORT NO. 50833-GLB

Agriculture and Rural Development
Health, Nutrition and Population

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Abbreviations and Acronyms

ASF	African swine fever
AHICP	Avian Influenza Control and Human Pandemic Preparedness and Response Project
ALive	Partnership for African Livestock Development
ALU	average livestock unit
AMA	American Medical Association
ARI	advanced research institution
AMVA	American Veterinary Medical Association
AU-IBAR	African Union/Interafrican Bureau for Animal Resources
BSE	bovine spongiform encephalopathy
CBPP	contagious bovine pleuropneumonia
CDC	Centers for Disease Control and Prevention
CFEZID	Centre for Food-borne, Environmental and Zoonotic Infectious Diseases
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CSCHAH	Canadian Science Centre for Human and Animal Health
CVO	Chief Veterinary Officer
CWGESA	Cysticercosis Working Group in Eastern and Southern Africa
DALY	disability-adjusted life year
DFID	Department for International Development
DZC	Danish Zoonosis Centre
EID	emerging infectious diseases
EIN	Emerging Infectious Diseases Network
FAO	Food and Agriculture Organization
FETP	Field Epidemiology Training Program
FMD	foot-and-mouth disease
FVE	Federation of Veterinarians of Europe
GAO	General Accounting Office
GEIS	Global Emerging Infections Surveillance and Response System
GFATM	Global Fund to Fight AIDS, Tuberculosis and Malaria
GF-TADs	Global Framework for Progressive Control of Transboundary Animal Diseases
GLEWS	Global Early Warning System for Major Animal Diseases
GPAI	Global Program for Avian Influenza

GPHIN	The Global Public Health Intelligence Network
H5N1	not an acronym; avian influenza A
HPAI	highly pathogenic avian influenza
IDRC	International Development Research Centre
IFPRI	International Food Policy Research Institute
IHR	International Health Regulations
INAPs	integrated national action plans
IOM	Institute of Medicine
MDGs	Millennium Development Goals
MRSA	Methicillin-resistant *Staphylococcus aureus*
OECD	Organisation for Economic Co-operation and Development
OIE	*Office International des Epizooties* (World Organisation for Animal Health)
OWOH	One World One Health
PHAC	Public Health Agency of Canada
PHEIC	public health emergency of international concern
PPR	Peste des petits ruminants
ProMED	Program for Monitoring Emerging Diseases
PVS	Performance of Veterinary Services
SAPUVET	*Sanidad Publica Veterinaria*
SARS	severe acute respiratory syndrome
TSE	transmissible spongiform encephalopathy
UNEP	United Nations Environmental Programme
UNICEF	United Nations Children's Fund
UNSIC	United Nations System Influenza Coordination
VPH	veterinary public health
WAHID	World Animal Health Information Database
WHO	World Health Organization
WWT	Wildfowl and Wetlands Trust
WCS	Wildlife Conservation Society
WNV	West Nile virus
ZVED	National Center for Zoonotic, Vector-Borne, and Enteric Diseases

Foreword

Emerging and re-emerging infectious diseases that have the potential to become pandemic occur with alarming regularity, and a substantial majority of these are zoonotic in origin—that is, transmissible from animals to humans. Developing preparedness through effective surveillance and control systems has been complicated for a number of reasons, not the least of which have been the difficulties of establishing reliable communications and consultation between public health and veterinary health agencies. Today we know that these channels of communication must be expanded to include monitoring of wild species and the health of ecosystems. Both natural habitats and those environments that are managed by humans, such as agricultural production systems and food supply chains, are habitats in which pathogens can emerge, circulate, change dynamics, and sometimes cross-host species. Recognition of the interrelatedness of the respective health domains and of the risks that zoonotic diseases represent to public health has led to appeals for more horizontal interaction among the disciplines and the sector agencies, departments, and ministries that are responsible for public health, medical professions, veterinary services, and the environment.

The idea of "One Health," as it became known, would assume urgent practical significance in late 2003 with the emergence of highly pathogenic avian influenza (HPAI). Since then, the prevention and control of avian influenza have been in the crosshairs of high-level international attention, most notably at a series of ministerial-level meetings held in Beijing and Bamako in 2006, New Delhi in 2007, Sharm el-Sheikh in 2008, and a One Health consultation in Winnipeg in 2009. While the Global Program on Avian Influenza (GPAI), developed in response to the spread of HPAI, did not fulfill all the aspirations of One Health, it did establish a precedent of considerable practical significance for emerging infectious zoonotic diseases. That progress now has to be built upon and developed further by the international organizations and national agencies whose mandates involve disease prediction, prevention, identification and response, and control—including institutions that deal with ecological issues and wildlife health. While the general concepts are now well accepted, how to implement the One Health *concept* is still not clearly understood.

Developing an institutional framework that builds on the model of the GPAI and that broadens its scope to cover future pandemics is a global priority with a wide consensus. One of the issues its planners need to confront is which aspects of that framework can be applied to long-standing endemic diseases that pose little or no risk of becoming pandemic, but that impose severe human and economic costs on the developing countries in which they persist. Many of these endemic diseases are confined to the tropics, or have been effectively controlled in industrialized countries for generations. Yet they clearly carry practical significance to the One Health perspective, recognizing the interrelatedness of health issues in all domains. Because the burden of these diseases fall overwhelmingly on the poor, they pertain directly to the poverty and health-related Millennium Development Goals (MDGs), and their control is therefore a global public good, even though many of them are local or national in range. A global surveillance and control system that is established primarily for emerging infectious zoonotic diseases with pandemic potential can be readily improvised to address the endemic diseases that are a priority in many developing countries, few of which have the capacity or resources necessary to monitor or control them effectively. Making One Health operational represents an extraordinary opportunity for convergence and synergy between the priorities of industrialized countries and those of developing countries. This paper discusses the practical issues involved in making One Health a reality, and argues that supporting the development of the national and international capacities and infrastructure required to do so is a highly appropriate area of investment on the part of the international development community.

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Executive Summary

Whether living in urban or rural environments, humans tend to perceive the world around them as being shaped by culture and industry more than by natural history. Humans, however, are part of a biological continuum that covers all living species. Charles Darwin's 200th birthday in 2009 could serve to remind us of this. All animals, including humans but also plants, fungi, and bacteria, share the same basic biochemical principles of metabolism, reproduction, and development. Most pathogens can infect more than one host species, including humans. In 1964, veterinary epidemiologist Calvin Schwabe coined the term "One Medicine" to capture the interrelatedness between animal and human health, and the medical realities of preventing and controlling zoonotic diseases or "zoonoses" –diseases that are communicable between animals and humans. One Medicine signaled the recognition of the risks that zoonotic diseases pose to people, their food supplies, and their economies. Given the interrelatedness of human, animal, and ecosystem health, the rationale for some form of coordinated policy and action among agencies responsible for public health, medical science, and veterinary services is quite intuitive. Later, the term "One Health" came into use, and later still, the broader concept of "One World One Health," which is today used to represent the inextricable links among human and animal health and the health of the ecosystems they inhabit.[1]

THE IMPACTS

Even as hunter-gatherers, humans were at risk of contracting diseases from the animals they used as food. The domestication and rearing of livestock in ever-increasing numbers and in close proximity to expanding human populations increased the risk of disease in both populations. While humans learned through experience and scientific research how to reduce that risk, the persistence of emerging infectious diseases of zoonotic origin was underscored early in the 20th century by the flu pandemic of 1918–1919 and later in the century by HIV/AIDS. More recently still, the emergence of severe acute respiratory syndrome (SARS),

1 "One World One Health" is today a trademark of the Wildlife Conservation Society.

H5N1 (highly pathogenic avian influenza—HPAI), and influenza A(H1N1) has pointed to our continued vulnerability. These diseases also have major economic impacts. The emergence of BSE, SARS, H5N1, and influenza A(H1N1) have caused over US$20 billion in direct economic losses over the last decade and much more than US$200 billion in indirect losses. Should HPAI evolve to relatively severe global pandemic—a prospect that has not yet been eliminated—estimated losses of US$3 trillion have been projected (Gale 2008). Aside from emerging infectious diseases, the less headline-grabbing but highly under-reported "neglected diseases" such as tuberculosis, brucellosis, and various forms of zoonotic parasitosis result from livestock to human transmission and impose significant health burdens—most of which are borne by poor people.

Despite important scientific progress, a variety of forces drive the increased incidence of emerging infectious diseases seen today. Intensified farming and concentration of animals, pressure on food production systems, and increasing global movement of people, animals, and animal products have led to evolutionary pressures on pathogens that present an expanding array of risks. The changing demographic composition increases the global share of vulnerable people. Public awareness of the risks of zoonotic diseases and political commitment to containing them tend to fade over time after an outbreak has run its course and as other priorities such as financial and food price crises and climate change become more prominent. The continuity of resources devoted to disease surveillance and control has therefore remained an enduring concern.

The sources of zoonotic disease are not limited to humans and their livestock. They extend to (and from) wildlife as well, and this source is the most significant. Wildlife ecosystems are characterized by a fine-tuned, dynamic balance among all their components, which consist of flows of organic and inorganic matter and energy as well as living organisms. While pathogens are very much part of this balance, they are prevented from exceeding certain levels of prevalence through negative feedback cycles such as induced resistance or host population size. Conceptually, two types of factors can destabilize wild ecosystems and their role in global health. The first is destruction and fragmentation, for instance through deforestation, which destroys the balance between different species and can enable individual species to become dominant. The second type of destabilizing factor occurs as the result of increased interaction between human and wild ecosystems. This interaction gives rise to more opportunities for the exchange of pathogens, including transmission to "naïve" or unprotected individuals. Farming near rainforests, the consumption of bushmeat, and ecotourism are examples of the types of interactions that can create opportunities for pathogens to "jump" species. Case studies often reveal the two pathways to overlap and to result in spillovers of pathogens into cultivated ecosystems.

THE CONSTRAINTS

One of the most essential factors in the control of any new emerging health risk is early detection of the disease and understanding of its epidemiology. This can enable the agencies responsible for disease control to attack the disease at its source, reducing its spread and preventing it from becoming endemic. A number of cases visited in this document, including West Nile virus (WNV) and H5N1, reveal the persistence of avoidable time lags between the emergence of a new disease and the implementation of an appropriate control strategy. The delays can be attributed to a variety of reasons. Limited human capacity and poor physical facilities often cause emerging new diseases to remain unnoticed, particularly in the developing world. Reporting is often delayed out of fear of the economic losses likely to result from trade bans and reduced tourism. However, delays are also caused by the piecemeal nature of work undertaken by public health, veterinary, and environmental agencies acting in isolation from one another along narrowly sectoral lines. Discrete, purely disciplinary approaches have led to delayed diagnoses and sometimes misdiagnoses of diseases and disease risks, and to the formulation of incomplete and ineffective control strategies by public institutions that do not effectively communicate with each other until the disease has spread widely.

THE ACTIONS

For professionals working in sector agencies, determining one's role begins with the question "What am I responsible for?" The answer tends to be defined bureaucratically according to the division of labor that distinguishes the work of different agencies. Overall, this makes for a vertical orientation by the respective agencies concerned with different aspects of an issue such as a newly emerging disease. Changing the organization of work across disciplines to start with the question "What needs to be done?" implies a substantial reorientation along horizontal lines in which regular communication takes place between staff at work in different disciplines and sectors. Substantial consensus can now be found among informed human and animal health authorities, scientists, and policy makers that effective prevention and control measures against emerging and re-emerging infectious diseases will require multisector strategies and active collaboration across professional disciplines. This does not imply an amalgamation of work but rather the creation of a culture in which, for example, a veterinary epidemiologist is more likely to (and indeed expected to) relate findings of potential significance to his or her counterparts working in public health. In fact, in this example, the veterinary epidemiologist is not just expected to communicate these findings, but doing so is an integral part of his or her professional responsibilities, just as making practical note of the findings is part of the public health practitioner's responsibilities. In this setting, the epidemiologist who fails to share information about a new pathogen in pigs, or a public health official who fails to duly note it as something to monitor, are both culpable of negligence. Responsibility is no longer conveniently divided according to bureaucratic mandate, and oversights are no longer the unfortunate but understandable byproduct of gaps in jurisdiction.

The actions that need to be taken to bring about such a working environment apply to both national and international institutions. National governments are, however, the principal agents, with international agencies playing a largely supporting role. Improved coordination among public, veterinary, and ecosystems health agents will rely on the following measures.

Consultation on Priority Setting

Zoonotic diseases often fall between the foci of agencies and institutions that specialize in human health, veterinary services, and wildlife conservation. Developing capacity for risk analysis, which remains an area of marked weakness in many resource-poor countries, is an important area of potential convergence and a necessary condition for more effective priority setting. Such a priority setting would identify "hot spots". Hot spots refer to those contexts in which climatic, social, and economic conditions—including the state of sanitation infrastructure and services and the proximity of humans and animals—provide a particularly favorable environment for diseases to emerge or re-emerge within.

Joint Preparedness Planning

The Global Program for Avian Influenza (GPAI), and especially the preparation of the integrated national action plans (INAPs), has shown the potential gains from joint planning exercises between public health and veterinary services. More attention is still needed to reduce transaction costs and to ensure that these plans are and remain realistic and implementable, for example, through simulation exercises.

Communicating Consistent Messages

Action is required at two levels. First, human and veterinary health channels to communicate information about disease outbreaks need to be harmonized. Currently in most countries, human and animal disease agencies have different and often completely separated disease reporting systems. Direct lines of communication at all (local provincial and national) levels of One Health actors need to be established. Second, communication of the different agencies on a disease outbreak needs to be coordinated. As shown in several instances, including the ongoing influenza A(H1N1) outbreak, different agencies often issue contradictory statements to the outside world in the case of a new disease outbreak. It is essential that issues such as how emerging diseases are being handled be explained to the general public in a coherent way. The public, and in particular the different participants in the animal source food chain, needs to understand clearly the rationales behind existing disease control strategies and the level of emergency status an emerging infectious disease is attributed at any given point in time. They also need to understand the safety issues involved in animal products that originate in affected areas.

Exchanging Select Staff and Sharing Facilities

With a proper legal framework and appropriate training, certain select public health activities could be shared—for instance, in surveillance by human and animal health field agents. Surveillance staff can especially be linked at the grassroots level. Sharing facilities such as transport and cold storage facilities, once the risk of cross-contamination is addressed, can greatly enhance surveillance capacity and result in significant economies of scale.

Strengthening Education

A review of curricula, with more emphasis on epidemiology and the wider effects of ecosystems on human and animal health, is needed because public human and veterinary health services must shift from controlling to preventing diseases. World Organisation for Animal Health (OIE) initiatives that support developing countries in devising more appropriate veterinary curricula can lay the basis for future generations of veterinarians to be better acquainted with the One Health concepts.

Providing the Appropriate Incentive Framework

Incentives that lead people to place a premium on collaboration and resource sharing would need to be introduced. This can include shared budget lines between different agencies and systems of matching grants, with increased cooperation leading to increased budgetary support. An overall increase in funding would have to be based on the results of the risk assessment.

Providing an Appropriate Institutional Framework

If the current levels of cooperation that have been built around the GPAI are not institutionalized into a more permanent arrangement, this cooperation is likely to fade. In that case, new cooperation mechanisms will have to be improvised in the event of each new outbreak. A number of institutional alternatives suggest themselves, based in large part on the current level of development that prevails within a given country.

- A permanent body that coordinates the preparation and regular update of contingency plans to deal with the eventuality of an outbreak. The coordination function might take place through the exchange of memoranda of agreement among the different sector agencies concerned. The body itself may consist of or be served by a number of working groups.
- Coordinating authority conferred as a function of executive office, such as a prime minister or deputy minister, who is served in this capacity by an advisory committee that operates with his or her authority.
- Special One Health teams, composed of representatives of the human, animal, and ecosystem institutions, with particular responsibility for diseases at the animal-human-ecosystem interface.
- Creation of an independent agency for public health, including zoonoses and food safety.

The prospective institutional architecture for global surveillance and control is also considered. How ecosystem health and wildlife organizations will be represented in this architecture will be an important issue to resolve. The challenge of systematizing disease reporting internationally will entail the establishment of clear financial incentives to encourage early reporting and enforceable legal restrictions to discourage under-reporting.

FINANCING NEEDS AND FUNDING MECHANISMS

The funding requirements of a global surveillance and control system are considerable. According to the Strategic Framework document *Contributing to One World, One Health*, presented at the Sharm el-Sheikh Ministerial Meeting, covering the 49 least-developed countries that are IDA eligible over the next decade will cost an estimated $800 million annually. This report argues that funding through conventional time-bound, project-based investments is inadequate for this purpose, and that more reliable, sustained flows of financial resources will need to be established. How this longer-term funding will be secured, and from what sources, are questions that will require purposeful deliberation. Among international foundations and OECD (Organisation for Economic Co-operation and Development) countries, emerging zoonoses that have pandemic potential are generally the principal concern and are the most likely to attract substantial commitments of resources. Resources may also become available through partnerships between health organizations in developing countries and those in industrialized countries. The imposition of levies on the trade of commodities that are associated with zoonotic diseases, such as meat and pharmaceuticals, is also raised as a possible source of funds.

Surveillance and control systems that focus on pandemic diseases can be applied to other diseases as well. This represents an important area of convergence between industrialized and developing countries, which sometimes have different priorities with respect to disease control. Industrialized countries often focus more on managing the risk of pandemic diseases, in part because most endemic diseases have been under control in these countries for years or even generations. In many developing countries, where these long-standing diseases have never been effectively controlled, and where the human and economic costs associated with them have remained high, these diseases are a more pressing priority. This report finds substantial latitude for synergy in the overlap between monitoring the risk of pandemic diseases and monitoring the risk and incidence of persistent endemic diseases. Both categories of disease are likely to be found in similar conditions. Monitoring both therefore focuses purposefully on hot spots. An integrated surveillance system would not discriminate between pandemic and endemic diseases because the two are inextricably intertwined. Areas that are heavily burdened by existing diseases are also areas in which new diseases are most likely to emerge, and some proportion of these will have the potential to become epidemic or pandemic. In this way a system that is put into place with the primary purpose of detecting pandemic risk can be organized to track existing diseases as well, and to do so more economically than maintaining separate systems.

1

Addressing Zoonotic Diseases at The Animal-Human-Ecosystem Interface

THE THREAT

The Spanish flu pandemic that killed between 50 and 100 million people between 1918 and 1919 had largely faded from public memory by the late 1990s and early 2000s, when outbreaks of SARS and HPAI took place (Taubenberger and Morens 2006). The emergence of influenza A(H1N1) in March 2009 provided still another reminder of the persistent risk of emerging infectious diseases of zoonotic origin or zoonoses—diseases that are transmissible from animals to humans. This class of diseases has been the principal source of emerging health risks. Of the 1,415 known human pathogens, 61.6 percent are of animal origin (Cleaveland et al. 2001) On average, a new disease has emerged or re-emerged each year since the Second World War, and 75 percent of these have been zoonotic (King 2004). An analysis published in 2008 found that of 335 emerging infectious diseases in the US, between 1940 and 2004, 60 percent were zoonotic—more than 70 percent of which came from wild species (Jones et al. 2008). A mutation or re-assortment of the H5N1 virus could lead to the deaths of several million people worldwide, and to the deaths of over 1 million even in a relatively mild pandemic form (Burns et al. 2008).

In addition to the potentially catastrophic impacts that zoonotic diseases have on human life and human health, the economic losses associated with these diseases are also enormous. The direct costs of outbreaks over the last decade surpassed US$20 billion—including public and animal health service costs, compensation for lost animals, and production and revenue losses to the livestock sector, and over US$200 billion of indirect losses to affected economies as a whole (see Annex 1). When indirect costs such as losses in other parts of the animal product chain, trade, and tourism are included, these costs multiply. In the UK, between 1990 and 2008, economic losses from bovine spongiform encephalopathy (BSE) totaled some US$7 billion (Pearson 2008). The outbreak of SARS in East Asia and Canada led to losses of between US$40 and $50 billion (Box 1), and HPAI in East Asia alone has caused US$10 billion in direct losses to the livestock sector (Naylor et al. 2003).

A number of less headline-grabbing "lingering" zoonotic and other diseases also cause significant human and economic losses. These "neglected zoonoses" such as rabies, bovine-induced human tuberculosis, brucellosis, and echinococcosis are major causes of morbidity and mortality among poor people. They are also almost certainly the most under-reported diseases. More than 55,000 people die of rabies each year, and about 95 percent of these deaths occur in Asia

Box 1: SARS in Canada

Canada experienced its first case of SARS when a guest of the Metropole Hotel—ground zero—in Hong Kong returned to Canada in February 2003. By August of that year, there were 438 suspected cases of SARS in Canada, including 44 deaths.

The epicenter of the SARS infection lay in Toronto and its surrounding suburbs, an area that is home to 5.3 million people and a thriving scene for the business, science, and arts communities. Canada's economy suffered as vacationers and business travelers avoided visiting the country. The accommodation and food services sectors are estimated to have declined by US$4.3 billion dollars between March and September of 2003 (Keogh-Brown and Smith 2008). The Conference Board of Canada estimated losses of $570 million from the travel and tourism sectors in the city of Toronto during 2003, and $222 million from Pearson International Airport, a major Canadian airport and a hub for international flights (Conference Board of Canada 2003).

While many abroad chose not to travel to Canada, those living in Toronto attempted to minimize their risk of exposure to SARS. Restaurants, shops, and theatres remained empty, especially in the popular Chinatown area. Canadian real GDP dropped by an annual rate of 0.3 percent during the second quarter of 2003, the time period corresponding with the SARS crisis (Government of Canada 2003).

Health-care professionals working on the front lines of the SARS crisis carried much of the disease burden. In addition to social effects such as stigmatization and isolation, and psychological effects such as guilt or worry about spreading the disease, more than 100 health workers became ill and three died due to probable SARS. Health-care costs soared. SARS-related and major one-time health costs for the province of Ontario reached $824 million in 2003–2004 (Government of Ontario 2005).

The handling of SARS by public health authorities emphasized the fundamental need for a stronger public health system in Canada and a stronger integration between public health and emergency response systems. Provincial and municipal health authorities responded to the immediate medical threat of SARS, but issues such as outbreak containment, timely access to laboratory results, surveillance, information sharing, and communication to the public remained inconsistent and an ongoing problem.

and Africa. Of the 1.6 million annual human deaths from tuberculosis, between 2 and 8 percent is estimated to be of bovine origin (Cosivi et al. 1998).

The World Health Organization (WHO) reported that in 2005 alone 1.8 million people died from food-borne diarrheal diseases such as *Escherichia coli,* Campylobacteriosis, and Salmonellosis. Food-borne pathogens were estimated to cost up to US$35 billion in 1997 in medical costs and lost productivity in the US (WHO 2007). A recent World Bank report estimated direct and indirect losses from food-borne disease in Vietnam could be up to US$1 billion per year (World Bank. 2006). Many of these food-borne disease-related costs are grossly underreported. A large proportion of these cases can be attributed to the contamination of food and drinking water including the contamination of those sources by infected humans. The issue of food safety and the threat of zoonotic diseases being transmitted through food supply chains have made sanitary standards a focal point of food trade policy.

The monetary costs of reduced productivity and market losses resulting from uncontrolled zoonoses are often difficult to allocate per sector. In the public health sector, these costs relate principally to diagnosis, treatment, and hospitalization. In the private sector, they relate largely to out-of-pocket expenses to the patient or animal owner, and to a variety of opportunity costs. Comprehensive cross-sectoral analysis can be applied to estimate the monetary benefits of control by sector, allowing proportional allocation of intervention resources. Such analyses have been carried out for brucellosis, echinococcosis, rabies, and *Trypanosoma rhodesiense.* Their results point to the high payoff and cost-effectiveness of control interventions—costing US$25 or less per disability-adjusted life year (DALY) averted (Roth et al. 2003; Coleman et al. 2004; Budke et al. 2005; Knobel et al. 2005; Budke 2006; Fevre et al. 2008).

Recognizing the interrelatedness of the human and animal health domains that is manifest in zoonotic diseases, the magnitude of these threats, and the need for more purposeful consultation between medical and veterinary health, in the 1960s concerned scientists and science policy makers began appealing for more systematic communication with One Medicine. These would evolve into a more expansive vision of One Health in which the concept of active interdisciplinary collaboration was extended to cover the additional domain of wildlife health, including the health of ecosystems and the wildlife inhabiting them. One Health is the subject of Chapter 3 of this report. It was the re-emergence of avian flu that prompted the international community into action, and while the global campaign against avian flu did not fulfill this aim, it did make a number of important strides that warrant building upon in pursuit of the longer-term vision of One Health.

While the prospect of a global pandemic caused by HPAI did not lead to the fulfillment or realization of One Health, it did galvanize enormous international resolve and unprecedented global collaboration. The importance and urgency of the threat from HPAI were illustrated by the Secretary General of the UN naming David Nabarro as his representative and high-level coordinator of the UN System response—the creation of the United Nations System Influenza Coordination (UNSIC), which has been indispensable to the global response. This was followed by a series of high-level meetings that provided direction, and created and preserved momentum. In Ottawa in October 2005, an International Meeting of Health Ministers issued a communiqué declaring their agreement that "a multi-sectoral approach, beginning with the animal health and human health sectors, must underlie global efforts towards coordinated pandemic planning," and that the immediate global public health issue is to work collaboratively with the animal health sector to prevent and contain the spread of the H5N1 virus among animals, and from animals to humans." While the focus of the meeting was on H5N1, the international coordination, capacity building, and communications strategies they advocated applied to emerging zoonotic diseases in general, including the formulation of veterinary policies with provision for "advice to farming communities to ensure appropriate animal and public health standards for the raising, handling, and transport of potentially flu-bearing animals."[2] At WHO headquarters in Geneva the following month, a Meeting on Avian Influenza and Human Pandemic Influenza brought together an even wider range of participants in addition to health ministers. Among the proposals made at the meeting was one for the international community to support individual countries in developing integrated action plans. The proposal would lead to the development of the integrated national action plans now used for surveillance and response throughout much of Africa. Summing up the proceedings, the WHO Director General also stressed the need to reduce the viral burden of H5N1 through "timely notification of outbreaks in birds, poultry culling and vaccination as indicated, including 'backyard' flocks, and provision of appropriate compensation for farmers" (WHO 2005)."

In Beijing in January 2006, the government of China, the European Commission, and the World Bank co-sponsored the International Pledging Conference on Avian and Human Pandemic Influenza, and was supported by the governments of the United States, Japan, and many others. There the international community pledged US$1.9 billion in financial support and held extensive discussion on prospective coordination mechanisms, the parameters of a common strategy, and reiterated the earlier meetings' call for emphasizing action at the national level. Eleven months later, at the Ministerial Meeting and Pledging Conference on Avian and Human Pandemic Influenza held in Bamako, Mali in December 2006, participants agreed to the compensation guidelines that had been prepared by the UN's Food and Agriculture Organization (FAO), International Food Policy Research Institute (IFPRI), OIE, and the World Bank, and pledged an additional US$475 million in support.

At the New Delhi International Ministerial Conference on Avian and Pandemic Influenza in December 2007, the Indian government presented its Road Map for the control of HPAI and offered its use to the global community. Participants called for the formulation of a strategic framework and pledged an additional US$400 million. The consultation document *Contributing to One World, One Health* was subsequently tabled at the Sixth

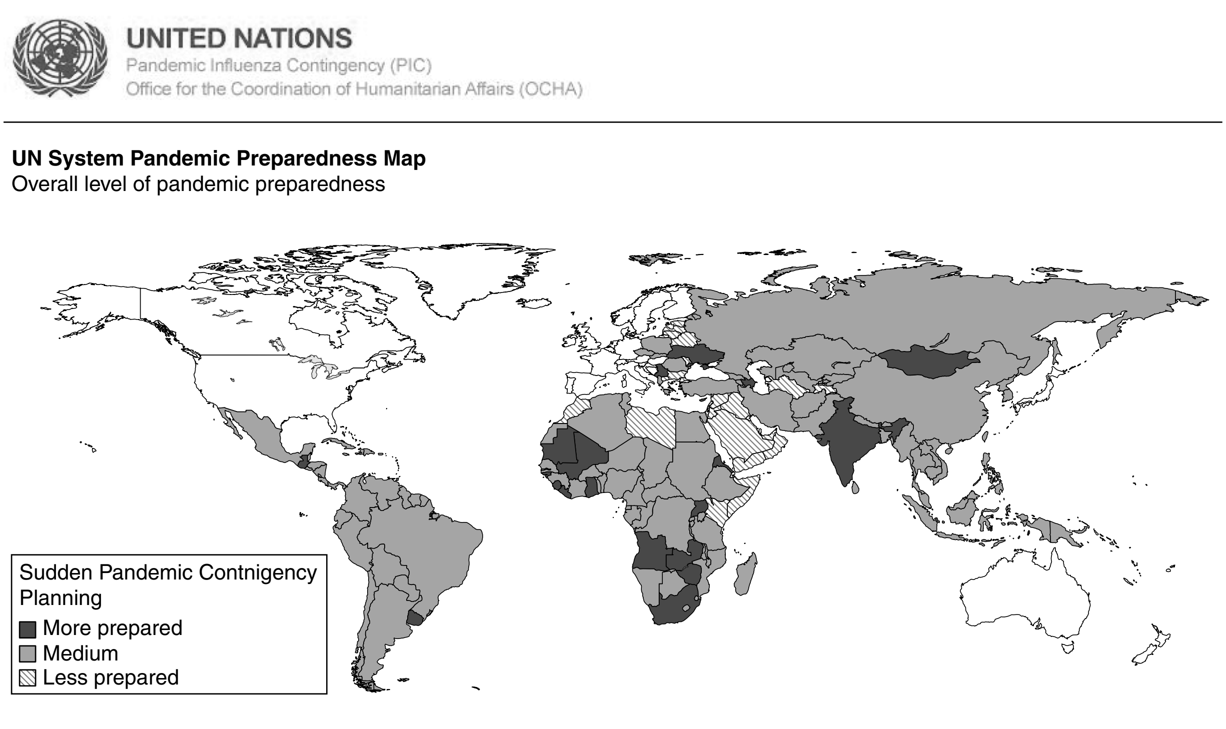
2 Global pandemic influenza readiness: an international meeting of health ministers. Communique, October 25, 2005.

International Ministerial Conference on Avian and Pandemic Influenza in Sharm el-Sheikh, Egypt in October 2008. There the technical details of the Strategic Framework were discussed, and the document was subsequently translated into a series of "key recommendations" at the Expert Consultation on One World, One Health in Winnipeg in March 2009. These are included at the end of this report as Annex 2. The next Ministerial meeting on Avian and Pandemic Influenza will take place in and be hosted by Vietnam in April 2010.

The series of international meetings reflects an unprecedented level of international cooperation, which while it continues to exist, represents a profound opportunity to create an integrated international surveillance and control system. The urgency of capitalizing on this opportunity arises out of changing priorities as the threat of an HPAI-related pandemic has faded from public awareness and as international attention has shifted to other emerging issues such as food prices, the financial crisis, and climate change. The persistence of the threat may be downplayed by many public officials, however much it remains recognized by medical and veterinary authorities. Barring the still-very-real possibility of the virus's re-emergence in a new and more virulent form, the GPAI, for instance, will eventually run its course. For the time being, the program remains in place not only to provide resources to continue to fight the persistent threat of avian flu, but also, as of June 2, 2009, to fast track an additional US$500 million from the World Bank to help countries finance emergency operations to prevent and control outbreaks of A(H1N1). Figure 1 illustrates the enormous success achieved in terms of pandemic preparedness by the global effort. It also illustrates that there is still considerable work left to be done.

It is therefore opportune to take stock of what has been learned from the experience of controlling HPAI and to consider how the lessons of this experience can inform sustainable international preparedness for future emerging and re-emerging infectious zoonoses.

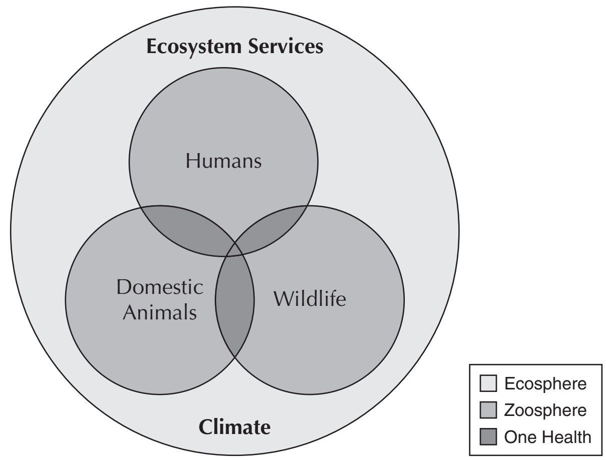
Figure 1: Global Pandemic Preparedness



Source: United Nations Pandemic Influenza Contingency, Office for the Coordination of Humanitarian Affairs. (Interactive map available at http://www.un-pic.org/web/)

The sum total of needs that prevail within the human, livestock, and wildlife health domains is beyond the scope of any one discipline, and is certainly beyond the scope of this report. The focus of One Health, then, is on areas of convergence, in which these needs overlap and interact, and which therefore generally excludes diseases that lack the potential to jump species—from animals to humans (Figure 2). This report examines the One Health concept as a framework for fostering more effective control across sectors. It also identifies a number of barriers to making the concept operational, including governance and institutional issues at local, national, and international levels, and considers ways to overcome them. Finally, it examines funding needs and prospective funding mechanisms for the control of emerging infectious diseases of animal origin. While a broad consensus exists with regard to the merits of the One Health approach, the question of how to make it operational raises a variety of issues that this report attempts to illuminate.

Figure 2: Interacting Health Domains



2 Drivers of Emerging Zoonotic Diseases

The factors that drive the emergence of new diseases can be usefully classified into those that occur in one of three environments: in the environment in which humans live, in the food and agriculture system, or in natural ecosystems.

In human living environments, changing consumer demand, urbanization, human and animal population density, the proximity of humans and livestock, changing demographics, increasing mobility, rates of poverty, and the deteriorating state of public health and veterinary services all serve as drivers of emerging and re-emerging zoonotic diseases. In food and agriculture systems, the number of livestock, the spatial concentration of livestock production, the existence of mixed biosecurity regimes, growth in the export of animal source products, inappropriate vaccination and drug use, and exploitative farming systems are prominent factors. In natural ecosystems, the effects of human encroachment and adverse land use such as deforestation, poaching, and trade in live animals and bushmeat carry considerable consequences in terms of habitat fragmentation, biodiversity loss, and climate change.

For a variety of reasons, the emergence of pathogens within these domains is on the increase, as is the exchange of pathogens between them (Woolhouse 2008; Taylor et al. 2001). A more detailed description of the factors driving increased disease emergence in each domain follows in Figure 3.

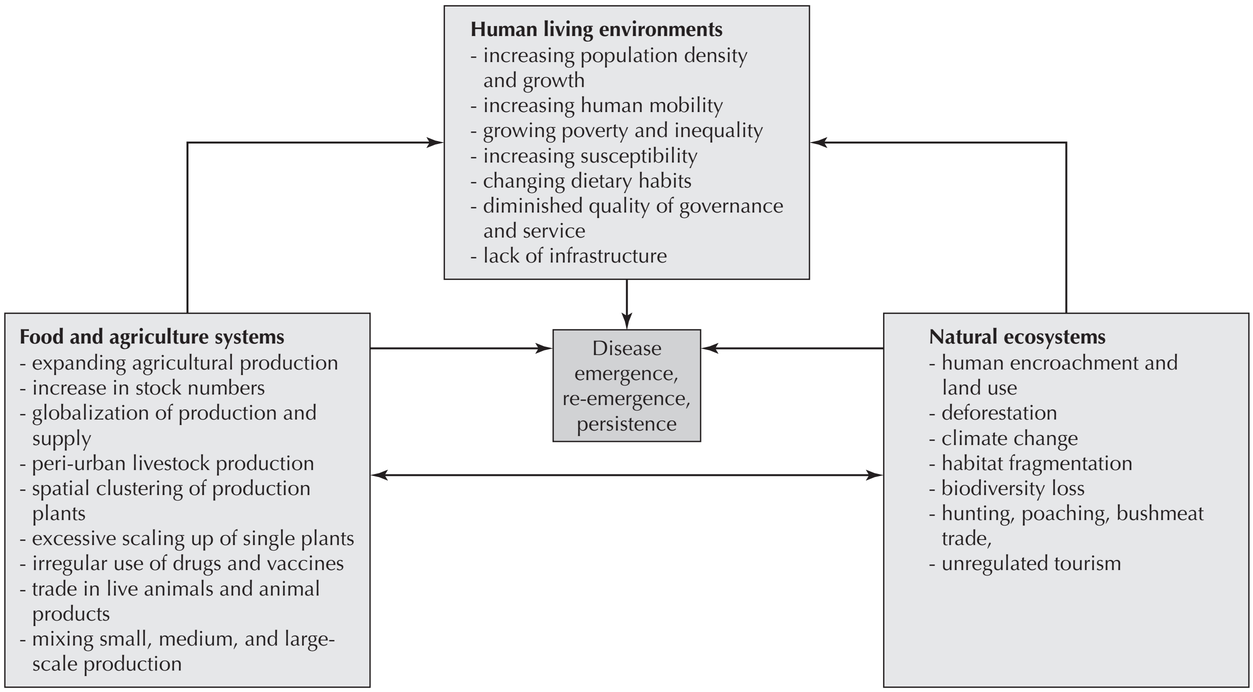
DRIVERS IN HUMAN LIVING ENVIRONMENTS

Changing Consumer Demand and Dietary Habits

Increasing demand for animal source foods is being driven by both human population growth and rising incomes. Per capita GDP in developing countries is expected to increase 4.6 percent between 2010 and 2015 (World Bank 2008). The expenditure elasticity for meat in low-income countries is 0.78, and in middle-income countries is 0.64.[3] Per capita consumption of meat in the developed world would increase from 76 kg in 1993 to 83 kg in the developed world and from 21 to 30 kg in the developing world over the same

3 Percent increase in expenditure on an item with a 1 percent increase in total expenditure.

Figure 3: Interplay of Three Host Health Domains



Source: Adapted from Institutes of Medicine 2009.

period (Delgado et al. 2001). This increase of consumption of animal source foods is driving the rapid expansion of the livestock sector in developing countries.

Urbanization and Human and Animal Population Density

The human population is also becoming more urban, and population density is therefore increasing. More than 50 percent of the global population now lives in urban areas. In many urban and peri-urban areas, people raise, and even share dwellings with, livestock as well as their pets. This level of proximity between humans and animals is a critical risk factor for zoonotic disease. Many of these cities are in humid areas, and many have no sanitation services or available means to dispose of wastewater or organic material. People often buy their meat at outdoor wet markets, where the animal is not inspected before it is slaughtered. Public awareness of hygiene measures that can substantially reduce the risk of diseases in these settings is often very limited.

The populations of eastern and southern Asia make up over 50 percent of the world population. FAO estimates that China alone accounts for half the world's standing population of domestic pigs and an estimated 5.5 billion birds including chicken, ducks, and geese. The global distribution of emerging infectious disease events in humans reflects this human and livestock density (Jones et al. 2008).

Changing Demographics

Factors such as aging populations, the prevalence of HIV/AIDS, the proportion of the population that is undernourished (notably the number of pregnant or lactating women who are undernourished)—in short, any demographic development that increases the number of people who are immunocompromised fosters a favorable environment for the emergence and spread of infectious diseases, among which zoonoses are generally prevalent.

Mobility

Populations are also becoming more mobile, especially as incomes rise, and this dramatically facilitates the spread of diseases that can be transmitted between people. Outbreaks of infectious diseases that remained isolated to specific localities in the past are far more likely to spread given this mobility. In 2008, the World Tourist Organization reported that international tourist arrivals reached 924 million, and this number is expected to increase to 1.6 billion by the year 2020 (World Tourism Organization 2009). There are newly emerging patterns of movements of irregular migrants from the less-developed parts of the world to the developed countries in search of better opportunities. In addition, it is estimated that there are 12 million internally displaced people in Africa alone. This mobility implies also the mobility of culture, health beliefs, food preferences, and hence epidemiological factors (Apostolopoulos and Sonmez 2007). Circular, intraregional, and irregular migrants may carry a higher risk of infectious diseases such as tuberculosis (Markel and Stern 2002).

Poverty

Poor, food-insecure people are more vulnerable to both emerging and lingering zoonotic diseases. Rabies and livestock-induced tuberculosis and brucellosis, for instance, are predominantly found among the poorer strata of the population. Impoverished people are moreover less likely to visit a health provider, thus reducing the chance for early detection of a new disease. In some areas poverty leads to greater reliance on bushmeat, which represents one of the most direct risks of contracting a zoonotic disease.

Deteriorating government public health services and stagnating public health and veterinary budgets in many countries have seriously limited disease surveillance and other preventive operations (World Bank 2009).

DRIVERS IN FOOD AND AGRICULTURE SYSTEMS

Food and agriculture systems constitute a major artificial ecosystem in which diseases can emerge or re-emerge. Many food supply chains involving animals and animal products have become increasingly globalized, and the transport of animals and animal products have become so extensive that food safety hazards and emerging infectious disease risks can travel rapidly and widely.

The number of livestock is increasing rapidly in order to meet rising demand for animal source products. FAO estimates that the number of food animals being processed each year will increase from about 21 billion currently to about 28 billion in 2030. The major share of this growth will be supplied by developing countries, where, between 2001 and 2050, meat production is expected to rise 1.8 percent annually (FAO 2006).

The Spatial Concentration of Livestock Production

The increase in animal numbers had led to a significant restructuring of how production is organized spatially, perhaps most notably in peri-urban areas, and particularly with respect to pig and poultry production. The scale of large commercial farms has increased dramatically, and has become concentrated in relatively small areas. In Brazil, 85 percent of hens and 56 percent of pigs are concentrated in 5 percent of the country's area. When transport facilities are poor, these large farms typically concentrate in peri-urban areas. With improved transport, large farms tend to move away from large cities to areas with abundant feed supplies (Steinfeld et al. 2006). In Thailand, for example, in 1992 there were an estimated 1,700 chickens per square kilometer within the 50-kilometer radius of Bangkok and only an estimated 100 chickens per square kilometer within the 300-kilometer radius of the city (Steinfeld et al. 2006).

Mixed Biosecurity Regimes

Livestock producers vary widely in their capacity to protect livestock from disease and to manage disease risk at the farm level. Much of this variation relates to the size of the enterprise, the scale of production, and the amount of capital that is available to its operators. Larger commercial producers can generally afford to invest in more sophisticated forms of biosecurity than small producers, who continue to operate with little if any biosecurity. Little attention has been given to innovations that can help small producers meet their biosecurity needs in their resource-poor circumstances. The coexistence of modern and traditional production, often in close proximity to one another, poses mutual risk. Pathogens that are endemic remain a persistent threat to both (Slingenbergh et al. 2004; Slingenbergh and Gilbert 2008).

Export of animal source products has grown faster than production, as global trade has expanded by 6 percent per year and now constitutes about 13 percent of total food export, reaching US$37 billion in fresh and frozen meat and $20 billion in live food animals (International Trade Centre, UNCTAD and WTO 2009).

Inappropriate vaccination and drug use are also factors in livestock and food chain systems. The inadequacy of the health systems causes gaps in vaccination coverage and suboptimal use of drugs, leading to drug resistance and hence increased risk of newly emerging pathogens. Adding antibiotics to livestock feed for nontherapeutic purposes is another cause of induced resistance to antibiotics in animal source foods. Methicillin-resistant *Staphylococcus aureus* (MRSA), circulating in pigs and calves and now a major threat in hospitals, is an example of the results of inappropriate drug use.

Exploitative farming systems in which working conditions and animal housing conditions are poor and prone to hazardous interactions between livestock and humans, and between livestock and wild species, should also be considered. These settings are well suited not only for the flare-up of novel agents, but perhaps more importantly, for the persistence of existing agents, adding to the endemic disease burdens that are already in place. The interplay of complex factors provides opportune environs in which many pathogens co-circulate. Most emerging disease events take place in these unregulated conditions, characteristic of production throughout much of the developing world. Once isolated, these hot spots are today increasingly connected to the larger world through trade and human traffic in a context of globalization.

DRIVERS AT THE EARTH AND ECOSYSTEMS LEVEL

In natural ecosystems, pathogens are natural elements of biological diversity, balance, and resilience. The impacts of human encroachment on the system can introduce new disease agents or present existing agents with opportunities to "escape" the habitat they are a natural part of. A variety of human activities may generate ecological vacuums that are filled by invasive predators or parasites that may carry diseases that indigenous species lack immunity to (Slingenbergh et al. 2009; Sakai et al. 2001; Daszak et al. 2000).

While human and domestic animal diseases do sometimes affect wildlife, pathogens that are transmitted from wildlife to humans, often through domestic animals, are considerably more numerous (Cleaveland et al. 2001). These include HIV, Ebola, SARS, H5N1, Nipah, and hantaviruses, Lyme disease, Crimean-Congo hemorrhagic fever, tick encephalitis, and West Nile virus. A number of pathogens, including HPAI, have been transferred from wild species to domestic ones in recent years. A diverse reservoir of influenza viruses circulates also in wild birds, and contacts between these birds and domestic poultry and pigs are common. These contacts lead to human exposure and to the exchange of viruses and genetic material between humans and animals. These contacts lead to human exposure and to the exchange of viruses and genetic material between humans and animals.

The pandemic risk these materials pose varies by type. RNA viruses, for instance, are known for their built-in instability, and their tendency to undergo replication errors gives them greater potential to invade any novel host niches that may be available. Arthropod-borne viral infections are prominent among the group of emerging disease agents, sometimes becoming manifest at medium-to-high latitudes. Insects, bats and birds, as well as humans are renowned spreaders of disease agents between continents.

Major Changes in Land Use and Agricultural Intensification

The rapidly growing livestock sector has been a principal driver in the conversion of natural habitats into pastures and cropland. More land was converted for the growing of crops between 1950 and 1980 than in the preceding 150 years (MEA 2005). The intensification of agriculture with ever-increasing use of inorganic fertilizer, together with increasing livestock density, has been a major source of water pollution, and often provides favorable environments for novel pathogens to emerge in.

Land Use Change, Deforestation, Habitat Fragmentation, and Biodiversity Loss

Major land-use changes, including intensification and deforestation, lead to a variety of impacts on ecosystems, including pollution, fragmentation of habitats, and changing host-pathogen dynamics. Degraded ecosystems with diminished biodiversity tend to favor opportunistic or generalist species, many of which are disease reservoirs. Deforestation in tropical regions is advancing at the rate of about 130,000 square kilometers annually, driven by cattle ranching and feed production in Latin America, by tree crop (oil palm) plantations in Southeast Asia, and by smallholder farming in Africa. The effects of habitat fragmentation on host-pathogen dynamics were evidenced in the epidemiology of the Nipah virus in Southeast Asia, where deforestation and large forest fires destroyed massive numbers of indigenous fruit and palm trees. This caused the fruit bat, the main transmitter of the Nipah virus, to change habitat to mango trees in populated areas that were associated with pig farming. As a result, pigs became infected and transmitted the disease to humans, causing a major outbreak of encephalitis with extremely high mortality. This led to a Malaysian government-sponsored culling program of 1.1 million pigs.

Increased Hunting, Poaching, and Bushmeat Trade

It is estimated that 4.5 million tons of bushmeat are extracted from the Congo basin each year. This meat is often consumed only partially cooked, thus bringing the principal source of a zoonotic pathogen in direct contact with human beings (Wolfe et al. 2005).

Trade in Live Animals

Both legal and illegal trade in live animals has increased rapidly over the last decades and is a major factor in the spread of diseases. While exact total figures are not available, the Institute of Medicine (2009) puts the figure at several US$ billion (Institute of Medicine 2009). A Congressional Research Service report estimates the illegal global trade in animals at a minimum $5 billion and potentially in excess of $20 billion annually (Congressional Research Service 2008).

Climate Change

Changes in long-term and seasonal weather patterns will have major effects on disease behavior such as spreading patterns, diffusion range, and introduction and persistence in new habitats. The extension of vector habitats will be a major factor in the impact of climate change on the spread of infectious diseases, as, for example, shown by the expansion of Rift Valley fever in East Africa. It might lead also to the emergence of novel pathogens and vectors such as the recent outbreaks of bluetongue disease among sheep in Europe that was caused by a virus carried by a small African midge known as *Culicoides imicola.* The vector appeared in southern Europe in 2000 and led to the evolution of novel *Culicoides* species that also transmit the bluetongue virus. The spread of the virus into more temperate zones was very likely facilitated by the warming trend in the region's climates.

The evidence presented in this chapter corroborates the vital need for a more complete understanding of the drivers in the human and animal zoosphere, and in particular in considering the health of the overall ecosphere in developing early warning and response systems for the detection, prevention, and control of emerging and lingering zoonotic diseases. How the One Health approach pertains to this understanding, and how it can be applied operationally at the interface of animal-human-ecosystem health, are the subjects of the following two chapters respectively. Volume 2 of this report will discuss in more depth the drivers of emerging and re-emerging diseases and how these may be mitigated. In a perfect world, the subject matter of Volume 2 would have preceded that of this volume. The urgency of dealing with the issues at the interface of the animal-human-ecosystem domains prompted this inversion.

3 One Health

In the twentieth century, human and veterinary health professionals became increasingly specialized and technically, institutionally, and even culturally separate. During the 1960s, Calvin Schwabe, who many consider the founder of veterinary epidemiology, questioned the wisdom of so rigid a division of labor. In 1960, Dr. Schwabe coined the term "One Medicine" to capture the interrelatedness between the health of different species, and to recognize the importance of reducing the risks that zoonotic diseases pose to people, their food supplies, and their economies (Schwabe 1964). In 1975, the FAO, OIE, and WHO followed suit in a joint report on *The Veterinary Contribution to Public Health Practice,* which established veterinary public health (VPH) as an area of cooperation among the three organizations that years later would become an important facilitator in formulating an international response to avian flu. (VPH will be considered in greater detail below in Chapter 4.)

The concept of One Health was later broadened to encompass the health of ecosystems as well as human, domestic animal, and wildlife health. In September 2004, the World Conservation Society convened a symposium at Rockefeller University titled "One World, One Health," based on the 12 Manhattan Principles appealing for more purposeful and systematic channels of communication among human, animal, and wildlife health services. The idea also involved a rejection of reductionist or piecemeal approaches and an embrace of systems thinking to accommodate intricate social and environmental interactions (Forget and Lebei 2001). The principle was perhaps best defined by the American Veterinary Medical Association Task Force in 2008 as "the collaborative efforts of multiple disciplines working locally, nationally and globally to attain optimal health for people, animals and our environment" (American Veterinary Medical Association 2008). One Health is used to refer to a more integrated or holistic approach to human, animal, and ecosystem health.

Events would bear out the arguments for greater collaboration between public and veterinary health. During the early outbreaks of HPAI in Hong Kong in 1997, the disease was seen as one of domestic poultry. Only later were wild bird species implicated as the source—a determination that could have been made much earlier had field biologists been consulted. The first research on the role of wild birds and ducks as a likely reservoir of the virus started only in late 2004. The UNEP (United Nations Environmental Programme) Convention on Migratory Species (CMS) established a scientific committee to assess wild birds as a vector in the transmission of HPAI in August 2005.

Greater interaction between public health and animal health specialists working within their respective organizations might have enabled them to address the disease at its source earlier on during the HPAI campaign. Instead, the campaign initially focused on building stocks of antiviral drugs to respond to a human pandemic.

The WHO issued a worldwide alert regarding SARS on March 12, 2003. In early 2004, the civet cat was identified as the source of the SARS coronavirus, an announcement that led to massive culling of the animal. Only in September 2005 was the horseshoe bat identified as the real vector. Earlier detection of this vector would not only have obviated the massive culling of the civet cat, but could have expedited earlier effective control of the disease, thus reducing the massive economic losses the disease caused in East Asia and North America.

With the outbreak of the Nipah virus in Malaysia in 1998, human cases were almost exclusively confined to male pig farmers. A further outbreak in Singapore among slaughterhouse workers in 1999 confirmed the link with pigs. As a result, 1.1 million pigs were culled in Malaysia. In 2000, the press reported a suspicion among experts that fruit bats were the actual disease vector—a suspicion that was confirmed in early 2001.

THE BARRIERS TO CHANGE

Why then, given the recognition of the existing continuum of infectious disease from humans to animals and animals to humans, has there until recently been so little progress in moving towards One Health? There are numerous barriers to the creation of health systems that functionally integrate services that have traditionally been delivered by individual sectors with little or no collaboration or interaction between them. Some of these barriers are erected inadvertently by the bureaucratic division of responsibility between institutions. Some of them relate to budgetary constraints, unequal institutional capabilities and differing cultures, limited communication of information, the absence of a shared vision, and disincentives to working horizontally.

Institutional Capabilities

There are major gaps in the capacities of sectoral institutions involved in disease control. Given the complex interaction among human, animal, and ecosystem domains, understanding the epidemiology of a disease can be delayed when one or more agencies lack necessary skills—even if the division of labor among them is not an issue. Most public health institutions are completely devoid of veterinarians, biologists, and ecologists, while public veterinary health institutions are usually staffed solely by veterinarians. Wildlife institutions have little in-house medical or veterinary expertise. In the absence of close working relationships between professionals with different and complementary skill mixes, delays in the diagnosis and reporting of disease outbreaks become more likely.

Budgetary Constraints

Sharing finances is constrained by low and unequal budget allocations. Although public health is underfunded in relation to health care, the human health sector generally has significantly more human and financial resources available for disease control activities than environmental or animal health agencies. Moreover, over the last decades, the relation between staff salaries and recurrent costs to enable the services to operate has deteriorated, leaving limited discretionary spending for all services. This has been well documented for the veterinary services, in particular for sub-Saharan Africa (Leonard 2004; Gauthier and de Haan 1999; World Bank 2009). Environmental agencies are often the poorest funded in the public sector.

Information Sharing

National public health authorities often use different disease reporting procedures and communication channels than the veterinary services. Despite the importance of understanding the life cycle of pathogens in humans, and in both domestic and wild animals, most national and international health organizations monitor, and can only generate information on, human or domestic animal disease but not both together (Kuehn 2006). In the case of the West Nile virus (Box 2), veterinary authorities actually learned about the human dimensions of the outbreak only through media coverage.

The normal bureaucratic constraints to sharing information among and within human and animal health agencies lead to such missed opportunities. The reporting of a suspected human or animal disease often causes disruption of tourism or the imposition of trade embargos by importing countries. This may have serious economic consequences for the reporting country or sector, and

Box 2: The West Nile Virus

The first incidence of a hitherto unknown disease in the Americas, with massive mortality, emerged in wild birds in June 1999, and the first human cases occurred in New York City in early August 1999. These were retrospectively identified as cases of West Nile virus. That month, a major incidence of bird deaths was also reported. In early September, the disease in humans was misdiagnosed as St. Louis encephalitis. Animal health officials learned of the outbreak in humans through the news media and began to suspect that the unknown disease in birds was linked to these human cases. In late September the up-to-then separate investigations converged thanks to the efforts of a veterinary pathologist at the Bronx Zoo.

In early October the connection between the two diseases was confirmed.

Dr. Laura Kahn observed that "physicians treating the initial patients in New York City in 1999 might have benefited if they knew that in the previous months and concurrently, veterinarians in the surrounding area had been seeing dozens of crows dying with neurologic symptoms similar to those of the affected humans."

Source: Kahn 2006.

trigger political pressure to delay reporting and limit communication of information. The first reports of the HPAI outbreak in East Asia, for instance, were delayed by national authorities, responding to pressure from political and economic agents who feared economic losses from trade (Dolberg et al. 2005). This does not necessarily imply corruption or collusion between economic interests and political decision makers—understanding the likely costs involved naturally creates pressure to be certain of a public health situation before announcing it to the world. Yet there has been gradual progress in international cooperation and information sharing during recent decades. Indeed, this progress has accelerated since the outbreak of HPAI. Box 3 depicts a number of the principal international information systems. One enduring challenge relates to the very number of institutions or networks at play in the current global system. Some of their roles are complementary, others overlap.

While a grand design to promote global collaboration might not be feasible, or even desirable, the international community can take measures to reduce gaps to a minimum. Some of these gaps are geographic, leaving resource-poor countries incompletely covered although the main risk factors for emerging diseases are found within these countries. The international community can also develop incentives for information networks to interact and improve their coordination.

Common reporting procedures and communication channels in the event of an outbreak will be an important step in encouraging timely reporting of emerging or re-emerging diseases. Establishing these channels is not only a matter of bridging professional and institutional divisions that separate public and animal health agencies, but also one of bringing greater consistency to the incentives and regulatory framework that govern national disease reporting. Human health reporting is governed by the International Health Regulations (IHR), which legally binds countries to report a disease that may constitute a PHEIC to the WHO within 24 hours, although it is not yet clear how countries are sanctioned in the case of delayed reporting (Hitchcock et al. 2007). Beyond the legal obligation, IHR also introduces a strong element of peer pressure, authorizing the Director General of WHO to act on informal disease reports from CSOs and networks such as ProMED. This is initiated through a formal request to the "state party" of the country in which the disease has informally been reported, asking for verification. If the public health event may be a PHEIC and if no adequate reply is received, the Director General of WHO is authorized to share the information with other state parties. The incentives and legal frameworks for animal disease reporting are somewhat different. Animal disease reporting often has major trade implications. Under OIE's Terrestrial Animal Health Code, OIE member countries have accepted

Box 3: Global Disease Information Systems

The Global Public Health Intelligence Network (GPHIN) focuses primarily on four human diseases: influenza, polio, SARS, and smallpox. The GPHIN was developed under the auspices of the WHO and is open to governments on a user fee basis. In addition to its four focal diseases, the network also monitors for certain diseases in which an outbreak would constitute "a public health emergency of international concern" (PHEIC).

The Global Outbreak Alert and Response Network is in place to follow up on any such outbreak identified by the GPHIN. It provides support to national governments on disease identification and characterization, outbreak preparedness and aid to affected populations. It is also under the auspices of the WHO.

The Program for Monitoring Emerging Diseases (ProMED)[4] is a disease reporting system of the International Society for Infectious Diseases. It is based on formal and informal sources of information. Data on human, animal, and plant diseases are collected by volunteers and screened by expert moderators. Most sources of information come from the US. Reporting by developing countries, particularly in sub-Saharan Africa, remains weak.

The Global Early Warning System for Major Animal Diseases (GLEWS) was set up to improve the tracking of diseases among animals in high-risk areas. The two zoonotic diseases it currently focuses on are HPAI and Rift Valley fever. Its principal source of data is the FAO, although it uses information from the OIE and WHO as well. It also uses a number of advanced databases such as ProMED, and the GPHIN.

The World Animal Health Information Database (WAHID) is used to store and summarize information on diseases reported to OIE.

Med-Vet-Net is a European network that maintains a database for the prevention and control of zoonoses and food-borne diseases.

The Global Emerging Infections Surveillance and Response System (GEIS) of the US Department of Defense focuses on infectious disease with a potential health risk for US military personnel.

ArboNET, the US national surveillance system for arboviral diseases, has a surveillance system for West Nile virus that can serve as an integrated system at the national level.

The Emerging Infectious Diseases Network (EIN), developed by the University of Iowa under the auspices of the US Centers for Disease Control and Prevention (CDC), is based on a network of pediatric, internist, and public health officials.

Source: Institute of Medicine and National Research Council 2008. Achieving Global Sustainable Capacity for Surveillance and Response of Emerging Diseases of Zoonotic Origin: Workshop Report. The National Academies Press. Washington, DC.

the legal obligation to notify the organization of an emerging animal disease. This obligation was reiterated in May 2009 by OIE's highest organ, the General Assembly. In addition, OIE collects and analyzes data from other sources and verifies such information with the Chief Veterinary Officer (CVO) of the country concerned. But it cannot take formal action, such as the recommendation of an export ban, until such information is officially confirmed by the CVO. However, the OIE members do not always reply to these requests for confirmation. OIE figures show only a 70 percent response rate to such requests (see Table 1). Improving this rate and exploring the possibility of bringing OIE and WHO regulatory frameworks into line are the topics of ongoing discussion. In May 2009, the OIE General Assembly decided to make disease reporting a legal obligation, an important step in this direction.

Under-reporting

Under-reporting or late reporting is still frequent, however, and given the importance of this issue to early detection of disease outbreaks—and for minimizing the cost of control—under-reporting warrants in-depth discussion. There are many reasons

4 ProMED is the only system that brings together information on human, animal, and plant diseases—a feature that must either be brought to other systems, or which new systems may have to be designed to accommodate.

Table 1: OIE Verification Requests and Responses to Them

Year	# of OIE Verification Requests	Answers (% of Requests)	No Answers (% of Requests)	Official Notifications (% of Requests)	Invalidated Non-Official Information
2002	32	18 (56%)	14 (43%)	18 (56%)	0%
2003	29	24 (79.2%)	5 (20.8%)	14 (48.27%)	30.93%
2004	85	67 (78.8%)	18 (21.2%)	39 (48.75%)	30.05%
2005	97	74 (76.28%)	23 (23.71%)	36 (37.11%)	39.17%
2006	113	80 (70.79%)	33 (29.20%)	66 (58.40%)	12.38%
2007	140	103 (73.57%)	37 (26.42%)	71 (50.71%)	31.06%

Source: Institute of Medicine and National Research Council. 2009.

for under-reporting, and a good understanding of these is a prerequisite for the design of improved reporting. While the reasons for under-reporting often differ from one case to another, a number of factors commonly prevail. These are presented graphically in Figure 4.

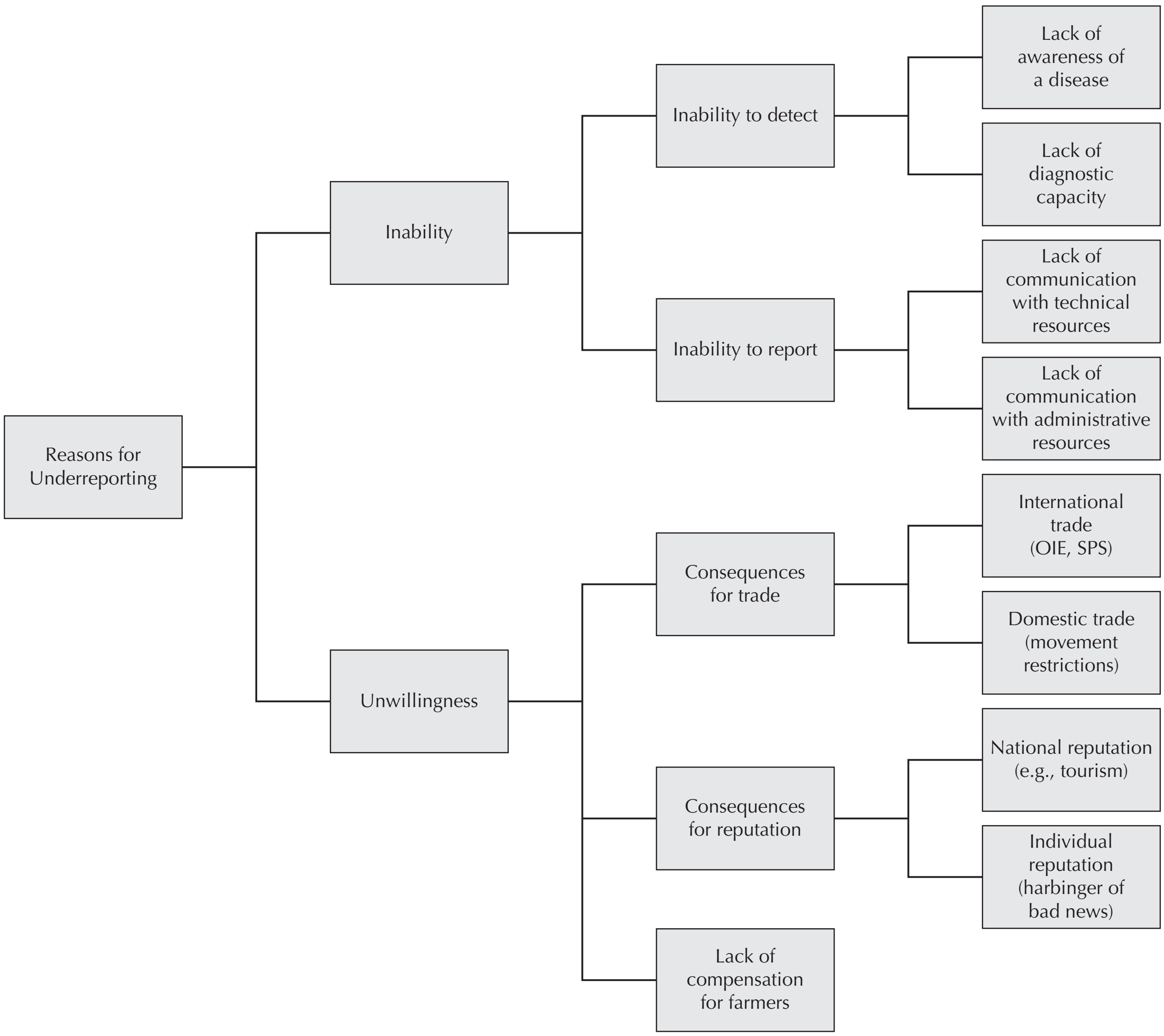
Programs to reduce under-reporting often focus on technical means and may address disease detection, disease reporting, or both. Detection is the limiting factor more often than access to reporting channels, and is commonly the result of insufficient awareness of a disease among farmers and field veterinarians—particularly at the beginning of the reporting chain. To improve early detection rates, these agents must not only be aware of the existence of the disease, but also have an understanding of the threat that it represents. In the case of endemic diseases, people can often become accustomed to the fact that some animals fall victim to them from time to time. This habituation effect is particularly common with slowly progressing production diseases such as tuberculosis or brucellosis that do not cause sudden death among large numbers of people or animals.

Yet awareness of a disease and its threats may be limited not only in the field but also among central planning and surveillance programs, where self-sustaining or even enhancing cycles of unawareness or neglect may occur. Poorly designed surveillance programs can also cause large numbers of cases to be overlooked if the populations at high risk are not sufficiently sampled. This was the case when BSE surveillance in Europe relied entirely on farmers and veterinarians reporting suspected cases—a system of passive surveillance. When the system was changed to targeted active surveillance, many more cases were detected. In fact, it was estimated that only one out of six cases was reported under the passive surveillance scheme ProMED 1997).

The absence of sufficient diagnostic capacity is another cause of limited ability to detect diseases. Lack of infrastructure and facilities such as properly equipped laboratories with well-trained staff, or simply the lack of affordable diagnostic tests of sufficient sensitivity, can lead to this constraint. Rapid tests for transmissible spongiform encephalopathy (TSE) in early subclinical phases of disease development illustrate how higher test sensitivities would lead to higher case numbers. Lack of appropriate samples can also be a critical limiting factor. In Uganda, for instance, mortality from sleeping sickness was suspected to be under-reported by a factor of 12 owing to difficulty in detecting the disease before parasites pass from the blood to the brain (Odiit et al. 2005 and ProMED 2004). The most recent example in which a rapid and broadly accessible test was absent altogether, therefore preventing the disease from being detected or reported, was the very first phase of the outbreak of Influenza A(H1N1) in North America.

Some programs focus more on the access to reporting channels, assuming that disease detection is not or not alone limiting. They address technological aspects such as access to the Internet in remote areas and often rely on mobile phone

Figure 4: Reasons for Disease Underreporting



technology to enable communication.[5] Less often, access to proper official communication channels is limiting, but unclear processes and case definitions can hinder disease reporting. The former was indicated as the major issue around underreporting of communicable diseases by doctors in New York, whereas the latter played a role during the outbreak of SARS in China (Konowitz et al. 1984 and ProMED 2003).

The reluctance to report animal disease outbreaks is often rooted in the existence of disincentives. For reporting to be improved, these disincentives must either be removed or compensated for. One of the principal disincentives relates to the consequences of disclosure for international trade of animals and animal products. The Terrestrial and Aquatic Animal Health Codes of the OIE are WTO-recognized standards that link the animal health status of a country to the right to trade certain products. The prevalence of reportable diseases can have a major economic impact on a country's farm industry. In extreme cases, such as BSE, a single case of a disease can bring the trade of certain products to a halt. How often this

5 For examples see: "Global Infectious Disease Surveillance and Detection: Assessing the Challenges—Finding Solutions, Workshop Summary (2007), Board on Global Health." The National Academies Press. http://www.nap.edu/catalog.php?record_id=11996 (accessed May 25, 2009).

actually results in hiding or denying an outbreak is a question that by its nature defies proper analysis.

The reporting of disease outbreaks, of course, has important consequences for domestic as well as for international trade. Outbreaks of highly infectious diseases are often controlled by restricting the movement of live animals and animal products. The anticipated decline in market value often leads farmers to clandestinely transport their animals to places outside the restriction zone in spite of the suspicion or even knowledge that the animals are infected. The CVO of a country with an emerging or re-emerging disease is often under pressure from powerful commercial and political interests to conceal an emerging infectious disease This appears to have been a major contributing factor to the rapid spread of H5N1-infected poultry in Indonesia in 2003 and to the ineffectiveness of the technocratic approaches that were employed to control the spread—and with significant loss of human life (Forster 2009). Ensuring adequate independence of the Veterinary Service is therefore important. OIE's assessment tool, the Performance of Veterinary Services (PVS), therefore attaches considerable weight to the independence of the veterinary service in disease reporting. Owing to informal peer pressure and the PVS assessments, under-reporting has been reduced according to OIE officials. But the independence of veterinary services should be a central point in international efforts in strengthening early warning systems.

Vigilant policing and strict law enforcement are vital elements in deterring animal owners from concealing possible outbreaks and subverting surveillance and control measures. They are not, however, sufficient, especially, of course, in countries in which the capacity to monitor compliance is limited. Fostering cooperation by owners also entails balancing these deterrents with positive incentives such as eligibility for indemnity and compensation so that complying with the law does not entail relinquishing the basis of one's livelihood. Concealing a disease outbreak may, after all, be the only rational economic decision an animal owner can make. Yet even where compensation mechanisms are in place and accessible, animal owners will still compare the value of their animals to the compensation offered for culling them, unless the healthy remainder of the herd or flock can be expected to be saved by sacrificing the diseased part. This calculation becomes straightforward when there is no compensation at all. In 2006, the World Bank, FAO, OIE, and IFPRI published guidelines for compensation payments in *Enhancing Control of Highly Pathogenic Avian Influenza in Developing Countries through Compensation.* The guidelines were adopted at the Ministerial and Pledging Conference in Bamako in December of that year. In addition to informing owners about the potential liabilities and consequences of violating the law, owners must also be educated about the rationale behind those laws, because laws that are perceived as being arbitrary or unfair are usually more difficult to enforce.

Not all of the potential consequences of reporting infectious diseases are economic. Some consequences concern the reporter's social and professional reputation. The fear and stigma associated with being the first to report or with corroborating early reports cannot be overstated, and in some cases has led to suicide among animal owners who were suspected of having been the source or an outbreak, or of having missed or concealed one (ProMED 2004a). Social pressure to not report may, of course, also stem from threatened economic interests. One's "hunch" that the animal symptoms that one is observing might be the early signs of an outbreak may after all come to nothing. But during the interim, while the threat is being evaluated at whatever pace the concerned public surveillance agency deems fit, business may well be closed for everyone in one's district or area. If the suspicion is found to be groundless, then, in hindsight, all the losses that have resulted from the unwarranted report are attributable to the reporter. If the suspicion is substantiated, then the reporter may be suspected within his or her community of having caused the problem. Ultimately, highly contagious diseases are impossible to conceal, and the disincentives that discourage people from reporting them tend to be concentrated in time during the early phase of an epidemic.

At the policy level, the prospects of allocating public revenues to compensation and insurance services are to be considered within a larger context of limited resources. These services are generally at a disadvantage in "competing" with other demands for public resources in that the issue of farm animal health is almost always assigned to the public institutions responsible for agriculture, institutions that are much less politically influential than other institutions such as public health or finance ministries. The matter of political clout will be addressed in greater detail in the following chapter.

In summary, there is a multitude of underlying reasons for under-reporting, and more often than not, more than one are at play simultaneously. Many programs to improve compliance with reporting duties have failed because they addressed only one reason, leaving others unattended to. All reasons for under-reporting must be addressed comprehensively, a Herculean task that nonetheless must not be avoided.

GLIMMERS OF HOPE

While disease outbreaks and the threat of bioterrorism have led many countries to revise their public health systems, the interconnectedness of health issues in different countries in the larger context of globalization has made it increasingly clear that countries cannot act effectively in isolation. Recent zoonotic disease outbreaks have already had a major impact on how national and international public human and animal health institutions communicate and interact. The emergence of SARS in particular was a major impetus for the finalization and adoption of the WHO's revised International Health Regulations of 2005. The Regulations constituted a paradigm shift in which the reporting of human diseases would no longer be limited to individual diseases, but rather would cover "illness or medical condition, irrespective of origin or source, that presents or could present significant harm to humans." The applicability of the Regulations to human disease in general was pivotal because it extended coverage to diseases that will emerge in the future.

By adopting the 2005 International Health Regulations, countries committed themselves to a revision of their core public health surveillance capacities by 2009. Governments appointed national IHR focal points to be the spokesperson in urgent communications between state parties and the WHO regarding events that may constitute a public health emergency of international concern. The WHO, however, can take into consideration unofficial reports and obtain verification from state parties concerning such events. The Director General of the WHO needs only to consider the recommendations of an emergency committee of international experts and does not need the country's concurrence to declare a "public health emergency of international concern."

It was in this context that the HPAI scare again created momentum to bring national and international stakeholders together. At the national level, public and animal health agencies have come together into joint health-agriculture task forces while INAPs have been prepared to coordinate their activities. At the international level, a global campaign against HPAI brought together a variety of agencies. The establishment of UNSIC and the Global Program on Avian Influenza Control and Human Pandemic Preparedness and Response (AHICP) in particular established more regular channels of communication among the FAO, the World Bank, the OIE, and UNICEF. The campaign made the prevention and control of emerging and re-emerging diseases with pandemic potential the focus of high-level attention by the international community.

There are a number of practical examples of collaborative human and animal health in the planning of One Health activities. However, there is less to show in the actual implementation of the concept as a whole. Moreover, the involvement of wildlife health specialists in most institutions is weak, if not completely absent.

The National Center for Zoonotic, Vector-Borne, and Enteric Diseases (ZVED), which was organized in April 2007 under the auspices of the CDC, is a good example of an operational One Health unit. ZVED provides leadership, expertise, and service in laboratory and epidemiological science, bioterrorism preparedness, applied research, disease surveillance, and outbreak response for infectious diseases. The Center's vision is to improve health by reducing the impact of infectious diseases using a comprehensive approach to ensure that human interactions with animals, animal products, wildlife, and the natural environment are healthier and safer (National Center for Zoonotic, Vector-Borne, and Enteric Diseases 2009).

In November 2007, One Health was identified as the top priority for the veterinary profession in Europe by the Federation of Veterinarians of Europe (FVE). In 2008, the European Academies Science Advisory Council prepared a policy report on the control of zoonoses, urging a closer integration of human and animal health (European Academies Science Advisory Council 2008).

In Canada, the limitations of the public health system were thrown into sharp relief by the outbreak of SARS in 2003 and the epidemic that followed. The Minister of Health established the National Advisory Committee on SARS and Public

Health to assess the factors that limited the effectiveness of the campaign against SARS and to recommend improvements in the country's preparedness and responsiveness to future disease outbreaks. The committee recommended that the national government create an agency mandated to coordinate federal and provincial public health responses, a departure from relying on provincial departments. In 2004, the government established the Public Health Agency of Canada. The Agency goes far in resolving two issues that are common to many countries: the fragmentation of functions and responsibilities among public institutions, and a lack of authority among public health entities. Box 1 describes the Canadian experience in greater detail.

National cross-sector and interdisciplinary working groups and task forces have been established in a number of countries. In Canada, the C-EnterNet (pronounced "centernet") is facilitated by the Public Health Agency of Canada to monitor for infectious enteric diseases, surveying sentinel sites to detect new threats, including zoonotic ones. Canada's International Development Research Centre (IDRC) hosts the Ecosystem Approaches to Human Health Program, which assesses the relationships between the health of different components of an ecosystem, including human health. The IDRC is also a partner in the International Association for Ecology and Health, which publishes the journal *EcoHealth* and which also stresses the interdependencies among development, human health, and healthy ecosystems. The Canadian Science Center for Human and Animal Health (CSCHAH) and Denmark's Zoonosis Institute promote collaboration between medical and veterinary health and are described in some detail in Boxes 4 and 5. In 2005, the "Canary Database" was established at Yale University for the use of animals as sentinels of human and environmental health risks, including emerging infectious diseases (Rabinowitz et al. 2008b). In Kenya, the International Emerging Infectious Disease Program has established joint surveillance systems and uses its diagnostic facilities for both human and animal specimens.

Both the American Medical Association (AMA) and the American Veterinary Medical Association (AVMA) established One Health task forces in 2007. In June 2008, the US National Academy of Science, through the Institute of Medicine (IOM) established a panel on "Sustaining Global Capacity

Box 4: The Canadian Science Center for Human and Animal Health

The CSCHAH is a research and diagnostic facility that contains specialized laboratories for human and animal health. Located in Winnipeg, Canada, the CSCHAH houses the National Microbiology Laboratory and National Centre for Foreign Animal Disease. The Laboratory is part of the Public Health Agency of Canada, and the Centre is part of the Canadian Food Inspections Agency. As such, the CSCHAH represents the integration and close partnership between these two federal agencies on issues concerning human and animal health.

The CSCHAH is an internationally renowned facility that is among an elite group of laboratories capable of working with the world's deadliest pathogens. The facility is the only one in Canada to operate at level 4 containment, allowing researchers to work safely with pathogens such as Ebola, Marburg, and Nipah. The CSCHAH also contains level 2 and level 3 laboratories, which make up the majority of the facility. These allow researchers to work on less pathogenic agents. The CSCHAH provides a unique environment for collaboration between researchers working on animal diseases and those working on human diseases.

Among its many activities, the National Microbiology Laboratory offers reference microbiology services and supports epidemiology, surveillance, and emergency response programs. During the H1N1 outbreak in April 2009, the National Microbiology Laboratory was the first laboratory to completely sequence the genomes of the H1N1 viruses from Mexico and Canada.

The CSCHAH continues to look forward and to innovate. Recently, the facility added a new operations center outfitted with a state-of-the-art communications network. The CSCHAH uses the operations center to coordinate activities among the provinces, other areas of the federal government, or international organizations.

Source: The Public Health Agency of Canada 2009.

Box 5: The Danish Zoonosis Centre

The Danish Zoonosis Centre (DZC) was established in 1994 as a separate unit within the Danish Veterinary Institute under the Ministry of Food, Agriculture, and Fisheries (now the National Food Institute, Technical University of Denmark). The reasons for the creation of DZC were the implementation of the EU Zoonosis Directive (92/117/92), an increasing incidence of reported zoonotic infections in humans, and an increased awareness of the occurrence of zoonotic agents in pork and poultry products In Denmark.

Before 1994 several institutions were responsible for control along the food production chain, resulting in suboptimal communication and coordination. The solution was the formation of DZC as a coordinating body that integrates all data on the occurrence of zoonoses in animals, food, and humans in one place. Furthermore, a zoonosis epidemiological research unit was established.

The objective of DZC is to guide prevention and control of food-borne zoonoses in Denmark, and DZC is based on an agreement between the Danish Veterinary Institute (food and animal data) and Statens Seruminstitut (human data). DZC has no power to make risk management decisions, but exerts its tasks through scientific assessments and advice to the risk-managing institutions such as the Danish Veterinary and Food Administration.

Funding comes partly from the Danish Government, partly from research and advisory service. The professional staff consists of approximately 13 people, with additional general support from the National Food Institute. Coordination at the national level takes place in regular meetings with industry and NGOs as well as with official administrative institutions and ministries and with research partners. Tasks performed by the DZC include to:

- Maintain the national statistics on zoonoses
- Carry out surveillance of antibiotic-resistant bacteria
- Trace sources of infection and uncover routes of transmission—sporadic cases and outbreaks
- Conduct epidemiological research
- Disseminate information
- Coordinate activities between institutions and authorities

Strong research areas were and are still the basis for the success of DZC. In particular, the "contamination source model"—which ties together the risk associated with occurrence of specific types of zoonotic microorganisms in production animal species, in food originating from these species, and in the human cases of these infections—has been instrumental in setting up monitoring and tracing of food-borne zoonotic infections.

for Surveillance and Response to Emerging Diseases of Zoonotic Origin." The panel was sponsored by USAID. Its report was published in October 2009. In 2001, the United Kingdom Zoonoses Group was set up at the ministerial level, bringing together representatives of veterinary and public health and other services on a permanent basis. Innovative research like the zoonoses research program of the German government prescribes compulsory cooperation between physicians and veterinarians.

These examples of cooperation between public health and veterinary services and the incorporation of wildlife and ecosystem health in disease surveillance need to inform similar initiatives in developing countries, including the institutional models used to foster new forms of collaboration.

However daunting the barriers to institutional coordination may appear, there are practical examples of operational coordination among human, animal, and wildlife health services, and there are glimmers of hope also in the developing world. At the sub-Saharan African level, the CDC center in Nairobi also seems to have a well-integrated disease surveillance system, and is a good example of the integration of the different disciplines. The Cysticercosis Working Group in Eastern and Southern Africa (CWGESA), which brought together medical, veterinary, and animal production scientists and professionals to coordinate research and development activities targeting this zoonotic disease, is mentioned as an example of institutional innovation promoting cross-sectoral collaboration for research targeting a specific disease (Boa et al. 2003). However, the Group does not appear to have contributed substantially to increased coordination between medical and veterinary institutions in controlling cysticercosis in the countries involved (Randolph et al. 2007).

In southern Sudan, for instance, mixed community-based teams provided both human and animal health services in the midst of civil war, carrying out human health activities such as polio vaccinations and guinea worm eradication while animal health workers on the teams carried out rinderpest vaccinations. In Mauritania, where cases of high fever were mistakenly diagnosed by the country's public health service as yellow fever, contacts with the livestock services revealed that these were in fact cases of Rift Valley fever (Digoutte 1999; Nabeth et al. 2001). Finally, in Chad, the combination of the vaccination for nomadic children for measles and whooping cough, and the compulsory cattle vaccination for anthrax, blackleg, and contagious bovine pleuropneumonia, increased the number of people vaccinated per day to 130 in joint vaccination campaigns from 100 without participation of the veterinary services. It also resulted in a reduction in the delivery costs of about 15 percent. Furthermore, pastoralist families vaccinated their livestock and children more spontaneously (Schelling et al. 2007). Though limited in scale, these experiences suggest that the coordinated delivery of human and animal health services and surveillance is feasible at the village level.

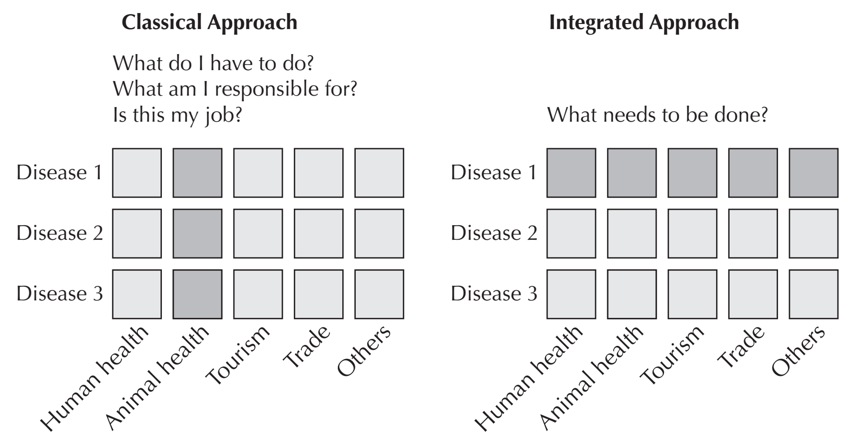
4 Making One Health Operational

While a number of countries employ, or are planning to introduce, integrated disease surveillance, prevention, and control systems along the lines of One Health, few existing systems can be classified as fully functional applications of the principle. Optimally, such a system would actively fulfill a number of functions. It would enable shared surveillance to improve the capability to detect the emergence of a disease event, thus fulfilling a prescription set forth in the International Health Regulations. It would allow the preparation of joint strategies for prevention and control, clearly defining roles, responsibilities, and accountabilities. A One Health approach would also facilitate joint preparation and testing of emergency preparedness plans and the joint formulation of internal and external reporting and communication plans. Sharing facilities and exchanging staff in surveillance and control operations would foster capacity throughout the system's membership. Finally, it would enable participating institutions to employ new modalities for mobilizing financial resources for joint planning and response to emergency and ongoing operating needs.

ADOPTING ONE HEALTH

The division of labor among public institutions makes for a segmented or vertical organization of work, in which institutions operate independently of one another and from the perspective of their discipline or sector. This unavoidably leads to gaps, and sometimes to overlaps. For practitioners working in this framework, the starting point for action tends to revolve around the question "What am I responsible for?" rather than "What needs to be done?" Figure 5 presents these two orientations. Changing the organization of work across disciplines to start with this latter question implies a substantial reorientation along horizontal lines in which regular communication takes place between practitioners at work in different disciplines and sectors. This does not imply an amalgamation of work but rather the creation of a culture in which practitioners are more likely to understand the significance of a finding or event within their own field for practitioners in other fields.

Figure 5: Vertical and Horizontal Orientation in Disease Prevention and Control



INSTITUTIONS AND ONE HEALTH

A number of areas suggest themselves as worth building upon in adapting the campaign against HPAI and A(H1N1) into a more general, permanent system for coordinated national and international surveillance and control. Such a system would certainly entail more regular channels of collaboration than the current communication between agencies that prevails to date, which is based on temporary arrangements formed in response to various contingencies. Better-defined joint-operational mechanisms would facilitate responsiveness by averting the need to negotiate agencies' respective roles on the fly, and would greatly reduce the likelihood of duplications of effort. More fundamentally, however, a more systematic approach to surveillance and control would be more inclusive in terms of sector and discipline, and would expand access to agencies and institutions concerned with environmental health, and wildlife health in particular. While joint actions presently focus overwhelmingly on diseases at the human-livestock interface, more than 70 percent of new zoonotic diseases originate in wild species (Jones et al. 2008). This represents a fundamental disconnect between human health priorities and the practical demands imposed by reality, one that needs to be resolved.

National Level Structures

Responsibility for the surveillance and control of zoonotic diseases within countries is typically divided among a number of ministries and agencies. Public health agencies usually belong to a country's ministry or department of health and are responsible for emergency preparedness and planning, including surveillance of infectious diseases, identification of possible syndromes, and pandemic planning. These roles are part of a broader institutional division of labor that includes strategic planning and resource mobilization. In some countries the supervision and regulation of private health providers and quality control over pharmaceuticals may extend to actively supplementing private firms in providing clinical services.

National veterinary services are generally agencies within the ministry of agriculture. They are typically responsible for ensuring the protection of animal health, for the safety of food products of animal origin, and for the eradication of major animal diseases. They are often responsible for the quality control of veterinary pharmaceuticals and the oversight of clinical services provided by private operators. Most veterinary services also oversee the sanitary aspects of international trade in animals and animal products, and may enforce animal welfare standards. In many developing countries, the public veterinary service still supplements the private sector in the provision of clinical services, although these "private good" functions are increasingly performed by private veterinarians. In some countries, the veterinary service is also responsible for monitoring and controlling wildlife diseases.

Issues that impinge on the health of ecosystems, including pollution related to livestock husbandry, generally fall under the jurisdiction of environment ministries. The ministries' involvement in wildlife is largely limited to the management of parks and related matters concerning biodiversity conservation. Their interest in wildlife diseases normally starts when the occurrence of a disease becomes a threat to the survival of the affected species. In most developing countries, these services are greatly underfunded. They are generally not allowed to use the revenues generated by the parks for their own operation and management costs.

Avenues for Improvement

The quality of a disease surveillance and control system depends in large measure on the speed with which potential health risks are identified and measures to mitigate them are undertaken. The rate of spread and the human and financial costs of emerging and re-emerging diseases can increase significantly, and sometimes exponentially, during the interim between when the disease emerges and when it is reported and control actions are taken. Delayed reporting also leads to a substantially increased risk of spillovers to other countries. Limited capacity to diagnose diseases and poor infrastructure are among the principal causes of delay in reporting and responding to outbreaks. Many outbreaks occur in poor rural areas, where there is very little if any coverage by human or veterinary staff, and where laboratory systems for timely diagnosis are entirely lacking. However, poor capacity is not the only cause. Organizational and legal constraints inhibit fast and reliable disease identification, reporting, and control. To address those constraints, a series of important measures are warranted, and most of them relate directly to One Health.

Consultation in priority setting between human and veterinary health agencies is an important area of potential convergence. Health ministries in low income countries tend to focus primarily on reducing mortality among pregnant and nursing women and children under five years old, and on controlling HIV/AIDS, malaria, and tuberculosis—functions closely aligned to the health-related Millennium Development Goals. Veterinary services often give the highest priority to the "diseases of trade," such as foot-and-mouth disease (FMD), classical swine fever, and contagious bovine pleuropneumonia (CBPP). Wildlife agencies are mainly concerned with conservation of threatened and endangered species. Zoonotic diseases often tend to fall between these foci.

National risk assessments and analyses of the potential costs and consequences of the principal zoonotic disease threats are likely to increase the profile of those threats, and support the arguments of those advocating increased levels of funding to address them. Compiling and communicating this information places zoonotic diseases more firmly on the public agenda and among the priorities of public agencies. The risk assessments should identify hot spots upon which the efforts of surveillance systems can focus, and in which the monitoring activities of different agencies can converge.

Joint preparedness planning has been exemplified in the formulation of INAPs under the aegis of the Partnership for African Livestock Development (ALive). As of October 2009, rapid assessments had been undertaken in 26 sub-Saharan Africa countries to evaluate their preparedness for avian and human influenza and to identify what was required to strengthen their response plans. The assessments were conducted by multidisciplinary teams from FAO, OIE, the African Union/Interafrican Bureau for Animal Resources (AU-IBAR), and the WHO's Regional Office for Africa and consisted of specialists in animal health, human health, communications, and finance. The results of the assessments were used as the bases for INAPs, most of which were then endorsed by their respective national governments. Several of the INAPs were used as input into externally supported projects to enhance influenza preparedness. These projects, such as the World Bank-funded Uganda Avian and Human Influenza Preparedness and Response Project provided a balanced distribution of responsibilities and resources. Among the principal challenges encountered when preparing the action plans were the high transaction costs of assembling multidisciplinary teams with members from multiple institutions, and the need to adapt interventions to the needs of individual countries. While the ALive initiative is widely considered a unique experience in intersectoral cooperation, the INAPs themselves still need to be tested through simulation exercises, such as have been conducted by countries in other developing regions.

Coordinating surveillance services may go far in preventing the kinds of delays that were experienced in diagnosing the West Nile virus and HPAI as a result of the disconnect between public health and veterinary surveillance systems. Coordinating grassroots surveillance systems through the participation of community representatives proved quite successful in the control of HPAI in Indonesia (Scoones and Forster 2008). Such grassroots systems are well suited to link human and veterinary health services. Sharing facilities such as transport and cold storage equipment is often met with resistance, partly out of fear of cross-contamination of human and animal specimens as we have seen. Such integration, however, must take into account prioritization of sample processing, specimen testing, and other services provided to ensure that animal and human health needs are met in times of high demand or pandemic outbreaks.

Communicating Consistent Messages

As shown in several instances, different agencies often issue contradictory statements to the outside world in the case of a new disease outbreak. It is essential that the way emerging diseases should be handled—that is, the most appropriate strategy to control an emerging disease, the safety of animal products from the diseased areas, the level of emergency status—is presented to the general public in a unified fashion. For example, the major economic losses experienced by the pig industry in several developing countries as a result of the premature identification of influenza A(H1N1) as swine flu shows the importance of close cooperation in national and international communication with the media (Box 6).

Legislation that Facilitates Selective Interaction Between Medical and Veterinary Services

Veterinarians are not allowed to treat human patients, and paraprofessionals often are not allowed to handle certain human and animal drugs or to

Box 6: What's in a Name?

The general public's awareness of the threat of zoonotic diseases, especially those that spread quickly around the world as a result of human movement, was heightened by the outbreak of influenza A (H1N1) in late April 2009. This outbreak and spread inflicted enormous social and economic costs on countries globally, but particularly on Mexico where it was first reported. In addition to the deaths and widespread illness caused, a very significant portion of the economic costs are associated with pandemic preparedness and disruption of economic activity. Some of the disruption to trade and to livelihoods for those concerned with pigs may have been minimized had it not been for the misnaming of the disease.

Although the genetic makeup of the influenza A (H1N1) virus proved to be a combination of human, swine, and poultry genomes, at the time of the outbreak and the name "swine flu" took hold, the virus was not detected in pigs, and up to the present time few diagnoses of the disease in swine have been made.

Within days of the official announcement of the new flu strain, international tensions rose as trade bans were announced that did not comply with exiting trade rules, and that restricted the import of pigs and pork products from countries reporting human cases of influenza A (H1N1). Responding to the name of the influenza virus and associating it with pigs, consumers reduced their purchases of pork, and prices slid in many markets. In a few countries, governments even ordered the culling of pigs, despite the lack of the disease and in disregard of the potential livelihood losses for poor affected farmers. Markets have remained depressed in most places of the world. Much effort was subsequently made to reassure the public that pigs were not the source and that consumption of pork products did not pose risk of exposure to the disease, but these had little effect as the name was already well established.

Hence, blame for this component of the economic losses suffered has been attributed to the name "swine flu," which, in the context of a pandemic threat, created a fear of disease transmission even though pigs and the consumption of pork products don't spread it. While political or economic winner and loser calculations should not be a consideration for reporting or naming the source of a disease, inadvertent consequences such as this should and could be avoided by designing and following appropriate procedures at both national and international levels.

perform simple interventions. These restrictions apply even in remote areas, where neither accredited physicians nor veterinarians are available. The establishment of private health providers in these contexts is constrained by the inability of potential clients to pay in such remote and resource-poor areas. Even in these settings, combining medical and veterinary practices to expand coverage is generally not recommended by the public health and veterinary authorities, owing to public health concerns regarding the possibility of cross-contamination and of cheaper veterinary drugs being used on humans. (In fact, the relative prices of human and veterinary pharmaceutical products drive a major black market for these products.) With a proper legal framework and appropriate training, however, certain select public health activities could be shared—for instance, in surveillance by human and animal health field agents. Patient care would, of course, remain the sole responsibility of the human health agents.

Strengthening Education

The number of veterinary schools has expanded dramatically in recent decades. In Africa, for instance, the number has increased from three to 40 schools since 1965. However, both veterinary and medical education systems remain weak in most developing countries, and many schools lack sufficient resources to provide quality instruction. In the former Soviet Union, and to a lesser extent elsewhere in Eastern Europe, the quality of instruction varies widely, and curricula are often more theoretical than practical. Limited western-language skills have been an important constraint (Schillhorn van Veen 2004). In China, the combination of formal and nonformal training systems prepares students for the traditional role of a veterinary clinician, but do not address the needs of the modern livestock sector or adequately cover public health or food safety issues (Bedard 2004). Much like in western countries, interdisciplinary training that relates human, veterinary, and ecosystem health is also very scarce. Veterinary faculties tend to focus on clinical skills that pertain to meat and milk production, and often operate under the auspices of their country's agriculture ministry. Human health faculties often focus on control or eradication programs on specific diseases such as malaria or HIV/AIDS. Joint training of community health technicians and animal health technicians is seldom seen, although it could enable trainees to play a critical role in the early detection of emerging zoonotic diseases. There are, however, some examples of integrated training programs. One is the CDC-sponsored Field Epidemiology Training Program (FETP), which originally focused on public health officials but more recently has also begun accepting veterinarians and biologists (CDC 2009). Another is the EU-sponsored *Sanidad Publica Veterinaria* (SAPUVET) program, which links universities in Europe and Latin America and focuses more on veterinary health. OIE is launching a major initiative to strengthen veterinary schools in Africa. A clear priority in establishing these and other initiatives as centers of excellence is to develop interdisciplinary curricula around topics such as wildlife disease and surveillance systems, communications, and the perception of risk among human populations.

Providing an Appropriate Incentive Framework

Although public health is underfunded in relation to health care, the human health sector has significantly more human and financial resources available for disease control activities than have environmental or animal health agencies. Hence, public health efforts to increase attention to zoonotic diseases often fail because of the lack of funds from the veterinary and environmental agencies. In Kenya, the Ministry of Health deployed five times more staff in response to Rift Valley fever than the Veterinary Services were able to (Schelling and Kimani 2007). The latter, it should be noted, are in charge of controlling the main source of human RVF infection. Incentive policies that place a premium on collaboration and resource sharing should therefore be introduced. This can include shared budget lines between different agencies and systems of matching grants, with increased cooperation leading to increased budgetary support. An overall increase in funding would have to be based on the results of the risk assessment.

Providing the Appropriate Institutional Framework

The campaign against avian flu has over time led to increased cooperation among national agencies within countries, including in the 26 African countries that have prepared INAPs as of August 2009. These current levels of cooperation are, however, likely to fade if the risk of avian flu continues to be contained. Unless countries find ways to institutionalize more permanent channels between their responsible line ministries and sector agencies, new coordination mechanisms will have to be built from scratch in the event of a new outbreak. The goal is to design institutional relationships and mechanisms—and perhaps even new institutions—that facilitate effective and efficient prevention, detection, and control of zoonotic and other diseases of national or international significance. Depending on the capacity of public institutions within a country, a number of options are available.

- Creating a special permanent cross-sectoral coordination mechanism (which could have several working groups), either through the exchange of memoranda of agreement between the different ministries and agencies involved, the primary responsibility of which is to prepare prevention strategies and regularly update contingency plans to address eventual new or re-emerging outbreaks.
- Establishing a coordinating authority at the executive level of government, such as at the prime minister or deputy prime minister level, to which the agencies responsible for public health, veterinary services, and the environment must all report. This may take the form of a task force assigned to define an integrated strategy, oversee the preparation of contingency plans, and ensure their full implementation.
- Establishing special One Health teams composed of representatives of the human, animal, and ecosystem institutions, with particular responsibility for diseases at the animal-human-ecosystem interface; or
- Creating an independent agency for public health, including zoonoses and food safety, with characteristics similar to those established in Canada and Denmark.

Experiences in the preparation and, in particular, the implementation of the HPAI emergency projects by the World Bank confirm the need for stronger coordination. In a number of countries, a committee or task force at the executive level to ensure coordination needed to be established. An internal World Bank evaluation of the HPAI campaign confirms that "the best functioning National Steering Committees are those chaired by the president's or prime minister's office, so that a top-down command structure exists which can, in case of outbreak emergencies, issue direct orders with authority to the lower levels and expect to have these complied with forthwith." At district and provincial levels, the degree of cooperation varies, depending in large measure on the trust between the main persons involved (Brandenburg, 2008).

Establishing Trust Among the Different Actors

Mutual confidence between the concerned parties, and between physicians and veterinarians in particular, is a necessary condition for effective collaboration. According to Joann Lindenmayer at the Cummings School of Veterinary Medicine at Tufts University, "Veterinary medical professionals always mentioned human and animal health together; public health and medical professionals always spoke of them separately" (Lindenmayer. 2007). Physicians are less inclined to analyze the role of animals in the transmission of zoonotic diseases, and to regard that analysis as being properly within the purview of veterinarians (Kahn 2006). In addition to the customary division of labor between them, the two disciplines are characterized by different modes of operation, with physicians more often using a syndrome approach and veterinarians more often using a "causative agents" approach (GAO 2000). Education, and assigning more importance to joint operations (such as in One Health teams), can help to increase opportunities to bridge these professional gaps and to form interfaces. Institutional and cultural change is long term in nature and requires deliberate and sustained efforts to achieve.

THE CURRENT INTERNATIONAL SITUATION

Cooperation at the international level is generally good. In 1975, the FAO and WHO published a joint report titled *The Veterinary Contribution to Public Health Practice,* and the WHO developed a program on veterinary skills in what has been called *veterinary public health*, which was further defined by WHO in 1999 as "the sum of all contributions to the physical, mental and social well-being of humans through an understanding and application of veterinary science" (WHO 2009) Zoonotic diseases are the core domain of veterinary public health, which provides a valuable channel between the FAO and OIE, although FAO has no human medical skills among its staff. OIE sets animal health standards, whose implementation FAO supports through technical assistance. The three organizations are also partners in the Codex Alimentarius Committee, which sets food safety standards, and in the Global Early Warning System for Major Animal Diseases, including Zoonoses (FAO 2007). These established instruments of collaboration among the FAO, OIE, and WHO would prove important in facilitating the international community's response to HPAI.

Despite the noteworthy levels of cooperation among these international organizations during the HPAI campaign, a number of impediments also became clear, particularly during the initial phase of the outbreak. Different legal and financial frameworks, as well as business models and operational procedures, remain hurdles to fuller collaboration. Much of the cooperation remains informal, and is the product of personal relationships among decision makers in the organizations—relationships that would likely quickly dissolve with changes in personnel. How to make these informal channels into formal, institutional ones that are an integral part of the terms of reference and performance expectations of professionals working within the organizations is the next challenge. While how the specialized international agencies is organized falls outside the remit of the World Bank, the institution does have a particular interest in this subject because the development mandate encompasses all these areas. Also, the partnership with the international agencies is indispensable to the Bank's work. The international community could aim for the improvement described below. In that regard, a report published by authority of the United Kingdom's House of Lords in July 2008 sought to initiate dialogue on this and related matters, and the recently released report of IOM (2009) also has a number of recommendations in this respect (House of Lords 2008).

AVENUES FOR IMPROVEMENT AT THE INTERNATIONAL LEVEL

Greater Involvement of Ecosystem Health and Wildlife Organizations

There is no UN agency or other international organization that is formally responsible for the surveillance or control of wildlife diseases.[6] UNEP hosts the secretariats for the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the CMS. OIE has a committee that oversees wildlife diseases, and GLEWS records wildlife diseases, but these diseases are mostly not part of the official monitoring and reporting system of the veterinary services. Because wildlife diseases have been left largely to NGOs, the involvement of international institutions dealing with wildlife has been limited and generally unofficial. FAO and WHO, however, have established strong relationships with a number of NGOs including Wetlands International, Wildfowl and Wetlands Trust, UK (WWT) and the Wildlife Conservation Society (WCS), developing new forms of networking. Strengthening the capacity of the FAO and OIE to monitor wildlife diseases is worth considering as a suitable priority.

Coordinating International Disease Reporting

While a country's IHR focal points are responsible for reporting human outbreaks to the WHO as stipulated by the International Health Regulations, its CVO is responsible for reporting animal outbreaks to the OIE as stipulated by the Terrestrial Animal Health Code. The Director General of OIE can also ask a country's CVO to verify informal reports that he or she may have received, but replying to this request is not obligatory as it is under IHR. As explained in Chapter 3, the response to these requests has been wanting.

Efforts should therefore be made to authorize the Director General to disseminate publicly information received from nongovernment sources, in the event OIE member states fail to confirm or

6 UNEP has only played a limited role in the control of HPAI, confined, in a later stage of the outbreak, to some work on the role of wild birds. This was done in cooperation with conservation-focused NGOs.

convincingly deny such information in a timely manner. This recommendation has also been made by the recent IOM panel (2009).

Capitalizing on Comparative Advantages

While the WHO is quite strongly decentralized with significant in-country staff, FAO and OIE have a much smaller in-country presence. The WHO's stronger country presence and IHR facilitate early detection and action on emerging diseases, and, with appropriate authorization, could also support FAO and OIE mandates. FAO, which has some country-level presence (although mostly outside the animal health sector) can support national efforts even more effectively than is the case now by strengthening field presence at least at the regional level. OIE would then be able to focus more on setting of standards and monitoring enforcement. This separation of responsibilities between standard setting and standard enforcement is in line with international good practice to avoid conflict of interest.

Joint strategy formulation by the WHO, OIE, and FAO would address the current lack of a formal mechanism to arrive quickly and efficiently at agreements on common strategies and priority actions. The need for such joint collaboration was illustrated by the debate in the first years after the outbreak of HPAI between WHO and FAO/OIE on critical issues such as stocking up of antiviral drugs versus strengthening veterinary services for early HPAI detection, and on culling versus vaccination as the most appropriate policies to control this disease. Taking stock of these experiences would lead to further clarification of roles and responsibilities that could in turn improve and expedite collaboration.

BUILDING ON ACHIEVEMENTS

Three general options are discussed next—from business as usual to more far-reaching and systematic approaches that fundamentally change how international organizations act and interact.

The first option is to proceed using the model that was established by the GPAI and consisted of a task force administered by the FAO, OIE, and WHO. Theoretically, this model can be expanded on a case-by-case basis to include other concerned agencies as well, depending on the challenges that are implicit in responding to a newly emerging or re-emerging highly infectious zoonotic disease. This represents an ad hoc and reactive orientation to emerging diseases that requires considerable improvisation on the part of the institutions involved. It is, moreover, based on the assumption that the HPAI model is more or less directly applicable to all emerging diseases in general.

The second option is to strengthen the existing joint Global Early Warning System by improving disease surveillance and reporting procedures from within countries. This option could be strengthened by streamlining with the WHO's International Health Regulations, with similar responsibilities, incentives, and penalties, applied to livestock/wildlife. Incentives could include linking access to funding of longer-term control operations to the availability of appropriate contingency plans, which include the improvement of communication channels, the availability of emergency funds, and the agreement to mandatory early reporting (OIE 2007).

The third option, and the one that is advocated in this report, is to strengthen the coordinating role of UNSIC, or introduce a similar high-level UN mechanism to facilitate consultation with concerned international organizations such as the FAO, OIE, and WHO, and to expand this consultation to include institutions specializing in wildlife and environmental health and others concerned. This coordinating role is by definition unintrusive and avoids impinging on the mandates of the organizations and institutions involved, limiting itself to building consensus and to formulating mutually agreed-upon strategies to employ during the early phases of an emerging outbreak. This would imply appropriate and secure funding, and extending UNSIC's mandate, which is now expected to run out by the end of 2010.

Whichever option is arrived at, three related imperatives require explicit action. First, a stronger global awareness program is needed that emphasizes the risks of emerging zoonotic diseases. Second, the low-income developing countries need financial and technical assistance to strengthen their health systems in the context of the One Health approach. Third, the provision of improved international research capacity for the control of zoonotic diseases is needed, that creates an active interface between medical and veterinary science. This research agenda needs to underpin efforts to develop and operate an efficient and effective global surveillance system and to anticipate technical challenges to controlling disease outbreaks.

5 Funding Needs and Funding Mechanisms

Reducing the enormous risks posed by the emerging and re-emerging zoonotic diseases will require, as a prerequisite, improving the installed physical and human resource capacity to predict, prevent and to control them. Such risk reduction is an important public good. While OECD countries are able to assess their respective needs and to develop the necessary physical and institutional capabilities to meet the challenge, that is not the situation in the low-income developing countries. Since the integrity of a global disease prevention and control capacity is dependent on a minimum capability of each member of the community and "the chain is only as strong as its weakest link," it is necessary to help the poor countries to make the necessary investments to install the requisite capability—physical and human. Estimates of what this will cost are presented below. Presented as well are suggestions for some financing mechanisms that could be used to make the up-front investment and maintain a response capability at both national and international levels. As the contributions of the international specialized agencies are indispensable to a global effort to predict, prevent, and control highly infectious diseases, including zoonoses, adequate funding for them must also be provided.

FUNDING NEEDS

An effective and efficient global surveillance system is key to reducing the risks associated with zoonotic diseases. The establishment and maintenance of such a system will require a substantial and reliable flow of financial resources. The first priority will be to carry out the ongoing international campaign to bring the pandemic risk of HPAI fully under control. Building on the model that has been established by the GPAI, funding mechanisms will then be needed to expand the model into a global human and animal disease (domestic and wildlife) surveillance and control system that covers emerging and re-emerging zoonotic diseases. The institutional architecture that is set up to monitor and control those diseases should also be well placed and wield substantial capacity to monitor and control the neglected zoonotic diseases, "diseases of trade" and other endemic ones as well.

Completing HPAI Control Activities

The framework document *Contributing to One World, One Health,* prepared for the Inter-Ministerial meeting at Sharm el-Sheikh in 2008, reported that US$2.7 billion had been pledged at the preceding international inter-ministerial meetings. As of October 2008, $2.054 billion of this amount had been firmly committed or already expended for the human and animal control cost of HPAI. $853 million, or 42 percent of this amount, was directed to national programs. $512 million, or 25 percent, went to international organizations. $301 million, or 15 percent, went to regional programs. The remaining 19 percent ($386 million) went to other programs, including those involving research.

This distribution of expenditures over the various groups differs from what was envisaged in the declaration of the first Inter-Ministerial Meeting on Control of HPAI in Beijing in January 2006. The declaration stated, among other things, that "individual countries are central to a coordinated response." Yet national programs received less than half the total available funding. This was in large measure attributable to the novelty of the HPAI threat, which required extensive globally coordinated epidemiological research and international stockpiling of antivirals. Future funds should be directed more towards national governments.

The framework document *Contributing to One World, One Health* presented at Sharm el-Sheikh reported a shortfall of US$836 million in the current programs, mainly as a result of a lack of grant financing for country level activities. US$440 million of this shortfall concerned sub-Saharan Africa. This was at first glance a surprising finding given the priority which the international development community generally assigns to Africa and the dire needs of health systems there. However, HPAI arrived in Africa about 18 months after the disease's outbreak in Asia, by which time the fear of a major pandemic had already subsided, and funding availabilities had diminished. Whatever its reasons, the funding shortfall for Africa represented a missed opportunity to build on efforts of the ALive platform and its members, with support from the EC, to develop INAPs discussed earlier.

Developing Global Capacity

The *One World, One Health* framework document made a very approximate assessment of the costs of a permanent global surveillance system. In its section on tailoring monitoring and control systems, the document acknowledged that "producing an estimate of the global financing needs to implement this Strategic Framework is an art, not a science," owing to the complexities of estimating costs in relation to "the level of risk deemed acceptable to the global community." More detailed individual country cost studies will clearly be required but the estimates presented here are sufficient for planning investments by the international donor community. These investments are urgently needed. The cost estimates used in the framework document, and hence in this chapter, are based on the figures for unit costs presented at the Bamako HPAI Conference in 2006 (ALive 2006). Individual countries were used as the basic unit. These cost estimates are based on human and livestock populations and distributed over the costs of developing and maintaining infrastructure. They take account of the previous investments already carried out under the ongoing GPAI and were calculated for each country for human, veterinary, and communication services. These figures were adjusted for:

- The country's income level, covering all World Bank client countries, differentiating the funding needs between low-income, and low-middle to high-income countries.[7] OECD countries were excluded. The lower-income-level countries were estimated to have a higher need but lower per-unit cost for infrastructure and maintenance, including staffing.
- The economies of scale in surveillance and early response costs, with a progressive decrease in per-animal unit cost if other species are covered in addition to the HPAI-related costs.
- The economies of scale in surveillance costs for wildlife disease monitoring assuming declining financial requirements as livestock density increases—that is, countries with a relatively low livestock density need a relatively larger fraction of their total funds for wildlife monitoring.
- Characteristics of the country with higher levels of intensity in wildlife disease monitoring if a country was considered a hot spot.
- Costs of preventing and controlling HPAI. This included also the need to complete the current campaign resulting from a considerable number (140 by September 2008) of already prepared INAPs. The annual additional financing need over the next three years would be US$542 million to US$735 million.

7 Low-income countries are defined as having per capita gross national income of US$935 or less. Low-middle income countries are defined as gross national income per capita between US$935 and US$11,450.

Table 2: Estimated Cost of Funding the OWOH Framework to 2020 (US$ million)

	49 Low-Income Countries	All 139 Eligible Countries
Public health services	1,264	3,083
Veterinary services	3,286	5,476
Wildlife monitoring	1,495	2,495
Communication	583	1,167
International organizations	3,180	3,475
Research	420	420
Total	**10,228**	**16,116**
Average per year	852	1,343
Average per country for the period	208	116*

*US$65 million per country for the middle-income countries only.

Source: Adapted from *Contributing to One World, One Health: A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystem Interface.* 2008.

- Additional information on these assumptions is provided in Annex 2.

Applying these assumptions, estimates of total costs over the next decade are presented in Table 2. Owing to the poor state of services in low-income countries, funding needs in those countries are estimated to be much higher than those in middle-income countries.

Funding Responsibilities

How financial responsibilities are divided between international and national public sources requires considerable deliberation. The responsibility for funding an activity or function is in principle determined by whether the good that is provided through that activity is global, national, local, or private in scope. Owing to their transboundary nature, protection from highly infectious zoonotic diseases with pandemic potential is generally considered a global public good. Control of these diseases clearly fulfills the criteria that are defined by the International Task Force on Global Public Goods (International Task Force on Global Public Goods 2006). "Issues that are broadly conceived as important to the international community, that for the most part cannot or will not be adequately addressed by individual countries acting alone and that are defined through a broad international consensus or a legitimate process of decision-making."

The benefits of controlling these diseases are not exclusive to any particular country and therefore fulfill the nonexclusion principle that is sometimes illustrated with the example of the benefits of a streetlight. Moreover, by benefitting from the control of these diseases, one country does not diminish the benefits that other countries enjoy, and control therefore also fulfills the non-rivalry character of global public goods. As a global public good, the control of these diseases falls firmly within the mandates of international institutions, and the activities that provide that control are clearly eligible for funding by international sources.

Applying the same principles, public goods that are national in scope are generally assigned to national-level institutions. The control of diseases that affect specific countries but that do not represent direct threats to human health on a global scale are less likely to be eligible for international support. The control of less infectious and more local diseases such as rabies or bovine tuberculosis yields benefits that are mostly local public goods and private goods. The responsibility for funding their control can therefore be delegated to local levels of government and to private individuals.

Neglected zoonotic diseases may fall short of satisfying the criteria of a global public good in some respects but not entirely. First, their impacts have been and remain important factors that actively contribute to world poverty and that undermine

Table 3: Activities for the Prevention and Control of Diseases at the Animal-Human-Ecosystem Interface and Their Status as a Public Good

Activity	Disease of Low Human Epidemic Potential	Disease of Moderate to High Human Epidemic Potential
1. Preparedness		
Risk analysis	Global	Global
Preparedness plan	National/regional	Global
Animal vaccine development	Private[8]	Global
2. Surveillance		
Public health, veterinary and wildlife	Global	Global
Diagnostic capacity	Global	Global
Managerial and policy arrangements	National	Global
3. Outbreak control		
Rapid response teams	National/regional	National/global
Vaccination	National/regional/private	Regional/global
Cooperation among human, veterinary, and wildlife services	National	Global
Compensation schemes	National/private	Global
4. Eradication plans	National/regional/private	Global
5. Research	National/regional/private	Global

Source: Contributing to One World, One Health: A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystem Interface 2008.

economic growth in every region of the developing world. These impacts disproportionately and sometimes overwhelmingly fall upon the poor and vulnerable. They therefore assume far more than local significance in terms of achieving the poverty- and health-related Millennium Development Goals—which, of course, are global public goods.

Moreover, disease pathogenesis does not discriminate between diseases that are endemic and those that have epidemic or pandemic potential. Nor do disease surveillance systems. While control measures are generally disease specific, surveillance systems monitor all categories of diseases—existing, emerging, and re-emerging. Any disease surveillance system will therefore also monitor the prevalence of diseases of a lower or nonpandemic risk. These considerations are reflected in Table 3.

FUNDING MECHANISMS

There is general agreement that industrialized and middle-income nations should be responsible for funding their own surveillance systems. Experience indicates that low-income countries, with so many other, often more direct needs, can't provide sustainable funding for the early detection of and response to zoonotic diseases, even though they generally have the most numerous and urgent needs to do so. Considering the global public goods involved, and the public health and economic benefits that the international community derives from early detection and control, international funding is clearly warranted. A variety of options are available for funding work related to these public goods.

Funding has generally been provided in the form of time-bound (mostly three to five years), project-based investments. The financier is usually a bilateral or multilateral donor or financing agency that funds most of the infrastructure costs such as laboratory and transport facilities, and some initial operating costs. The recipient country is then responsible for funding part of the operating costs and is expected to continue funding the activity after the time-bound project closes. Long-term financing by these international agencies is often not possible owing to administrative constraints related to exigencies such as parliamentary approval cycles, policy changes, and a variety of geopolitical considerations. There are usually

8 This may also be a global public good depending on diseases and context.

significant financial constraints on the national share of operating costs even during the life of the project. These constraints become more pronounced as the project ends and international funding stops. The commitments that governments sometimes make to fund maintenance costs following the project period are difficult to enforce. Activity levels typically remain high during the project's implementation when external financing is available, and then slackens—often precipitously—when that funding ends. For a system that is expected to provide a continuing service to the global community, such a "boom and bust" model is grossly inadequate. The instability also represents a source of global risk because diseases that emerge in countries with few resources and with little capacity can spill over into the rest of the world.

Establishing a global funding mechanism that facilitates a constant and permanent flow of resources of about US$800 million annually is therefore needed.

A combination of different funding sources can be envisaged. First, the global community could seek to establish a permanent obligation on the part of high- and middle-income countries to support low-income countries in the operation of their surveillance and early response systems. Such a contribution is not foreseen under the WHO's International Health Regulations, which is considered one of its main weaknesses (IOM, 2009). It could take the form of long-term twinning arrangements between veterinary and human health service agencies in industrialized and developing countries. Or the annual Ministerial Meeting on Avian and Pandemic Influenza could be "fixed" on the international events calendar and be used as a permanent mechanism to formulate and drive the One Health agenda, to secure pledging from its members, and to and monitor the funding for the global program.

Second, nonconventional donors and foundations, such as those devoted to individual diseases, may provide financial support as many of them are able to commit funds over longer periods of time than conventional bilateral donors. The funding they provide may be on a regular basis or channeled through an endowment that is established for a specific set of purposes. Adequately resourced, such endowments are a highly appropriate solution, but are unlikely to be able to fund the amounts required in the near future. Additional sources therefore need to be identified.

Third, a levy on certain articles or commodities might be used to channel resources into a global fund or funds. This could provide the regular stream of income needed to sustain a global surveillance and early detection system. This option was considered in *Contributing to One World, One Health,* in particular for fragile states, and proposed in the IOM's *Sustaining Global Surveillance and Response to Emerging Zoonotic Diseases.* The articles or commodities to be levied could be selected according to a number of criteria. They would be generally recognized as being related to the spread of zoonotic diseases, so that the parties levied would understand the purpose of the levy—thus increasing the acceptability of the levy's cost. The levy would have to be relatively easy to collect and preferably have a limited effect on the poor.

- *A levy on meat exports.* This would be directly related to the global public good of control of zoonotic diseases. It would directly benefit middle- and high-income countries by protecting their livestock sectors against the introduction of contagious animal diseases such as foot-and-mouth disease. Its cost to low-income countries would be moderate given that their meat exports account for only 5 percent of exports globally.[9] Its costs could also be limited if based on a clear and well-established system of collection. The levy would preferably not apply to live animals in order to avoid driving live animal trade further underground into illegal channels—this despite the fact that live animals are important transmitters of zoonoses with pandemic potential. With the total volume of meat trade from the middle- and high-income countries estimated at about 20 million tons (FAOSTAT), the incremental costs per kilogram would vary between US$0.04 (all costs) and US$0.02 (operating costs only). Additional contributions from the nonconventional sources described above could further reduce these costs.
- *A levy on processed meat products,* which has a more indirect link with zoonotic diseases than meat but is also easy to collect and is typically a product of wealthier consumers.

9 Source: Calculated from ITC 2005 data set, http://www.intracen.org/tradstat/sitc3-3d/ep001.htm (accessed March 14, 2009).

- *A levy on pharmaceutical products,* which would also have a rather direct link with zoonotic diseases, would also be easy to collect, but, if restricted to products to control zoonotic diseases, would directly affect the poor.

Such dedicated levies have been used at the national level. In the Netherlands, for example, a levy is charged on each animal slaughtered, and the proceeds are used to fund national emergency disease control measures—compensation mechanisms in particular. These have not yet been used at the international level (although France has proposed a similar scheme to generate funds for a global public good by levying airlines to control global climate change).

Access to these funds by resource-poor countries would be conditional on a proven political commitment to cooperate. That commitment would be determined by the countries' performance in integrating human and animal health systems and their gradual contribution to the operating costs of the surveillance and response systems. A more detailed discussion on criteria for access to such a fund can be found in a 2007 OIE-World Bank study on the feasibility of establishing a global fund for animal disease emergencies (OIE 2007).

A global fund for the control of zoonoses has been proposed by FAO among others. The option is specifically described by Zinstag et al. 2007, who suggest global subsidiary contributions from countries that are currently free of certain contagious diseases to countries where those diseases are endemic. Care would have to be taken to ensure that such a vertical funding approach does not undermine funding for health systems as a whole, as can occur with this mechanism.

Resource mobilization can be a contentious issue because there is often a disconnect between the resources and the priorities of high- and middle-income countries and those of low-income countries. In low-income, resource-poor countries in which the human and economic costs of neglected zoonotic diseases have persisted over generations, the control of these diseases is deemed by them to be far more pressing than potential pandemics. However, emerging zoonoses that have pandemic potential are assigned higher priority by governments and international agencies in wealthier countries, where resources are relatively abundant and fund-raising potential is far greater. This apparent dilemma, however, becomes less important, and might disappear altogether if the opportunities for convergence and synergy implicit in an effective surveillance system are taken. Monitoring for the potential pandemics that are the chief concern of contributing countries and investing donor agencies may be the raison d'être of a surveillance system, but that system will also be able to apply its capacity and some proportion of its resources to monitor lingering zoonoses and diseases of trade.

Operation of the Mechanism

The management of a global surveillance system may be delegated to an international organization. Activities may then be implemented through technical agencies such as WHO, OIE, FAO, and others that specialize in areas such as communications and wildlife management. In order to avoid conflicts of interest, none of these technical agencies would be charged with the overall management of the surveillance system. Alternatively, individual developed countries may maintain their own systems based on national priorities and preferences—following the example of the HPAI campaign after the Beijing Conference.

Prompt disbursement of the available funds with appropriate fiduciary controls is essential for emergency response. The general picture that emerges from the HPAI campaign shows a very satisfactory disbursement rate from bilateral grant funds but a stagnating flow of funds from the multilateral development banks. By April 30, 2008, multilateral development banks had committed just US$403 million (41 percent) and disbursed only $87 million (9 percent) of the $968 million that was pledged at the Beijing Conference in January 2006. Bilateral donors, on the other hand, had committed all $1.4 billion they had pledged, and disbursed $1.266 billion (90 percent) (UNSIC and World Bank 2008). The main causes of this delay were the reluctance of many governments to borrow funds for what is considered a global public good, elaborate approval procedures for loans, and the strict fiduciary requirements of multilateral development banks. Before any decision is made regarding the eventual involvement of a multilateral bank or other international finance institution, these administrative and policy constraints need to be addressed.

Annex 1: Economic Losses from Zoonotic Diseases

Disease	Location	Data source	Period	Direct losses/costs: Sources of Loss/ Costs	Direct losses/costs: Amounts (US$ millions)	Indirect losses: Sources of Loss	Indirect losses: Amounts (US $ million)
BSE	UK	UK BSE inquiry[10]	1988–1996	Vet service costs	150		
				Health services	6		
				Compensation	360		
				Research	60		
		OECD review[11]	1986–1996	Total/year	935		
			1997–2000	Total/year	850		
		CDC (2005)[12]	2003–2007	Total	11,000		
Nipah virus	Malaysia	CDC (2005)	1999	Total	400		
		FAO (2002)[13]	1990–1999	Culling	97	Lost export trade	120
				Income loss farmers	124	Lost tax revenue	105
		Hosono et al. (2006)[14]	1998–1999	Culled animals	90	Ripple effect to other livestock industries	170
SARS	East Asia	Asian Development Bank[15]	2003	Direct costs	18,000	Ripple effect to other sectors	60,000
	Canada	Darby	2003	Total	C$1,500 or 0.15 percent of GDP		
	Global	CDC (2005)		Total	50,000–120,000		
	East Asia	Wong (2008)[16]			GDP growth—1.2 %YY changes in visitors arrivals 2 percent in East Asian GDP or US$200 billion		
	Canada[17]		2003	Health costs one hospital	12		
HPAI	East Asia	EU[18]	2003–2006	Total	8,000		
	East Asia	Elci[19]	Dec. 2003–Feb. 2006	Total	10,000		
	Thailand	Safman[20]	2004 (first wave)	Compensation	132	Lost trade	500
Rift Valley fever	East Africa	See case study in box on social impact					

Lingering Zoonotic Diseases							
Rabies	Asia Africa	WHO[21]	Annually	Total	590		
Porcine cysticercosis/ taenosis	India	WHO[22]	Annually	Health and production	150		
Cystic Echinococcosis	Global	Budke et al. (2006)[23]	Annual	Livestock losses	140–2200[24]		N.A.
				DALY	194–765[25]		N.A.
Food borne	US	WHO[26]	1997	Total	35,000		
	Vietnam	World Bank[27]	Annual	Lost products	250	Hospital cost and lost labor	250

10 UK Government Web Archive. 5 May 2009.
11 OECD (2003) "Food Borne Diseases in OECD Countries. Present State and Economic Costs."
12 Presentation by Dr. Lonnie King (CDC), Washington.
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17 VIGILAIR 2005.
18 European Commission Health and Consumer Protection Directorate-General 2006.
19 Elci, C., 2006.
20 Safman, R., 2009.
21 WHO 2009a.
22 Ibid.
23 Budke, C. M., Deplazes, P., and P. R. Torgerson. 2006.
24 Depending on under-reporting assumptions.
25 Ibid.
26 WHO 2007.
27 World Bank, 2006.

Annex 2: Basic Assumptions Regarding Financing Requirements

This annex describes the assumptions used to calculate the different components of the financial gaps and needs provided in Chapter 5. In summary, the cost estimate is based on individual countries as the basic unit, and takes account of the countries' human and livestock population and land area for wildlife. As the requirements will depend on the development level of a county, the costs are further based on each country's income level, differentiating between low-income (LI), low-middle income (LMI), upper-middle income (UMI) and five high-income countries (HI). Only IDA and IBRD countries were included, not included were OECD countries and other non-World Bank clients. Table 1 Annex 2 provides the details on a regional basis.

The estimated unit costs per country were based on the cost figures provided in the paper prepared for the Bamako HPAI conference (ALive 2006). Following this paper, the costs were divided into costs for infrastructure development and costs for maintaining the infrastructure, and split out for:

- Human health services (in US$ per 1,000 people);
- Communication (in US$ per 1,000 people); and
- Veterinary services (in US$ per ALU).

These unit costs were adjusted for:

- The economies of scale in surveillance and early response costs, if other species are to be covered in addition to poultry. The calculated costs per ALU were therefore converted with 0.7 for the second species and 0.15 for the third species to be covered. No additional costs were assumed if more than three species were included.
- The *infrastructure funded from previous investments* according to Table 2 Annex 2.

This led to the unit costs for human and livestock services as shown in Table 3 Annex 3.

Table 1 Annex 2: Background Data of the Countries Included in this Study

Region*	# countries LI	LMI	UMI	HI	Total	Human Population in Million	# ALU in Million**	Area of Land in Million km²
AFR	34	8	0	0	42	806	167	24
EAP	6	12	3	0	21	1931	335	103
ECA	3	9	11	1	24	466	100	24
LCR	1	11	16	4	32	555	178	20
MNA	1	9	2	0	12	310	44	9
SAR	4	4	0	0	8	1567	231	12
Total	**49**	**53**	**32**	**5**	**139**	**5635**	**1055**	**192**

*AFR: Africa Region; EAP: East Asia and Pacific Region; ECA: East Europe and Central Asia Region; LCR: Latin America and Caribbean Region; MNA: Middle East and North Africa Region; SAR: South Asia Region.

**ALU: Average Livestock Unit.

Table 2 Annex 2: Assumptions on Percentage of Total Costs Already Covered by Previous Investments

Region	Veterinary Services	Human Health and Communication	Wildlife Monitoring
AFR	0%	0%	0%
EAP	50%	50%	0%
ECA	75%	75%	0%
LAC	75%	75%	0%
MNA	75%	75%	0%
SAR	50%	50%	0%

Source: Background paper to Strategic Framework paper.

Table 3 Annex 2: Unit Costs (US $) Used in the Calculations for the Investment Needs for Different Income Level Countries

			Veterinary Service/ALU[28]			
Income Level	Human Health Service/ 1,000 Humans	Communication/ 1,000 humans	1st species	2nd species	3rd species	4th species
Infrastructure						
LI	437.616	111.491	10.728	7.663	1.533	0.000
LMI	466.790	118.923	11.443	8.173	1.635	0.000
UMI	525.139	133.789	12.873	9.195	1.839	0.000
HI:	525.139	133.789	12.873	9.195	1.839	0.000
Maintenance						
LI	466.723	57.594	1.746	1.247	0.249	0.000
LMI	466.790	61.434	1.862	1.330	0.266	0.000
UMI	525.139	69.113	2.095	1.496	0.299	0.000
HI:	466.790	61.434	1.862	1.330	0.266	0.000

To these unit costs per country for human and livestock disease surveillance systems, the cost of wildlife disease monitoring still has to be added. However, there were no reliable data on unit costs of such monitoring programs available, and a more indirect method, based on the assumption that countries with a relatively low livestock density need a relatively larger fraction of their total funds for wildlife monitoring, was adopted. Based on this rationale, the share of the total veterinary service cost for monitoring zoonotic diseases in wildlife was made dependent on livestock density (four groups) and monitoring intensity (three levels), as shown in Table 4 Annex 2, assuming that countries with a low livestock density. For example, the humid, tsetse fly-infected areas of Central Africa have weaker veterinary services, but in most instances larger wildlife populations.

To the surveillance (including communication) costs of emerging diseases, the cost for eradication HPAI still had to be added. The main cost elements are:

- Compensation costs, estimated at $2 per chicken;

28 Average livestock units. Data refer to the number of animals of the species present in the country at the time of enumeration in terms of livestock unit (LU). It includes animals raised either for draft purposes or for meat and dairy production or kept for breeding. Live animals in captivity for fur or skin such as foxes, minks, and so on, are not included. The enumeration chosen, when more than one survey is taken, is the closest to the beginning of the calendar year. Live animals data is reported in livestock unit (LU) for comparison of different species across geographical regions. The conversion factors used to calculate ALU for number of animals are: cattle 0.9, sheep and goats 0.1, pigs 0.2, chickens 0.01, and ducks and geese 0.03. (Source: http://www.fao.org/es/ess/os/envi_indi/annex2.asp.)

Table 4 Annex 2: Assumed Percentages of the Total Animal Monitoring Costs Related to Wildlife Monitoring for Three Different Monitoring Strategies and Four Different Livestock Intensities

		Monitoring intensity		
Group	Maximum ALU/km²*	Intensive	Medium	Extensive
1	1.2	80%	50%	20%
2	6.3	60%	30%	10%
3	11.6	40%	20%	5%
4	39.5	20%	10%	5%

*ALU/ km² average livestock units per square kilometer of counties area.

- Culling and destruction and disinfection, assumed at US$1 per bird;
- Vaccination costs, at US $ 0.38 per bird, similar to the costs of the last vaccination campaign in Vietnam (of which vaccine cost is US$$0.18).[29]

For the number of new outbreaks, the number of outbreaks during 2007 and up to July 2008 of HPAI in low- and medium-income countries not endemically infected[30] was defined, and it is assumed that the frequency and location of new outbreaks would be similar to those in the past one and a half year. To calculate the costs for the ten-year period, it is assumed that the HPAI outbreaks continue for another three years before the disease is controlled. Finally, the strategy also should be able to address outbreaks of previously unknown diseases, for which it is assumed that during an outbreak 1 million average livestock units would have to be culled. Analyses of historic data indicate that the emergence of new zoonotic diseases occurs on average once every two years. With the farm gate price of US$234 per ALU, this would result in a total funding need of US$ 234 million per outbreak.[31]

Finally, a special assessment was made for the funding needs of the 43 low-income countries, in line with the recommendations of Chapter 5, which would make the costs of surveillance and eradication of HPAI a global public good and therefore the responsibility of the global community.

Table 5 Annex 2: Low-Income Countries

Afghanistan	Haiti	Rwanda
Bangladesh	Kenya	São Tomé and Principe
Benin	Korea, Dem Rep.	Senegal
Burkina Faso	Kyrgyz Republic	Sierra Leone
Burundi	Lao PDR	Solomon Islands
Cambodia	Liberia	Somalia
Central African Republic	Madagascar	Tajikistan
Chad	Malawi	Tanzania
Comoros	Mali	Togo
Congo, Dem. Rep	Mauritania	Uganda
Côte d'Ivoire	Mozambique	Uzbekistan
Eritrea	Myanmar	Vietnam
Ethiopia	Nepal	Yemen, Rep.
Gambia, The	Niger	Zambia
Ghana	Nigeria	Zimbabwe
Guinea	Pakistan	
Guinea-Bissau	Papua New Guinea	

29 For Africa, due to distribution of poultry units and backyard flocks, the costs were estimated at US$0.90 (of which vaccine cost is US$$0.18).

30 Based on the number of outbreaks in 2007 until July 2008 in low- and medium-income countries. (Source: http://www.OiE.int.)

31 Average from value of African and Asian ALU (Source: FAOSTAT 2005).

Annex 3: Contributing to One World, One Health: A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystem Interface

EXECUTIVE SUMMARY

Humanity faces many challenges that require global solutions. One of these challenges is the spread of infectious diseases that emerge (or re-emerge) from the interfaces between animals and humans and the ecosystems in which they live. This is a result of several trends, including the exponential growth in human and livestock populations, rapid urbanization, rapidly changing farming systems, closer integration between livestock and wildlife, forest encroachment, changes in ecosystems, and globalization of trade in animal and animal products.

The consequences of emerging infectious diseases (EID) can be catastrophic. For example, estimates show that H5N1 HPAI has already cost over US$20 billion in economic losses. If it causes an influenza pandemic, it could cost the global economy around US$2 trillion. Therefore, investments in preventive and control strategies are likely to be highly cost-effective.

Concerns about the potential for a pandemic have spurred worldwide efforts to control the H5N1 virus subtype. This virus spread out of the People's Republic of China in late 2003 into the rest of Asia, then Europe and Africa. The success of these control efforts is reflected in the fact that over 50 of the 63 countries affected by the virus have managed to eliminate it. But H5N1 HPAI remains entrenched in several countries, and it still has the potential to cause a pandemic.

Participants in the December 2007 New Delhi International Ministerial Conference on Avian and Pandemic Influenza recommended that the international community draw on experiences with HPAI and develop a medium-term strategy to address EID. It was agreed that a better understanding of the drivers and causes around the emergence and spread of infectious diseases is needed, under the broad perspective of the "One World One Health" (OWOH) principles (see Annex 1). The following Strategic Framework has been developed jointly by four specialized agencies—FAO, OIE, WHO, and UNICEF—and by the World Bank and UNSIC in response to the New Delhi recommendation.

The Strategic Framework focuses on EID at the animal-human-ecosystem interface, where there is the potential for epidemics and pandemics that could result in wide-ranging impacts at the country, regional, and international levels. The objectives and outputs of the Strategic Framework focus on some of the major drivers for the emergence, spread, and persistence of EID. The approach pursued in the Strategic Framework builds on lessons learned from the response to ongoing HPAI H5N1 infections.

The objective of the Framework is to establish how best to diminish the risk and minimize the global impact of epidemics and pandemics due to EID, by enhancing disease intelligence, surveillance, and emergency response systems at national, regional, and international levels, and by supporting them through strong and stable public and animal health services and effective national communication strategies. National authorities play a key role in devising, financing, and implementing these interventions. Successful implementation will contribute significantly to the overall goal of improving public health, food safety and security, and the livelihoods of poor farming communities, as well as protecting the health of ecosystems.

There are five strategic elements to this work:

- Building robust and well-governed public and animal health systems compliant with the WHO International Health Regulations (IHR 2005) and OIE international standards, through the pursuit of long-term interventions

- Preventing regional and international crises by controlling disease outbreaks through improved national and international emergency response capabilities
- Better addressing the concerns of the poor by shifting the focus from developed to developing economies, from potential to actual disease problems, and through a focus on the drivers of a broader range of locally important diseases
- Promoting wide-ranging collaboration across sectors and disciplines
- Developing rational and targeted disease control programs through the conduct of strategic research.

The overall objective of the Strategic Framework represents an international public good. Its achievement will involve the strengthening of existing animal and public health surveillance, response, prevention, and preparedness systems at the country, regional, and international levels.

Priority interventions and associated actions will be established by officials at the country level and will be prioritized with the help of experienced international agency personnel. They will be identified based on known areas of risk (hot spots) for disease emergence and on research findings that point to new risks. The Strategic Framework does not propose prioritization of diseases to target; instead, it brings benefits to poor communities and agricultural sectors by reducing the risks of infectious diseases that are important locally—for example, Rift Valley fever, tuberculosis, brucellosis, rabies, foot-and-mouth disease, African swine fever (ASF), and Peste des petits ruminants (PPR). This approach will not only control existing and often neglected infectious diseases, but will also promote surveillance for EID at a grassroots level by embedding global concerns within a local context.

Based on these considerations, the following six specific objectives have been identified as areas for possible priority emphasis by national authorities:

- Develop international, regional, and national capacity in surveillance, making use of international standards, tools, and monitoring processes
- Ensure adequate international, regional, and national capacity in public and animal health—including communication strategies—to prevent, detect, and respond to disease outbreaks
- Ensure functioning national emergency response capacity, as well as a global rapid response support capacity
- Promote interagency and cross-sectoral collaboration and partnership
- Control HPAI and other existing and potentially re-emerging infectious diseases
- Conduct strategic research

Implementation of the Strategic Framework will be guided by key principles. These include the adoption of a multidisciplinary, multinational, and multisectoral approach; the integration of technical, social, political, policy, and regulatory issues; and the establishment of broad-based partnerships across sectors and along the research-to-delivery continuum. They will include engagement of wildlife and ecosystem interests, the human and veterinary medical community, and advanced research institutions (ARI).

National authorities will be encouraged to build on national strategies on EID, to engage with the private sector to strengthen local capacity and to promote long-term sustainability. This would include the strengthening of institutions already in existence, in addition to the structures, mechanisms, and partnerships that have been developed in response to the HPAI crisis among international agencies (FAO, OIE, WHO, and UNICEF) such as UNSIC, GLEWS, the Global Framework for Progressive Control of Transboundary Animal Diseases (GF-TADs), and the FAO/OIE Crisis Management Centre (CMC-AH), as well as those developed between the public and animal health sectors. This would be done without requiring the integration or fusion of their roles. The Strategic Framework will encourage the formation of flexible, formal, and informal networks of partners, and will promote pro-poor actions and interventions.

In considering options for financing implementation, key issues to be addressed include the benefit-cost ratio of various options, long-term sustainability, public versus private goods, and the political commitment of key stakeholders. Donor funding will be sought, including a combination of grants and loans.

This joint Strategic Framework will be presented as a consultation document at the International Ministerial Conference on Avian and Pandemic

Influenza in Sharm el-Sheikh, Egypt, October 25–26, 2008. It will be discussed by high-level participants from countries, international technical agencies, regional organizations, ARIs, donors, and the private sector. This should provide an opportunity for the key stakeholders to discuss the Framework and consider how best to reach a consensus on sustained efforts to control EID. In due course, national authorities should consider the degree to which they are ready to make long-term political and financial commitments for validation, implementation, and monitoring impact.

Annex 4: One World One Health: From Ideas to Action

REPORT OF THE EXPERT CONSULTATION
MARCH 16–19, 2009, WINNEPEG

CONSULTATION OVERVIEW AND KEY RECOMMENDATIONS

The Public Health Agency of Canada's (PHAC) Centre for Food-borne, Environmental and Zoonotic Infectious Diseases (CFEZID) hosted the One World One Health™ Expert Consultation in Winnipeg, Manitoba, from March 16–19, 2009. ("One World One Health" is a registered trademark of the World Conservation Society.)

The One World One Health (OWOH) concept proposes an international, interdisciplinary, cross-sectoral approach to surveillance, monitoring, prevention, control, and mitigation of emerging diseases, as well as to environmental conservation (from OWOH Strategic Framework, 2008). It recognizes the linkages among animal, human, and ecosystem health domains. Broadly stated, the OWOH concept provides a framework for preventing emerging infectious diseases of animal origin, instead of simply responding to them once they have occurred.

International and Canadian experts from academia, government, NGOs, United Nations organizations, and the private sector gathered together at the Fort Garry Hotel to discuss "Contributing to One World One Health: A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystems Interface." The Strategic Framework was the joint product of six major international organizations: the FAO, WHO, OIE, UNICEF, the World Bank, and UNSIC. The document sets out six priority objectives for countries to consider, such as developing capacity in surveillance, promoting interagency and cross-sectoral partnerships, and ensuring functioning national emergency response capacity.

The Strategic Framework was first released at the International Partnership on Avian and Pandemic Influenza meeting in Egypt in October 2008. At that meeting, PHAC offered to host a consultation to further discuss the objectives in the Strategic Framework.

Over the course of the three-day consultation, experts from 23 countries shared their knowledge of best practices, challenges, and barriers to implementation of an OWOH approach. Representatives of the six international organizations discussed their vision of the Strategic Framework and answered questions from the participants. A number of experts provided presentations and case studies on key areas, and participants had the opportunity to work in small groups to discuss issues such as surveillance data gathering, management and ownership, interdisciplinary training, and maintaining political will. Recommendations included creating transdisciplinary networks for information sharing, developing a "Global Health" university curriculum, and engaging grassroots involvement in animal, human, and ecosystem health initiatives.

In her closing remarks, Danielle Grondin, Acting Assistant Deputy Minister of the Infectious Disease and Emergency Preparedness Branch, PHAC, encouraged participants to take the spirit of OWOH and apply it in whatever sphere of influence they might have.

KEY RECOMMENDATIONS

The following key recommendations emerged over the course of the consultation. They represent areas of focus for moving forward the animal-human-ecosystem interface concepts of OWOH and the objectives presented in the Strategic Framework.

- *Foster political will*—Multilevel, multi-ministry political will is crucial to driving the OWOH concept forward.

- *Support partnership and collaboration*—Finding new ways to work together and build new attitudes is essential. This will require leadership and commitment to make multidisciplinary collaboration a common practice.
- *Encourage data sharing and integration*—Working in more integrated ways and sharing data and information will help eliminate "data silos" and "data hugging."
- *Build capacity (infrastructure and skills)*—The building of knowledge, skills, and OWOH attitudes at the local level is important. There is a need to encourage the academic community to develop and implement integrated curricula and to foster transdisciplinary collaboration.
- *Develop communication strategies/plans*—Media should be engaged as a partner. This will require investment in training. Working with the media is critical to getting information to the public and other target audiences.
- *Provide incentives for reporting adverse events*—Incentives are important to encourage key actors to report in a timely manner.
- *Encourage stakeholder and community engagement*—Everyone who is part of these issues needs to understand their role and contribution. This will require the engagement of stakeholders and communities in OWOH concepts.
- *Develop supra-country approaches*—In addition to a multidisciplinary/transdisciplinary approach, the integration of efforts, data, and so on also needs to take a transboundary/regional approach.

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