

Response of developing countries to biological threats: the case of the Republic of Haiti

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Summary

In spite of scientific progress, the world is still facing major biological threats. Not only are there epidemics caused by wildlife pathogens under natural conditions, there are also those caused accidentally when researchers handle highly hazardous organisms stored in research laboratories, and those caused when countries use these organisms as biological weapons of war or when criminal groups use them for bioterrorism.

Developing countries tend to be more vulnerable to such threats than developed countries owing to the poor resilience of their animal health systems, their advanced state of environmental degradation, their socio-economic fragility and their political instability.

The occurrence of emerging and re-emerging diseases (avian influenza, Ebola virus disease) has caused deep concern around the world in recent years and has shown how important it is for countries to strengthen the organisation of their Veterinary Services.

The Republic of Haiti is one of the developing countries with the most acute biophysical vulnerability. Over the years, it has experienced a large number of earthquakes, hurricanes, floods, droughts and epidemics that have further weakened a country with already scarce financial resources. However, Haiti is endeavouring to address biological threats by modernising its Veterinary Services and by implementing the animal health standards and guidelines of the World Organisation for Animal Health (OIE) for establishing resilient animal health systems.

Keywords

Animal disease – Animal health system – Biological threat – Bioterrorism – Developing country – Haiti – International standards – Resilience – Veterinary Services – World Organisation for Animal Health.

Introduction

The modern world is facing increasing threats that can have devastating consequences, depending on the nature of the threat and a country's vulnerability. In many instances, it is unexpectedly large-scale events that place society at serious risk, causing losses so heavy that they disrupt the social structure, rendering it unable to fulfil many of its essential functions (1).

Such disasters take a variety of forms, including hurricanes, floods, droughts, earthquakes or epidemics. They are usually localised within a well-defined area and affect specific social

and/or environmental units. The impact of such disasters can sometimes be so great that, while localised, they affect the entire population. This was the case with the earthquake that struck the Republic of Haiti on 12 January 2010 (2).

Natural disasters, like biological threats, are often preceded by risks, the level of which is usually correlated with a number of different environmental, socio-economic, legal or institutional factors, in particular public governance. The greater a country's vulnerability, the higher the risk.

Vulnerability is defined as a measure of fragility and the inability to cope with a disaster or threat and to recover from a crisis. Although developing countries tend to have

a higher level of vulnerability than developed countries, some show great resilience when confronted with natural disasters or other threats.

In some developing countries, shortcomings are thrown into stark relief when a biological threat emerges, because these countries rarely have the human, material or financial resources needed to establish well-organised and functional Veterinary Services capable of analysing and properly assessing animal health risks and of taking the necessary early action to mitigate the risks by the appropriate means. This raises the question of how economically and socially underdeveloped societies and states respond when faced with biological threats.

Biological threats

Biological threats take a variety of forms, each with its own specific characteristics. Down through history, animals and humans have constantly come under attack from pathogens. The earliest accounts attest to this, even though knowledge about the nature of these pathogens is more recent. The occurrence of animal and human diseases resulting from the pathogenic action of viruses, bacteria, prions, fungi and parasites continues to pose a real danger to all people.

Over the past 30 years, more than 30 new pathogens have been identified that have given rise to emerging animal and human diseases, while others, previously considered totally or partially under control, are giving rise to what are referred to as reemerging diseases (3).

Biological threats stem from a number of potential sources:

- They may be of natural origin, such as when an organism is passed from wildlife to domestic animal species or even to humans.
- They may result from international trade. With the globalisation of markets, organisms travel rapidly from one continent to another, posing a real challenge to developing countries, which tend to be big importers of animals and animal products.
- They may, in some countries, including Haiti and certain African countries, result from political instability, leading to the mobilisation of police forces and multinational armies to restore order within borders. The presence of these forces triggers movements of people and foodstuffs, which increase or maintain the level of biological risk.
- They may be caused accidentally or unintentionally, through a failure to control highly virulent organisms stored in laboratories, which can harm laboratory professionals or

cause considerable damage if the organisms escape into the wild.

- They may result from a deliberate act by countries using animal pathogens as biological weapons against both animals and humans (4).
- They may stem from criminal action associated with bioterrorism.

With the rise in international terrorism, countries are required to carry out their statutory public security and animal health oversight functions in a competent and conscientious manner, by being ever more vigilant so as to take early action to impede anyone wishing to sow confusion and chaos through bioterrorism. Countries are therefore obliged to take the necessary measures to protect themselves against bioterrorism or to avoid being the source of such attacks.

Characteristics of biological risks

Biological threats usually cause considerable damage in terms of animal or human lives and economic losses. In the second half of the 14th century, the Black Death pandemic killed around one third of Europe's population (5). Similarly, the 1918 influenza pandemic (of avian origin) is thought to have caused the death of more than 40 million people across the world (6).

As animals are deeply enmeshed in the fabric of our society, any mass mortality of animals can have serious economic, health, socio-political or even military consequences. The use of a biological weapon against animals can destabilise a country (4).

The economic consequences of biological disasters are much more severe for developing countries, whose economies rely heavily on agriculture, livestock, aquaculture and fisheries.

The panic caused by the outbreaks of influenza A virus subtype H1N1 (swine flu) in Mexico in 2009 and of Ebola in Africa in 2014 is sufficient to remind us of the importance of biological threats and of how all states should take them seriously, prepare proper contingency plans and mobilise appropriate resources to prevent or counter them. Although Ebola is confined to Africa, and shows little sign of spreading beyond the African continent thanks to the mobilisation of relevant international institutions, it has captured the world's attention because of the high case fatality rate of the Ebola virus.

Main factors of variation in the intensity of biological threats

The intensity or level of biological threats varies according to different factors, in particular:

- A country's socio-political stability, which is often related to a democratic system of political organisation, without there necessarily being a positive correlation between the two variables. No prevention or control plan or programme can be implemented properly and produce the desired results without a minimum level of social and political stability.
- The existence of veterinary or animal health legislation, that is to say, an up-to-date legal framework for dealing with biological threats. Developing countries should have modern veterinary legislation that defines the procedures for implementing prevention or risk mitigation actions and establishes the need for cross-sector coordination.
- The nature of the hazard, in terms of either the characteristics of the phenomenon or the probability of its occurrence and intensity in a given region and period. In the case of biological threats, the risk may stem from pathogens, toxins or biological pests.
- A country's level of vulnerability, which must be understood in biophysical, social and territorial terms. A country's biophysical vulnerability depends essentially on three factors: exposure of the populations concerned to the hazard, their resilience and their susceptibility. Social vulnerability relates to the ability of individuals and societies to anticipate, confront, manage and overcome a crisis (7). Territorial vulnerability is considered in order to identify the areas that are likely to suffer significant damage, the places from which disturbances could spread within a given locality or territory, as well as the zones or strategic areas capable of halting this spread.

Factors that are likely to sustain, or even exacerbate, this vulnerability include the precarious living conditions of people in poor countries, the low level of state investment in environmental protection, the lack of a multi-hazard plan and shortcomings in the system of social organisation.

A country's geographical position may also increase its level of vulnerability because it can expose the country to one or more risk factors.

A country's vulnerability also relates to the organisation of its Veterinary Services, which must be able to provide an appropriate response to biological threats in consultation with the other sectors concerned by these threats.

Main challenges facing developing countries in dealing with biological threats

In addition to extreme biophysical vulnerability, the living conditions of much of the population of developing countries tend to be rather precarious. The most disadvantaged groups often face the following challenges, as in Haiti:

- undernourishment and various water-, food- and vector-borne diseases
- shortcomings in the general water and electricity supply infrastructure, or even a lack of such infrastructure in some villages
- inadequate housing infrastructure, the poor quality of which results in (often enormous) human and material losses in the event of a natural disaster, such as an earthquake, flood or hurricane; it leads to the mass destruction of houses, making hundreds or even thousands of people homeless from one day to the next and forcing them to live in overcrowded relief camps or substandard huts.

In terms of animal health, most developing countries have inefficient animal health control systems at their borders, making them highly susceptible to infection with transboundary diseases of natural, commercial or criminal origin. They also find it more difficult to adequately control movements of people and animals within the country in the event of an epizootic disease outbreak, owing to their physical structure or to the limited response capability of their Veterinary Services.

The combination of all these negative factors further complicates the task of developing countries whenever they are required to take action to control animal and human diseases, which tend to become endemic once they have been introduced.

To overcome these challenges, developing countries have three top priorities:

- To ensure animal health protection throughout their territory by strengthening veterinary structures. The most effective and sustainable method for protecting themselves from threats caused by the release of animal pathogens is to reinforce existing surveillance, early detection, rapid response, biosafety and biosecurity systems (8). In order to achieve this, it is important for policymakers in developing countries to make informed choices so that they can establish resilient animal health systems, as recommended by the World Organisation for Animal Health (OIE).

– To reinforce public security measures, in general, and animal health measures, in particular, in order to prevent bioterrorism operations from being deployed on their territory, as far as is possible. Different animal pathogens (including anthrax, glanders, plague and other bacilli, and foot and mouth disease, swine fever and other viruses) have been used in the past as biological weapons. The danger, nowadays, is all the greater because progress in biotechnology, through genetic manipulations, has made it possible to increase the virulence of already highly pathogenic organisms for use in bioterrorism. There is a real concern that poor, socio-politically destabilised countries will be used for the transit or collection of such pathogens, or to establish laboratories for producing them, or else as platforms for launching bioterrorism operations. Indeed, such pathogens are relatively easy to obtain and to smuggle past conventional customs controls.

– To implement OIE recommendations and standards for reducing the country's vulnerability and building the resilience of their Veterinary Services to animal diseases and zoonoses. National Veterinary Services are called upon to play a key role in fighting bioterrorism (9). The OIE has issued a number of standards that are compiled in the *Terrestrial Animal Health Code* and *Aquatic Animal Health Code*, together with guidelines on the reduction of biological threats from the natural, accidental or deliberate release of animal pathogens. The OIE encourages its Member Countries to develop strong cross-sector cooperation and to make public security one of the state's sovereign duties, through good bio-risk management, in order to mobilise the material, human and financial resources required to establish resilient animal health systems.

Haiti and natural threats

Haiti's geographical position and relief

Haiti is bounded to the east by the Dominican Republic, to the north by the Atlantic Ocean (which is crossed by ships of different nationalities throughout the year for a variety of purposes), to the south by the Caribbean Sea (where pleasure craft and trading vessels also operate), and to the west by the Windward Passage separating it from Cuba (Fig. 1).

Haiti is situated on the island of Hispaniola, which it shares with one other independent country: the Dominican Republic. The latter is situated in the east of the island. Haiti is in the west and has an estimated area of around 27,700 square kilometres.

The terrain of Haiti is very mountainous and is suffering severe erosion following an accelerated process of deforestation (leaving only 1.5% plant cover), together

with heavy flooding, which the country has experienced for the last 40 years (10, 11). Haiti comprises 10 geographical departments, 140 communes and 570 communal sections.

Seismic hazards

The island of Hispaniola is located on the Caribbean tectonic plate (between the South American and North American plates), which is shifting eastwards by 2.5–4 centimetres per year. It has four main faults: the Southern Peninsula or Enriquillo fault, the Septentrional fault, the North Hispaniola fault and the Muertos–Neiba–Matheux fault. As a result, it has experienced several earthquakes in its history.

The earthquake of 12 January 2010 was the most deadly, killing 200,000–300,000 people and injuring more than 300,000 (2).

Climate and hydro-meteorological hazards

These are characterised by internal precipitation which, during the hurricane season, causes tropical disturbances (storms), often compounded by low-pressure disturbances, causing heavy rains and strong winds, as well as by polar and orographic frontal systems, causing flooding and ground movement. Between October 1935 and August 2008, the country experienced more than a dozen major hurricanes.

There are also periods of drought, which are tending to increase as a result of climate change, while rainfall appears to be becoming heavier during the rainy season (10, 11).

This combination of seismic, climatic and hydro-meteorological factors has further weakened Haiti's ecosystem and helped to make it more susceptible to biological threats.

Haiti and biological threats

Haiti is characterised by the acute vulnerability caused by its geographic location, ecological fragility and socio-economic organisation (12). Added to these factors is a lack of good state governance, with the resulting political instability.

Haiti faces not only natural disasters but also biological threats from animal pathogens. Moreover, these threats are often associated with damage caused by natural events (earthquake, floods), leading to uncontrolled movements of people and animals.

Epizootics

Over the past four decades, Haiti has faced three major epizootics: African swine fever (1978), classical swine

fever (re-emergence in 1996) and porcine teschovirus encephalomyelitis (previously known as Teschen disease) (2009).

In addition, outbreaks of anthrax are often observed in animals in areas of the country affected by hurricanes or floods.

Despite the successful eradication of African swine fever in 1984, Haiti's rural economy is still suffering from the adverse effects of this epizootic, which have served to intensify the process of decapitalisation for farmers, as pigs have always been considered as the main savings bank for them. Regrettably, these effects have been exacerbated by losses from classical swine fever and porcine teschovirus encephalomyelitis.

While the origin of the spread of African swine fever in Haiti has been clearly defined epidemiologically, this has not been the case with classical swine fever and porcine teschovirus encephalomyelitis, owing to a lack of good systems for the

epidemiological surveillance of animal diseases and for animal health controls at the border.

Public health issues

A few months after the deadly earthquake of 12 January 2010, the country suffered a cholera epidemic which, between October 2010 and 9 July 2016, killed 9,242 people out of 782,559 registered cases (13).

The shortcomings in animal health structures and the water supply system, which were already severe prior to the 2010 earthquake, became alarming afterwards. Compounded by overcrowded and unsanitary conditions in the temporary relief shelters and surrounding areas, these shortcomings not only made it more difficult to control cholera but also facilitated outbreaks of other diseases, such as malaria, dengue fever and human tuberculosis.

An additional risk factor for exotic animal and human diseases is the complexity of Haiti's current social fabric,



Fig. 1
Map of Haiti and its geographical position in relation to the rest of the world
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where thousands of foreign police and military personnel from different countries involved in the United Nations peacekeeping forces (United Nations Stabilization Mission in Haiti: MINUSTAH) intermingle. The presence of these forces has introduced a new element into the analysis of the epidemiological status of animal and human diseases. Reliable studies have attributed Haiti's cholera outbreak to these forces (14).

It is a pity that some researchers studying natural disaster risks and biological threats in developing countries have failed to take political instability sufficiently into account in their analytical framework.

Main responses to biological threats to date

Haiti has adopted the OIE Biological Threat Reduction Strategy, which was approved by the OIE Global Conference on Biological Threat Reduction held in Paris in 2015. The strategy's main recommendations to Member Countries are to:

- implement good governance, capacity-building and the 'One Health' approach
- implement global disease intelligence and the latest methods for disease prevention and control
- develop international cooperation and solidarity between countries.

In October 2010, a few months after the earthquake, the Ministry of Agriculture, Natural Resources and Rural Development of the Republic of Haiti (MARNDR) requested technical assistance from the OIE to conduct an evaluation of the country's Veterinary Services using the OIE Tool for the Evaluation of Performance of Veterinary Services (PVS). In 2012, the country underwent a further two evaluations: a PVS gap analysis and an assessment of their veterinary legislation.

These three OIE evaluations recommended the establishment of a system for the organisation of Veterinary Services that conformed with OIE standards. The OIE PVS gap analysis report was shared with various international financial institutions, which led to the initiation, in 2015, of a programme to modernise public animal and plant health protection services, with funding of US \$16 million from the Inter-American Development Bank and the Haitian Treasury. Prior to this, an animal health and plant protection component had been included in the Reinforcement of Public Agriculture Services project (RESEPAG), which is a project financed by the World Bank that was established to initiate activities to restructure the Veterinary Services (15).

A new organisational model for the Veterinary Services has been adopted and five draft bills have been prepared on animal health and veterinary public health, with the technical assistance of an OIE expert, while draft implementing regulations are being drawn up to establish a legal framework for consolidating activities to modernise the Veterinary Services. The aim of these texts is to:

- Establish a system for the epidemiological surveillance of animal diseases based on a participatory epidemiology approach and on epidemiological surveillance networks for the main transboundary animal diseases. This work will be carried out not only with public service veterinarians and para-veterinarians but also with animal health groups, to be set up in each of Haiti's 570 communal sections. An animal health group generally comprises 25–30 farmers and 2–3 veterinary workers who deal with domestic animal vaccination, farmer training and epidemiological surveillance of animal diseases and zoonoses.

- Establish an animal health contingency fund to facilitate the swift deployment of rapid response teams in order to stamp out an animal health crisis or to take the necessary recovery measures following an outbreak of infection or disease.

- Draw up and implement a five-year strategic plan for the development of Veterinary Services. The first plan, designed in 2014 with the technical assistance of an international consultant, is currently being implemented. It will be regularly evaluated in order to make the necessary adjustments and to collect basic data for preparing the second plan.

- Promote the development of cooperation within and across sectors in order to obtain the benefits of working together and increase the effectiveness of efforts to improve veterinary public health.

In the case of zoonotic animal diseases, priority will be given to the One Health approach, because animals act as biosensors capable of detecting releases of pathogens or toxins that may infect animals or humans (8). However, in order to be fully effective, these actions must form part of a comprehensive framework of State reform designed to improve public governance and ensure the adoption of a wide-ranging socio-economic development plan that recognises the safety of animals, people and the environment as a key priority.

Conclusion

Across the globe, biological threats are becoming more evident by the day, despite the belief, in the late 1960s, that

humankind was moving towards eradication of epidemics. Emerging and re-emerging diseases have become a source of ongoing concern as not a year goes by without an outbreak of one or more of these diseases occurring somewhere in the world.

Experts believe that many as yet unidentified diseases exist in outlying areas of the globe and remain confined to these undeveloped areas. An ecological change is all it would take for such diseases to spread through developing countries and even beyond (3). It is therefore vital for all countries, particularly those in the developing world, to prepare for every type of biological threat – natural, accidental or deliberate – because an animal disease outbreak can have a direct negative impact on the local economy, livestock productivity, market access and public health. ■

The success of biological threat management lies in anticipation, because it is more beneficial for a country to address risk factors than to take action after a disaster has occurred. At the same time, international terrorism is growing at an ever faster pace, using a variety of attack methods. It increases the likelihood that malicious parties will resort to bioterrorism to sow confusion and panic in what they view as enemy societies. Developing countries therefore have no choice but to organise or reorganise their Veterinary Services on the basis of OIE standards, to enable them to deal with the various biological threats caused by pathogens and to contribute to livestock development, to public health promotion and to improving food security and the environment.

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