



ECONOMIC AND SECTOR WORK

PEOPLE, PATHOGENS AND OUR PLANET

Volume 2

The Economics of One Health

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AGRICULTURE AND RURAL DEVELOPMENT

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ABBREVIATIONS AND ACRONYMS

ALive	Partnership for African Livestock Development
AI	Avian Influenza
AMA	American Medical Association
ASF	African Swine Fever
AVMA	American Veterinary Medical Association
BSE	Bovine Spongiform Encephalopathy
CBPP	Contagious Bovine Pleuro-Pneumonia
CDC	Centers for Disease Control
CSF	Classical Swine Fever
DPT	Diphtheria, pertussis (whooping cough), and tetanus
FAO	Food and Agriculture Organization
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GMOs	Genetically modified organisms
HPAI	Highly Pathogenic Avian Influenza
H1N1	not an acronym; Pandemic Influenza A, subtype H1N1
H5N1	not an acronym; Influenza A, subtype H5N1 (HPAI Avian Influenza)
IDRC	International Development Research Centre
IFPRI	International Food Policy Research Centre
INAPs	Integrated National Action Plans
LSU	Livestock Standard Unit (see Annex 1)
NPS	National Protection Service
ND	Newcastle Disease
OECD	Organization for Economic Cooperation and Development
OIE	Office International des Epizooties (World Organisation for Animal Health)
PHAC	Public Health Agency of Canada
PPR	Peste de Petits Ruminants
RP	Rinderpest
RVF	Rift Valley Fever
SARS	Severe Acute Respiratory Syndrome
TADs	Trans-boundary animal diseases
TOR	Terms of reference
USA	United States of America
USAID	U.S. Agency for International Development
VLUs	Veterinary Livestock Units
WAHID	World Animal Health Information Database
WHO	World Health Organization

EXECUTIVE SUMMARY

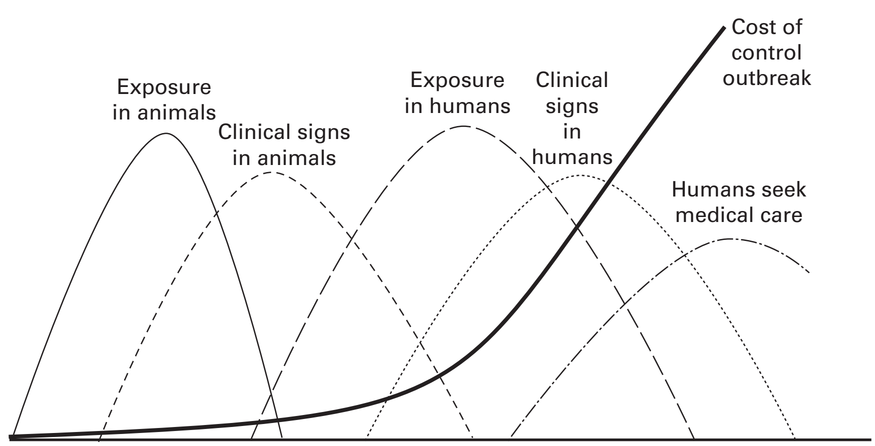
This report analyzes and assesses the benefits and the costs of control of an important group of contagious diseases. Zoonotic diseases are caused by pathogens that can infect both animals and humans, resulting in disease outbreaks, including epidemics in humans and epizootics in animals. These diseases account for 70 percent of emerging infectious diseases. In the absence of timely disease control, zoonotic pathogens can cause pandemics, with potentially catastrophic impacts that are global in scale. The report also touches on food safety, but does not cover other risks and opportunities at the interfaces between humans, animals, and the ecosystem, such as food security and pollution. Limiting its focus to this topic matter has important advantages, particularly with respect to immediate relevance and relative simplicity.

The case for control of zoonotic diseases (zoonoses) is compelling. The economic losses from six major outbreaks of highly fatal zoonoses between 1997 and 2009 amounted to at least US$80 billion.[1] If these outbreaks had been prevented, the benefits of the avoided losses would have averaged $6.7 billion per year. Fortunately, none of those outbreaks developed into a pandemic. If any of them had, the economic losses would have been much higher, and they would have been accompanied by societal disruptions and a possibly staggering human toll. A 2011 report by the OECD shows that pandemics are a prime global catastrophic threat—a finding that is consistent with a number of other assessments (OECD 2011). Potential losses resulting from a severe influenza pandemic, for instance, that leads to 71 million human fatalities would be US$3 trillion, or 4.8 percent of the global GDP. Preventing and controlling zoonotic disease outbreaks thus benefits economies and public health because epidemics and pandemics do not develop. In addition, tackling endemic zoonoses would reduce a major source of human suffering and economic losses that disproportionately affects many of the poorest households in developing countries. Echinococcosis, for instance, imposes a human and economic burden in developing countries that each year costs at least 1.5 million healthy life-years as well as US$2 billion in livestock losses.

Control of a zoonosis requires early and rapid actions. A typical episode may involve a pathogen that originates in wildlife, then passes to livestock, and is then transmitted from livestock to humans. As figure E.1 shows, exposure to the pathogen in animals could be followed by symptoms in animals. Then there is a rise of exposure in humans, who subsequently could develop symptoms, may seek treatment, and

1 Nipah Virus (Malaysia), West Nile Fever (USA), SARS (Asia, Canada, other), HPAI (Asia, Europe), BSE (US, UK), Rift Valley Fever (Tanzania, Kenya, Somalia)

FIGURE E.1: Early Control of Zoonotic Disease Is Both Cost-effective and Prevents Human Disease



Source: Adapted from IOM (2009).

infect each other. If the disease reaches the point of spreading among humans, the disease will have already done substantial damage. Moreover, the spread of the disease among humans at that point may be difficult to slow or reverse, and the cost of disease control will usually increase rapidly. This pattern of progression is evident from the high and rising cost of controlling HIV/AIDS, which is also of zoonotic origin. Thus, effectiveness of zoonotic disease control requires early detection at the source of the disease in animals, an early and accurate diagnosis, and rapid disease control measures. Delays substantially reduce effectiveness. The more effective an approach is, the more lives it will save, and the higher the benefits in terms of avoided losses. Authorities too often start looking for the disease in animals and undertake diagnostic and control efforts only after human cases and deaths have been observed. When disease surveillance and control take this form, humans essentially serve as a sentinel species—human death and illness act as indicators of disease in animals.

Because surveillance, diagnosis, and control of zoonotic disease take place at the interface between animals and humans, systematic communication and substantial coordination between human, wildlife, and veterinary health services is an important practical necessity. And this communication and coordination also needs to extend to those services that monitor food safety. One Health is an approach to ensure that this critically important interdisciplinary collaboration occurs. This collaboration reduces the gaps between institutions and disciplines that can cause costly delays, and even failures, in disease detection and control. One Health refers to "the collaborative efforts of multiple disciplines working locally, nationally and globally to attain optimal health for people, animals and our environment." The technical agencies and organizations that are responsible for this work have been working to develop implementation modalities in line with this definition.[2]

The conceptual case for early control of contagious diseases at their animal source is robust. Numerous examples already exist of more efficient and effective control of zoonotic diseases that is attributable to the type of interdisciplinary collaboration that is prescribed by One Health. Efficiency gains, which involve either doing more with the same resources or doing the same with fewer resources, have been evident in a number of these examples, including the following.

- In Chad, joint animal–human vaccination campaigns of DPT and polio in children and CBPP control in livestock resulted in greater coverage in both humans and livestock, and pastoralists became more aware of public health services.
- In Jaipur, India, dog vaccination and sterilization resulted in a decline of human rabies cases to zero (whereas cases increased in other states that did not have this campaign). The population of stray dogs declined by 28 percent.
- In Kyrgyzstan, public health and veterinary workers together visit farms, resulting in lower costs of surveillance for brucellosis, echinococcosis, and other zoonotic diseases.
- In Canada, the integration of animal and human health facilities led to a 26 percent reduction in operation costs, an improvement in efficiency that is not yet directly applicable in most developing countries.

A number of additional examples exist in which efficiency gains were achieved by arriving earlier, identifying the zoonotic disease more accurately, and undertaking control actions accordingly. These include the following:

- In Mauritania, public health and veterinary diagnostic services worked together to correct an initial diagnosis (Yellow Fever) and establish the correct one (Rift Valley Fever).
- In Madagascar, ministries of agriculture and of health worked together on prevention and control of Rift Valley Fever, which reduced the number of cases of the disease in humans and resulted in improved prediction and mapping of outbreaks.
- Confronting the H5N1 virus threat, since 2005 many developing countries, especially those in Africa and Asia, developed multisectoral plans for responses to outbreaks in animals and humans, including collaboration between animal and human health systems. Although the cooperation did imply additional initial costs, the resulting preparedness and control capacity in the countries with such programs was significantly improved, especially if the plans were exercised in simulations or tested in actual outbreaks.
- A number of integrated surveillance systems and data bases, such as ArboNet for West Nile Virus, GLEWS, and a number of national programs, for example, for rabies in India, have been developed, allowing researchers and the authorities to more readily "connect the dots," which is an essential step in activi-

2 These institutions include: WHO, OIE, FAO, and the World Bank; professional organizations such as AMA, AVMA, and the European Federation of Veterinarians; national institutions such as US CDC, the Canadian Science Centre for Human and Animal Health, and the Danish Zoonosis Center; and academics at many universities in the developed as well as the developing world.

ties ranging from risk assessment, to detection, to diagnosis.

This report lists other examples of the benefits of One Health, as well as examples of cases where poor coordination and weak integration between the relevant departments led to human deaths, illness, significant livestock losses, and other economic costs.

Not only is a One Health approach to zoonotic disease more effective, it is likely to be also more efficient as it entails sharing of some costs among the services responsible for animal, human, and environmental health. For instance, during a joint vaccination campaign (such as that noted earlier for Chad), some human capacities and equipment, as well as operating costs, can be shared, resulting in lower costs for the joint campaign than for two separate campaigns. Laboratories, which have a key role in early detection of disease and accurate diagnosis, can also reduce costs through attention to how animal and human health work is carried out. This report is based on tentative assumptions (endorsed by the expert panel as "reasonable first assumptions") about the cost savings attributable to the introduction of One Health. These savings would range from 10 to 15 percent of the total costs of a global surveillance and disease control system, as presented in this report. Much of these potential savings would come from activities that both lend themselves well to cooperation and are high-cost endeavors, such as surveillance and diagnostics.

Bringing disease prevention and control up to OIE and WHO standards will require additional expenditures to build animal and human public health systems and to sustain them in the medium and long-term horizons. An initial estimate, prepared for the 2008 for the Sharm El-Sheikh ministerial conference on avian and pandemic influenzas, was that a system would cost US$1.3 billion per year for 139 developing countries.[3] This estimate was not, however, based on disaggregated costs of specific tasks, and covered only the costs of surveillance and early response to emerging and re-emerging zoonotic diseases, excluding the cost of fully controlling epidemic outbreaks.

This report presents detailed information on the allocation of funds between the human and animal health sectors. It also provides an estimate of funding required by all developing countries for the main prevention and control tasks in public, veterinary, and wildlife health services, as well as initial estimates of the cost savings and effectiveness gains from establishing the One Health approach. Because no comprehensive study of the economics of One Health has been undertaken before, this report aims, above all else, to stimulate discussion of economic issues relating to One Health. This will include identifying and describing existing gaps in part to invite additional work in these areas. For instance, the cost data generated for this report can serve as benchmarks for reviews of expenditures on systems at country and regional levels.

This report disaggregates costs by task, making explicit those activities that are critical for effectiveness and identifying scope for efficiencies. The analysis draws on a range of data sources and earlier work, including integrated national action plans for, and World Bank staff appraisal reports on, avian and pandemic influenzas responses, a survey of the directors of wildlife services, assessments of veterinary systems in developing countries, and OIE analyses of disease prevention systems. The result is the most informative picture to date of the financial and economic aspects of preparedness and control systems from a One Health perspective. As noted earlier, timeliness and accuracy are critical in reducing the total losses (including disease control costs), as in most diseases the costs will go up exponentially as more time elapses between an outbreak and a correct identification and control method of the disease. The results underscore the substantial promise of One Health approaches and the benefits and savings that could be achieved through collaboration among human, animal, and wildlife health services.

The annual funding needs to bring the major zoonotic disease prevention and control system in developing countries up to OIE and WHO standards—which are referred to as "One Health systems" in this report—range from US$1.9 billion to US$3.4 billion, depending on whether the risk of disease prevalence is low or high.[4] These funds are needed for expenditures in 60 low-income and 79 middle-income countries, for that part of the global system that comprises the systems in these developing countries and that delivers a public good to the whole world. The needs

3 *Contributing to One World, One Health: A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal–Human–Ecosystem Interface*, prepared by a group of international agencies that included FAO, OIE, WHO, and the World Bank, among others, 2008.

4 This estimate is based on cost estimates over a five-year period with a full depreciation of the investments over the same period. A similar level of investment will therefore be necessary after the five-year period to maintain the capability. The figures of US$1.9 billion and US$3.4 billion per year can therefore be assumed as continuous over the medium-term future.

of wildlife health services could not be included because relevant cost data are too limited.

The required investments in One Health systems of between US$1.9 billion and US$3.4 billion per year are substantially below the average US$6.7 billion per year in losses due to the six major zoonotic disease outbreaks in 1997–2009, in particular considering that none of the disease outbreaks developed into a pandemic. The underlying risk factors behind such disease outbreaks are growing. The required investments in One Health systems are modest when compared to the costs of diseases of zoonotic origin that had unfortunately not been controlled at their animal source before they spread in humans. These include expenditures to control tuberculosis (US$5 billion annually) and HIV/AIDS (an estimated cost up to US$722 billion in 2009–2031, or US$28 billion annually) (Hecht et al. 2010).

A cost-benefit analysis, which corrects for the very low probability of pandemics, shows that benefits far exceed costs in all plausible scenarios. For instance, if the international community invests at the upper end of the range (US$3.4 billion per year), the annual expected rate of return would be between 44 percent and 71 percent (corresponding to, respectively, half or all mild pandemics being prevented) and still a respectable 14 percent when the system would prevent only one in five pandemics. A severe pandemic costing US$3 trillion may occur, on average, once in a hundred years. If the investments in One Health systems are made and such a pandemic is prevented, the global expected benefits are US$30 billion per year. Every year, an investment of US$3.4 billion would produce an expected benefit of US$30 billion for the international community. The challenge confronting policy-makers is therefore to review these and other assessments of the benefits of pandemic prevention and weigh them against the cost of prevention, as well as returns on other public investments. This report finds that investment in One Health systems for prevention and control of zoonotic diseases offers extraordinarily high expected benefits, with rates of return far above those of other public and private investments. All countries have an interest in realizing these benefits.

The effectiveness gains presented in this report would be additional to substantial gains such as poverty reduction, improved food security, and improved food safety. Both the emerging and the neglected endemic zoonoses affect poor, rural populations in particular. Addressing these zoonoses would therefore significantly improve the livelihoods of the poor. So, if a realistic assessment of pandemic risks is the main driving force behind implementing One Health, this approach will also reduce the large number of local epidemics arising from zoonoses. This will cause a substantial welfare gain, especially for marginalized poor people.

The following recommendations emerge from the analysis in this report:

- Countries should record and provide public access to their expenditures on public health services, preferably detailed by task (within prevention and control) across human and animal health sectors and for joint planning and communications, and by investment and recurrent costs. This work should be monitored by OIE and WHO and, when possible, be included in public expenditure reviews.
- Because control of these zoonotic diseases is a global public good, constraints on prompt and complete reporting on disease outbreaks and control capacities should be addressed, through sets of positive (access to international funding) and negative (regulation) incentives.
- The economic case for One Health approaches, and the qualitative evidence on benefits from closer collaboration at the animal–human–ecosystem interface, suggests future wider implementation. To this end, sustainable funding mechanisms that were described in Volume 1 of this report will be required.
- Governments and international agencies may wish to review the estimated costs of investments in One Health systems for pandemic prevention, compare them to the expected benefits, and suggest (to the World Bank or other stakeholders) what further analyses or actions are required to substantially increase expenditures on pandemic prevention.

Chapter 1: BACKGROUND

THE PROBLEM

Emerging and re-emerging diseases at the human–animal–ecosystems interface have been occurring with alarming frequency. These include highly contagious trans-boundary diseases that have the potential of becoming pandemic, as well as the many food scares that arise from animal-source food. They also include less headline-grabbing, so-called neglected or endemic zoonoses, such as bovine-induced tuberculosis, and a large number of parasitic diseases.

Many factors contribute to the emergence of these diseases, and detailed overviews are provided in IOM (2009) and Volume 1 of this report of the World Bank (2010b). In summary, in the environmental domain these factors include habitat destruction and fragmentation, climate change, and pollution. In the animal domain, they include illegal trade in animals, intensification of livestock production, irregular use of drugs and vaccines, and spatial clustering of livestock farming. The irregular use of drugs and vaccines is associated with the emergence of drug-resistant disease varieties. The issue of spatial clustering is associated with different scales of production and different levels of biosecurity. In the human domain, contributing factors include, among others, increased population density and mobility, growing inequality, and increasing numbers of susceptible groups. In the human–animal interface, supply chains of animal-source foods are rapidly becoming much longer and more complicated, expanding the channels through which pathogens travel. Livestock farming has greatly increased in size and intensity, and much of it is in closer proximity to urban dwellings than it has been in the past.

These pressures are exacerbated in the Bank's client countries, where past potential pandemics have significantly strained public veterinary and human health services. Moreover, approximately 70 percent of all zoonotic diseases originate in wildlife populations (Jones et al. 2008) but have been neglected by the veterinary services there. It is therefore no surprise that experts predict that the next major pandemic will be of zoonotic origin, and that it will emerge in a developing country, where population growth is rapid and land clearing and farming near wild ecosystems is common and public services are weak.

A pandemic has the potential to have catastrophic effects on human and animal life, ecosystems, and whole national economies, through direct and indirect losses. The recent pandemics of SARS, H5N1, and H1N1 were reminders of the persistent risk of emerging infectious, zoonotic diseases, and the economic losses they cause. Information on the direct and indirect costs of emerging zoonotic diseases has been documented in a number of reports, including in IOM (2009) and World Bank (2010b). These costs vary from US$500 million to US$1 billion for Nipah Virus–induced encephalitis, West Nile Virus Fever, and the Plague to over US$10 billion for Bovine Spongiform Encephalopathy (BSE), Severe Acute Respiratory Syndrome (SARS), and Highly Pathogen Avian Influenza. A study carried out as background for this report conservatively estimated the total economic losses of six potential pandemics between 1997 and 2009 to have been about US$80 billion (or about US$6.7 billion per year).[1] Figure 1.1 illustrates these economic losses (the exact data are provided in Annex 2, table A.1).

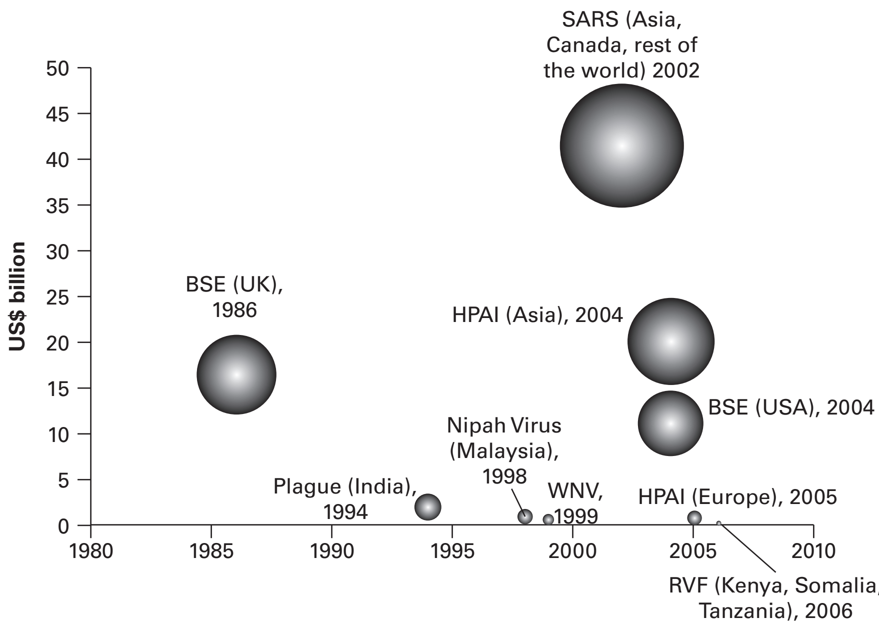
Fortunately, none of these outbreaks developed into a global pandemic; otherwise the human and economic losses would have been much higher. The World Bank estimated the potential economic losses in a worst-case scenario for an influenza pandemic involving 71 million human fatalities, or 1 percent of the global population, at US$3 trillion (Burns et al. 2008). Animal losses from zoonotic diseases are also high. Fifty percent of the 762,212 Livestock Unit (LSU)[2] losses reported on annual average by veterinary services to the OIE-WAHID data base in 2006–2009 were the result of zoonotic diseases (World Bank/Tafs s 2011). Given that the global standing population of LSUs is somewhere between 1.5 and 2 billion, this figure most likely grossly underestimates the real losses, because of underreporting to WAHID.

Interestingly, the zoonotic diseases have a much higher percentage of slaughterings (43 percent) than the non-zoonotic

1 Nipah Virus (Malaysia), West Nile Fever (USA), SARS (Asia, Canada, other), HPAI (Asia, Europe), BSE (US, UK), Rift Valley Fever (Tanzania, Kenya, Somalia).

2 See Glossary for definition of the Livestock Unit.

FIGURE 1.1: Estimated Costs of Emerging Zoonotic Diseases (1986–2006)



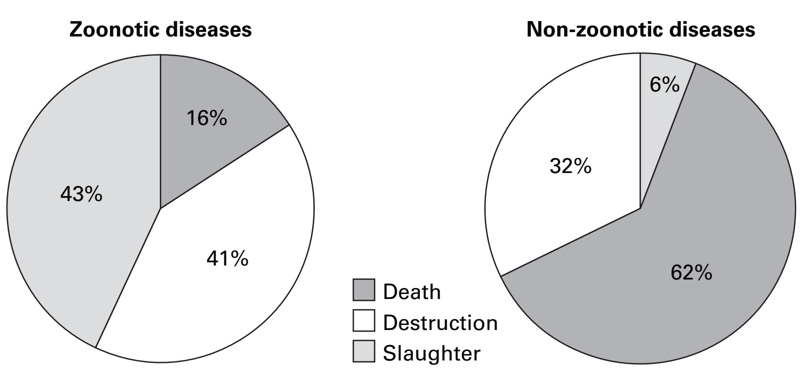
Source: Authors' estimate from the literature.

diseases of animals (6 percent), as can be seen in figure 1.2. A country's income level seems to be a major determinant of the share of losses from zoonotic diseases. The World Bank/Tafs (2011) study found that the share of losses from zoonotic diseases is 72 percent in high-income countries, 64 percent in upper-middle-income countries, 35 percent in lower-middle-income countries, and 38 percent in low-income countries. These findings suggest that the share of losses that result from zoonotic diseases is lower in poorer than in wealthier countries. This seems in contrast with the data on humans, where according to the Global Disease Data Base, the incidence of diarrhea-type diseases (used in this study as a proxy for the importance of zoonotic diseases) is highest in those poorer countries.

CURRENT KNOWLEDGE ON THE ECONOMICS OF DISEASE CONTROL

Numerous available studies estimate the direct and indirect costs and benefits of the control of animal and human diseases. For animal diseases, the methodologies have been reviewed by, for example, Umali, et al. (1994), Perry (1999), Otte and Chilonda (2001), Leonard, (2004), Rich et al. (2005), and Tisdell (2006). They are well summarized in the OIE/World Bank publication *Prevention and Control of Animal Diseases Worldwide, Economic Analysis—Prevention versus Outbreak Costs, Final Report, Part I*. That report found that "when a comparison of prevention versus outbreak costs is made, the majority of the reviewed studies conclude that the

FIGURE 1.2: Livestock Losses by Type of Disposal



Source: World Bank/Tafs (2011).
Note: Based on economic losses, with death (the animal died prior to be culled or slaughtered) allocated a value of 0.8 LSU, destroyed a value of 1.0 LSU, and slaughtered a value of 0.4 LSU.

significant benefits that accrue from improved prevention and control measures outweigh the cost of investment in animal health services to control the disease" (OIE 2007a). For example, in Latin America investment in improvements to animal health of some additional US$157 million per year over 15 years generates a net present value of US$1.9 billion. In Africa it has been estimated that an investment of €14.7 million to control CBPP could save €30 million annually in losses from morbidity/mortality, leading to a net benefit of €15.4 million. In Asia eradication programs for FMD have been estimated to provide benefits in improved trade and market access that are worth several times the investment (OIE 2007a). Additional cost-benefit analyses of individual diseases have been prepared for Rinderpest in 10 African countries by Tambi et al. (1999), and for FMD comprehensively summarized by James and Rushton (2002). The control of African Sleeping Sickness (Trypanosomosis) has also been extensively evaluated. Summaries of these evaluations have been prepared by FAO,[3] by the Tropical Institute for Veterinary Medicine for DFID,[4] and more recently by Shaw (2009). All these studies arrive at high positive economic rates of return. Finally, the World Bank, with support from IFPRI and the Swiss government, is preparing a toolkit titled "Assessing the Costs and Benefits of the Control of Zoonotic Diseases."

For human diseases, zoonotic disease occurrence is documented by WHO, but the coverage is incomplete. Some examples are: In 2004, the prevalence of tuberculosis (TB) in humans was about 14 million, with an estimated mortality of 1.7 million, and a loss in Disability Adjusted Health Years (DALYs) of 36 million. A part will have originated in livestock. Diarrheal diseases, besides those caused by poor-quality drinking water, are often of zoonotic origin and cause a total of 73 million DALYs, whereas internal parasites cause 4 million DALYs (WHO 2008). Echinococcosis causes at least 1.5 million DALYs and up to US$2 billion in livestock losses per year (Torgerson et al. 2010).

Data on the economics of control are scarcer. As Zhang (2009) noted, "[t]he influence of economics in guiding public health policy and programs has been sub-optimal, limited by the perception that the discipline is overly theoretical and not readily applicable to public health decision-making." Most studies focus on the economics of the control of a single disease, including DALYs as part of the costs. Zinstag et al. (2007) provide interesting cost-benefit analyses on zoonosis control in humans through interventions on the animal side. They are summarized in tables 8.1 and 8.2, and clearly demonstrate that "control at source" (i.e., at the animal interface) yields higher returns than having to control the human disease later. The information on the costs of food safety control (an important aspect of zoonotic disease control) is more extensive. One overview is provided by Henson (2003). However, these studies focus on specific animal or human diseases and the costs associated with controlling those diseases. They do not provide budget data on the total financing needs to bring human and/or veterinary health systems up to OIE and WHO standards for all diseases.

ONE HEALTH AND KNOWLEDGE GAPS

A significant amount of thought has gone into how to implement the One Health concept. The main technical agencies concerned, the WHO, OIE and FAO, agreed under a tri-partite concept note[5] to share responsibilities and coordinate global activities to address health risks at the animal–human–ecosystems interfaces. Regional organizations, such as the European Union and Federation of Veterinarians, have endorsed the One Health concept as a cornerstone of their veterinary strategy: "prevention is better than cure." Similarly, national organizations such as CDC of the United States have promoted the approach. The United States Agency for International Development (USAID) is sponsoring a major international operation in over 20 countries to build a global early warning system for pathogens that move between wildlife and humans (PREDICT).[6] This project seeks to bring health and wildlife specialists together. As an activity of PREDICT, it recently brought the UNSIC, FAO, WFP, and UNWTO together "to capture the lessons that were learned from preparing for an influenza pandemic, and inspire leaders to apply those lessons and best practices to continuing and emerging threats." They published *Beyond Pandemics: A Whole-of-Society Approach to Disaster Preparedness* (USAID 2011).[7] The One Health concept also takes hold in developing countries. For example, in Nigeria, a private initiative has established the One Health Nigeria group, which seeks support from its federal government in the establishment of a National Zoonoses Center.

3 http://www.fao.org/DOCREP/006/Y4619E/y4619e04.htm.
4 http://www.dfid.gov.uk/r4d/SearchResearchDatabase.asp?ProjectID=3721.
5 http://web.oie.int/downld/FINAL_CONCEPT_NOTE_Hanoi.pdf.
6 http://www.vetmed.ucdavis.edu/ohi/predict/index.cfm.
7 http://towardsasaferworld.org/featured/beyond-pandemics-whole-society-approach-disaster-preparedness.

As can be seen later in this report, the government of Canada is practically the only government that has implemented the One Health approach, by actually integrated the human and veterinary diagnostic services at all levels (from administration, to common services, to laboratory research, to emergency response). The government of Denmark has integrated the surveillance for zoonotic and food-safety-related diseases in the Danish Zoonosis Center. The World Bank has published a general overview in the first volume of this report, *People, Pathogens and Our Planet,* and summarized its main findings from its involvement in the HPAI campaign. That volume informed a subsequent report titled *Towards One Health: Lessons Learned from the Global Program on Avian and Human Pandemic Influenza (H5N1)*(World Bank/Ministry of Health/Ministry of Agriculture 2011). The latter includes step-by-step recommendations on the introduction of One Health (see box 1.1). Finally, on the request of the technical agencies, the World Bank is preparing a self-assessment tool to help countries determine their readiness for a One Health approach.

Although the importance and general concepts of One Health are now well accepted, it remains unclear how it should be implemented and how much it will cost. Earlier studies (Addis Antenneh 1984; de Haan and Nissen 1985; Gauthier et al. 1999) have provided budgetary data for African Veterinary Services. That data revealed the disproportional share of the funds going to salaries, leaving little for operating costs to enable the staff to work. However, these studies did not disaggregate the costs of specific diseases and tasks. Nor did they provide estimates on the funding required to bring these services up to OIE and WHO standards, under which they would be able to effectively prevent and (in the case of an outbreak) control these emerging zoonotics. Later studies made some assessments on emergency support, but this was done only for sub-Saharan Africa, and mostly for H5N1 (OIE/Alive 2006).

Country budget data on animal and human disease prevention and control systems are not in the public domain and are not covered by the Bank's expenditure reviews. The only global estimate is presented in *Contributing One World, One Health: A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal–Human–Ecosystem Interface,* prepared by a group of international agencies that includes FAO, OIE, WHO, the World Bank, and others. This so-called Framework Paper estimated the cost of a global surveillance system for the prevention of emerging and re-emerging zoonotic diseases and the control of HPAI to be US$852 million per year for the 49 low-income countries and US$1.343 billion for 149 non-OECD countries.[8] It was acknowledged, however, that preparing these estimates constitutes an "art not a science." For want of better data, these estimates have been repeated in a number of other documents, such as *Sustaining Global Surveillance and Response Systems for Emerging Zoonotics Diseases* published by the Institute of Medicine of the US National Academy of Science (2009) and the first volume of *People, Pathogens and Our Planet* (IOM 2009; World Bank 2010b).

BOX 1.1: Steps in Establishing One Health at the Country Level

1. Identification of in-country champions.
2. Joint priority setting and preparedness planning, including the identification of hot spots.
3. Preparing and implementing of legislation that promotes One Health through obligatory disease reporting and decision-making processes, etc.
4. Establishing institutional frameworks that facilitate enhanced cooperation and communication among human, animal, and ecosystem health agencies. This can range from setting up of memoranda of agreement between the services, to joint One Health task forces or permanent teams, to partial integration of the services.
5. Providing of an incentive framework, through the establishment of joint budgets of the services, and the provision of special grant mechanisms for One Health activities.
6. Implementing joint surveillance and diagnostic systems for pandemic and endemic diseases.
7. Preparing and disseminating joint communications.
8. Developing educational curricula, in particular at the university level, that integrate human, veterinary, and ecosystem health.

One needs to realize also that One Health is not all or nothing but can be implemented incrementally, and countries can chose from various elements of integration and will benefit to different degrees, depending on the level of integration

Source: Towards One Health, World Bank (2011).

8 See Annex 5 for the list of countries.

FOCUS OF STUDY AND TARGET AUDIENCE

This study aims to build on the findings from the previously mentioned studies, and seeks to provide more detailed information on the costs of the various functions and categories of expenditure involved in the establishment and operation of system for the prevention and control of emerging zoonotic diseases at country and global level. It will also seek to provide information on efficiency and effectiveness gains that would result from the introduction of a One Health approach. With these aims, the study has two target audiences: (a) project planners, who would benefit from the information of the costs of setting up surveillance and control systems to be used as benchmarks when planning preparedness and control operations; and (b) policy planners at the decision-making level, who would use the information on the efficiency and effectiveness gains to guide them in the decision-making process regarding the eventual introduction of One Health.

CAVEATS

A study of this kind, focusing on the economics (i.e., efficiency and effectiveness gains) of the implementation of One Health has not been done before, in part because of the lack of field experience and proven field data. Therefore, this study, while using the limited field data that is available, depends largely on expert opinions. The information provided should therefore be seen as very approximate. The report is meant above all to stimulate the discussion around the economics of One Health, and provide a benchmark and framework for further study.

Chapter 2: OBJECTIVES OF THE STUDY

The objectives of this study were threefold:

- First, to make a further assessment of the funding requirements to bring public human and animal (domestic and wild) health services up to OIE and WHO standards. Although this study focuses entirely on zoonotic diseases, a number of indirect benefits of an improved preparedness and control system for zoonotic diseases will spill over to the management of non-zoonotic diseases as well. Further, such spillover effects will apply to enhanced food security and to the promotion of poverty reduction.
- Second, to assist planners of disease prevention and control systems with information on the appropriate amounts and allocation of funds among human, animal, and wildlife health services, between prevention and control tasks, and on the average costs of different functions within prevention and control systems.
- Third, to provide a quantitative estimate of the potential efficiency and a qualitative description of the effectiveness gains resulting from the application of the One Health concept.

In order to achieve these objectives, the following tasks were carried out:

- Collection and analysis of data on the estimated funding needs for incremental investments for an efficient prevention and control system for zoonotic diseases in the human, animal, and wildlife sectors. More specifically, this involved:
  - Analysis of the funding required to bring human and animal health services up to OIE and WHO standards to address the H5N1 Avian Influenza threat, using data from the 2006–2008 Integrated National Action Plans (INAPs) and relevant World Bank Staff Appraisal reports;
  - Analysis of the costs of developing National Disease Prevention Systems, carried out by the OIE with funding from the Development Grant Facility of the World Bank;
  - Quantitative evaluations of needs and priorities for the Veterinary Services (gap analysis) prepared by national Veterinary Services in collaboration with OIE; and
  - Results from a survey under Directors of Wildlife Services, prepared in collaboration with the EcoHealth Alliance.
- Preparation of a summary of key cost components for the prevention and control of prevailing and emerging zoonotic diseases;
- Estimation of the cost for national and global prevention and control systems for those diseases;
- Estimation of the cost savings and efficiency gains from a closer coordination, and eventually through some degree of integration, between animal and human health services, based on the authors estimates, validated by an international panel of specialists in human and veterinary health and environmental sciences; and
- Demonstration of the effectiveness gains achieved through the introduction of One Health.

Chapter 3: METHODOLOGY

DATA—SOURCES AND COLLECTION

1. Sources of budget data were identified and data collected integrated into a large data base. Data sources and their geographical distribution are shown in table 3.1.
2. Data was disaggregated by disease and by type of service.

- Disease: Avian Influenza and other zoonotic diseases (these varied depending on the sample country but typically included, in addition to H5N1, also H1N1, anthrax, rabies, brucellosis, and tuberculosis). In the OIE report on the cost of animal diseases, other non-zoonotic diseases (foot and mouth disease, sheep pox) were also included.
- Type of service: animal, human, and wildlife health services.
- Tasks within the disease prevention and control systems:
  - For veterinary services: surveillance, bio-security, diagnostics, control (vaccination and hygiene programs), culling, and compensation. For the Gap Analysis, the costs are distributed among the five pillars; (1) Strengthening Competencies for Trade; (2) Strengthening Competencies for Animal Health; (3) Strengthening Competencies for Veterinary Public Health (Food Safety and Zoonoses); (4) Strengthening Competencies for Veterinary Laboratories; and (5) Strengthening Organizational Structure, and a further differentiation is made for pillars (2, 3, and 4) on the allocations for zoonotic diseases and food safety;
  - For public health services: surveillance, diagnostic services, control/investigation, and control/vaccination;
  - For wildlife services: total wildlife budgets and disaggregation by investment and recurrent costs and also disaggregation by wildlife health and other tasks, and within livestock health into surveillance, diagnostics, control, and other eco-risks (pollution etc.); and
  - For planning and communication: costs relating to training and education of staff, meetings with government/sectors/industries/communities, preparation of background materials and draft guidelines, media and awareness campaigns.
- Funding source: domestic and external; and
- Object of expenditure: recurrent and investment costs as described in table 3.2.

DATA ANALYSIS

The data of the INAPs, World Bank appraisal reports and OIE budget summary reports, OIE Gap Analysis studies, wildlife health service surveys, and other preparedness and response plans was then analyzed in three steps.

TABLE 3.1: Budget Data Sources

DATA SOURCE	TOTAL	SUB- SAHARAN AFRICA	SOUTHERN AND EASTERN ASIA	LATIN AMERICA	EUROPE AND MIDDLE EAST
Integrated National Action Plans (INAP Reports)	24	24	0	0	0
World Bank Staff Appraisal Reports	12	2	5	4	1
OIE Budget Summary Reports (OIE 2007c)	11	2	3	2	4
OIE Gap Analysis	14	8	4	1	1
Wildlife Health Service Survey	7	3	1	2	1
Other (Preparedness and Response Plans)	20	18	1	1	0
World Bank/Tafs Analysis	All OIE member states				
Total	88	57	14	10	7

Source: General country data was obtained using FAOSTAT and Euro-monitor.

TABLE 3.2: Description of Object of Expenditure Categories

INVESTMENT COSTS (OR CAPITAL EXPENDITURES)	RECURRENT COSTS (OR OPERATING EXPENDITURES)
Definition: Costs of purchasing fixed assets) that are typically used over a long period of time, i.e. over three years (OIE 2009). A depreciation period of five years for investment items was assumed. In the Gap Analysis, this included the so-called "Exceptional Budget."	**Definition:** Cost of day-to-day spending on salaries, consumables, and everyday items that get used up as the good or service is provided (OIE 2009).
Typical examples: Investing in land and buildings; establishing laboratories, surveillance posts, and offices; and purchasing vehicles and equipment (laboratory, surveillance, and culling). Training, as investment in long-term human capabilities, is also considered an investment.	**Typical examples:** Government and council fee rates, rental fees, operation and maintenance (i.e. vehicles, laboratory, surveillance, and culling equipment), reagents, disinfectants, vaccines and office supplies, salaries and wages, and compensation.
How investment and recurrent costs were determined or separated from data: INAP reports listed costs by task or function (e.g., surveillance) and also provided a detailed description (often costs were differentiated into investment or recurrent costs). Where costs were not disaggregated into investment and recurrent costs, the detailed description was used together with the above guidelines to determine if the cost was an investment or recurrent cost.	

Step 1: Calculation of unit costs for different services:

- By type of service (animal health, human health, wildlife health, and communications and planning) and within type of service by function (prevention vs. control) and within function by task (surveillance, diagnostics, control, etc.);
    - The analysis of the gap analysis documents covered all five pillars, but paid particular attention to the three pillars relevant to One Health: (2) Strengthen Competencies for Animal Health; (3) Strengthen Competencies for Veterinary Public Health (Food Safety and Zoonoses); (4) Strengthen Competencies for Veterinary Laboratories. In the analysis, the total budget was broken down by pillar, by investment, and by recurrent costs. The proposed actions related to preparedness and control of zoonotic diseases were then summarized, thus providing also a qualitative assessment of the kind of gaps the veterinary services identified;
- By object of expenditure (investment and recurrent costs); and
- By key parameters, such as human and poultry population numbers and Veterinary Livestock Units (VLUs),[1] per capita GDP, livestock contribution to GDP, and private-/public-sector veterinarians.

Step 2: Estimation of the cost for national and global prevention and control system for zoonotic diseases. This was done by extrapolating (up-scaling) the estimated funding needs per capita and VLU calculated under Step 1 to the global level, under the following assumptions:

- The distribution of funds estimated earlier between human and animal health services and investment and recurrent costs are the same for other zoonotic diseases as for HPAI; and
- The share of direct economic cost of animal (and human) losses due to zoonotic diseases is a proxy for the share of funding allocated to zoonotic diseases versus non-zoonotic diseases.

Step 3: Estimations used for the economics of One Health were made by:

- Identifying the most costly tasks in a disease prevention and control system for the animal health, human health, and communications and planning sectors;
- Collecting information from case studies where personnel and other investments and resources were shared between animal, human, and wild life health sectors, and identifying efficiency and effectiveness gains. Most data from the case studies originated from existing literature, with the exception of a field visit to the Canadian Science Centre for Human and Animal Health. However, detailed data from this source was considered too atypical and was therefore not included in the analysis; and
- Developing assumptions on the degree of integration of the different services and validating those assumptions in a round table discussion with high level specialists from veterinary and human health sectors and arriving at "best" estimates of the global costs of prevention and control systems and the potential savings from One Health.

1 Bovine (*1), buffaloes (*1), camels (*0.5), horses (*0,5), donkeys (*0.3), pigs (*0,2), sheep (*0.1), goats (*0.1), poultry (*0,01), rabbits (*0,01).

Chapter 4: DATA LIMITATIONS AND GAPS

There are data gaps and weaknesses, as shown in table 4.1.

Overall, it should be noted that the cost estimates in the previously mentioned studies are based on ex-ante data, and reflect the budget needs for prevention and control of zoonotic diseases in "peace time" or during minor disease outbreaks. Budgetary needs would significantly increase if a major disease outbreak or pandemic were to occur, as modeled in the "Extrapolating these findings to a global scale" section. Also the data and the resulting outcomes are livestock focused. This is due to the stronger data base on the animal health side and the weaker data base on the human side. Until human health data are improved, there is little that can be done to improve the analysis on the human health side. Despite these setbacks, the previously noted data sources were all that was available and have led to a first attempt or initial recommendations and benchmarks that can be improved in time (when additional data become available). In addition, despite the livestock-centric focus of the data and analysis, significant efficiency and effectiveness gains have been demonstrated in the case studies.

TABLE 4.1: Notes on Data Selection, Allocation, and Limitations/Gaps and Suggestions for Future Improvements

ITEM	DATA SELECTION AND ALLOCATION	BENEFITS AND LIMITATIONS/GAPS	SUGGESTED APPROACH FOR FUTURE
Data sources	Restricted to data available in the public domain.	INAPs: Prepared by joint teams of WHO/OIE/FAO experts on grant from the World Bank. Comprehensively cover costs for incremental needs for the prevention and control of Avian Influenza across both human and animal health sectors. However, data are mostly from countries in Sub-Saharan Africa and do not include costs for prevention and control of other zoonotic or non-zoonotic diseases. It has been suggested that INAP reports might have been biased by the composition of the INAP teams and by the scope of their task. Budget data from INAP reports represent the "ideal" amount of funding required to bring prevention and control of zoonotic diseases in the animal and human health sectors up to OIE and WHO standards for "peace time" as well as actual outbreak control. These data do not represent funding amounts provided in the past nor do they represent what will be provided in the future (this will depend on what each country can afford).	Countries should be encouraged to record and collect data on a range of diseases to be disaggregated by task (prevention and control), by sector (human and animal health and joint planning and communications), and by objective of expenditure (investment and recurrent costs). Encourage the collection of wildlife and ecosystem data.
		OIE reports: Prepared by OIE on a World Bank grant. Cover costs for a range of diseases in different regions of the world. However, data are only for "peace time"; therefore costs are mostly provided for prevention and only partially for control. In addition, costs are only provided for the animal health sector and not the human health sector. **Gap Analyses:** Prepared by OIE on request of governments as part of the OIE PVS Pathway. This is a global program for the sustainable improvement of a country's Veterinary Services' compliance with OIE standards. The budget data of the gap analysis refer to the incremental needs. It has good data on food safety capacity requirements, but does not distinguish in costing between zoonotic and non-zoonotic diseases in surveillance and diagnostic capacity requirements. It does not have data on human health capacity needs and covers prevention costs only, not control. **Wildlife Health Surveys:** Data are not based on the original documents, but are the result of a survey under directors of wildlife services (see Annex 2). Wildlife budgets did not always differentiate for diseases functions; directors were asked to provide estimates and provide breakdowns on budgets per function (surveillance, etc.) and objects of expenditure, but the data do not distinguish between zoonoses and non-zoonoses. Data are from actual budgets, which might not reflect actual needs. **World Bank/Tafs Study** is (i) exclusively based on 2006–2009 data, which are exceptional years because of the HPAI outbreak. Therefore the analysis is biased by this major crisis. (ii) It is based on official reporting to OIE and therefore suffers from underreporting. (iii) It covers 30 zoonotic diseases.	

(Continued)

TABLE 4.1: Continued

ITEM	DATA SELECTION AND ALLOCATION	BENEFITS AND LIMITATIONS/GAPS	SUGGESTED APPROACH FOR FUTURE
Countries	Data were collected for as many countries as possible (across a number of income groups and regions).	Restricted to data available in the public domain. Variations occur between countries because of their different stages of development, population and livestock numbers, market access (domestic or export), disease prevalence or threat, as well existing infrastructure and resources.	As above.
Diseases	Data were collected for as many countries and diseases as possible (across a number of income groups and regions, although excluding the developed countries), using OIE (WAHID), and WHO data bases.	Data suffer from underreporting, because of poor disease surveillance capacity and adverse (mostly economic) incentives for accurate disease reporting. Data on wildlife diseases were particularly weak.	Need capacity building in surveillance and structural changes to remove adverse incentives.
Data period	On average, projects ran for a three- to five-year period with, on average, a start date between 2006 and 2009.	Restricted by availability of data in the public domain.	
Currencies and conversion rates	Most data were listed in local currency but were converted to US$ using a conversion rate from June 1 for the year that the project commenced.	Inflation was not taken into consideration, as this was seen as being insignificant in between 2006 and 2010.	Consider inflation in future when more precise data are available.
Distributing budget data into categories	Budget data were allocated to human health, animal health, or planning and communications sectors. Under each sector data were allocated by prevention or control task.	Not all data sources listed animal and human health prevention and control tasks.	Encourage countries to record and collect data in this way for future use.
Investment and recurrent costs	Where possible, under each task, investment and recurrent costs were identified and listed separately.	Not all data sources listed investment and recurrent costs separately.	Encourage countries to record and collect data in this way for future use.
Depreciation of investment costs	Investment costs were depreciated in five years.	No data available, but with fast-advancing technologies in this sector, and means of mobility an important component of the investment, a five-year average was considered appropriate.	When more precise data are available, include a depreciation period for the main items.
Funding	Where possible, information on funding sources (local and/or foreign) for projects was collected.	Not all data sources provided information on funding, and not all services have multiple sources of funding.	Encourage countries to record and collect data in this way for future use.

Source: This study's analysis.

Chapter 5: ANALYSIS AND RESULTS

AVIAN INFLUENZA

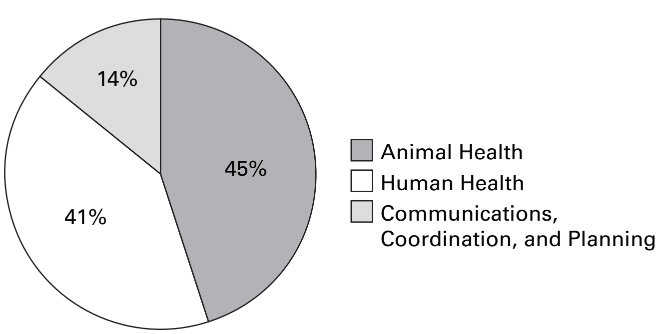
Allocation among Sectors

The following results were obtained through the analysis of mostly INAP data from 46 countries, mostly from Sub-Saharan Africa, with a few countries from southern Asia, Latin America, and Europe and the Middle East.[1]

- Of the total incremental budget allocated to bring the national systems for the prevention and eventual control (if the prevention fails) of Avian Influenza (i.e., peace-time and outbreak control) up to OIE and WHO standards, 45 percent was allocated to animal health, 41 percent to human health, and 14 percent to joint planning and communication activities (figure 5.1).
- Of the total incremental budget, 55 percent was allocated to recurrent costs and 45 percent to investment costs. This was even higher (82 percent in recurrent and 18 percent on investment) in the gap analysis. These figures underscore the critical importance of the recurrent budget in disease preparedness and control activities, although these are often neglected in externally funded projects because most donors assign priority to financing capital investments. Too often health services have been deprived of adequate recurrent expenditure budgets. More sustainable systems of recurrent cost funding, through a Global Fund, must be developed, as proposed in World Bank's *People, Pathogens and the Planet* (2010) and summarized in box 5.1.
- More specifically, the average incremental estimated funding needs to bring the animal and human health services up to OIE and WHO standards were (based

1 In the analysis, the largest number of countries with data available is used. Differences between similar parameters can be the result of difference in the number of countries with data availability.

FIGURE 5.1: Estimated Incremental Funding Needs (percent) to Bring Animal and Human Health Sectors Up to OIE and WHO Standards for the Prevention and Control of Avian Influenza (based on INAP reports from 45 countries)



Source: This study's analysis.

BOX 5.1: Funding a Global One Health Network

- Because of its trans-boundary nature and major impact on poor people, the prevention and control of emerging and re-emerging zoonotic diseases is generally considered a global public good;
- In the past, such as with the H5N1 and H1N1 outbreaks, the international community has provided large amounts of emergency funding (i.e., US$4.3 billion between 2005 and end 2009; UNSIC 2010) to control these diseases;
- However, with a declining threat, international support is drying up, and much of the capacity that has been built up will be lost. This current "boom-and-bust" model is therefore grossly inadequate;
- More sustainable funding mechanisms are therefore needed. This can be a combination of:
  - National government contribution, in particular to take responsibility for at least a part of the recurrent costs (such as the salaries);
  - International donor contribution linked to national government contribution, availability of operational preparedness plans, and full transparency regarding disease reporting and financial aspects of the services;
  - Nonconventional sources of funding (foundations, etc.), preferentially in the form of endowment to ensure sustainability;
  - Levies, for example, on meat exports or pharmaceutical products; although politically sensitive, a levy of only $0.04 per kg would provide adequate funding for at least the operating costs of the global network.

Source: People, Pathogens and the Planet, Volume 1 (World Bank 2010b).

on the average of the aggregate total population) US$0.15 per capita and US$0.13 per head of poultry, respectively, and (based on the average cost per sampled country) US$0.35 and $0.33 (per capita and per head of poultry, respectively). The difference is caused by the preponderance in the sample of small countries, which have a relatively high cost per unit. The variation between countries was extremely large, with US$0.02 and US$2.10 per capita per year and $0.02 and $2.20 per head of poultry per year. The key factors influencing this variation include:

- Population density: countries with a low population density required higher budgets per capita.
- Existing infrastructure and resources: the countries in Sub-Saharan Africa required slightly higher budgets. On a per capita basis, calculated over the aggregate sample, the analysis showed an estimated funding need of US$0.17 for Sub-Saharan Africa and US$0.13 for other developing regions and on a per-head-of-poultry basis US$0.15 per head of poultry in Sub-Saharan Africa and US$0.07 in the rest of the world (figure 5.2).

Allocation among Main Functions (prevention or control) within Sectors

Animal Health Services

The analysis of the 23 countries for which data were available for a more detailed breakdown by main function found that the animal health sector in Sub-Saharan Africa on average required US$1.2 million per country per year (or about US$0.14 per head of poultry per year) for the prevention and control of HPAI. Of this, about 48 percent was allocated to prevention and 52 percent to control. In other regions, the animal health sector required US$2.7 million per country per year for the prevention and control of Avian Influenza, with about 70 percent allocated to prevention and 30 percent to control. These differences seem to be based on regional conditions:

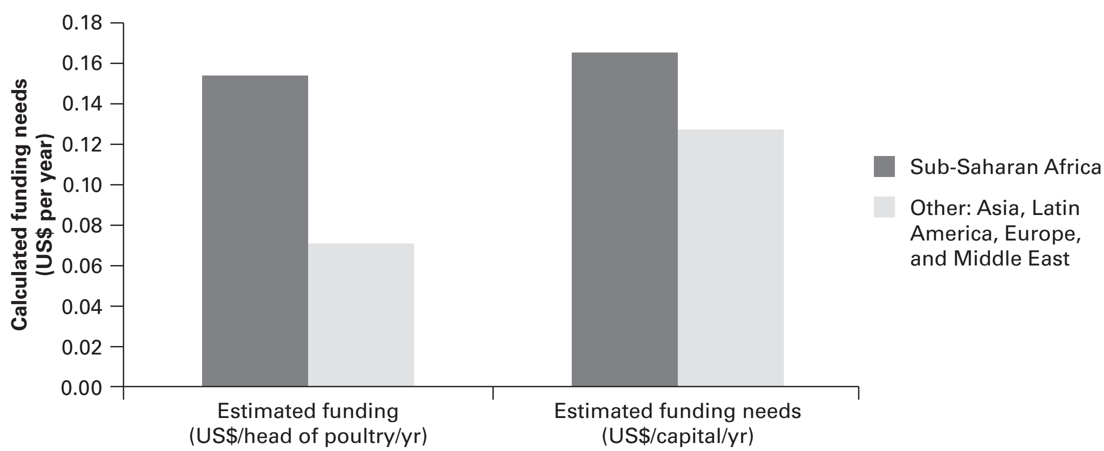
- In Sub-Saharan Africa, the emphasis seems to be on a more reactive control strategy. These countries lack infrastructure and resources and have poor communication facilities. An active and reliable surveillance system in Sub-Saharan Africa would be extremely costly and difficult to maintain, hence more emphasis on control; and
- In the rest of the world, the priority is given to prevention to rigorously impose the necessary bio-security measures, and thus avoid major losses from animal diseases. In addition, some of these countries have strong meat export sectors, and the emphasis on quarantine and other bio-security measures protects their export interests.

The incremental funding needs for the different tasks of animal health services are provided in figure 5.3.

In this context it is also interesting to present the results of a recent study of OIE PVS evaluation from 12 developing countries relating some critical competencies with efficiency and effectiveness in the control of HPAI (Swayne 2011). It shows that although economic indicators play a role in laboratory capacity and diagnostic facilities, other factors such as environment, ecology, poultry production systems, veterinary services, and implementation of control measures play a vital role as well. Swayne (2011) reported:

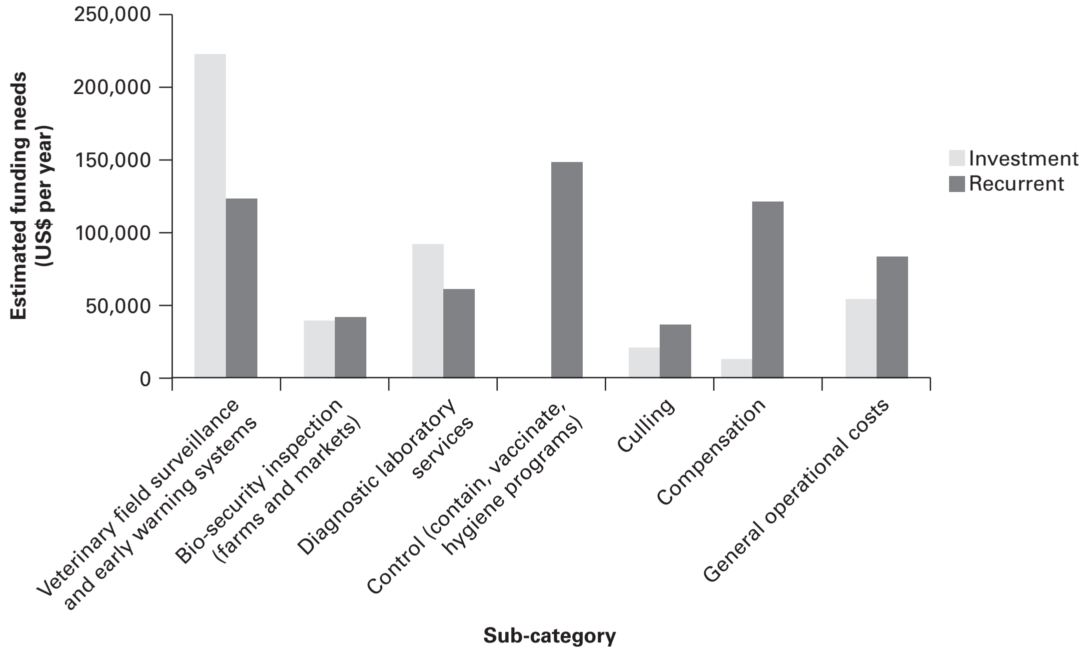
- Negative correlation of staffing of veterinarians and other professionals with eradication time, mortality rate, culling rate, and number of outbreaks;

FIGURE 5.2: Estimated Incremental Funding Needs per Head of Poultry and per Capita for the Prevention and Control of Avian Influenza (based on 45 countries and aggregate sample)



Source: This study's analysis.

FIGURE 5.3: Calculated Funding Needs for Prevention and Control Tasks for HPAI in the Animal Health Service (US$ per country per year), Based on 23 Countries



Source: This study's analysis.

- Negative correlation of staffing of veterinary paraprofessionals with mortality rate;
- Negative correlation of professional competencies of veterinarians with mortality rate;
- Negative correlation of continuing education with mortality rate;
- Negative correlation of emergency funding with eradication time;
- Negative correlation of epidemiological surveillance with HPAI eradication time;
- Negative correlation of availability of veterinary medicines and veterinary biological products with culling rate and number of outbreaks;
- Negative correlation of transparency with culling rate and number of outbreaks;
- Negative correlation of disease prevention, control, and eradication measures with eradication time, culling rate, and number of outbreaks; and
- Increased critical competencies of veterinary services are associated with an improvement in the Avian Influenza outbreak control.

Human Health Services

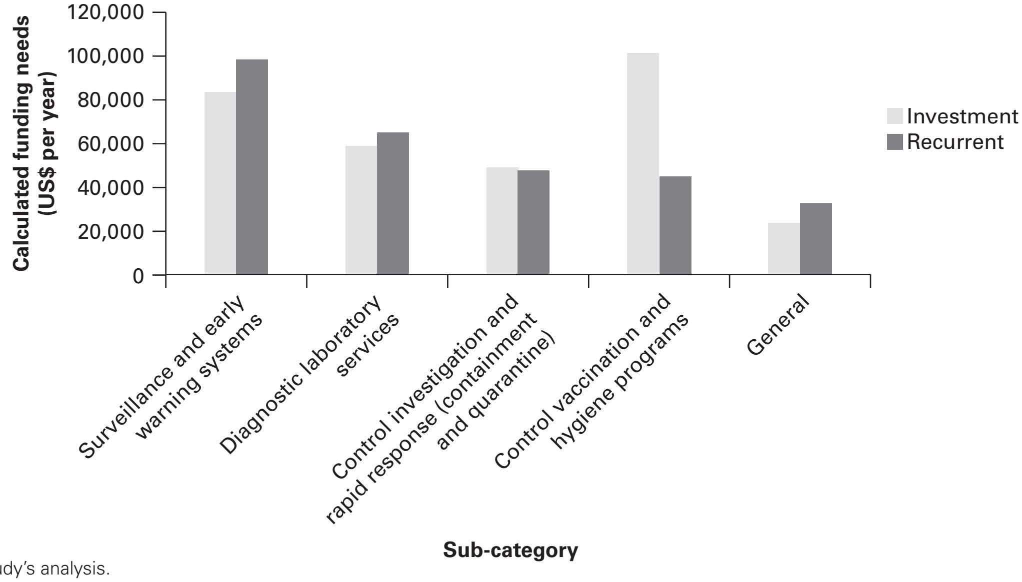
The human health sector in Sub-Saharan Africa on average required US$1.3 million per country per year (or on the aggregate sample about US$0.10 per capita per year) for the prevention and control of Avian Influenza, with about 36 percent allocated to prevention and 64 percent to control. In the other developing regions, funding was higher, at US$3.4 million per country per year (or about US$0.20 per capita per year), but with a similar distribution between prevention (31 percent) and control (69 percent) as was found for Sub-Saharan Africa. The priority on the human health side is therefore on control, which is also in line with the strategy of "prevention at source" (i.e., on the animal side), with resources allocated to control if these primary defenses at the animal level fail.

Allocation among Specific Tasks within Sectors

The incremental funding requirements for the prevention and control of human HPAI, available from estimates from 23 countries, were itemized by specific tasks, with the results presented in figure 5.4.

Figures 5.3 and 5.4 show that in both sectors, the major cost items for the upgrading of the prevention and control systems for Avian Influenza are surveillance and diagnostic systems. In the "Efficiency gains from One Health" section, these tasks also emerge as having possibly the greatest efficiency and effectiveness gains through closer coordination and collaboration between the animal and human health sectors. A detailed breakdown of the cost items for the control of HPAI (vaccination and hygiene programs) is provided in table 5.1.

FIGURE 5.4: Estimated Funding Needs for Prevention and Control Tasks for Avian Influenza in the Human Health Sector (US$ per country per year), Based on 23 Countries



Source: This study's analysis.

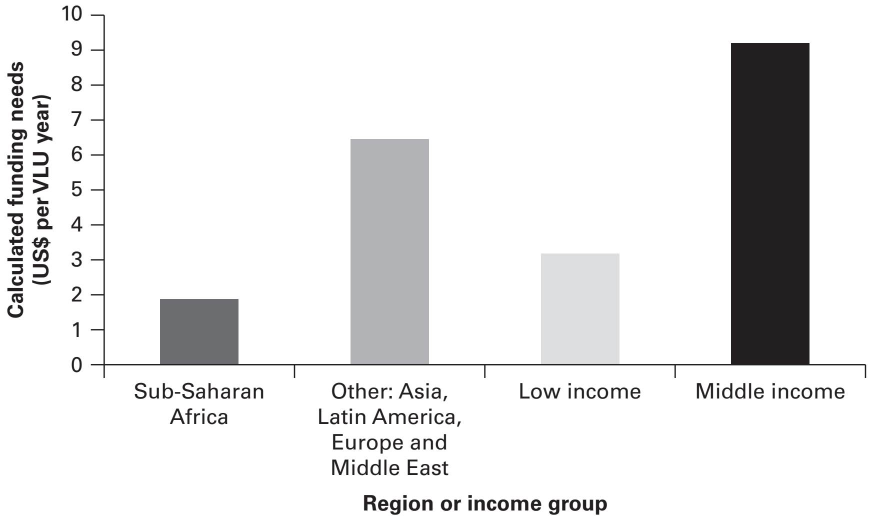
TABLE 5.1: Allocation of Estimated Funding Needs (percent of overall budget) for Different Prevention and Control Tasks in Animal and Human Health Sectors, Based on 23 Countries[2]

ANIMAL HEALTH			HUMAN HEALTH		
TASK	**INVESTMENT/ RECURRENT COST**	**PERCENT OF OVERALL BUDGET REQUIRED**	**TASK**	**INVESTMENT/ RECURRENT COST**	**PERCENT OF OVERALL BUDGET REQUIRED**
Prevention (28 percent)			**Prevention (17 percent)**		
Surveillance (16 percent)	Investment	10 percent	Surveillance (10 percent)	Investment	5 percent
	Recurrent	6 percent		Recurrent	5 percent
Diagnostics (8 percent)	Investment	5 percent	Diagnostics (7 percent)	Investment	3 percent
	Recurrent	3 percent		Recurrent	4 percent
Bio-security (4 percent)	Investment	2 percent			
	Recurrent	2 percent			
Control (24 percent)			**Control (31 percent)**		
Quarantine, vaccination, and hygiene programs (15 percent)	Investment	9 percent	Rapid response and isolation (12 percent)	Investment	6 percent
	Recurrent	6 percent		Recurrent	6 percent
Culling (3 percent)	Investment	1 percent	Vaccination and hygiene programs (19 percent)	Investment	13 percent
	Recurrent	2 percent		Recurrent	6 percent
Compensation (6 percent)	Investment	1 percent			
	Recurrent	5 percent			
TOTAL		**52 percent**			**48 percent**

2 This table excludes communication; hence the share between human and veterinary health varies from the data in figure 1.2, where communication is included.

Source: This study's analysis.

FIGURE 5.5: Estimated Funding Needs (US$ per VLU per year) for the Prevention and Control of Other Diseases in the Animal Health Sector, by Region and Income Group (based on aggregate numbers of nine countries)



Source: OIE (2007c).

OTHER DISEASES

The "other diseases" category covers zoonotic diseases other than Avian Influenza as well as non-zoonotic diseases. The diseases covered in the analysis varied, depending on the country, but each country typically included data on about five diseases (e.g., anthrax, rabies, brucellosis, bovine tuberculosis, sheep pox, etc.). The analysis covered two data sets: the OIE study with data from nine countries,[3] and the results of the analysis of the gap analysis of 14 countries.[4] Because the data of these two sets are not fully compatible, they are reported separately.

OIE Studies

The figures and trends that emerged from the analyses of the nine countries are enumerated as follows, with strong caveats for the accuracy because of the limited data sets:

- The average funding requirement to bring the animal and human health services up to OIE standards for the prevention and control of other diseases was US$2.55 per capita per year, with a variation between US $0.52 and US$7.96 per capita per year. On a per VLU basis, the average was US$5.53 per VLU per year with a range between US$1.83 and US$10.50 per VLU per year. The main factors influencing this variation include:
  - Livestock population densities: Higher livestock densities offer economies of scale and therefore lower per unit service costs; and
  - Export interests: Most non-African countries in the sample export to Europe and the USA, which require higher but also more costly sanitary standards. This might explain, at least in part, the difference between the estimated funding requirements of rest of the developing world (US$6.43 per VLU per year) and the middle-income countries (US$9.20 per VLU per year), as shown in figure 5.5.

Like in the figures arrived at by the INAP analysis, these results show a strong effect of economies of scale, with, for example, Barbados and Belize, with less than 0.5 million VLUs, showing an average cost of veterinary services of US$4.5 per VLU per year, whereas Uruguay, with 14 million VLUs, expends US$0.85 per VLU per year, in spite of its strong export orientation (OIE 2007c).

It is also interesting to note that although for HPAI, Sub-Saharan Africa had a higher estimated funding requirement than other regions of the world (see figure 5.2), for the other diseases, the other regions of the world had a higher funding requirement. This is probably to the result of:

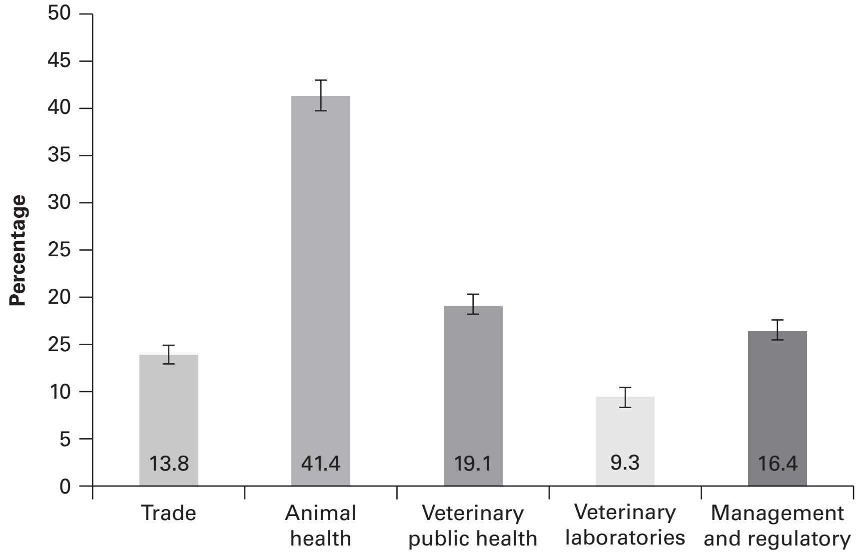
- The smaller poultry sector in Sub-Saharan Africa and its lack of infrastructure and resources.
- The higher and more costly sanitary standards required for export interests in the "rest-of-the-world" category.

The Gap Analysis

A summary of the results from 21 countries' gap analysis reports, prepared by OIE,(2011a) is provided in figure 5.6.

3 Argentina, Belize, Costa Rica, Kyrgyzstan, Mongolia, Morocco, Turkey, Uganda, and Vietnam.
4 Armenia, Belize, Cambodia, Cameroon, Guinea Bissau, Guinea Republic, Mali, Mauritania, Mongolia, Mozambique, Myanmar, Nigeria, Senegal, and Vietnam.

FIGURE 5.6: Distribution (%) of the Calculated Requirements of 21 Countries by Five OIE Pillars



Source: OIE (2011a).

Figure 5.6 shows that pillar 2 (Animal Health), which is the core of the veterinary service, has the highest budgetary requirement to bring services up to OIE standards. This pillar has also the lowest coefficient of variability (0.38). Overall, the cross-country variability of the share of the total budget allocated to the pillars is relatively small (0.38 to 0.75), except for the Veterinary Laboratories pillar, whose coefficient of variation is 0.90. A more in-depth analysis was carried out as part of this study on 14 countries and the results are provided in table 5.2.

A qualitative review of the same 14 countries' gap analysis reports shows that the main priorities and activities envisaged, if the funding gap would be met, are as follows (see also Annex 3):

- Although the non-zoonotic diseases, such as FMD, CPBB, and Newcastle Disease seem to get the overall priority, 12 countries out of the 14 have surveillance for zoonotic diseases also high on their priority list of overall animal diseases to control. Moreover, the majority of countries envisage active surveillance, rather than the passive slaughterhouse inspections.
- Although the attention to active surveillance is encouraging, only a few countries had concrete plans with follow-up campaigns.
- Most food safety tasks envisaged concern meat inspection and slaughterhouse improvement.
- For the diagnostic facilities, no differentiation between zoonotic and non-zoonotic diseases is made. Costs of an active surveillance system vary between US$0.4 million and US$0.7 million per year.

TABLE 5.2: Average Incremental Funding to Bring Veterinary Services Up to OIE Standards for 14 Countries as Reported in the Gap Analysis

ITEM	AVERAGE FUNDING REQUIREMENT (US$ MILLION PER COUNTRY PER YEAR)	AVERAGE FUNDING (US $ PER VLU PER YEAR) AND RANGE
All pillars	16.0	1.95 (0.49–41.8)
Pillar 1 (Competency for Trade)	1.7	0.21 (0.02–13.21)
Pillar 2 (Animal Health)	7.9	0.96 (0.07–6.61)
Pillar 3 (Veterinary Public Health)	2.3	0.28 (0.01–5.12)
Pillar 4 (Diagnostic Capacity)	0.7	0.08 (0.003–4.78)
Pillar 5 (Regulation and Management)	3.5	0.42 (0.03–12.15)
Investment/recurrent cost ratio (pillars 1–5)%	18/82	
Funding US$ per $ livestock contribution to GDP for all pillars		0.02

Source: This study's analysis.

Wildlife Health Service

The results of the analysis from the wildlife health service questionnaire survey (see Annex 4) are provided in table 5.3. A total of eight countries[5] provided budget data that could be used in this analysis.

5 Chile, Ghana, Kenya, Malaysia, Sudan, Surinam, and Tajikistan.

TABLE 5.3: Funding of Wildlife Health Services

ITEM	INVESTMENT	OPERATING COSTS
Average annual wildlife budget per country (US$) for:	US$3.3 million	US$5.0 million
• Disease surveillance	US$9,700	
• Disease diagnostics	US$11,200	
• Disease control	US$4,300	
• Other aspects of ecosystems health (pollution, etc.)	US$9,300	

Source: This study's analysis.

The conclusions from this analysis are:

- Government investment in wildlife services is minimal. The figures in table 8 are heavily skewed by the Kenyan wildlife services budget. Would that be excluded, the total annual allocation in the seven other countries would be US$50,000 for investment and US$ 60,000 for recurrent costs.
- Within this small overall amount, the share allocated to wildlife health services is a paltry 5 percent. Most services must therefore rely on the services of the animal health departments.

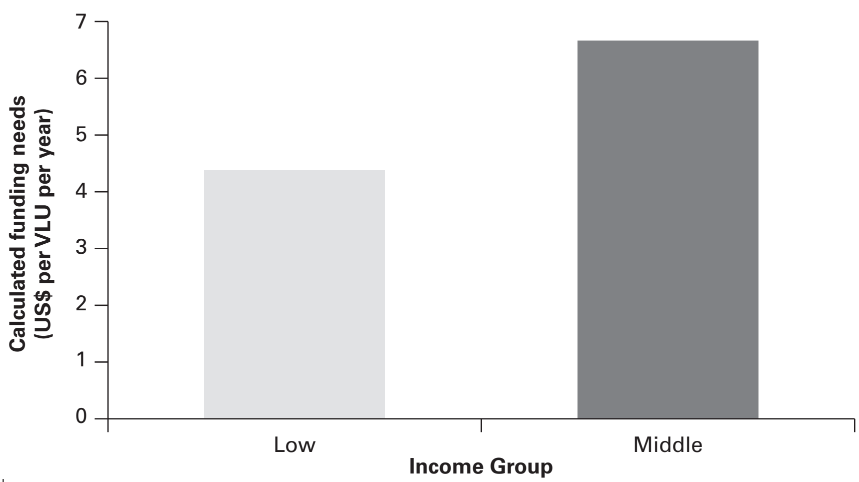
The survey also inquired about the interaction between the wildlife department and veterinary and human health services. The responses show that some countries lack contacts altogether, most contacts are informal and predominantly at the research level, and three (Democratic Republic of Congo, Ghana, and Kenya) have formal agreements, mostly in the framework on an externally funded project (e.g., PREDICT, Arbovirus).

ALL ZOONOTIC AND NON-ZOONOTIC DISEASES COMBINED (AVIAN INFLUENZA PLUS OTHER DISEASES)

Before the previously noted findings could be extrapolated to a global scale, the estimated funding needs for the prevention and control of HPAI were added to that of other diseases and the aggregate average was taken for low- and middle-income countries. The results are as follows:

- The combined INAP analysis and OIE studies result in an average incremental funding need, for prevention *and control* of the prevailing and emerging zoonotic and non-zoonotic diseases (across the human health, animal health, and planning and communication sectors) for low-income countries, of US$4.38 per VLU per year and for middle-income countries of US$6.65 per VLU per year (figure 5.7).
- The gap analysis (which is based on peace time, *without control*) provides an incremental requirement overall of US$1.95 per VLU. A breakdown by country income level has not been done, because it is not relevant, with only two countries in the sample classified as poor (of which one is an outlier with a very low livestock population).
- OIE's literature review of budgets for the public veterinary services in Latin America (OIE 2007c; i.e., inadequate peace-time allocations) shows that, on average, the current expenditure is about US$1.20 per VLU per year. It is interesting to note that this OIE study shows an additional expenditure of about US$9 per VLU per year from private veterinary service providers.

FIGURE 5.7: Estimated Funding Needs (US$ per VLU per year) for the Prevention and Control of All Zoonotic and Non-zoonotic Diseases, across the Animal, Human Health, and Planning and Communication Sectors (based on averages of aggregate numbers of all countries)



Source: Analysis of this study.

- With these facts in mind, the real figure will most likely fall within the range of US$4 to US$10 per VLU per year, depending on the country and available resources. As the One Health concept is implemented and more data become available, more concrete figures for different regions of the world would become available.

The remarkably wide range in values obtained in all the analyses reflects, at least in part, the differences among countries in health service capacity, the priority assigned to the sector, the stage of development, economic and health policy, and other factors. But this wide range of values might also be the result of differences in standards (i.e., what each country regards as essential requirements), in spite of the OIE and WHO efforts to promote standardization through the PVS and IHR tools, respectively.

OTHER ANALYSES

The major data base that was set up as part of this study also enabled a number of other analyses to be performed, with the following results:

- Ratio of public to private veterinarians:
  - On average, the ratio of public to private veterinarians was 4:1. No data could be found on public versus private physicians in the human health sector.
  - Asia, Latin America, Europe, and the Middle East have significantly more veterinarians (public and private) as compared to Sub-Saharan Africa (average of 3,602 compared to 416 veterinarians per country, respectively).
  - Similarly, middle-income countries have significantly more veterinarians (public and private) compared to low-income countries (average of 10,757 compared to 710 veterinarians per country, respectively).
- Relationship between the number of veterinarians and the total funding needs for the prevention and control of zoonotic diseases:
  - There was a positive relationship ($r = +0.46$) between the number of public veterinarians and the estimated funding needs. The strength of this relationship decreased if private veterinarians were added; and
  - There was a slightly negative correlation ($r = -0.18$) between the contribution of livestock to GDP and the estimated funding needs.

Chapter 6: EXTRAPOLATING THESE FINDINGS TO A GLOBAL SCALE

MAIN ASSUMPTIONS

In order to approximate the total funding requirement to bring the prevention and control of zoonotic diseases up to OIE and WHO standards in low- and middle-income countries, numerous basic assumptions were made and the extrapolation from the data that was presented in the "Analysis and results" section was carried out. In this extrapolation, the INAP/OIE budget study is used because of its more complete data set (i.e., its inclusion of peace-time and control costs) and the broader coverage among low- and middle-income countries. The wildlife data were too limited to enable any extrapolation to a global level. The data of the gap analysis will be used only for comparative purposes. These assumptions should be refined as better data become available. These assumptions cover:

- **The share of the public health, veterinary, and wildlife services' total budgets allocated toward the surveillance and control of zoonotic diseases.** This is the parameter with the largest impact, and about which the least is known. To estimate this share, several parameters can be used as proxies. These include the following:
  - The share of livestock mortality due to zoonotic diseases (i.e., the 50 percent livestock mortality due to zoonoses from the recent World Bank /Tafs Study [2011] study ["Background" section]);
  - The significant attention given by national public veterinary services to the control of zoonotic diseases, as shown by the gap analysis ("Analysis and results" section);
  - The share of human losses (i.e., number of DALYs lost to zoonotic disease). Regrettably, in this segment such data are not directly available, but WHO's Global Burden of Disease (GBD; 2008)[1] provides a figure of 11 percent of total DALYs, worldwide (9.3 percent for the middle-income and 16.5 percent for the low-income countries), that are due to diarrheal and respiratory diseases, which are the broad disease groupings and cover zoonotic diseases; and
  - The stage of development of the country. As already shown by the data from GBD, low-income countries have a higher incidence of zoonotic diseases, whereas on the livestock side, higher-income countries have a greater interest in protecting their export trade, where non-zoonotic diseases play the dominant role.

With these considerations, this study (as a first attempt and a *low-prevalence assumption*) assumes that *in low-income countries,* on average, about 25 percent of the total funding required for the prevention and control of all diseases would be needed to cover zoonotic diseases. The remaining 75 percent would be needed to cover other, non-zoonotic diseases. *In middle-income countries,* on average, 15 percent of the total funding for all diseases would be needed to cover zoonotic diseases, with the remaining 85 percent needed for other, non-zoonotic diseases. The expert panel that reviewed this report suggested a proportionately higher allocation to zoonotic diseases to cover higher-prevalence scenarios in both low-income and middle-income countries—to 40 percent in low-income countries and to 30 percent in middle-income countries.

- **The distribution of funding needs among the animal and human health sectors.** Here it is assumed that the same distribution would apply as that found in the analysis of the HPAI budget data in the "Analysis and results" section (figure 5.1)—that is, the calculated funding needs for human health services would be 41 percent, animal health service needs 45 percent, and joint planning and communication needs 14 percent.
- **The distribution among investment and recurrent costs.** Again the same distribution as found in the INAPs (i.e., 45 percent and 55 percent, respectively) and among different tasks of an animal and human health prevention and control system (i.e., the tasks in figures 5.3 and 5.4) would apply to other zoonotic diseases.

This implies that for zoonotic diseases, on average, the calculated funding needs to bring animal health services up to OIE standards in low-income countries are estimated to be

1 http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf.

US$1.10 per VLU per year (25 percent × US$4.38 per VLU per year for all diseases) and in middle-income countries would be US$1.00 per VLU per year (15 percent × US$6.65 per VLU per year for all diseases). This is using an assumption of lower limit (i.e., lower disease prevalence). For results based on a higher disease prevalence assumption level, see table 6.1.

RESULTS

Using the previous assumptions and extrapolating collected data, the estimated funding needs for the prevention and control of zoonotic diseases in 139 World Bank client countries (60 low- and 79 middle-income countries) are provided in table 6.1.

Thus, the total estimated funding needs to bring the global zoonotic disease prevention and control system up to OIE and WHO standards is approximately US$1.9 billion per year in the low-prevalence assumptions. As the services in the high-income countries can be expected to already meet the OIE and WHO standards, this figure would also signify total global need. The US$1.9 billion compares with the US$1.35 billion per year required for the same 139 eligible countries estimated in the *Strategic Framework* paper prepared by FAO, OIE, WHO, and the World Bank and further reported in IOM (2009) and World Bank (2010b). The difference could be explained by the *Strategic Framework*'s omission of control measures other than the control of HPAI. The high-case-prevalence assumption would amount to an incremental funding need of US$3.4 billion per year.

THE ECONOMIC BENEFITS OF A GLOBAL ZOONOTIC DISEASE PREPAREDNESS AND CONTROL SYSTEM

These total estimated funding needs are significantly lower than the actual historical costs of emerging and re-emerging zoonotic diseases of about US$6.9 billion per year described in the "Background" section. This cost savings is particularly evident when one considers that this amount reflected only six emerging zoonotic diseases. It included neither neglected zoonoses nor non-zoonotic diseases, which would also benefit from such a global system.

These estimated required funding levels are also low when considering the benefits of averting a pandemic. To illustrate the range of the magnitudes of these benefits, consider two cases: a severe and less likely pandemic and a milder, more likely, one. If the likelihood of a severe pandemic occurring in any year is 1 percent (a "once-in-100-years event"), then the expected value of annual potential savings is US$30 billion (i.e., 0.01 multiplied by US$3 trillion of the severe pandemic cost cited earlier). In this case, an annual expenditure of US$3.4 billion on prevention (the high-case-prevalence assumption noted earlier) will have been cost-effective if

TABLE 6.1: Estimated Incremental Funding Needs to Bring Prevention and Control of Zoonotic Diseases Up to OIE and WHO Standards in the Human and Animal Health Sectors (by income level) for the 139 World Bank Client Countries (60 low- and 79 middle-income countries) and Two Scenarios

			ANIMAL HEALTH	HUMAN HEALTH	COMMUNICATIONS
INCOME GROUP AND DISEASE PREVALENCE	TOTAL VLUS (MILLIONS)	TOTAL ESTIMATED FUNDING NEEDS (US$/VLU/YR)	TOTAL ESTIMATED FUNDING NEEDS (US$ MILLIONS/YR)		
Low income (low prevalence)	822	$1.10	$405	$369	$126
Low income (high prevalence)		$1.75	$648	$590	$202
Middle income (low prevalence)	965	$1.00	$433	$395	$135
Middle income (high prevalence)		$2.00	$866	$789	$269
Total (low prevalence)	**1,787**		**$1,862**		
Total (high prevalence)	**1,787**		**$3,364**		

Source: This study's analysis.

every eighth severe pandemic is averted. If a larger proportion of severe pandemics is prevented, then the returns to the investment in prevention would be very high indeed, reflecting a global net benefit of up to US$26.6 billion annually. For a mild pandemic, with an economic impact of US$600 billion and occurrence every 40 years, the expected annual benefit of prevention is US$15 billion (i.e., 0.025 multiplied by US$600 billion). The annual expenditure of US$3.4 billion on prevention will have been cost-effective if thereby one mild pandemic out of four is prevented. Higher success at prevention will increase benefits. For example, if one-half of mild pandemics are prevented, then the global net benefit is a substantial US$4.1 billion per year (i.e., 0.5 multiplied by 15, or US$3.4 billion). Prevention of all mild pandemics would yield a net global benefit of US$11.6 billion annually. Because the establishment of robust public health and veterinary systems in all countries will prevent at least a significant number of new outbreaks and some pandemics, these favorable ratios need to be communicated widely to decision makers.

The expected rates of return of these investments are shown in table 6.2. The calculations show two main scenarios: one for a mild pandemic that would cost the world US$600 billion and a second for a severe pandemic that would cost US$3 trillion. If no preventive measures to strengthen systems for early disease detection and effective control at the source are taken, a mild pandemic could occur with a probability of 3 percent in any year. A severe pandemic would occur with a probability of 1 percent in any year (a "once-in-100 years" event). The expected costs of other major disease outbreaks would continue to be about US$6.7 billion per year, as discussed earlier. The table shows the rates of return if the probabilities of a pandemic (and thus expected costs) are reduced by 20 percent (only some outbreaks are prevented), 50 percent (half of outbreaks are prevented), and 100 percent (perfect prevention). Two figures are shown for each scenario: one where spending on prevention is US$1.9 billion, and a second where this spending is US$3.4 billion, as described in this paper. These annual costs of prevention as well as the costs of disease impact are assumed to grow at 2 percent per annum, to reflect expected growth in the economy and in disease risks. Finally, in the calculations, no benefits from disease risk reductions are assumed to appear before year 5 (without this assumption the rates of return would be much higher). The rates of return range from high (14 percent) to very high (123 percent), indicating that investments in prevention are strongly justified. For instance, under a plausible expectation that improved systems could detect and control half of incipient pandemics, the rates of return range from 44 to 88 percent, which is well above the returns available on nearly all other public spending and private capital markets.

These highly favorable ratios show that One Health investments should be undertaken without delay. In allocating resources, decision makers should consider the extraordinarily high returns to pandemic prevention through early detection and effective control of zoonotic diseases at their animal source.

TABLE 6.2: Annual Expected Rate of Return on Investments in Prevention

		DISEASE OUTBREAKS BEING PREVENTED			
		MILD PANDEMIC		SEVERE PANDEMIC	
		Low preventive effort	High preventive effort	Low preventive effort	High preventive effort
Reduction in expected disease outbreak impact	20%	31%	14%	49%	25%
	50%	65%	44%	88%	57%
	100%	97%	71%	123%	86%

Source: This study's analysis.

Chapter 7: EFFICIENCY GAINS FROM ONE HEALTH

THE DATA BASE

Actual data on the savings from the introduction of One Health do not exist in the public domain. This is first because only a couple of countries have actually implemented the One Health approach and second because these data are often confidential (due to trade and other economic interests). One example where One Health has been implemented (see box 7.1) provided some data, but they are too unique to be extrapolated to a broader scale. This study team has therefore postulated a set of assumptions and their justifications (see table 7.1), which were endorsed by the panel of high level experts as "reasonable." The levels of savings listed in the next section are preliminary estimates, considered by the majority of the expert panel as "reasonable first estimates," but are to be validated by field data as the One Health concept is implemented. They also strongly depend on local conditions. In any case, table 7.1 demonstrates that considerable savings can be made, even under modest efforts between the animal and human health sectors to collaborate. Moreover, this table does not include joint planning and communication activities, where even further savings could be achieved.

POTENTIAL SAVINGS THROUGH ONE HEALTH

Using the basic costs data from this report and the assumptions validated by the panel of experts, the cost savings achievable through the implementation of the One Health approach in the 139 World Bank client countries are significant (see table 6.2).

Applying those estimated cost savings to the calculated budget sum for the 139 World Bank client countries (combining tables 5.1 and 7.1, see for more details Annex 6) to determine total savings, in the low-prevalence scenario, this could lead to a savings of US$184 million per year, or 10 percent of the total costs, about equally divided between low- and

TABLE 7.1: Potential Savings Achievable through the Implementation of the One Health Concept in 139 World Bank Client Countries (60 low- and 79 middle-income countries) in Peacetime and Emergency Operations

TASK	INVESTMENT/ RECURRENT COST	SAVINGS %	SPECIFIC AREAS OF SAVINGS
Surveillance	Investment	10–30%	Joint transport and communication systems, as has been demonstrated in HPAI and other campaigns
Surveillance	Recurrent	20–40%	Shared front-line staff, as already has been demonstrated in many countries with para-veterinary systems
Bio-security	Investment	5–20%	Shared border control and abattoir and market inspection in buildings and equipment, as already done in several countries; sharing also possible with plant sanitary service
Bio-security	Recurrent	10–30%	Shared border control and market inspection, with clear agreement on responsibilities. Sharing also possible with plant sanitary service
Diagnostics	Investment	5–25%	Joint facilities and equipment, as already done in a number of countries
Diagnostics	Recurrent	15–30%	Shared support staff, as already done and recommended in other countries
Control (vaccinations, hygiene, and rapid response)	Investment	5–15%	Shared quarantine of infected areas, as successfully done in HPAI campaigns
Control (vaccinations, hygiene, and rapid response)	Recurrent	10–30%	Shared staff and hygiene and awareness programs
Culling	Investment/recurrent	0%	
Compensation	Investment/recurrent	0%	
Additional costs	Training	5–10%	Of total budget
	Research	5–10%	Of total budget

Source: Authors' assumptions, endorsed by expert panel as "reasonable first estimates."

middle-income World Bank client countries. In the high-prevalence scenario the savings could amount to US$506 million per year, or 15 percent. It should be noted, however, that these figures do not include potential savings in the areas of planning and communication, education, and the extra costs of training or research. In table 7.1, training and research are each budgeted at 5 percent of the total costs (i.e., about US$95 million per year).

BOX 7.1: The Canadian Science Centre for Human and Animal Health, Winnipeg, Canada

The Canadian Science Centre for Human and Animal Health in Winnipeg is one of the few institutes worldwide that has effectively sought to integrate animal and human health to promote efficiency and effectiveness. It is the first organization in the world to house, in one facility, the laboratories for human (Public Health Agency of Canada's National Microbiology Laboratory) and animal (Canadian Food Inspection Agency's National Center for Foreign Animal Disease) disease research at the highest level of bio-containment.

Construction of the facility began in 1992 and it was officially opened in 1999. The design of the facility (separate blocks within the one facility) provides the necessary separation between the animal and human health sectors for high-level bio-containment work. Containment Level 3 and 4 areas contain air-tight rooms with interlocking and air-tight bio-seal doors with damper systems, and the facility features state-of-the-art security as well as air filtration and waste sterilization and disposal systems.

Whilst some level of separation is required, the design of the facility (common areas joining the two blocks) provides a unique environment that promotes collaboration among researchers in the human and animal health sectors. Finally and most important, the facility provides significant cost savings to both sectors.

After 11 years of operation, the main conclusions that Canadian Science Centre for Human and Animal Health has drawn around One Health are that:

- The One Health concept can be implemented successfully, although the level to which services can be shared will depend on the country and its resources. For example, establishing a Level 3 and 4 containment laboratory like that in Canada will be restricted to very few locations worldwide. However, lower-level containment laboratories and sharing of common services (outlined next) can be implemented in most locations worldwide;
- The greatest efficiency gains (i.e., savings) can be made through:
  - Greater collaboration between the animal and human health sectors for surveillance activities (facilities, field staff, and communication);
  - Establishing one facility for animal and human health diagnostics. Significant savings are made through sharing the costs of common services. These include sample reception/dispatch, library, information technology, emergency response, operation and maintenance of the facility (wash-up, cleaning, air filtration, disposal of bio-waste, hydro power and generators), common area staff, safety, training, quality assurance, communication, media, and so forth. More specifically, the operational (recurrent) costs of two separate diagnostic facilities (one for the animal health sector and one for the human health sector) would amount to US$19.55 million per year (i.e., US$12.3 million for the human health facility and US$7.25 for animal health facility);
  - The operational costs of a joint facility amount to US$14.5 million per year, a saving of about US$5 million, or 26 percent (with about 6 percent coming from the human health services and 20 percent from the veterinary services). These data do not include costs and their respective savings on investments, nor on surveillance, control, communication, and other joint activities; and
  - Further efficiency gains can be made through sharing one electronic software system across animal and human health sectors and across national, provincial, and local levels. This improves communication flow and knowledge sharing.

Source: Authors' assumptions, endorsed by expert panel as "reasonable first estimates."

Chapter 8: EFFECTIVENESS GAINS FROM ONE HEALTH

No rigorous scientific, testable information is available on increased effectiveness (i.e., faster identification of emerging diseases, which results in reduced disease spread and lower control costs of an eventual emerging disease outbreak) from the introduction of One Health. To produce such empirical information would require a with/without comparison under similar ecological conditions, which would be almost impossible to establish. Even a before/after comparison would be affected by the complex epidemiology of any emerging disease, as, at any moment in time, its evolution is the result of an unique set of ecological and social conditions.

However, in principle, the cost of control grows progressively (although with the rate of increase depending on the specific disease) as time between the outbreak and its detection and control increases. This is demonstrated in figure 8.1.

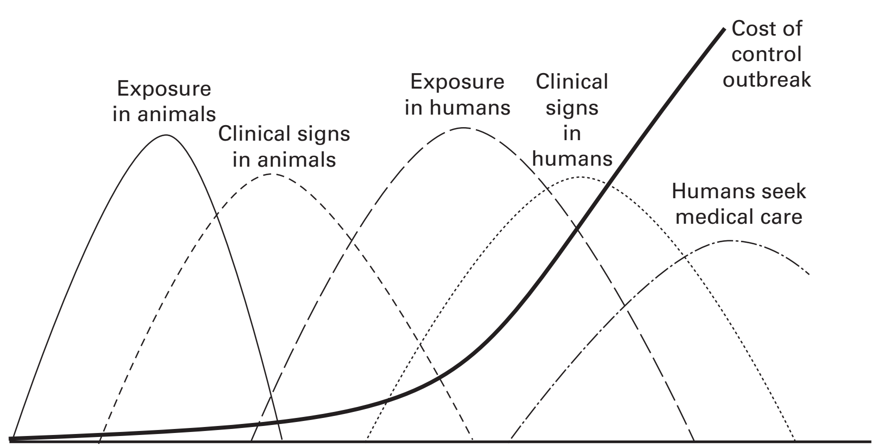
The description of the benefits will therefore have to be mostly qualitative. They can be differentiated in two categories. First, in table 8.1, positive experiences—that is, where a closer integration of human, animal, and wildlife health services led to a more accurate or faster diagnosis—are summarized. Second, table 8.2 describes a number of situations where lack of communication and interaction between human, animal, and wildlife services led to a delay in the accurate identification of the source of the disease outbreak, and possibly an increase in control costs. There are several cases, for example in West Nile Fever in the USA, Q fever in the Netherlands, and Nipah Virus in Malaysia, where this relationship is demonstrated. In all of these cases, closer communication between human and animal health services would have led to a faster and/or more accurate diagnosis.

Table 8.1 covers a variety of situations, from where *"control at source"* (Mongolia, brucellosis; India rabies) led to more efficient and effective control of human health risk, to where close cooperation led to a *better diagnosis* (Mauritania, Rift Valley Fever), to where the collaboration of services led to *more efficient and effective control* (Chad, various diseases; Kyrgyzstan, brucellosis) or *better epidemiological tools* (Tanzania, tuberculosis and brucellosis; Kenya and Madagascar, Rift Valley Fever).

Table 8.2 covers three reported case studies where a lack of interaction seemingly caused a delay in either the diagnosis or effective control of the disease, acknowledging that the qualification of the time lapse between emergence and identification of the disease and its control, as being late or timely, can be argued as being arbitrary.

The most important effects of improved *One Health* systems will often be seen in the faster and more accurate identification of health risks. Among the most significant indirect effects will be market access, food security, poverty reduction—especially given that many zoonotic diseases are, quite appropriately, called the "diseases of the poor"—reduced loss of biodiversity, and increased income from tourism.

FIGURE 8.1: Illustrative Relationship between Time of Detection of Emerging Zoonotic Disease and Total Cost of Outbreak



Source: Adapted from IOM (2009).

TABLE 8.1: Summary of the Benefits of Closer Coordination and/or Integration of Health Services between Sectors, from Published Case Studies

COUNTRY	DISEASE	ACTION	QUANTIFIABLE RESULT	NONQUANTIFIABLE RESULT	REFERENCE
Chad	Anthrax, pasteurellosis, blackleg, and CBPP in livestock; diphtheria, pertussis tetanus (DPT) and polio in children	Joint vaccination campaigns	Costs of joint campaign reduced by 15% compared with separate campaigns, cost per vaccinated child reduced from €30.3 to €11.9	Increased vaccination coverage in both humans and livestock; Increased awareness of pastoralists of public health services	E. Schelling et al., *Emerging Infectious Diseases,* 13(3), March 2007, http://www.cdc.gov/eid
India (Jaipur)	Rabies	Vaccination and sterilization campaign for dogs	Human cases declined to zero, vs. increase in other states; stray dog population declined 28%		J. F. Reece and S. K. Chawla, *The Veterinary Record,* 159, 2006, p. 379
Kenya	Rift Valley Fever	Multidisciplinary group with human, veterinary, and wildlife institutions formed Arbovirus Incidence and Diversity group		Risk-based contingency planning tool developed; emergency fund and communication channels established	
Kyrgyzstan	Brucellosis	On-farm visits detecting brucellosis in humans and animals	Reduced surveillance costs	Other zoonotic or livestock diseases assessed at the same time (e.g., echinococcosis)	J. Zinsstag et al., *Veterinaria Italiana,* 45(1), 2009, pp. 121–133
Madagascar	Rift Valley Fever	Integrated approach between Ministries of Agriculture and Health		Improved prediction and mapping of outbreaks; reduced number of human cases	
Mauritania	Rift Valley Fever	Cooperation of human and veterinary diagnostic services		Shift from erroneous diagnosis of Yellow Fever to correct one of Rift Valley Fever	J. Zinsstag and M. Tanner, *Ethiop. J. Health Dev.* (Special Issue), 2008, p. 22
Mongolia	Brucellosis	Mass vaccination of livestock	49,207 DALYs averted at an inversion of US$8.3 million, with US$26.6 million in economic benefits	A cross-sector cost-benefit and cost-effectiveness analysis of brucellosis control in Mongolia shows that whereas a 10-year mass vaccination of livestock is not profitable, if all the benefits, including private health cost, loss of income, and increase in agricultural production are included, the societal benefit-cost ratio is 3.1; if cost of intervention is shared proportionally to benefits, the public health sector would contribute 11% of the intervention cost, which would result in a cost-effectiveness of 19 USD/DALY averted	J. Zinsstag et al., *View Point,* 366, December 2005, http://www.thelancet.com
Spain	Echinococcis	Improved control of stray dogs, echinococcidal treatments of working sheep dogs, providing means for safe disposal of slaughtered sheep offal and safe disposal of dead sheep in sanitary pits	75% reduction in prevalence in sheep; the rate of diagnoses of new cases in humans dropped by 79%, from 19 to 4 per 100,000 population; cost-benefit of 1.96		Jimenez et al., 2002
Southern Sudan	DPT plus polio and rinderpest in cattle	Joint use of cold chain facilities		Increased coverage of children	Ward et al., 1993
Sub-Saharan Africa	HPAI	Joint planning and implementation of Avian Flu campaigns		Improved preparedness and control capacity	
Tanzania	Tuberculosis and brucellosis	Multidisciplinary team focused on medical, ecological, socio-economic, and policy issues driving the system		Improved understanding of epidemiology and spatial distribution of diseases and pastoral perception of disease led to better control	http://www.haliproject.wordpress.com/

(Continued)

TABLE 8.1: Continued

COUNTRY	DISEASE	ACTION	QUANTIFIABLE RESULT	NONQUANTIFIABLE RESULT	REFERENCE
Africa	Rabies	Rabies control by human postexposure treatment	Costs 50 USD per DALY averted; but an effective dog mass-vaccination campaign, capable of interrupting transmission, becomes cost-effective after 6 years, reaching 32 USD per DALY(2).	This examples show the power and added value of One Health by taking a cross-sector perspective, which shows economic results that could not be achieved by a single-sector perspective alone	J. Zinsstag et al., PNAS 106, 2009, pp. 14996–15001.
	General	Culling activities are sometimes performed by trained human health professionals in times of a disease outbreak		Reduced culling costs through utilizing trained human health professionals	Panel experts

TABLE 8.2: Examples of Disease Outbreaks Where Poor Coordination and Integration Were Shown between Sectors and the Impact This Had on the Human and Animal Sectors

COUNTRY	DISEASE	KEY DELAYED ACTION	RESULT	REFERENCE
Malaysia	Nipah	Lack of interaction between human, veterinary, and wildlife services caused delay in understanding role of fruit tree habitat for bat-to-swine transmission	More than 100 people died and over 1 million pigs culled	http://rsif.royalsocietypublishing.org/content/early/2011/06/01/rsif.2011.0223.full?sid=00c0299e-6937-4c10-81c2-d3630a47a8a8
Netherlands	Q Fever	Lack of interaction between veterinary and human health services	Likely increased disease spread (more than 2,000 human cases) and over 40,000 goats culled	M. Enserink, "Questions Abound in Q-Fever Explosion in the Netherland," *Science*, 327(5963), January 2010, pp. 266–267
USA	West Nile Fever	Delayed interaction linking human cases with dead birds, and refusal of CDC to check birds, because of its mandate restrictions	Delayed and initial erroneous control program of intermediate host	http://www.gao.gov/products/HEHS-00-180 and http://sciencebulletins.amnh.org/biobulletin/biobulletin/story1378.html

Chapter 9: CONCLUSIONS AND RECOMMENDATIONS

Emphasizing the multiple caveats regarding the limitations and gaps of the data sources described in the "Data limitations and gaps" section, and the resulting tentative and approximate character of the result, the analysis of several different sources of budget information on animal and human health service needs demonstrates the following:

- Roughly equal allocation of funds among animal and human health sectors (45 percent to animal health, 41 percent to human health, and 14 percent to joint planning and communication);
- An allocation of funds between investment and recurrent costs of approximately between 40 and 50 percent and 50 and 60 percent, respectively (with a minimum/maximum of 20/80 percent, respectively); and
- An allocation in the animal health sector of 50 to 70 percent for prevention and 30 to 50 percent for control activities. For the human health sector, this is approximately 70 percent for control and 30 percent for prevention activities.

These findings point to balanced investments and a complimentary role between the sectors, with the priority for "prevention at the source" at the animal side, and a more control-focused approach at the human side.

Middle-income countries show higher calculated incremental funding needs for prevention and control of zoonotic diseases than low-income countries. This is because their economies are to a greater extent driven by larger agricultural industries and export interests that require and must comply with stricter and therefore more costly sanitary standards. However, economies of scale can bring this cost down significantly. Low-income countries show lower requirements, mostly aimed at strengthening control systems.

The most costly activities in both the animal and human health sectors for the prevention of zoonotic diseases are surveillance, followed by diagnostics, and then bio-security. They are also the activities where cooperation is easiest. On the control side, the most costly activities are vaccination and hygiene programs followed by investigation and rapid response in the human health sector, and compensation and culling in the animal health sector.

The data base on costs in the human, animal, and wildlife health services is weak. Countries should be encouraged to record and collect data, with costs split by task (prevention versus control), function (surveillance, etc.), object of expenditure (investment versus recurrent costs), and disease category (zoonoses versus non-zoonotic disease). With the control of emerging pandemics, and with One Health generally considered a global public good, the existing constraints in capacity and the perverse incentives that have been described in this document should be more purposefully addressed. The existing gap in essential data also needs to receive greater attention in public expenditure reviews.

The total calculated incremental funding needs to bring the zoonotic disease prevention and control system up to OIE and WHO standards in World Bank client countries ranges from US$1.9 billion per year (under modest assumptions of the importance of zoonotic diseases) to US$3.4 billion (under higher-disease-prevalence assumptions). This calculation is based on the extrapolation of data from the 60 low-income and 79 middle-income countries treated in this report, applying a number of preliminary assumptions that were explained in the results section. Given the advanced state of these prevention and control services in high-income countries, the calculation made for the 139 low- and middle-income countries is a close approximation to the total global funding requirement.

For the low-prevalence case, this is higher than the US$1.3 billion per year recommended for the same 139 developing countries in *Contributing One World, One Health: Strategic Framework* because the study that led to that *Framework* document included only the surveillance and early response costs and omitted control and eradication measures for diseases other than HPAI. However, the cost range of $1.9 to $3.4 billion is much less than the annual average US$6.7 billion of economic losses from major outbreaks that have been incurred historically. And it is vitally important to note that this historic annual figure of US$6.7 billion does not include the severe impacts that zoonotic diseases have inflicted on rates of poverty reduction and food security. The calculation moreover reveals a highly positive expected rate of return varying from 14 to 123 percent annually, depending on the assumptions regarding the reduction of the disease risk, the severity of the outbreak, and the prevalence of the disease.

Based on conservative assumptions that were considered reasonable "first estimates" by the expert panel, efficiency gains between US$184 million and US$506 million per year, or 10–16 percent, could be engendered if cooperation between the sectors through One Health is established.

A mounting although still limited body of evidence from case studies suggests that significant effectiveness gains can also be achieved through One Health. Some noteworthy examples of these efficiency gains include: (a) control at source (i.e., in the animal ecosystem) is often more cost-effective than combating the disease in humans later (rabies, tuberculosis, brucellosis); (b) cooperation in surveillance and diagnostics often leads to faster and more accurate diagnosis (Rift Valley Fever, West Nile Virus); (c) cooperation in prevention measures, such as vaccination, often leads to increased coverage (DPT, CBPP); (d) detailed and immediate communication reduces the number of human cases (Q Fever, West Nile Virus).

This study of the economics of One Health is the first of its kind. Despite the limitations of the available data, the preliminary results this study arrived at underscore the importance of One Health and the potential benefits and savings promoted through better collaboration among human, animal, and wildlife health services. The most important outcome of these preliminary results is to provide a basis for further discussion, with a clearer understanding of existing gaps and issues that need to be resolved.

Current budgets for wildlife health surveillance and control are extremely low, in spite of wildlife being the principle source of zoonotic diseases rather than livestock (the second most important source). Wildlife is not only a source of risk, however. Wildlife itself is at significant risk of zoonotic diseases. Ecotourism involving wildlife provides a significant source of revenue in many developing countries. Interaction between the wildlife health sector and other departments is also minimal. Resources and cross-sectoral interactions need to be drastically strengthened if One Health is to make a meaningful contribution to efficiency and effectiveness gains in the early detection and control of zoonotic diseases.

For the future, the following recommendations emerge from the analysis:

- Countries should be encouraged to record and provide public access to information about their public expenditures on health services, preferably detailed by task (within prevention and control) across human and animal health sectors and for joint planning and communications, and by investment and recurrent costs. Data availability is heavily constrained by capacity constraints and by perverse incentives, often in the form of trade and other economic interests opposing requirements to provide full disclosure regarding the prevalence of certain diseases or limitations in the capacity of some institutions. These influences militate against greater transparency. They tend to lose traction, however, when broad consensus emerges recognizing the control of zoonotic diseases as a public good. This consensus can generate substantial leverage for control—both through positive measures that can, for instance, lead to access to international funding, and through more negatively defined measures such as regulation. This is also an area for future work in the public expenditure reviews, which up to now have neglected detailed expenditure reviews on health services.
- With efficiency and effectiveness gains (qualitatively, and to some extent quantitatively, proven), discussion of One Health needs to move from the conceptual stage to implementation. This will include the implementation of the sustainable funding mechanisms that were detailed in Volume 1 of this report.

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WEBSITES

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Food and Agriculture Organization of the United Nations (FOASTAT): www.faostat.com

OIE World Animal Health Information Database Interface (WAHID): www.oie.int/wahis/public.php?page=home

World Health Organization (WHO): www.who.int

WHO Global Burden of Disease: http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/index.html

World Organization for Animal Health (OIE): www.oie.int

Annex 1: GLOSSARY OF TERMS

Active Surveillance: Purposeful and comprehensive searching for evidence of disease in animal populations (FAO, http://www.fao.org/DOCREP/004/X2096E/X2096E05.htm).

Animal disease prevention: In the context of the study, this term is understood as precautionary measures, such as surveillance, bio-security, and border controls, aimed at minimizing the risks of outbreaks of epidemic diseases. This includes prevention of trans-boundary animal diseases (TADs), but is not limited to them (Horst et al. 1999; Otte, Nugent, and McLeod 2004). This report focuses on one group of trans-boundary diseases, the zoonotic diseases.

Average on aggregate data: Average based on the total population of the sample of countries included in the analysis.

Average on country data: Average based on the average of each country in the sample.

Benefits of improved prevention and control systems include:

- Enhanced food security and poverty alleviation (from improved production systems);
- Improved market access; and
- Savings in potential outbreak costs (OIE 2007a).

Bio-security: Bio-security is a strategic and integrated approach that encompasses the policy and regulatory frameworks (including instruments and activities) that analyze and manage risks in the sectors of food safety, animal life and health, and plant life and health, including associated environmental risk. Bio-security covers the introduction of plant pests, animal pests and diseases, and zoonoses; the introduction and release of genetically modified organisms (GMOs) and their products; and the introduction and management of invasive alien species and genotypes. Bio-security is a holistic concept of direct relevance to the sustainability of agriculture, food safety, and the protection of the environment, including biodiversity (FAO 2003).

Border inspection: Veterinary border control to ensure that the live animals and products of animal origin entering a country are safe and meet the specific import conditions laid down by that country in legislation.

Compensation: Money provided as payment for loss of income from livestock because of a contagious disease outbreak. The specific losses of costs (direct, indirect) included depend on country policies.

Control: Disease control by way of investigation, quarantine, vaccination, hygiene programs, culling of infected livestock, and compensation for loss of livestock.

Costs of animal diseases include:

- Direct costs and losses: from the culling and disposal of animals, control costs, and consequential farm losses (i.e., fall in breeding stock, restricted movements, loss of value of animals etc.);
- Indirect costs: domestic market and export losses, spillover to tourism and wider society (i.e., food availability, environment, economic losses from higher human mortality) and ripple effects on upstream and downstream industries (i.e., breeders, feed supply, processors, retailers, consumers) (OIE 2007a).

Culling or stamping-out: Carrying out under the authority of the veterinary authority, on confirmation of a disease, the killing of the animals that are affected and those suspected of being affected in the herd and, where appropriate, those in other herds that have been exposed to infection by direct animal-to-animal contact, or by indirect contact of a kind likely to cause the transmission of the causal pathogen (OIE 2008a).

Disinfection: The application, after thorough cleansing, of procedures intended to destroy the infectious or parasitic agents of animal diseases, including zoonoses; this applies to premises, vehicles, and different objects that may have been directly or indirectly contaminated (OIE 2008a).

Early detection system: A system for the timely detection and identification of an incursion or emergence of diseases/infections in a country, zone, or compartment. An early detection system should be under the control of the veterinary services and should include the following characteristics: (a) representative coverage of target animal populations by field services; (b) ability to undertake effective disease investigation and reporting; (c) access to laboratories capable of diagnosing and differentiating relevant diseases; (d) a training program for veterinarians, veterinary paraprofessionals, livestock owners/keepers, and others involved in handling animals for detecting and reporting unusual animal health incidents; (e) the legal obligation of private veterinarians to report to the veterinary authority; and (f) a national chain command (OIE 2011b).

Effectiveness gains: In this report, faster, more accurate diagnosis and control of a specific disease measurable, for example, in the number of days between the emergence of a zoonotic pathogen and the days it is formally reported and/or a full campaign is under way.

Efficiency gains: In this report, providing an increased surveillance effort with the same resources, or the same level of surveillance with less resources. This can be measured by the number of staff involved in surveillance per thousand humans or livestock.

Emerging disease: A new infection resulting from the evolution or change of an existing pathogenic agent, a known infection spreading to a new geographic area or population, or a previously unrecognized pathogenic agent or disease diagnosed for the first time and that has a significant impact on animal or public health (OIE 2011).

Endemic: A disease that is constantly present to a greater or lesser degree in people of a certain class or in people living in a particular location.

Epidemic: When new cases of a disease, in a given human population, and during a given period, substantially exceed what is expected based on recent experience. The disease is not required to be communicable.

Epidemiological surveillance: The investigation of a given population or subpopulation to detect the presence of a pathogenic agent or disease; the frequency and type of surveillance will be determined by the epidemiology of the pathogenic agent or disease, and the desired outputs (OIE 2008a).

Eradication: The elimination of a pathogenic agent from a country or zone (OIE 2008a).

Investment costs or capital expenditure: Incurred when money is spent to buy fixed assets (e.g., land, buildings, and equipment) that are typically used over a long period of time, that is, over three years (OIE 2009). See also the "Data limitations and gaps" section.

Laboratory: A properly equipped institution staffed by technically competent personnel under the control of a specialist in veterinary diagnostic methods who is responsible for the validity of the results. The veterinary authority approves and monitors such laboratories with regard to the diagnostic tests required for international trade (OIE 2011).

Livestock Unit (LSU): As defined in the World Bank Tafs Atlas on Animal Diseases: 1 camel or "other camelid" 1.1 LSU; 1 cattle 0.9 LSU; 1 buffalo 0.9 LSU, 1 horse or mule (equidae) 0.8 LSU, 1 pig 0.25 LSU, 1 sheep 0.1 LSU, 1 goat 0.1 LSU, 1 poultry bird 0.015 LSU.

Monitoring: The intermittent performance and analysis of routine measurements and observations, aimed at detecting changes in the environment or health status of a population (OIE 2011).

National prevention system (NPS): Sum of all services and activities of the public veterinary services and other relevant public providers at national and subnational levels allowing early detection and rapid response to emerging and re-emerging animal diseases, including the services of accredited private veterinarians undertaking public service missions financed from the public budget (OIE 2009).

Notifiable disease: A disease listed by the veterinary authority, and that, as soon as detected or suspected, should be brought to the attention of this authority, in accordance with national regulations (OIE 2011).

OIE Standards: As defined in the OIE tool: performance of veterinary services.

One Health: The collaborative efforts of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, and our environment (AVMA 2008), *or* diverse collaborations of inter-professional and international health care professionals working at multiple levels of government and in private practice that can improve human, environmental, and animal health (Hodgson 2010).

Other diseases: The non-zoonotic diseases, mostly the so-called diseases of trade (FMD, CBPP, etc.).

Outbreak of disease or infection: The occurrence of one or more cases of an epidemiological unit (OIE 2011).

Passive surveillance: Routine gathering of information on disease incidents from sources such as requests for assistance from farmers, reports from field veterinary officers and livestock officers, submission of diagnostic specimens to laboratories, and the results of laboratory investigations. Routine disease reports may also come from other sources, such as abattoirs and livestock markets (FAO, http://www.fao.org/DOCREP/004/X2096E/X2096E05.htm).

Pandemic: An epidemic of infectious disease that is spreading through human populations across a large region—for instance, a continent, or even worldwide.

Pathogen: Any disease-producing agent (especially a virus, bacterium, or other microorganism).

Preparedness: The state of having been made ready or prepared for use or action (in this case having disease prevention and control strategies in place).

Recurrent costs or operating expenditures: Relate to day-to-day spending, that is, spending on recurring items. This includes, for example, spending on consumables and everyday items that get used up as the good or service is provided (OIE 2009). See also "Data limitations and gaps" section.

Trans-boundary animal diseases (TADs): "Those [diseases] that are of significant economic, trade and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management requires cooperation between several countries" (Otte et al. 2004). This report focuses on trans-boundary zoonotic diseases

Vaccination: The successful immunization of susceptible animals through the administration, according to the manufacturer's instructions and the *Terrestrial Manual*, where relevant, of a vaccine comprising antigens appropriate to the disease to be controlled (OIE 2011).

Veterinarian: A person registered or licensed by the relevant veterinary statutory body of a country to practice veterinary medicine/science in that country (OIE 2011b).

Veterinary Livestock Units: As defined by OIE: equivalence unit for the estimate of annual veterinary cost and care. Conversion coefficients for calculating VLU: cattle and buffalo = 1 VLU; sheep and goats = 0.1 VLU; pigs = 0.2 VLU; poultry, ducks, geese, guinea fowl, and turkeys = 0.01 VLU; horses, donkeys, mules, camels, and other camelids = 0.5 VLU (OIE 2011b).

Veterinary paraprofessional: A person who, for the purposes of the OIE Terrestrial Code, is authorized by the veterinary statutory body to carry out certain designated tasks (dependent upon the category of veterinary paraprofessional) in a territory, and delegated to them under the responsibility and direction of a veterinarian. The tasks for each category of veterinary paraprofessional should be defined by the veterinary statutory body depending on qualifications and training, and according to need. (OIE 2011b)

Veterinary services: The governmental and nongovernmental organizations that implement animal health and welfare measures and other standards and recommendations in the Terrestrial Code and the OIE Aquatic Animal Health Code in the territory. The veterinary services are under the overall control and direction of the veterinary authority. Private-sector organizations, veterinarians, veterinary paraprofessionals, or aquatic animal health professionals are normally accredited or approved by the veterinary authority to deliver the delegated functions (OIE 2011b).

WHO standards: As defined in the international health regulations by WHO.

Zoonosis: Any disease or infection that is naturally transmissible between animals and humans (IOM 2009).

Annex 2: ADDITIONAL TABLES

TABLE A.1: Detailed Economic Losses from Potential Emerging Zoonotics

PERIOD	DISEASE (COUNTRY)	ESTIMATE (US$)
1986–2009	Bovine Spongiform Encephalopathy (UK)	15,500,000,000
1997–2009	BSE (UK)	6,100,000,000
1994	Plague (India)	2,000,000,000
September 1998–April 1999	Nipah Virus (Malaysia)	671,000,000
January 1999–December 2008	West Nile Fever (USA)	400,000,000
November 2002–July 2003	Severe Acute Respiratory Syndrome (Canada, China, rest of the world)	41,500,000,000
January 2004–January 2009	Highly Pathogenic Avian Influenza (Asia)	20,000,000,000
2003–2007	Bovine Spongiform Encephalopathy (USA)	11,000,000,000
October 2005–January 2009	Highly Pathogenic Avian Influenza (Europe)	500,000,000
November 2005–January 2009	Highly Pathogenic Avian Influenza (Africa)	
November 2006–May 2007	Rift Valley Fever (Tanzania, Kenya, Somalia)	30,000,000
Total 1986–2009[1] Total Period 1997–2009		97,701,000,000 80,210,000,000

1 Incomplete for this period.

Source: Authors' assessment from various World Bank and other documents.

Annex 3: DESCRIPTIVE SUMMARY OF MAIN ACTIVITIES IN 14 GAP ANALYSIS STUDIES RELATED TO ONE HEALTH

TABLE A.2: Descriptive Summary of Main Activities in 14 GAP Analysis Studies Related to One Health

COUNTRY	PILLAR 2	PILLAR 3	PILLAR 4
Armenia	Active epidemiological surveillance for brucellosis, tuberculosis, and leucosis.	Infrastructure for slaughtering	Upgrading diagnostics central lab
Belize	A national herd test for bovine TB and brucellosis, followed by active surveillance for these diseases and for BSE across the cattle population; passive surveillance will continue for rabies	Strengthening the meat, fish, and dairy inspection services; residue testing of meat and improved control of zoonotic diseases	Lab support for surveillance of TB and brucellosis, US$433,000
Cambodia	Assess current disease/infection situation for zoonoses; rabies control program	Enhance food safety through registration and record keeping of throughput in abattoirs, monitoring, reducing residues and hormones; rabies control program.	Lab support for surveillance of HPAI and other zoonoses, US$700,000
Cameroon	Passive surveillance for echinococcosis, TB, and cysticercose; future active surveillance on TB and brucellosis, eventually followed up with control campaigns; establishment of a rapid alert system and a compensation fund for HPAI control	Meat, milk, and residue inspection in cooperation with the Ministry of Health, also joint control for rabies; awareness raising at producer level for hygiene of food of animal origin	An expected 25,000 food samples expected, but outside competence of veterinary service
Guinea	Passive surveillance for echinococcosis, TB, and cysticercose; active surveillance HPAI and Rift Valley Fever; establishment of a rapid alert system fund for HPAI, joint programs on rabies; all delegated to private veterinarians	Control of zoonoses (echinococcosis TB, cysticercose) in collaboration with the Ministry of Health; slaughterhouse improvement	Support for diagnostics on zoonoses (Rift Valley Fever, rabies, HPAI, blackleg)
Guinea Bissau	Active surveillance on brucellosis	Meat inspection and slaughterhouse improvement	Construction/rehabilitation and quality control system of national veterinary lab, for an expected 500 samples (brucellosis) eventually to be sent outside the country
Mali	Training and implementation of epidemiological surveys in particular in dairy cattle for TB and brucellosis, and for *Salmonella* in poultry; establishment of risk analysis capacity; follow-up control (vaccinations) to be charged to the farmers	Public awareness on, in particular, milk and meat hygiene; meat, milk and residue inspection	No specific zoonotic-related activities mentioned
Mauritania	No specific zoonotic-related activities mentioned	No specific zoonotic-related activities mentioned	No specific zoonotic-related activities mentioned
Mongolia	No specific zoonotic-related activities mentioned	No specific zoonotic-related activities mentioned	No specific zoonotic-related activities mentioned
Mozambique	Rift Valley Fever: Emergency plan and a program including epidemiological surveillance; HPAI: active surveillance plan targeting migratory bird sites and nearby chicken farms and establishment of compensatory measures for economic losses experienced by small farmers (peasants); bovine brucellosis: control and reduce the disease prevalence to levels; rabies: to prepare a joint public health program considering annual vaccination covering approximately 80% of canine population	Control of zoonoses (rabies, tuberculosis, brucellosis, cysticercosis), sanitary inspection at slaughtering level, and sanitary control at manufacturing and distribution level for meat and milk products, feed	No specific zoonotic-related activities mentioned
Myanmar	Control of brucellosis, TB, rabies, ND, IBD, IB, CSF, Marek, leptospirosis, babesiosis as “Group 2” priority diseases	Monitoring and control of rabies and Japanese encephalitis (JE); residues and meat inspection improvement	No specific zoonotic-related activities mentioned
Nigeria	Active surveillance on brucellosis, tuberculosis	Meat, milk, and residue inspection	No specific zoonotic-related activities mentioned
Senegal	Control of rabies, active surveillance of Rift Valley Fever and HPAI; active surveillance for brucellosis in dairy recommended	Improve meat inspection; start traceability system	Improve quality control of foods of animal origin
Vietnam	HPAI and rabies control	Meat, milk, and residue inspection	No specific zoonotic-related activities mentioned

Annex 4: WILDLIFE SERVICES SURVEY

TOWARD AN ASSESSMENT OF THE COSTS AND BENEFITS OF CONTROL OF ZOONOTIC DISEASES—A SHORT QUESTIONNAIRE ON WILDLIFE DISEASES

General Information

Name of country or state:

Currency:

Year:

Importance of wildlife in the national economy (income from wildlife tourism):

Protected wildlife area (km^2):

Main wildlife health risks:

Budget

Please list the four main items included respectively in investments and operating costs.

TABLE A.3: Main Annual Budgetary Items

ITEM	INVESTMENT COSTS[2]	OPERATING COSTS[3]	COMMENTS
Total wildlife department budget			
Budget within wildlife health services department for:			
Disease surveillance			If figures are not available, estimates of the percentage of the total budget would be useful
Disease diagnostics			Same
Disease control			Same
Other aspects of ecosystems health (pollution, etc.)			Same, but please specify which specific aspects
Total staffing			Please provide a breakdown by category
Budget for wildlife health services within other departments			Please specify which (i.e., animal health, human health)
Total staffing			Please provide a breakdown by category (professional, paraprofessional, veterinarian, biologist, etc.)

2 Investment costs: Items with a useful life of three years or more, such as buildings, cars, laboratory equipment.
3 Operating costs: Items with a shorter useful life, such as salaries and allowances, fuel, laboratory consumables, etc.

Interaction with the Other One Health Partners

Coordinating and cooperating mechanisms with public human and animal health services:

- Please describe institutional framework (contact on personal basis, memorandum of agreement, joint teams, etc.)
- Please describe joint activities with human and animal health services (joint surveillance, diagnostics, etc.)
- Please describe any evidence where working with the human and animal health services increased the effectiveness of disease identification and control, or where the absence of such collaboration delayed an early identification of an emerging disease.
- Please provide references for publications relating to using the One Health approach from your organization or country, or any others that you may know from elsewhere.

Annex 5: LIST OF COUNTRIES DIFFERENTIATED BY INCOME LEVEL

TABLE A.4: 49 Low-Income Countries (US$1005 and less) According to the World Bank Criteria

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	

Source: FAO, OIE, World Health Organization, UN System Influenza Coordination, UNICEF, and the World Bank. (2008). *Contributing One World, One Health: A strategic framework for reducing risks of infectious diseases at the animal–human–ecosystem interface. World Bank, Washington D.C.*

TABLE A.5: 139 Eligible Countries (60 low- and 79 middle-income countries)

LOW-INCOME COUNTRIES (60)	MIDDLE-INCOME COUNTRIES (79)
Afghanistan	Argentina
Angola	Botswana
Bangladesh	Brazil
Benin	Cape Verde
Burkina Faso	Chile
Burundi	China
Cameroon	Costa Rica
Central African Republic	Croatia
Chad	Djibouti
Congo, Democratic Republic	Ecuador
Côte d'Ivoire (Ivory Coast)	Egypt, Arab Republic
Eritrea	Gabon
Ethiopia	Guatemala
Gambia	Indonesia
Ghana	Iran
Guinea Republic	Iraq

LOW-INCOME COUNTRIES (60)	MIDDLE-INCOME COUNTRIES (79)
Guinea-Bissau	Mauritius
Haiti	Mexico
India	Morocco
Kenya	Namibia
Kyrgyz Republic	Peru
Lao PDR	Russian Federation
Lesotho (Kingdom of)	South Africa
Liberia	Swaziland
Madagascar	Turkey
Malawi	Uruguay
Mauritania	Albania
Mongolia	Algeria
Mozambique	Antigua and Barbuda
Nepal	Armenia
Nicaragua	Azerbaijan
Niger	Belarus
Nigeria	Belize
Rwanda	Bolivia, Plurinational State of
Senegal	Bosnia and Herzegovina
Sierra Leone	Colombia
Sudan	Dominica
Tanzania	Dominican Republic
Togo	El Salvador
Uganda 1	Fiji
Vietnam 1	Georgia
Zambia	Grenada
Zimbabwe	Guyana
Bhutan	Honduras
Cambodia	Jamaica
Comoros	Jordan
Congo (Republic)	Kazakhstan
Equatorial Guinea	Kiribati
Mali	Korea, Republic of
Moldova	Kosovo
Myanmar	Lebanon
Pakistan	Libyan Arab Jamahiriya
Papua New Guinea	Macedonia, the former Yugoslav Republic of
Sao Tome and Principe	Malaysia
Solomon Islands	Maldives
Somalia	Marshall Islands
Tajikistan	Micronesia, Federated States of

LOW-INCOME COUNTRIES (60)	MIDDLE-INCOME COUNTRIES (79)
Timor-Leste	Montenegro
Uzbekistan	Palau
Yemen Republic	Panama
—	Paraguay
—	Philippines
—	Saint Kitts and Nevis
—	Saint Lucia
—	Saint Vincent and the Grenadines
—	Samoa
—	Serbia
—	Seychelles
—	Sri Lanka
—	Suriname
—	Syrian Arab Republic
—	Thailand
—	Tonga
—	Trinidad and Tobago
—	Tunisia
—	Turkmenistan
—	Ukraine
—	Vanuatu
—	Venezuela, Bolivarian Republic of

Source: World Bank, http://data.worldbank.org/about/country-classifications/country-and-lending-groups.

Annex 6: POTENTIAL SAVINGS FROM THE INTRODUCTION OF ONE HEALTH UNDER TWO SCENARIOS

TABLE A.6: Potential Savings from the Introduction of One Health Under Two Scenarios

SAVINGS IN LOW-PREVALENCE SCENARIO (US$/YR)								
TOTAL SPENT ($ PER VLU)				**1.09**	**1.00**	**1.09**	**1.00**	
TASK	**INVESTMENT/ RECURRENT COST**	**SAVINGS %**	**SPECIFIC AREAS OF SAVINGS**	**SAVINGS (US$ 000s/YR) IN THE ANIMAL HEALTH SECTOR**		**SAVINGS (US$ 000s/YR) IN THE HUMAN HEALTH SECTOR**		**SAVINGS (US$ 000s/YR)**
				Low income	**Middle income**	**Low income**	**Middle income**	**Total**
Surveillance	Investment	10%	Joint transport and communication systems	$9,412.03	$10,069.89	$3,858.93	$4,128.65	$27,469.51
Surveillance	Recurrent	20%	Shared front-line staff	$11,294.44	$12,083.87	$9,432.95	$10,092.27	$42,903.52
Bio-security	Investment	5%	Shared border control and market inspection	$705.90	$755.24	$0.00	$0.00	$1,461.14
Bio-security	Recurrent	10%	Shared border control and market inspection	$1,882.41	$2,013.98	$0.00	$0.00	$3,896.38
Diagnostics	Investment	5%	Joint facilities and equipment	$2,117.71	$2,265.73	$1,500.70	$1,605.59	$7,489.72
Diagnostics	Recurrent	15%	Shared support staff	$4,235.41	$4,531.45	$4,502.09	$4,816.76	$18,085.72
Control (vaccinations, hygiene, and rapid response)	Investment	5%	Shared quarantine of infected areas	$4,235.41	$4,973.98	$8,789.79	$9,404.16	$27,403.35
Control (vaccinations, hygiene, and rapid response)	Recurrent	10%	Shared hygiene and awareness programs	$8,470.83	$9,947.96	$17,579.58	$18,808.32	$54,806.69
Culling	Investment	0%						
Culling	Recurrent	0%						
Compensation	Investment	0%						
Compensation	Recurrent	0%						
TOTAL				**$42,354.14**	**$46,642.10**	**$45,664.04**	**$48,855.75**	**$183,516.03**

(Continued)

TABLE A.6: Potential Savings from the Introduction of One Health Under Two Scenarios, Continued

SAVINGS IN HIGH-PREVALENCE SCENARIO (US$/YR)								
TOTAL SPEND ($ PER VLU)				**1.8**	**2.0**	**1.8**	**2.0**	
TASK	**INVESTMENT/ RECURRENT COST**	**SAVINGS %**	**SPECIFIC AREAS OF SAVINGS**	**SAVINGS (US$ 000s/YR) IN THE ANIMAL HEALTH SECTOR**		**SAVINGS (US$ 000s/YR) IN THE HUMAN HEALTH SECTOR**		**SAVINGS (US$ 000s/YR)**
				Low income	**Middle income**	**Low income**	**Middle income**	**Total**
Surveillance	Investment	30%	Joint transport and communication systems	$28,236.10	$30,209.67	$11,576.80	$12,385.96	$82,408.53
Surveillance	Recurrent	40%	Shared front-line staff	$22,588.88	$24,167.73	$18,865.89	$20,184.53	$85,807.04
Bio-security	Investment	20%	Shared border control and market inspection	$2,823.61	$3,020.97	$0.00	$0.00	$5,844.58
Bio-security	Recurrent	30%	Shared border control and market inspection	$5,647.22	$6,041.93	$0.00	$0.00	$11,689.15
Diagnostics	Investment	25%	Joint facilities and equipment	$10,588.54	$11,328.63	$7,503.48	$8,027.94	$37,448.58
Diagnostics	Recurrent	30%	Shared support staff	$8,470.83	$9,062.90	$9,004.18	$9,633.53	$36,171.43
Control (vaccinations, hygiene, and rapid response)	Investment	15%	Shared quarantine of infected areas	$12,706.24	$14,921.95	$26,369.38	$28,212.47	$82,210.04
Control (vaccinations, hygiene, and rapid response)	Recurrent	30%	Shared hygiene and awareness programs	$25,412.49	$29,843.89	$52,738.75	$56,424.95	$164,420.08
Culling	Investment	0%						
Culling	Recurrent	0%						
Compensation	Investment	0%						
Compensation	Recurrent	0%						
TOTAL				**$116,473.89**	**$128,597.67**	**$126,058.48**	**$134,869.39**	**$505,999.43**

Source: This study, based on the assumptions in table 7.1.

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