Emergency management of disasters involving livestock in developing countries

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Summary
Different disasters have similar consequences on the health and welfare of livestock. Numerous geophysical disasters can exacerbate epizootics, resulting in the deaths of many animals and the reduction of production efficiency. These disasters also present a considerable threat of spoilage of processed foods, endangering public health. Furthermore, large-scale disasters involving animals can modify the long-term stability of national economies, the environment and social structures.

The authors discuss the vulnerability of the livestock industry to natural disasters and the impact of floods, droughts and transboundary diseases and pests on national economies. Examples are given on how some losses can be avoided, evaluated and compensated. The role of the veterinarian is presented in relation to work conducted by other relief organisations in cases of emergency.

In developing countries, mitigation programmes should focus on strengthening global animal health services. Preparedness needs to be community based, with education provided in a timely manner. Effective recovery from disasters should be based on mitigation programmes, including international trade and mutual aid agreements between neighbouring countries to supply appropriate goods and environmentally and culturally appropriate breeds of livestock.

Disaster relief for the care of livestock should be recognised as a form of humanitarian assistance, given the benefits to be derived for public health and the socio-economic implications of successful intervention.

Keywords

Introduction
The two major causes of disasters which occur in developing countries are epizootics and geophysical events (3, 4, 5, 6). Throughout history, epizootic diseases have killed large populations of animals and reduced the production efficiency of many animals. In addition to epizootics, and sometimes exacerbating these, numerous geophysical disasters affect livestock agriculture every year. These geophysical events can also cause considerable loss of animal life and spoilage of processed foods for humans (1, 6, 21).

In many ways, the same threats of disaster face developed countries. The difference lies in the frequency and relative magnitude of impact that disasters have in the two types of countries (Tables I and II) (9). Industrialised countries are usually capable of compensating losses rapidly through insurance programmes, government assistance, access to credit and activation of business reserves. By contrast, over 60% of the entire livestock industries of some developing countries may be at risk of geophysical disasters in cases where these safety nets do not exist (Tables III and IV) (5, 16). Furthermore, the frequency and magnitude of disasters,
including war, is higher in developing countries than elsewhere. As a result, many disasters in developing countries bring with them the potential for serious long-lasting impacts on animal agriculture and, therefore, also on the economic and public health of the country in question (4, 18).

Tending to livestock in developing countries employs many more people than in developed countries (18). Consequently, animal husbandry systems contribute significantly to the economic and political strength of developing countries, and represent a large portion of the gross national product (GNP), cultural heritage and identity of many countries. In many areas, the long-term stability of the environment also depends highly on sustainable agriculture which is based on traditional livestock husbandry systems and social structures. Growing population pressures and certain forms of development are a constant threat to this stability and these pressures on the environment substantially modify the impact which results from disasters involving animals.

The economic consequences of disasters reflect some of the fundamental differences between the rearing of livestock in developed and less developed countries. In developing countries, livestock may be kept as units of production but are also just as likely to be kept as repositories of wealth and an important means of draught power for cultivation and transportation (22). Disasters that affect animals can, therefore, also affect the infrastructure of a country, thereby hindering the distribution of food and goods, and in addition, reducing an important source of employment, revenue and wealth in rural countries. Greater numbers of livestock in a country also mean an increase in disposable income for farmers (5).

The heavy dependence of populations on agriculture in developing countries means that following a disaster normal agricultural activities must be resumed as rapidly as possible and long-term changes must be made to the structure of the livestock sector to reduce the impact of future disasters.
Table IV
Number of large-scale natural disasters in the world, by region (1970-1995)

<table>
<thead>
<tr>
<th>Type of disaster</th>
<th>Africa</th>
<th>Americas</th>
<th>Asia</th>
<th>Europe</th>
<th>Oceania</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthquake</td>
<td>41</td>
<td>137</td>
<td>245</td>
<td>186</td>
<td>85</td>
<td>674</td>
</tr>
<tr>
<td>Drought and famine</td>
<td>278</td>
<td>52</td>
<td>91</td>
<td>16</td>
<td>15</td>
<td>452</td>
</tr>
<tr>
<td>Flood</td>
<td>184</td>
<td>390</td>
<td>565</td>
<td>155</td>
<td>139</td>
<td>1,523</td>
</tr>
<tr>
<td>Landslide</td>
<td>12</td>
<td>91</td>
<td>101</td>
<td>22</td>
<td>10</td>
<td>236</td>
</tr>
<tr>
<td>High wind</td>
<td>85</td>
<td>452</td>
<td>703</td>
<td>218</td>
<td>200</td>
<td>1,658</td>
</tr>
<tr>
<td>Volcano</td>
<td>9</td>
<td>33</td>
<td>45</td>
<td>16</td>
<td>5</td>
<td>109</td>
</tr>
<tr>
<td>Other</td>
<td>220</td>
<td>103</td>
<td>198</td>
<td>100</td>
<td>8</td>
<td>629</td>
</tr>
<tr>
<td>Total</td>
<td>829</td>
<td>1,258</td>
<td>2,048</td>
<td>693</td>
<td>463</td>
<td>5,281</td>
</tr>
</tbody>
</table>

Source: International Federation of Red Cross and Red Crescent Societies. World Disasters Report, 1996(9)

Examples of disasters involving the livestock industry

Geophysical disasters

In 1970, the East Bengal cyclone killed approximately 60% of the entire cattle population within an area of >5,000 km² (20). Throughout this extensive area 30%–80% of farmers lost cattle due to drowning. Six months later a survey revealed that as a result of the cyclone the amount of land being cultivated had decreased from over 20% to approximately 6%. The most common explanation given by farmers was the lack of bullocks and buffalo to plough the fields. To return the area to pre-cyclone production levels would have required an estimated 123,000 cattle (12.8 cows per 100 acres) and 127,000 ploughs. The fishing industry was also severely affected; nearly 90% of all fishermen were unable to fish because of the loss of essential equipment (20).

In 1991, Mount Hudson erupted in southern Chile. Volcanic ash was blown as far south as the Falkland Islands and covered areas of Chile and Argentina where approximately 2.5 million sheep grazed. As the ash was deposited on pastures, thousands of these sheep died due to starvation as the ash prevented access to forages and wore down their teeth (17).

In 1992, droughts in Zimbabwe resulted in a 12% decrease in the national economy, principally due to reduction in productivity of the agricultural sector.

The severe winter of 1996 caused the death of 700,000 cattle and yak in the People’s Republic of China. As a result, farmers were unable to plough large areas of fields the following spring (12).

Over 20,000 cattle drowned in floods which affected the Pacific coast of El Salvador in 1996. Later, the damp soil conditions caused by flooding favoured the growth of parasites, which resulted in increased mortality and morbidity in livestock (5).

In 1998, an extremely harsh winter in northern Tibet resulted in the death of over 10 million buffalo and sheep, most of which belonged to nomads. Many people also died (12).

Epizootics

In 1978, an outbreak of African swine fever in Haiti and the Dominican Republic necessitated the slaughter of most of the swine on the island. The indigenous black pigs were replaced with ‘improved’ white breeds. Farmers continued to lose income because the new breeds were not hardy enough to walk long distances to market for sale.

In 1997, 3.85 million pigs on 6,147 farms in Taipei China died from foot and mouth disease (FMD) or were slaughtered as part of the disease control programme. For a period of one year following the outbreak, the export of swine from Taipei China to Japan was banned and as a result the United States of America (USA), took over from Taipei China as the primary provider of swine to Japan.

In 1998, outbreaks of Rift Valley fever (RVF) were associated with heavy rains in north eastern Kenya, southern Somalia and Tanzania. The rains were thought to have been associated with El Niño. Several hundreds of thousands of livestock were affected, with mortality rates of between 50% and 75% recorded in the early stages of the outbreak. Over 89,000 human cases of RVF occurred and resulted in over 300 deaths.

On average, human cases of rabies in Indonesia total 70-80 each year, and over 1,300 dogs are affected by the disease. In 1998, the government of Indonesia decided to implement a control programme against rabies by killing 150,000 dogs, 100,000 cats and 170,000 monkeys. Concerns arose over methods used for carcass disposal and the possible emergence of diseases that would normally have been controlled by predation by cats.
Natural disasters associated with epizootics
In 1979, Hurricane David was suspected of contributing to the introduction of the *Amblyomma* tick and subsequent infection of cattle on Dominica with cowdriosis (infected cattle were probably imported after the hurricane) (8).

In the thirty years between 1950 and 1980 three major El Niño events were recorded. More recently, in the period between 1984 and 1998 (14 years), four such events have occurred. With an increasing understanding of weather patterns, it has been possible to associate increases in diseases and disease outbreaks with increased rainfall or droughts. Associations between diseases and the El Niño years have been demonstrated for pneumonic plague in Ecuador, and rabies and leptospirosis in Cuba and the Caribbean, respectively (4).

Technological disasters
Ten years after the Chernobyl nuclear disaster in 1986, sheep farmers in parts of Wales still could not sell any sheep for human consumption due to excess radioactivity on Welsh pastures.

Vulnerability of the livestock industry to natural disasters
In developing countries the animals of prime economic importance are livestock, including poultry and equines (horses, donkeys and mules). These animals are essential as a source of wealth, food and power for work and transportation. The principal issues that arise in disaster situations in developing countries are a shortage of food for the human population, spoilage of food and a loss of economic viability and employment in the agricultural sector (1, 3, 6, 15, 21).

Estimation of the number of animals at risk
Estimates of approximate numbers of livestock populations in disaster-prone areas can be made in most countries by overlaying maps with agricultural census data and geographic distributions of hazards. This estimation method has been used in Central and South America (5). These simple methods are useful in estimating the impact of mitigation and preparedness programmes but not for the assessment of damage following a disaster. Methods used for assessment of damage after a disaster are described below. However, these methods can be susceptible to inaccuracies as they are based on estimates of numbers of animals which are obtained by taking averages over large geographic areas.

Estimation of the number of animals affected by a geophysical disaster
The first method of estimation is based on knowledge of the extent of the area affected by the disaster. To assess the total number of animals affected, the area affected (number of hectares) is multiplied by the average number of animals in that area.

The second method requires estimates of the number of people in the region. These figures are usually available. To estimate the number of animals affected, the ratio of animals to people in a representative area is calculated. Once the number of people affected by the disaster is known, the number of animals can be estimated by multiplying the number of people affected by the ratio of animals to people. Often the number of livestock in rural areas exceeds the number of people.

However, in many disasters shelters are used only by a small proportion of those people affected; for example, in the drought of 1984 in the Sudan, primarily sedentary farmers entered displacement camps, whereas others moved to urban centres and formed squatter settlements, or stayed with extended family. Transhumant and nomadic populations moved with their surviving livestock to other areas, frequently across national boundaries.

Economic impact
Added value of livestock
Measurement of the impact of disasters on the livestock industry and national economy is difficult because the value of livestock is greater than the market value of the animals or their pastures (18). For example, a cow is most valuable as a producer of milk, additional calves and manure; a chicken is most valuable as a source of eggs and fertiliser; pigs provide a source of piglets, remove garbage and keep land free from snakes. In both cases, an estimate of the loss suffered due to a disaster should take into account not only the replacement value of the animal, but also the loss of production, power, and alternative uses, each of which accrue until the replacement animals become productive again.

The use of cattle in a variety of production systems to control weeds and reduce the need for herbicides and fertiliser is another prime example of the added value of livestock. In Malaysia, for example, cattle graze in palm and rubber plantations and reduce the cost of weed control by 40%. Similar programmes in Colombia in sugar cane plantations reduce costs of weed control by up to 50% (18).

In nomadic and transhumant societies, the income generated by livestock populations may appear low. As animals in such societies represent wealth, the number of animals that are owned are an important insurance against disaster, and a certain minimum number of animals is required to maintain the nomadic existence. In these societies, loss of livestock strikes at the structure of society in ways which cannot be quantified monetarily.
Loss of income
Livestock are an essential component of sustainable agriculture systems. Owners of livestock gain income from sales of live animals and animal products, fees for services (draught, transport) and sales of raw products that are processed on and off the farm (18). Livestock are the principal source of agricultural power in many developing countries.

The livestock industry is more labour intensive than many other sectors of agriculture. Therefore, any given disaster may affect relatively more people in the livestock industry than other sectors of agriculture. Estimating the impact of disasters on the livestock industry should also take this aspect into account (5, 18).

Animal health concerns that result from disasters
The most important causes of a deterioration in animal (livestock and equines) health in disasters are poor nutrition and subclinical disease which result from contagious disease and geophysical events (Table V). The combination of exposure to waterlogged pastures and malnutrition predisposes animals to many infectious diseases. In tropical climates, some of these diseases can have a rapid and devastating impact. Malnutrition results in loss of body weight, energy and mineral imbalances, all of which can increase susceptibility to disease, decrease reproductive efficiency and can even be fatal.

Both malnutrition and infectious disease can be responsible for reduced reproductive efficiency. Fewer calves will be born and those that are born will be weaker and are more likely to die. A reduction in reproductive efficiency is an important cause of decreased economic performance of livestock, as it interrupts the cycle of sustainability in pastoral agriculture systems. Prolonged flooding can reduce the reproductive efficiency and viability of the calf crop so that the value of the entire herd decreases by as much as 25%-40%.

Impact of floods on animal health
Flooding occurs in two ways: flash-floods and cresting floods. Flash-floods occur following heavy rainfalls in low-lying and drainage areas and in areas where irrigation is not adequate. Cresting floods often pose the greatest immediate threat to lives as animals and people can be trapped and drowned. Cresting floods usually arrive after a warning of several days or weeks. Cresting floods often rise slowly, trapping animals on islands without feed and threatening hypothermia and drowning (Fig. 1). Cresting floods are a common problem along low-lying coastal areas, where overflowing rivers cannot drain into the sea. All flooding results in displacement of livestock and other animals and their owners.

Prolonged flooding of pastures kills vegetation, therefore reducing the nutritional value of pasture to grazing animals. Flooding also removes organic matter from the soil which reduces the water-holding capacity of the soil. Soils that have a low content of organic matter are more prone to droughts and landslides, and are less productive for plant growth.

The average grazing density for cattle in wet tropical climates is approximately one cow per ha per year. Pastures are used on a rotational basis every 60 to 70 days. The nutritional quality of grasslands that have been flooded is reduced because of decreased soil fertility, decreased organic matter in the soil, and because of parasites that destroy plant roots. As a result, pastures can only maintain cattle for 20 to 30 days per rotation. This increased rate of rotation increases the need for grazing land approximately four- to five-fold.

If grazing is continued at the same density as before a flood or on pastures that flood repeatedly, a vicious cycle is created of flooding, decreased soil quality, overgrazing and increased susceptibility to erosion, which may continue for many years. In some cases, flood-damaged pastures that have been overgrazed may only be repaired by leaving the land free of livestock and other crops for several years.

Subsistence farmers may move animals to higher ground when floods are imminent or, in rare cases, build rafts for minor species (pigs, chickens, sheep, goats, guinea-pigs) to float on when waters rise. However, most subsistence farmers take their animals with them when they are displaced. This means that city shelters for displaced subsistence farmers are

<table>
<thead>
<tr>
<th>Disease</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein energy malnutrition, mineral deficiencies</td>
<td>Loss in economic value, decreased economic efficiency (fewer calves). In addition, cattle seek and eat carcasses to compensate for mineral imbalances. Botulism can result, killing the animal</td>
</tr>
<tr>
<td>Respiratory disease</td>
<td>Pasteurella, Mycoplasma pneumoniae</td>
</tr>
<tr>
<td>Gastro-intestinal parasites</td>
<td>Helicobacter, coccidiosis and transovarian infections, protozoal diarrhoea</td>
</tr>
<tr>
<td>External parasites (vector-borne diseases)</td>
<td>Tick and leech infestations</td>
</tr>
<tr>
<td>Blood-borne parasites</td>
<td>Babesiosis, kedenserisiosis</td>
</tr>
<tr>
<td>Bacterial diseases</td>
<td>Dermatomycosis</td>
</tr>
<tr>
<td>Vector-borne diseases</td>
<td>Rift Valley fever, Venezuelan equine encephalomyelitis, heartwater, bebesiosis, anaplasmosis, theileriosis</td>
</tr>
</tbody>
</table>
often inundated with animals, thereby presenting considerable public and animal health problems.

Floods also deposit large amounts of debris in pastures which can be hazardous to grazing animals (for example, puncture wounds to the feet and skin). Following floods, livestock and equines are particularly prone to these injuries because their hooves are weakened through continual exposure to water and mud. Damaged hooves and skin of livestock and equines can become infected, resulting in severe lameness and generalised illness. Lame cattle and equines can no longer plough fields or carry loads; the resulting lack of animals for transport increases the cost of crops, such as citrus and cacao, that need to be transported from terrain that may only be accessible on foot. Debris also reduces the effective grazing area of pastures. Debris can often be contaminated with hazardous chemicals that may affect the health of grazing animals, and may endanger humans who later consume contaminated meat or milk products.

Floods are often predictable events to farmers. Producers with large herds, who have substantial economic commitments to raising livestock are generally aware of common weather-related problems. For example, producers know the areas that flood regularly and how to prevent extensive losses when flooding occurs. In addition during the winter months cattle herds are usually moved to higher pastures, where they are not threatened by floods and where replenished grasslands can be found. As cattle are being moved, producers also provide preventive health care to their cattle. This includes vaccination, deworming and treatment against clinical disease.
Cattle exposed to floods suffer from a number of ailments that can affect their health, economic value, and can prevent movement of cattle (Table VI). The detrimental impact of disasters on the health of a herd may reduce the value of the herd by between 30% and 70%. Income is lost through death of animals, weight loss, reproductive losses and additional health care expenditures. The greatest problems that producers report in flood-affected cattle are foot rot (infection of the foot with *Fusobacterium necrophorum*), viral and vesicular diseases, including FMD, blackleg (*Clostridium chauvoei*), and other contagious diseases such as internal and external parasites, respiratory infections (*Pasteurella* spp. and *Mycoplasma* spp.) and skin diseases (*Dermatophilus* spp.). Public health concerns may also arise due to outbreaks of zoonotic disease, including vector-borne diseases (10), hydatidosis and visceral larva migrans.

Impact of droughts on livestock production

Susceptibility to drought is associated with low rainfall but droughts also commonly occur in previously flooded areas, where soils have been leached of organic matter. During droughts, livestock experience a rapid reduction in weight and reproductive efficiency. Both of these concerns result in considerable economic loss, and a reduction of the food supply for humans. As cattle seek food and water in drought-affected areas they are more likely to consume unsuitable feeds and water, which may exacerbate other diseases, cause further loss of weight, and kill the animals. Wells and water-holes that are nearing empty may have increased salt and other noxious solutes in them, making them unpalatable or dangerous to drink.

Farmers wanting to protect their animals from starvation and dehydration will move them long distances to areas where feed and water may be found. On these journeys, animals may be exposed to unfamiliar diseases and predation, and consume energy that would otherwise be available for growth, reproduction and milk.

**Table VI**

<table>
<thead>
<tr>
<th>Species</th>
<th>Disease</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poultry (chickens, turkeys, ducks)</td>
<td>Abcesses</td>
<td>Antibiotic supplemented feed</td>
</tr>
<tr>
<td></td>
<td>Respiratory diseases</td>
<td>Antibiotic supplemented feed</td>
</tr>
<tr>
<td></td>
<td>Mites</td>
<td>Topical treatment with parasiticide</td>
</tr>
<tr>
<td>Swine</td>
<td>Cholera</td>
<td>Kill and remove affected animals</td>
</tr>
<tr>
<td></td>
<td>Scabies</td>
<td>Topical treatment with parasiticide</td>
</tr>
<tr>
<td></td>
<td>Foot rot</td>
<td>Pare foot and treat with penicillin</td>
</tr>
<tr>
<td>Cattle, goats, camelsids</td>
<td>Foot rot</td>
<td>Pare foot, wrap with copper sulphate bandage, treat with penicillin</td>
</tr>
<tr>
<td></td>
<td>Respiratory tract infections</td>
<td>Treat with long acting tetracycline</td>
</tr>
<tr>
<td></td>
<td>Vector-borne diseases (Rift Valley fever)</td>
<td>Quarantine</td>
</tr>
<tr>
<td>Horses</td>
<td>Vector-borne diseases (Venezuelan equine encephalomyelitis)</td>
<td>Vaccination</td>
</tr>
<tr>
<td>Dogs</td>
<td>Rabies</td>
<td>Kill all aggressive dogs and those suspected of being infected. Vaccinate all other dogs</td>
</tr>
<tr>
<td></td>
<td>Scabies</td>
<td>Topical treatment with parasiticide</td>
</tr>
</tbody>
</table>

Drought-affected areas are often at increased risk of fire. Increased amounts of dead vegetation present a fire hazard which, once burning, may be very difficult to control.

An investigation into the impact of drought in Somalia in the early 1970s showed that it took many years for the livestock industry to recover (7). The immediate losses experienced by farmers and the country as a whole were the deaths of many thousands of animals. Additional losses included reduced fertility for several years after the drought and the failure of the livestock industry to regain the same size as before the drought occurred. It took three years after the drought for cattle to return to their normal reproductive capacity. Herds still did not return to their original size for several more years because farmers were forced to slaughter animals at a younger age as a source of nutrition and extra income.

**Transboundary diseases and pests**

In the USA, many of the diseases responsible for reduced productivity of livestock are referred to as 'foreign animal diseases' (FADs), indicating that they have been eradicated or are exotic to the USA. However, FAD is a paradoxical term, as it includes vesicular diseases (e.g. vesicular exanthema of swine) that occur principally in the USA. Therefore, to be consistent with other countries, the preferred and less ambiguous term is 'transboundary' diseases. This term also truly reflects the potential of these agents to cause disasters. The Office International des Epizooties (OIE) is the one of the most important organisations that monitors transboundary diseases. Many books describe these diseases and their epidemiology, such as those produced by the OIE (11) and the United States Animal Health Association (2).

The economic implications on international trade of a diagnosis of a transboundary disease in a country are massive. The diagnosis of transboundary diseases in a country may be accompanied by a complete ban on the exportation of animals.
Transboundary diseases are also costly because they cause increased morbidity and mortality in animals. Consequently, productivity and the economic value of the livestock industry are reduced, and indigenous sources of food for a nation are difficult to obtain. Some transboundary diseases are zoonotic and consequently pose an additional direct threat to public health.

Therefore, the impact of transboundary diseases is very similar to other (geophysical) types of disasters. The greatest impact is due to animal death and decreased productivity, with the predictable result that the human food supply is compromised. Transboundary diseases are an important contributory factor in human malnutrition.

Increased awareness of the vulnerability of the world to these diseases has developed as wars in Europe have shown that boundaries are easily changed and disease control along borders has been insufficient to prevent the spread of contagious disease. Increased international movement of livestock and food of animal origin has introduced an increased risk of spread of disease. Nine of fifteen major epidemics in recent years have occurred in 'developed' countries.

An increased incidence of contagious disease appears to correlate well with years in which other natural disasters occur. For example, in years of increased rainfall due to El Niño, there are often increased numbers of reports of infectious disease. Examples are RVF in Africa, FMD in South America, mongoose and human rabies in Cuba, and human leptospirosis in the Caribbean. In these years and when vector control efforts break down, the incidence of vector-borne diseases, such as Venezuelan equine encephalomyelitis, also appears to be increased (4).

A role for veterinarians

For many years veterinarians have been the pioneers of animal health throughout the world. The veterinary profession has been responsible for the eradication of many diseases from many countries, the development of vaccines, disease surveillance and intervention programmes (13). Veterinarians have also responded to the needs of countries affected by geophysical disasters on many occasions (3). However, it has been non-veterinary organisations that have led the field in an organised approach to disasters.

Much of the involvement of veterinarians in disasters in developing countries has suffered from the perception that programmes for the control of epizootics are exclusively veterinary in nature. Veterinarians have also placed a disproportionate emphasis on the response phase to disasters, and have failed to adopt an 'all-hazards' approach (see below) to disasters involving livestock. These actions may have alienated other disaster-relief agencies and professionals active in developing countries. A regrettable consequence of such alienation is the increasingly prevalent point of view that veterinarians are merely technicians, rather than professionals who have a tremendous amount to contribute to societal well-being, including public and animal health.

Further, the disproportionate emphasis given to the response to disasters involving the livestock industry, in comparison with preventive measures (mitigation), has done little to dispel the traditional and costly vicious cycle of damage and repair.

The solution to this dilemma starts with an all-hazards appreciation of disasters. All-hazards emergency management is based on the concept that, regardless of the impact of many different types of disasters, the socio-economic consequences of disasters on a country are usually similar, including those on animal agriculture. Therefore, the responsibility of veterinarians is to participate as members of the emergency management team and to work within integrated programmes dealing in all types of disaster reduction. This can probably only be accomplished by being present in a country before a disaster strikes (14).

The role of the veterinarian in this integrated programme of emergency management should be clear, and is no different from other aspects of veterinary disaster management: the care of animals is an effective method to provide better care for people. In the case of national disasters in developing countries, the attention to animal agriculture is an effective method to improve public health, the environment and the economy of the country.

International veterinary disaster management is an effective form of humanitarian assistance. The Food and Agriculture Organization (FAO) of the United Nations and several other organisations have recognised this (3). The FAO is potentially able to co-ordinate the needs for agricultural relief through the United Nations Development Program, the principal body entrusted with the coordination of humanitarian assistance.

Applying the four phases of emergency management

Mitigation

The most effective mitigation of any disaster in developing countries is to strengthen the animal health services of those countries. A strong Veterinary Service is one that is well
trained in all aspects of veterinary medicine, including public health and epidemiology, and that operates under the authority of the government of the country in question. Mitigation (strengthening the veterinary profession) against transboundary diseases is a global issue in which every country plays a role.

The common approach to mitigation in developed countries is to attempt to prevent the entry of transboundary diseases through extensive border controls. However, conventional border controls at ports are becoming increasingly futile, because of the sheer number of tourists who travel between countries with and without diseases. The lack of awareness of these travellers and the volume of travel make the introduction of transboundary disease an increasing concern. There are many examples of countries in the Americas where the threat of transboundary diseases prevails. Recent threats have included classical swine fever (hog cholera) from the Dominican Republic and Haiti, and screwworm from Cuba. Another threat is the act of terrorism, where infected material may have been deliberately introduced into a country.

Although the identification of illegally imported goods at ports in the USA has been improved in recent years by random baggage sampling at ports, these methods are derived from statistical theory on how to estimate the amount of illegally imported goods to the USA. The random sampling methods, however, cannot prevent importation in all cases, and are insufficient to detect deliberate acts of terrorism.

Developed and less developed countries can only expect to prevent the introduction of diseases by forming partnerships with their trade and travel counterparts to deal with diseases at their endemic sites. Countries with well-developed veterinary professions must offer and share their resources. Only a strong global veterinary community will be able to reduce the impact of all types of disasters, especially those due to epizootic disease.

Many developing countries have suffered an erosion of the effectiveness of their Veterinary Services in periods of economic difficulty. Veterinary Services have become weakened as the animal health service budget is reallocated away from disease control programmes and applied to salaries to maintain the number of people employed in the Service. In other countries, indications of a weakened veterinary profession are a lack of access to or familiarity with current disease diagnostic and monitoring techniques or an insufficient number of veterinarians. The effect of weakened Veterinary Services has been the continued presence of diseases which could be eradicated given adequate human and financial resources. Some countries that have privatised animal health programmes have suffered new outbreaks of diseases that were once considered eradicated. In countries where these disease outbreaks are transboundary and notifiable in other countries, the economic impact of export restrictions dwarf most other costs related to disasters.

Supporting the education of veterinarians in other countries should become a major focus of mitigation against the introduction of transboundary diseases in developed countries. Mitigation implies that those countries in a position to assist should be present and provide support to countries with transboundary diseases by offering training, expertise, and resources to eradicate diseases that are a threat to animal health worldwide.

Mitigation programmes that should be supported are those that focus on epidemiology and clinical and laboratory diagnosis of disease, herd health management, nutrition and public health. Furthermore, programmes that improve animal identification should be developed, so that trace-back procedures become an efficient component of disease control and eradication. Finally, mitigation for the livestock industries of developing countries should involve financial planning for post-disaster recovery. Effective financial mitigation includes the insurance of the livestock industries of entire countries against catastrophic losses (known in insurance terms as uncorrelated risks), and international mutual trade arrangements with neighbouring countries, so that replacement livestock that are environmentally and culturally suitable can be exchanged for other goods and money should the need arise.

Mitigation programmes for geophysical disasters also involve implementing early-warning systems of pending floods (river water flow metres) and food storage banks for droughts. Construction of holding facilities for livestock, using indigenous technology which has developed over the centuries, can also prevent losses from common natural hazards, such as hurricanes and earthquakes.

**Preparedness**

The essence of an effective preparedness phase of disaster reduction programmes in developing countries is in the development and implementation of timely (seasonal) education that is community based. Examples include weather forecasting and river flow monitoring which can be used to advise farmers on the optimal time to move cattle.

The FAO operates two programmes in these areas. These are the Global Information and Early Warning System (GIEWS) for food and agriculture and the Emergency Prevention System (EMPRES) against transboundary animal and plant pests and diseases. The latter is used to watch globally for signs of emerging threats from pests and epidemics whereas the GIEWS monitors food supply and demand across the world, and provides policy makers and analysts with up-to-date information on crop prospects and gives early warning on imminent food crises. The goal of these systems is to enable governments and international organisations to take early action should the need arise (3).
Educational programmes may provide an added incentive to ensure more rapid and thorough dissemination of knowledge. A ‘pyramid of education’ is an example, whereby government officials or industry generate appropriate materials for education and offer this information to livestock producers. Livestock producers who pass the information on to others become eligible for bonuses. The incentive for passing on this education would therefore, be linked to bonuses (e.g. access to information technology, participation in programme development, early access to research information, lower drug costs). Farmers who receive this information and disseminate it to yet others would also be eligible for bonuses and those responsible for the initial sharing of information would receive additional bonuses. Every few years the focus of education can be revised and a new pyramid created.

Response

In the response phase to disasters, several major issues need to be addressed regarding the livestock industry. Animals will be displaced and will congregate, resulting in the increased potential for disease transmission. In addition, substantial donations will be received, some of which will originate in countries that would normally not be accepted for import because of animal or plant health restrictions. These products need to be identified and dealt with appropriately, so that diplomatic relations between donor and recipient countries are not harmed. Early intervention to support animal health is likely to be highly cost-effective (Table VII).

Facilities provided for displaced subsistence farmers should provide separate facilities for animals; it is important to keep animals and people apart. Animals should be vaccinated and treated if necessary upon arrival. Human vaccination programmes could be co-ordinated with animal vaccination programmes as vaccination programmes for humans have been shown to have a high compliance rate when conducted in concurrence with animal vaccination programmes.

Areas in which large numbers of animals congregate should be prepared, with a layer of at least 5 cm of lime, and channels should be dug for adequate drainage. Some typical disease problems that will arise and potential protocols for treatment are listed in Table VI.

Following floods, large numbers of carcasses are often scattered throughout the countryside (Fig. 2). It is often not possible to bring these to a common site for disposal, therefore, on-site disposal is often the only practical solution. While many carcasses in remote areas will be scavenged (Fig. 3), carcasses lying close to human or animal habitation, or water sources, should either be removed or destroyed rapidly. Composting on site may be the most practical alternative in many cases to dispose of large carcasses (Fig. 4). Increased rates of rotation and reduced availability of land make pastures extremely sensitive to overgrazing, which may result in decreased productivity for several years. Increased grazing intensity also dramatically increases the need for preventive health care, such as the need to treat animals against internal and external parasites. This can become such a problem, that livestock farming becomes unprofitable. The only cost-effective measures that can be used to counteract decreased efficiency are to either decrease the stocking density of cattle (decrease herd size or increase available pasture) or to increase use of parasiticides and feed (e.g. by feeding flood-damaged crops, such as bananas, that can no longer be used for human consumption). However, neither of these approaches are likely to be able to sustain economic viability for the producer, unless they are subsidised by disaster-relief funding.

To some degree, overgrazing can be prevented by offering supplemental feed to livestock. Damaged crops which were originally intended for human consumption are often available for use as feed for livestock. The use of these feeds, however, requires funding to pay for transportation and processing. Making funds available to do this is a cost-effective response activity that should be included as part of disaster-relief efforts. Following a large-scale disaster, donors should consider applying disaster relief funds to preventive measures, because these measures are cost-effective in preventing greater losses at a later stage.

<table>
<thead>
<tr>
<th>Table VII</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimation of the benefit/cost ratio for intervention measures for the care of animals owned by 100 subsistence farming families</strong></td>
</tr>
<tr>
<td>In this example the benefit/cost ratio is &gt;10:1 (5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>Number</th>
<th>Replacement value (US$)</th>
<th>Cost of vaccination (US$)</th>
<th>Replacement value</th>
<th>Lost production (US$)</th>
<th>Human health costs (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chickens</td>
<td>400</td>
<td>600</td>
<td>NA</td>
<td>600</td>
<td>1,500</td>
<td>6,000</td>
</tr>
<tr>
<td>Pigs</td>
<td>50</td>
<td>2,000</td>
<td>250</td>
<td>2,000</td>
<td>4,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Dogs</td>
<td>100</td>
<td>NA</td>
<td>500</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Subtotals</td>
<td></td>
<td>2,600</td>
<td>750</td>
<td>2,600</td>
<td>5,500</td>
<td>26,000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td><strong>3,350</strong></td>
<td><strong>750</strong></td>
<td></td>
<td><strong>34,100</strong></td>
<td></td>
</tr>
</tbody>
</table>

NA: Not applicable
Fig. 2
Thousands of animals drowned in Central America after Hurricane Mitch, 1998

Fig. 3
Scavengers play an important role in carcass disposal after a natural disaster
Photo: courtesy of C.A. Zepeda Sein, Organismo Internacional Regional de Sanidad Agropecuaria

Fig. 4
Carcass disposal becomes a very difficult task during floods
An attempt is made to burn a drowned cow carcass

Animal welfare considerations
An important emergency response consideration in natural disasters is the alleviation of suffering and humane destruction of moribund animals. This includes the provision of feed and water in episodes such as fire, drought and floods. Veterinarians are best qualified to ensure the welfare of animals, including the decision and recommendations on methods for euthanasia (19). Euthanasia programmes are intended to prevent animal suffering and the spread of epizootics. However, the methods used and their intended effectiveness will also need to be justified to an international public who may have a poor understanding of the issues and benefits of such practice. Effective communication is probably only possible as part of a co-ordinated emergency management effort.

Recovery
An effective recovery phase from disasters commences with effective mitigation programmes which include the establishment of trade and mutual aid agreements between countries to supply goods and to restock livestock populations following a disaster. These agreements are implemented in the recovery phase and provide an opportunity to improve on existing systems. Appalling results can be seen if livestock are replaced without prior consideration of local needs following a disaster. There are too many examples of Bos taurus cows being sent to tropical countries, where they succumb to endemic diseases to which Bos indicus breeds are resistant. Furthermore, animals that are not adapted to heat suffer greatly from climatic change, resulting in extremely low fertility rates and virtually no milk production. These secondary disasters can be prevented through planning.

Development of international disaster reduction programmes for livestock industries in developing countries
The process of developing an international disaster reduction programme is similar to other emergency management planning processes. The following recommendations have been adapted from those made by the FAO (3) and are very similar to the four phases of plan development used in emergency management in the USA. To emphasise this
similarly, the terms from ‘Project Impact’ (United States Federal Emergency Management Agency) are used to summarise this process.

**Building community partnerships**

The four elements which comprise the building of community partnerships are as follows:

- Establish a national committee for veterinary disaster management. This committee should have the expertise to address contagious disease and geophysical disasters.
- Review existing national and international laws, regulations and policies and determine how these can be adapted to meet the needs of a national disaster reduction programme.
- Develop a matrix that clearly defines the relationship between Veterinary Services, and public health and environmental impact agencies.
- Establish a chain of authority and a chain of command to determine how the members of the disaster response force communicate with one another and with all other agencies active in all stages of the emergency management cycle. Examples of such agencies include emergency management, military services, and those with diplomatic ties, international trade partners, and departments of finance.

**Identify hazards and community vulnerability**

Hazards need to be identified and the vulnerability of the community assessed, by performing the following tasks:

- Establish a committee which reviews the impact of disasters and assesses the potential impact of disaster on the livestock industry of the country. This group should also develop and maintain disease surveillance methods using epidemiology, geographic information systems (GIS) and risk assessment methodology to enhance their efforts.
- Identify resources (laboratories, veterinary schools, animal and human health departments) that could play a role in the response to disasters and characterise the function of these resources in the cycle of emergency management.

**Prioritise hazard risk reduction actions**

The reduction of hazards needs to receive priority, through the following activities:

- Identify and make arrangements with national and international organisations which could provide resources and immediate and long-term response and recovery funds after a disaster.
- Establish a network of private resources willing and able to assist in recovery from disasters.
- Establish a committee that oversees the development and maintenance of resources through written and verbal agreements in non-disaster periods.
- Maintain census data and maps on livestock populations and public health indices that are related to food production (child mortality, infectious disease, per capita protein consumption).

**Communicate success**

Effective communication needs to be developed with farmers and their representatives in the livestock industry. Finally, plans should be rehearsed and practised at least once annually.

**Disaster relief**

International disaster relief can play an important role in recovery from disaster and subsequent development of a country. The World Health Organization recognises that disaster ‘relief must be integrated into long term plans for health and social development’ … because … ‘there is a clear link between emergency, rehabilitation and development. Humanitarian assistance should be accompanied by a renewal of commitment to economic growth and sustainable development of developing countries’ (23). In an ideal world, disaster-relief funding to support, rebuild and develop the livestock industry in a country should also be seen as a form of humanitarian assistance which benefits public health, and the social and economic power of a country.

The Pan American Health Organization has published guidelines on how to make international disaster relief effective. Although these guidelines were originally developed to address the needs of human disaster victims in Central and South America they also apply to animal health in many countries throughout the world (15).

Of particular importance is the emergency intervention fund which exists at the OIE; this shall be used for the sole purpose of a Member Country to deal with an animal disease emergency (e.g. following national disasters), while awaiting the provision of aid by other national or international institutions’.

**Acknowledgement**

Sections of this paper have been adapted from Chapters 31 and 32 of *Animal management in disasters*, published by Mosby-Year Books, St Louis, Missouri (USA) (4).
Gestion des catastrophes naturelles et de leurs conséquences sur la production animale dans les pays en développement

S.E. Heath, S.J. Kenyon & C.A. Zepeda Sein

Résumé
Les catastrophes naturelles, quelle qu’en soit l’origine, ont toutes des conséquences similaires sur la santé et le bien-être des animaux d’élevage. Les catastrophes d’origine géo-physique favorisent les épizooties, accroissent la mortalité animale et limitent la productivité. Ces catastrophes peuvent également altérer la qualité des produits alimentaires, ce qui représente un danger pour la santé publique. À terme, les catastrophes de grande ampleur affectant la production animale ont également un impact sur l’équilibre des économies nationales, sur l’environnement et sur les structures sociales.

Les auteurs décrivent la vulnérabilité du secteur de l’élevage devant les catastrophes naturelles ainsi que les conséquences des inondations, des sécheresses et des maladies et ravageurs transfrontières sur les économies nationales. Des exemples sont présentés, qui permettent d’éviter certaines pertes, de les évaluer ou de les compenser. Les auteurs définissent le rôle du vétérinaire et sa relation avec le travail mené par d’autres équipes de secours en cas de catastrophe.

Dans les pays en développement, les programmes visant à réduire les effets des catastrophes doivent se fixer pour objectif prioritaire le renforcement global des services de santé animale. La préparation doit être conduite en intégrant l’ensemble de la population, dûment formée à cet effet. La réhabilitation et le soutien après une catastrophe doivent se fonder sur de tels programmes, avec notamment la prise en compte du commerce international et des accords d’aide mutuelle entre pays voisins pour l’approvisionnement de marchandises et le transfert d’animaux acceptables sur le plan culturel et écologique.

Les soins d’urgence aux espèces animales domestiques doivent être considérés comme un aspect de l’aide humanitaire apportée après une catastrophe, compte tenu des bénéfices qui en découlent pour la santé publique et des effets socio-économiques d’une intervention réussie.

Mots-clés

Manejo de desastres que afectan al ganado en los países en desarrollo

S.E. Heath, S.J. Kenyon & C.A. Zepeda Sein

Resumen
Los diversos desastres naturales tienen consecuencias análogas sobre la sanidad y el bienestar de los animales de granja. Los desastres de origen geofísico favorecen las epizootias, incrementan la mortalidad y reducen la productividad. Estos desastres también representan un peligro para la salud pública, debido al riesgo de deterioración de los productos alimentarios elaborados. Además, los desastres en gran escala que afectan a los animales suelen modificar la estabilidad económica de los países, trastornando también el medio ambiente y las estructuras sociales.
Los autores describen la vulnerabilidad del sector ganadero ante catástrofes naturales y el impacto sobre las economías nacionales de inundaciones, sequías, pestes y enfermedades transfronterizas. Dan ejemplos de cómo evitar ciertas pérdidas, evaluarlas o compensarlas. Definen el papel que asume el veterinario en casos de emergencia, y su relación con el trabajo de los demás equipos de socorro.

En los países en vías de desarrollo, los programas destinados a reducir los efectos de los desastres deben tener como objetivo central el fortalecimiento de los servicios de sanidad animal. La preparación debe incluir la participación de la comunidad, educada al respecto en tiempo oportuno. La recuperación después de un desastre debe basarse en tales programas, y tomar en cuenta el comercio internacional y los acuerdos de ayuda mutua entre países vecinos para el suministro de mercancías y el aprovisionamiento de razas de ganado adecuadas desde los puntos de vista ecológico y cultural.

Las operaciones de socorro a los animales de granja durante un desastre merecen ser reconocidas como parte integrante de la ayuda humanitaria, considerando los beneficios que implican para la salud pública y las consecuencias socioeconómicas favorables de las intervenciones.

**Palabras clave**


**References**


