TECHNICAL REPORT

Analysis of the Status of Transboundary Animal Diseases and their Control in the SADC Region During the Period 2005-2011, Focusing on the Five Countries that Contribute Land to the Kavango Zambezi (KAZA) Transfrontier Conservation Area (TFCA)

Wildlife Conservation Society
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ANALYSIS OF THE STATUS OF TRANSBOUNDARY ANIMAL DISEASES AND THEIR CONTROL IN THE SADC REGION DURING THE PERIOD 2005 – 2011, FOCUSING ON THE FIVE COUNTRIES THAT CONTRIBUTE LAND TO THE KAVANGO-ZAMBEZI (KAZA) TRANSFRONTIER CONSERVATION AREA (TFCA)

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EXECUTIVE SUMMARY

A desktop study was undertaken to determine the status of transboundary animal diseases (TADs) in the countries that comprise the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA) and their neighbours. An attempt was made to compile a comprehensive database of relevant disease-related information from the region during the period 2005 – 2011, in order to inform ongoing policy discussions related to the application of alternative TADs control strategies in southern Africa. Examination of the data, however, revealed that disease-related information available in the public domain is incomplete and, in many cases, difficult to interpret.

Information related to the status and control of selected transboundary animal diseases and zoonoses in Angola, Botswana, Namibia, Zambia, and Zimbabwe (partners in the KAZA TFCA) for the period 2005 – 2011 was compiled from open access databases and scientific publications. Similar information was also assembled for the five neighbouring countries - Democratic Republic of Congo (DRC), Malawi, Mozambique, South Africa and Tanzania - that share borders with the KAZA countries. Although their borders are in general distant from the KAZA area it is possible that unrestricted movement of animals or infected material could introduce diseases that would ultimately impact on biodiversity, livestock and livelihoods in the KAZA region.

Diseases were selected based on their potential for transboundary spread, relevance for international trade, livelihoods and rural development, zoonotic potential, the presence of a wildlife reservoir host, and their potential to impact wildlife health and biodiversity conservation, directly or indirectly. They include multi-species diseases (anthrax, bluetongue, foot and mouth disease, rabies, Rift Valley fever and tsetse-transmitted trypanosomosis), diseases of cattle (bovine brucellosis caused by *Brucella abortus*, bovine tuberculosis, contagious bovine pleuropneumonia, lumpy skin disease, wildebeest-associated malignant catarrhal fever and theileriosis caused by *Theileria parva*), and diseases of other domestic animal species, *viz.* peste des petits ruminants, African horse sickness, African swine fever, notifiable avian influenza (H5 and H7) and Newcastle disease. Additionally, although information on its occurrence is not available from animal disease databases, the issue of canine distemper virus infection at the interface is discussed.

Sources of information included the World Animal Health Information Database (WAHID) of the World Organisation for Animal Health (OIE), the i-EMPRES database of the Food and Agriculture Organization of the United Nations (FAO), the Pan African Animal Health Yearbooks published by the African Union Interafrican Bureau for Animal Resources (AU-IBAR), the World Reference Laboratory for Foot and Mouth Disease (Institute for Animal Health, Pirbright, UK), and scientific publications. The information contained in this report is not exhaustive and it should be viewed as a dynamic document that can be expanded as more information becomes available.

Information retrieved related largely to the incidence of specific diseases and whether or not they are endemic, the control measures as reported to OIE and as reflected in the national animal health legislation, and the duration of outbreaks.

The frequency and quality of reporting varied according to countries, diseases and time periods. Reporting of the former OIE List A diseases (see introduction) was generally more complete than that for other diseases. There were some discrepancies between the reports for the same period reflected by WAHID and the Yearbooks.

With certain exceptions (notifiable avian influenza, contagious bovine pleuropneumonia, East Coast fever and peste des petits ruminants), all the diseases investigated are present or potentially present in all the countries, even if only in wildlife reservoirs.

The survey revealed that the information available in the public domain remains incomplete for most of the important diseases in the region. As a result, this report may not reflect the true pattern of their occurrence in the region during the period covered. The information does, however, provide a sense of major disease events and it also suggests that some of the control measures in place may be insufficient or inappropriate because there is little indication that important animal diseases are being managed in a way that effectively reduces their occurrence. Outbreaks of foot and mouth disease and Rift Valley fever, for example, appear to have increased during the 2005-2011 period studied. It is recommended that current control efforts be evaluated carefully and more effective approaches sought.

CONCLUSIONS

- Published information on the selected diseases including major TADs is incomplete for most countries in the study.
- Reporting on foot and mouth disease (FMD) by some countries in the region (for example Botswana and Namibia) has been timely and accurate and appears to provide a true reflection of the situation, an imperative dictated by the export trade in beef. Reporting on FMD elsewhere in the region, however, has been less rigorous and is less likely to reflect the true situation on the ground.
- Apart from FMD, diseases of particular concern for KAZA countries include contagious bovine pleuropneumonia (CBPP) for cattle, and bovine brucellosis, bovine tuberculosis, rabies and canine distemper where wildlife shares habitat with domestic animals.
- Peste des petits ruminants (PPR) has been identified by SADC as an immediate threat to the entire region. Although the only countries that have officially reported that the disease is present are DRC and Tanzania, seropositive goats were found in Zambia near the border with Tanzania, thus bringing the infection closer to the KAZA area. Since the DRC shares extensive borders with Angola and Zambia, it is not unlikely that improved surveillance in those countries might reveal further unwelcome information about this serious disease of small ruminants.
- Specific evaluation of the efficacy of control measures applied by the various countries was not possible but the reports of diseases indicate that more is needed for effective control.
- Disease outbreaks, in particular FMD and RVF, appear to be increasing in the region. Although some of this may be due to improved reporting, FMD is widely recognised to be on the increase in SADC countries and this is attributed at least in part to loss of effectiveness of vaccination.

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We are grateful to all the many people whose labours have produced and made available the information about animal disease occurrence in the region to the sources consulted.

ACRONYMS AND ABBREVIATIONS

AHEAD	Animal & Human Health for the Environment And Development
AHS	African horse sickness
AI	Avian influenza
AlHV-1	Alcelaphine *Herpesvirus*-1
ASF	African swine fever
AU-IBAR	African Union Interafrican Bureau for Animal Resources
BT	Bluetongue
BTB	Bovine tuberculosis
BTV	Bluetongue virus
CBPP	Contagious bovine pleuropneumonia
COMESA	Common Market for Eastern and Southern Africa
DRC	Democratic Republic of Congo
EAC	East African Community
EMPRES	Emergency Prevention Systems
EU	European Union
FAO	Food & Agriculture Organization of the United Nations
FMD	Foot and mouth disease
FMDV	Foot and mouth disease virus
FTA	Free Trade Area
HPAI	Highly pathogenic avian influenza
KAZA TFCA	Kavango-Zambezi Transfrontier Conservation Area
KNP	Kruger National Park
LSD	Lumpy skin disease
MCF	Malignant catarrhal fever

NCA	Northern Communal Area (Namibia)
ND	Newcastle disease
OIE	World Organisation for Animal Health
PATTEC	Pan African Tsetse and Trypanosomiasis Eradication Campaign
PPR	Peste des petits ruminants
RAB	Rabies
RVF	Rift Valley fever
SADC	Southern African Development Community
SAT	South African Territories
SIT	Sterile insect technique
TAD	Transboundary animal disease
TFCA	Transfrontier Conservation Area
VCF	Veterinary cordon fence
UK	United Kingdom
USA	United States of America
WAHID	World Animal Health Information Database
WCS	Wildlife Conservation Society
WRLFMD	World Reference Laboratory for Foot and Mouth Disease (recognised by the FAO)

INTRODUCTION

The Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA) is one of the most ambitious transfrontier biodiversity conservation initiatives in Africa, involving an area of more than 400 000 km^2 with five participating countries (Angola, Botswana, Namibia, Zambia, Zimbabwe) and with diverse land uses that include nature-based tourism and livestock production (WCS AHEAD 2011), as well as crop production. Managing wildlife-associated diseases that are of concern for livestock while protecting wildlife from diseases that are associated with domestic animals is a major area of potential conflict, particularly as the interface between wildlife and livestock increases (Bengis *et al.* 2002). There is also concern about zoonotic diseases at the wildlife/livestock/human interface. Approximately 75% of zoonoses that have emerged over the past two decades have a wildlife source (Bengis *et al.* 2004).

Among the KAZA countries there are marked differences in status with regard to animal diseases, including foot and mouth disease (FMD), the most trade-sensitive livestock disease. Botswana and Namibia maintain zones that are recognised as free of FMD without vaccination in order to export beef to the European Union (EU)[1], and both Zambia and Zimbabwe are in the process of trying to establish FMD-free zones for trade as well (Thomson & Penrith 2011). The SAT serotypes of FMD are endemic in most large populations of African buffalo (*Syncerus caffer*) in the SADC region. Democratic Republic of Congo (DRC), Tanzania and Zambia have experienced outbreaks caused by Type O as well as SAT serotypes, and Tanzania has reported outbreaks due to Type A as well (Table 2). The traditional methods of maintaining FMD-free zones in southern Africa, which include widespread application of veterinary cordon fences (VCFs), are often in direct conflict with the principles of biodiversity conservation (Ferguson & Hanks 2010, Mbaiwa & Mbaiwa 2006). The approach also denies access to higher value markets to livestock producers living in or adjacent to infected areas, many of whom depend almost entirely upon raising cattle for their livelihoods (Scoones *et al.* 2010, Thomson *et al.* 2004). The FMD problem in the SADC region can largely be overcome by new approaches to ensure safe trade in livestock commodities (Brückner 2011, Rossiter & Al Hammadi 2004, Thomson *et al.* 2004) provided that these are accepted by international trading partners. However, many other interface diseases have severe effects on livestock health and production and they must be adequately managed if livelihoods derived from raising livestock are to be sustained and improved. Having as much information as possible about the diseases of relevance is essential to enable predictions about infectious disease events (Woolhouse 2011).

The purpose of this study was to collate relevant, publicly available information on infectious diseases of importance in the KAZA region, including currently employed approaches to management, conduct an analysis of the quality and completeness of the data and the extent to which it provides an accurate picture of the animal disease situation in the region, and identify knowledge gaps.

The target countries for the study were Angola, Botswana, Namibia, Zambia and Zimbabwe. The following countries have been included in the tables because they share borders with one or more of the KAZA countries (indicated in parentheses) and could therefore potentially serve as a source of

[1] Botswana maintains this system but as of this writing not exporting to the EU.

infection due to cross-border movement of animals or products: DRC (Angola, Zambia), Malawi (Zambia), Mozambique (Zambia, Zimbabwe), South Africa (Botswana, Namibia, Zimbabwe) and Tanzania (Zambia). None of these countries share borders with the KAZA TFCA. However, there is increasing pressure for free trade in agricultural commodities in the SADC region (SADC 1996), and a decision taken in 2008 to establish a free trade area (FTA) by 2012 that will comprise SADC, COMESA and EAC (BBC News 2008), will eliminate import tariffs on agricultural products. Up-to-date information will be required by decision-makers to identify if and where such free trade might increase animal health risks - while non-tariff barriers to trade have not been abolished, both SADC and COMESA are exploring ways to minimise their impact on trade in the region (COMESA 2007, 2009; SADC 2008a,b).

According to the terms of reference for the study, the diseases to be included were the so-called transboundary animal diseases or TADs. The former List A diseases - FMD, vesicular stomatitis, swine vesicular disease, rinderpest, peste des petits ruminants (PPR), contagious bovine pleuropneumonia (CBPP), lumpy skin disease (LSD), Rift Valley fever (RVF), bluetongue (BT), sheep pox and goat pox, African horse sickness (AHS), African swine fever (ASF), classical swine fever, highly pathogenic avian influenza (HPAI), Newcastle disease (ND) - of the World Organisation for Animal Health (OIE) were defined as 'transmissible diseases which have the potential for very serious and rapid spread, irrespective of national borders, which are of serious socio-economic or public health consequence and which are of major importance in the international trade of animals and animal products' (Anon 2001). This definition has underpinned the concept of TADs although the separation of reportable diseases into List A and List B for the purposes of the OIE *Terrestrial Animal Health Code* has been abandoned in recognition of the fact that diseases that do not necessarily fit the definition of List A diseases can also have very serious consequences. It is evident that in a TFCA, where there should ideally be free movement of wildlife across national borders, any infectious animal disease present in the area becomes a potential TAD. The diseases were selected using the following criteria in addition to their potential for transboundary spread: potential to impact international trade, livelihoods and rural development, and their relevance at the wildlife/livestock/human interface, including presence of a wildlife reservoir host and/or zoonotic potential. The diseases are listed in Table 1.

The selected diseases are discussed in terms of their significance in the context of the KAZA TFCA, their status and activity in the region from 2005 – 2010/2011, the measures that are used to control them, and the degree to which these measures have succeeded and can be expected to succeed in the future. In view of the importance placed by OIE on particular diseases being notifiable to the veterinary authorities by law, an attempt was made to derive this information from the veterinary legislation of the different countries and the results are included in the notes on the individual diseases. All the diseases occur in at least two of the 10 countries, and most are present to a greater or lesser extent in all of them (Appendix 1 Table 1).

Table 1 Diseases selected

Disease	Observations
Anthrax	Zoonosis sometimes associated with wildlife in the region
Bluetongue (BT)	Vector-borne disease of ruminants with possible wildlife reservoirs
Foot and mouth disease (FMD)	Trade sensitive interface disease that is not eradicable in southern Africa because of the buffalo wildlife reservoir
Rabies	Zoonosis that presents an additional risk to threatened wild carnivores
Rift Valley fever (RVF)	Zoonosis that affects a wide range of species and has occurred in Botswana and Namibia in the period 2010 – 2011
Trypanosomosis	Vector-borne and sometimes zoonotic disease no longer notifiable to OIE (not included in the Terrestrial Animal Health Code for 2010 but information is available on the OIE WAHID interface); interface disease that impacts on livelihoods and has in the past impacted severely on wildlife due to depopulation in attempts to control tsetse fly
Bovine brucellosis	Zoonosis that has infected wildlife in various parts of the world and is difficult to eradicate from wildlife reservoirs
Bovine tuberculosis (BTB)	Increased zoonotic potential due to HIV/AIDS and has had severe effects on wildlife in some areas
Contagious bovine pleuropneumonia (CBPP)	Strictly a disease of cattle but three of the five countries are infected, CBPP is considered a major TAD by OIE and it can impact severely on livelihoods as occurred in Botswana in 1996; fencing deployed to control cattle movements can impact wildlife
Lumpy skin disease (LSD)	One of the most frequently reported diseases in sub-Saharan Africa and although it is a cattle disease and is usually non-fatal it has been included because of its high prevalence in the KAZA countries and its effect on hides and possible wildlife involvement in its epidemiology
Malignant catarrhal fever (MCF)	Wildebeest-associated MCF is an interface disease that is often fatal in cattle
Theileriosis (East coast fever, Corridor disease)	Disease caused by *Theileria parva* is a major constraint for cattle production and Corridor disease is associated with African buffalo
Peste des petits ruminants (PPR)	Spreading southward in Africa, endemic in Tanzania since introduction in 2009 with impact on livelihoods
African horse sickness (AHS)	Zebras are considered to be a maintenance host
African swine fever (ASF)	Interface disease with wild host; outbreaks are related to contact with warthogs in Botswana and Namibia but mainly related to movement of domestic pigs, in which it is endemic, in Angola and Zambia
Avian influenza (AI)	Potential zoonosis (H5N1) that is absent from the region so far; outbreaks of H5N2 in ostriches in Zimbabwe and South Africa have resulted in trade bans
Newcastle disease (ND)	Most frequently reported disease of poultry in the region, also occurs in wild species and is a major differential diagnosis for HPAI
Canine distemper virus (CDV)	Serious viral disease of carnivores that has caused outbreaks with fatalities in wild carnivores including African wild dogs, lion and cheetah

SOURCES OF INFORMATION

The information on the status and activity of the selected diseases was drawn mainly from OIE-WAHID (World Animal Health Information Database), supplemented by other sources (FAO i-EMPRES, AU-IBAR

Pan African Animal Health Yearbooks 2005 - 2010, FAO World Reference Laboratory for FMD (WRLFMD) reports and various scientific and related publications cited in the reference list).

Reports of disease events to OIE by member countries fall into two categories:

- exceptional epidemiological events, for which immediate notifications and follow-up reports are submitted until a final report is submitted when the event is considered to be resolved, and
- routine reports on the disease situation that are submitted every six months to OIE in which all the disease events for that period are reported, i.e. the occurrence of endemic diseases and exceptional events.

Exceptional epidemiological events that qualify for immediate reporting to OIE are outbreaks of a disease in an area where it is not endemic or, particularly in the case of FMD, where it is controlled, for example in protection zones and even in infected zones in countries that export beef from "free" zones. The status of endemic diseases is reflected in the routine 6-monthly and annual reports.

Reporting of animal disease events at the country level is also required by AU-IBAR and is published in the Pan African Animal Health Yearbooks with an analysis for each disease and for the disease situation in the region.

QUALITY OF INFORMATION

The quality of the data from any of the sources depends on a number of factors. Firstly, it depends on the accuracy and completeness of reporting, as well as how and whether the diagnosis was confirmed in a laboratory. For example, some reports of outbreaks do not specify the area in which the outbreak occurred and simply refer to 'the whole country'; some reports on FMD outbreaks indicate that the serotype was not determined. Secondly, it depends on the disease involved. In general, the reporting on FMD tends to be more complete than it is for most diseases, but information on the topotype is only available for recent samples processed by the WRLFMD for which reports are readily available. Thirdly, it depends on how the reporting countries interpret the reporting requirements. This is particularly noticeable in terms of the number of outbreaks. An outbreak may refer to the occurrence of the disease in a particular area regardless of the number of cases or foci, each focus may be treated as an outbreak, or each case is regarded as an outbreak. It is sometimes difficult to determine whether reports from different sources refer to the same or different outbreaks. The WRLFMD reports only reflect localities from 2009 onwards, and sometimes the date of collection of the sample is missing; samples are more often than not submitted to the WRLFMD after a time lapse, sometimes months. The information on the EMPRES database is almost entirely derived from the reports to the OIE but is comparatively easier to access.

The results of routine reporting to OIE are available from 2005 – 2010. They are reflected in Appendix 1 Tables 2 – 19. Only five countries (Botswana, DRC, Malawi, Mozambique and Namibia) had submitted reports for the first half of 2011 by the end of December 2011; these are reflected in Appendix 1 Table 20. Reporting of most TADs and zoonoses is routine in several of the selected countries because the diseases are endemic and outbreaks are therefore not considered exceptional. In many cases the

monitoring of such diseases is not conducted rigorously; disease occurrence may not be reflected in the reports, or where it is noted, may lack the supporting quantitative data necessary for confirmation. Often their presence refers to 'the whole country', which may not really be the case. The status of some diseases in some countries for particular periods is simply indicated to be unknown (e.g. for FMD in DRC in 2008 and in Malawi in the first half of 2009). There is no information for Zambia for 2005 or for Zimbabwe and Tanzania for 2006. The information for those periods was available from the AU-IBAR yearbooks for Zambia and Tanzania but no information was available for Zimbabwe for 2006 from that source either.

Immediate notifications and exceptional epidemiological events for 2011 are available on OIE WAHID, which also provides maps of outbreaks. The FAO i-EMPRES database provides information and maps for the last two years (from the date accessed) for the more important TADs. For the diseases accessed for this report almost all the information on i-EMPRES is derived from immediate and follow-up reports to OIE but occasionally other reports e.g. reports from FAO field officers are incorporated as well. This database provides a very useful and easily accessible synthesis of the information.

NOTES ON SELECTED DISEASES

The notes on the selected diseases include the following:

- Brief description of the disease
- Distribution
- Epidemiological features of importance
- Importance at the wildlife/livestock interface
- Occurrence (and reporting)
- Management

1. Multi-species diseases

1.1 Anthrax

Anthrax is a serious disease of mammals caused by *Bacillus anthracis*. Species susceptibility varies. Ruminants are severely affected and usually die within 24 hours of infection. Omnivores and carnivores are less severely affected; after ingestion of infected material they frequently develop a pharyngeal form of anthrax which, while potentially fatal if left untreated has a slower course and intervention is possible, as is the case with humans who develop the pharyngeal form after eating the uncooked meat of animals that have died of anthrax. Humans most often develop cutaneous anthrax after butchering animals that are dying or have died of anthrax.

Anthrax occurs worldwide and is endemic in all the KAZA countries and their immediate neighbours.

Infection usually results from the ingestion of spores; entry of spores via abraded skin is a rather common route of infection in humans, and inhalation of spores is considered to be rare. The spores are highly resistant and can persist in the environment, usually in soil, for very long periods of time, more

than 200 years under favourable conditions (De Vos & Turnbull 2004). The carcasses of animals that have died of septicaemic anthrax are potentially rich sources of infection. They contain large quantities of bacteria and sporulation starts before death, but most sporulation takes place if the carcass is opened, as exposure to oxygen is necessary. Disturbance of soil that contains large numbers of spores can also result in infection of animals grazing in the area. By opening carcasses and disseminating spores, scavengers and humans are potentially important in spreading anthrax. The spores may also be transmitted by blood-sucking flies and by contamination of vegetation by flies (as well as vultures) that feed on carcasses. Conditions considered to predispose to outbreaks are stagnation of water, overstocking or large concentrations of animals at watering points, and stress, for example caused by poor nutrition (De Vos & Turnbull 2004).

In many parts of the world anthrax has been largely controlled in domestic livestock by vaccination, but remains endemic in many national parks (Hugh-Jones & De Vos 2002). Anthrax is not an interface disease in the sense that it requires the presence of livestock to occur. However, where people have access to wildlife areas, outbreaks of anthrax can lead to human exposure following butchering of fresh carcasses. The Times of Zambia on 8th September 2011 reported that more than 90 hippos and 5 people had died of anthrax in the Chama District of Zambia's Eastern Province. It reported that 278 cases of anthrax had occurred in people, all of whom had touched or eaten the meat of the dead hippos. It is evident from this that anthrax is important at the wildlife/human interface.

By its nature anthrax is a sporadic disease that occurs when spores become available for ingestion. Endemic areas are characterised by the occurrence of sporadic large outbreaks which in the Kruger National Park (KNP) of South Africa have an approximately 10-year periodicity (De Vos & Turnbull 2004). In southern Africa major epidemics have occurred in the Luangwa Valley in Zambia, the Etosha National Park in Namibia and the Kgalagadi TFCA in Botswana and South Africa. Outbreaks outside conservation areas also occur, for example with some regularity in the Kimberley area in the Northern Cape Province of South Africa, where both farmed wildlife and domestic animals may be involved. Reporting for South Africa is fairly detailed and indicates that from 2005 – 2010 outbreaks occurred in six of the nine provinces as well as the KNP, with a major outbreak in the KNP in 2010 and otherwise the greatest number of reports coming from the Northern Cape. During the period 2005 – 2011 only DRC reported an outbreak of anthrax as an unusual epidemiological event (Appendix 1 Tables 21, 22), but anthrax featured prominently in the regular 6-monthly and annual reporting of most of the countries, with only Malawi not reporting any anthrax during the entire period (Appendix 1 Table 2). Namibia and DRC reported outbreaks during the first half of 2011 (Appendix 1 Table 20).

Relevant legislation in all the KAZA countries and their neighbours contains provisions for reporting anthrax, and in most cases control measures too, including quarantine, vaccination, treatment, proper disposal of carcasses and disinfection. Anthrax can be well controlled in livestock by vaccination of cattle, but the shifting of the responsibility for vaccination to farmers has led to less effective coverage, e.g. in South Africa (De Vos & Turnbull 2004). The application of vaccination in wildlife is problematic on account of the logistics and costs involved, for example vaccination by darts administered from a helicopter, which was found to be the most effective approach (De Vos & Turnbull 2004). Prompt disposal of carcasses is also often problematic as these may be in inaccessible areas or only observed

when scavengers have already opened them; they may also be very large. The recommended ways of disposal involve incineration, preferably smokeless, or rendering, both of which are expensive. Deep burial or simply covering the carcass to prevent access by scavengers can also be effective and may be the only methods available in remote areas.

Because of the length of time that the spores can remain viable, it is unlikely that any country could definitively state that it is free of anthrax. What is very important is to attempt to prevent human infection, which commonly occurs in poor countries where people butcher and eat animals that have died of disease. Creating awareness in communities of the dangers of this practice may be helpful to an extent, particularly where domestic animals are involved, as community leaders might be able to intervene and prevent access to the carcasses. When anthrax kills numbers of large animals like hippos, disposal of carcasses becomes problematic and human cases are likely. This is an example of an interface problem that should be tackled by human and animal health authorities as well as educationalists and social workers.

1.2 Bluetongue (BT)

Bluetongue (BT) is a vector-borne disease of domestic and wild ruminants caused by viruses belonging to the genus *Orbivirus* (family *Reoviridae*). It is a multisystemic febrile disease characterised by haemorrhage and oedema in target tissues that include the subcutis, upper gastro-intestinal tract, skeletal and cardiac muscle, lung, and coronary band of the claw as a result of injury to small blood vessels (Maclachlan *et al.* 2009).

BT was first diagnosed in South Africa but has subsequently been reported from all continents except Antarctica, occurring mainly in tropical and subtropical regions but also some temperate regions. From 2006 to 2009 outbreaks occurred throughout Europe and there was also expansion of the distribution of Caribbean serotypes into south-eastern USA and new serotypes invaded northern Australia (Maclachlan *et al.* 2009). The distribution of BT is largely determined by the presence of cattle and wild ruminants that act as amplifying reservoir hosts and of suitable species of *Culicoides* that are able to transmit the virus. Severe disease with high mortality has mostly been described in sheep and some wild species, for example white-tailed deer (*Odocoileus virginianus*) in the USA, but the serotype that invaded northern Europe proved highly pathogenic for cattle and also demonstrated the ability of northern *Culicoides* species to transmit the virus efficiently (Maclachlan *et al.* 2009). Carnivores can be infected by ingestion of animals infected with bluetongue virus (BTV) (Alexander *et al.* 1994).

BTV is transmitted by midges of the genus *Culicoides*. The main vector in southern Africa is *Culicoides imicola*. BT has a seasonal pattern in temperate and sub-tropical areas, occurring during summer and disappearing after the first frosts; the mechanism for survival of the virus during long cold winters has not yet been fully elucidated but is likely to involve both cattle and wild antelope (Verwoerd & Erasmus 2004).

African antelope and some indigenous breeds of sheep infected with BTV do not develop clinical disease (Verwoerd & Erasmus 2004). Their role in maintaining the virus means that BT may occur as an interface

disease and also that BT is likely to be widely distributed in southern Africa but is not detected on account of the absence of clinical disease.

Botswana reported outbreaks of BT in 2006 (Mahalapye) and 2008 (Lobatse). Namibia reported sporadic outbreaks in 2006 and 2010 and unquantified presence of the disease in 2007, 2008 and 2009. Zimbabwe reported no outbreaks but queried the presence of BT in Manicaland, Masvingo and Midlands in the first half of 2008, and reported two outbreaks of BT to the Pan African Yearbook in 2008, with 10 cases and one death. A single outbreak was reported to AU-IBAR in 2010 (Appendix 1 Table 23). Outbreaks occurred sporadically throughout South Africa in all the years of the study period. Malawi indicated that the status of the disease was unknown. The remaining countries did not report BT between 2005 and 2010 (Appendix 1 Table 3) but Namibia reported eight outbreaks between February and May in 2011 (Appendix 1 Table 20). This was likely the result of the unusually heavy rains experienced in large parts of the country.

As a former List A disease BT is notifiable in most countries as well as to OIE. Protection of livestock by vaccination is the responsibility of the farmer in South Africa and certainly elsewhere as well. Among the KAZA countries and its neighbours BT is of greatest importance in South Africa, which has a very large population of sheep susceptible to development of clinical disease that outnumbers cattle. Commercially farmed sheep are usually protected by vaccination. However, South Africa is the only one of the ten countries that reported a significant number of outbreaks during the study period.

1.3 Foot and mouth disease (FMD)

Foot and mouth disease (FMD) is a highly contagious vesicular disease of cloven-hoofed animals and some camelids caused by members of the genus *Aphthovirus* (family *Picornaviridae*). However, in sub-Saharan Africa the disease often does not spread with the rapidity characteristic of the disease in temperate climates (Du Toit 1932). It is typically characterised in temperate climates by high morbidity and low mortality but, once again, in sub-Saharan Africa morbidity rates may not be dramatic. The lesions in cattle affect the oral mucosa, the coronary band and interdigital space of the claws, and sometimes the udder. Pigs develop lesions predominantly on the snout rather than inside the mouth. It is without doubt the livestock disease that has the highest impact on trade and results in the exclusion of the majority of poorer countries from high value markets for livestock commodities.

FMD has been eradicated from most of the industrialised world (North America, western Europe, countries in South America and eastern Asia), although some countries, for example the United Kingdom, Japan and South Korea, have suffered severe outbreaks in recent years. FMD is otherwise widespread and is endemic in many developing countries, including most of sub-Saharan Africa. Seven serotypes are recognised that fall into two genetically distinct groups, one consisting of types A, O, C and Asia-1 with types A and O occurring widely in South America, south-eastern Europe, Asia and Africa, and a second consisting of the SAT (South African Territories) types 1, 2, and 3, which are confined to sub-Saharan Africa although exceptional outbreaks have occurred in North Africa and the Middle East (SAT 1) and the Arabian Peninsula (SAT 2) (Thomson & Bastos 2004). The great majority of outbreaks in southern Africa are caused by the SAT types. Outbreaks due to type O occur in DRC and types A and O

occur in Tanzania, north-eastern Zambia and northern Malawi, due to incursion from Tanzania. A recent publication indicates considerable FMD activity along the border between Tanzania and Zambia (Picado *et al.* 2011). A type O outbreak in South Africa in 2000 resulted from the feeding of ship's swill to pigs and it is believed that type O outbreaks in Angola in 1974 and in Mozambique in 1974 and 1980 may have resulted from cattle introduced from South America; type A outbreaks recorded in Namibia between 1958 and 1968 were believed to be imported from northern neighbours (Thomson 1994; Thomson & Bastos 2004).

Transmission of foot and mouth disease virus (FMDV) is usually by direct contact between susceptible and infected animals or their secretions and excretions. The mechanisms of transmission are fully discussed by Thomson & Bastos (2004). In the SADC region and East Africa the SAT types 1, 2 and 3 are endemic in most populations of African buffalo (*Syncerus caffer*). FMD outbreaks in cattle result from spill-over from buffalo but also from movement, usually illegal, of infected cattle. The carrier state in African buffalo that can result in infection of other wild species and domestic livestock is a unique feature of FMD in the parts of Africa where it occurs.

Intratypic variation of FMD viruses (i.e. genomic and antigenic variation within types) is common to all FMD virus types but more particularly to the SATs. Genotypes with more or less specific geographic distributions are known as topotypes, a situation that makes determination of viral spread relatively simple (Thomson & Bastos 2004).

FMD outbreaks were reported as exceptional epidemiological events in Angola in 2009, Botswana in 2005, 2006, 2007, 2008, 2010, and 2011, Namibia in 2007, 2008, 2010 and 2011, Zambia in 2008, 2010 and 2011, Zimbabwe in 2010, DRC in 2006, Malawi in 2008 and 2009, Mozambique in 2010, and South Africa in 2006, 2008, 2009, 2010 and 2011 (Appendix 1 Tables 20, 22). Angola reported an outbreak of FMD to OIE in 2009 in the Luiana area of Cuando-Cubango Province, which is within the KAZA TFCA. It was stated to be the first occurrence of FMD in Angola since 1974, and follow-up reports indicate that the outbreak is continuing and has not yet been resolved. Routine reporting (Appendix 1 Tables 4, 5) reveals that FMD was suspected in Zambia in 2006 and occurred in the second half of 2007 and in 2009. It also occurred in Zimbabwe in 2005 and 2007 – 2010; no information is available for 2006. The reports also indicate that it is endemic in DRC, Malawi and Tanzania. A recent publication maps 858 outbreaks of FMD that occurred in Tanzania from 2001 to 2006 (Picado *et al.* 2011), and notes that the areas where the most outbreaks occur are not areas where wildlife is most likely to be implicated. The routine reports for Tanzania included 192 outbreaks from 2005 to 2010, with no information available for 2006, but judging from Picado *et al.*'s data for 2001 to 2006 the incidence is likely to be much higher. The reports available from the WRLFMD provide information about phylogenetic relationships derived from genome sequencing. Additional information about the topotypes involved in outbreaks is available, mainly after 2009 (Table 2), but the value of this is reduced by the fact that there is inconsistency in the naming of topotypes.

Table 2. FMD information from the World Reference Laboratory reports 2005 – 2011

Country	Year	Serotype	Topotype
Zambia	12/2004	SAT 1	Northwest Zimbabwe (NWZ)
Botswana	08/2005	SAT 2	None defined; on dendrogram all 2005 isolates group together, nearest group 2 SAT 2 ZIM 2002
Zambia	01/2005	SAT 1	NWZ
Botswana	04/2006	SAT 2	None defined
DRC	03/2006	O	East Africa 2 (EA-2)
Botswana (Thokwana cow)	06/2006	SAT 1	Western Zimbabwe (WZ)
Botswana (buffalo 2)	07/2006	SAT 1	WZ
Botswana (buffalo 6)	07/2006	SAT 2	None defined
Botswana	10/2007	SAT 2	None defined
Zambia	11/2007	SAT 2	None defined
Namibia	11/2007	SAT 2	None defined; genetically closely related to ZAM 2007 viruses
Botswana	2008 (1-9)	SAT 2	None defined
Botswana	2008 (1-9)	SAT 2	None defined
Zambia	2008 (1-3)	SAT 1	WZ
Zambia	2008 (1-3)	SAT 2	None defined
Namibia	01/2008	SAT 2	None defined
Botswana	2008 (1-7)	SAT 2	None defined
Namibia	2008	SAT 2	None defined
Zambia	2008 (1-7)	SAT 1	NWZ
Botswana	10/2008	SAT 2	None defined
Zambia	01/2009	SAT 1	NWZ
Zambia	01/2009	SAT 2	III
Botswana	05/2009	SAT 2	III
Botswana	07/2009	SAT 2	III
South Africa	07/06(2009)	SAT 3	I (SEZ)
Mozambique	11/02(2009)	SAT I	I (NWZ)
Malawi	01/08(2009)	SAT 2	I
Tanzania (Iringa)	08/2008	A	AFRICA (Genotype G-1)
Tanzania (Morogoro)	05/2009	A	AFRICA (Genotype G-1)
Tanzania (Njombe Mun)	06/2009	A	AFRICA (Genotype G-1)
Tanzania (Kibaha)	06/2009	A	AFRICA (Genotype G-1)
Tanzania (Mpwapwa)	09/2009	A	AFRICA (Genotype G-1)
Tanzania (Iringa Rural)	11/2009	A	AFRICA (Genotype G-1)
Tanzania (Bagamoyo)	11/2009	A	AFRICA (Genotype G-1)
Tanzania (Morogoro)	09/2008, 05/2009	O	EA-2
Tanzania (Makete)	10/2009	O	EA-2
Tanzania (Makete)	10/2009	SAT 2	IV
Botswana (Kasane)	08/2010	SAT 2	III
Mozambique (Bilene)	10/2010	SAT 2	I
Zambia (Mbala, Northern)	10/2010	O	EA-2
Zimbabwe (Plumtree)	07/2010	SAT 2	II
Zimbabwe (Plumtree)	06/2010	SAT 2	I
Botswana (Maun)	02/2011	SAT 2	III
Botswana (Matsiloje)	04/2011	SAT 2	I
Botswana (Selibe Phikwe)	05/2011	SAT 2	I

Endemicity of FMD in African buffalo means that control efforts have largely focused on separation of domestic livestock from wildlife by means of veterinary cordon fences (VCFs) and vaccination of adjacent or sympatric cattle populations. The widely held perception that FMD is the world's most

important and threatening disease of livestock therefore dictates that FMD is the most important disease in the KAZA TFCA, because Botswana, Namibia and Zimbabwe (up to 2002) achieved access for their beef to the EU market by creating FMD-free zones without vaccination of cattle. This involves ensuring separation between cattle and buffalo by the creation of a protection zone in which cattle are vaccinated and by implementing strict movement controls. Zimbabwe lost its access after uncontrolled FMD outbreaks occurred in the formerly free zones from 2002 onwards owing to ineffective disease management. Botswana has temporarily lost access to the EU beef market owing to problems with its traceability system and food safety issues in its export abattoirs. FMD is one of the most regulated animal diseases in the region, featuring prominently in the legislation of all the countries included in the study.

An upsurge in the occurrence of FMD in SADC countries from 2002 - 2009 compared with the preceding 20 years was noted by Thobokwe *et al.* (2010). The change was attributed to climatic factors such as flooding that resulted in increased wildlife movement and mixing with domestic livestock as well as excessive reliance on vaccination. Other factors may include poor fence maintenance, decreased efficacy of vaccination, and generally poor disease management and control procedures in some countries in the region. There is evidence that vaccines against FMD in use currently in the SADC region do not adequately match some viral variants endemic to the region (SADC 2010).

Since cattle production in the region is not severely affected by FMD but the effects on trade, especially the export trade, can be devastating, it is evident that improved management of FMD is essential, while in the interests of biodiversity this needs to be achieved with no or minimum use of fences. The acceptance of appropriately processed de-boned beef as a safe product would go a long way towards improving market access for farmers currently excluded from higher value markets (Paton *et al.* 2010, Thomson *et al.* 2009). The availability of efficacious vaccines and their proper use could provide the reassurance that is crucial for sustainable marketing of beef from the region. Vaccination is usually used to control outbreaks. Neither Botswana nor South Africa has resorted to stamping out (culling) to control the free zone outbreaks that occurred there in 2010/2011 in spite of the fact that it facilitates regaining free status in the shortest possible time.

1.4 Rabies

Rabies is a fatal neurological disease that can affect all mammals caused by *Lyssavirus* 1 (family *Rhabdoviridae*). According to an editorial by Dr Bernard Vallat on the OIE website in September 2011 one person dies of rabies every 10 minutes.

Rabies occurs worldwide although a number of countries, mainly islands and peninsulas, are free of the disease. The disease is present throughout the southern African region.

Rabies virus is almost exclusively transmitted by the bites of diseased animals that excrete virus in their saliva before succumbing to the disease. The vast majority of people in southern Africa who die of rabies, as is the case throughout the world, acquire the infection from the bites of domestic dogs (Swanepoel 2004).

In the SADC region two groups of wildlife reservoir have been identified. There is a viverrid cycle (viverrid bio-type), in which several variants of mongoose virus circulate, the principle species involved in transmission being the yellow mongoose (*Cynictis penicillata*), slender mongoose (*Galerella sanguinea*), and suricates (*Suricata suricatta*). There is also a canid cycle (canid bio-type) with the most important maintenance hosts being domestic dogs, black-backed jackals (*Canis mesomelas*) and bat-eared foxes (*Otocyon megalotis*), with side-striped jackals (*Canis adustus*) being involved as well in some countries (King *et al.* 1994, Van Zyl *et al.* 2010). Viverrid viruses do not appear to spread epidemically in dogs and *vice versa*.

An exception to transmission via bites of infected animals is believed to have occurred during an outbreak of rabies in kudu (*Tragelaphus strepsiceros*) in Namibia from 1977 to 1985. Although the outbreak was apparently initiated by bites from rabid jackals, the number of kudu infected was very large in comparison to jackals and it is believed that kudu also became infected via abraded mucosa when browsing on thorny vegetation contaminated by the saliva of infected cohorts (Barnard & Hassel 1981, Barnard *et al.* 1982, Swanepoel 2004).

Domestic dogs are the major reservoir, and outbreaks of rabies have occurred in wildlife owing to contact with domestic dogs (Cleaveland *et al.* 2006, 2007), although transmission by wildlife hosts also must be considered (Hofmeyr *et al.* 2000, 2006, Johnson *et al.* 2004). Ultimately, rabies in wild African canids originates from domestic dogs, although populations of black-backed jackals and bat-eared foxes are able to maintain the virus independently of other species (Bingham 2005). Apart from sporadic events due to introduction of infected dogs in the 19th and early 20th centuries, the introduction of canid rabies into the areas of southern Africa south of the Zambezi River and its subsequent establishment as an endemic disease occurred relatively recently, in the middle of the 20th century (Brown 2011, Swanepoel *et al.* 1993).

Rabies is notifiable to OIE and legislation for its control is included in the animal health laws of all the countries in southern Africa, usually including specific regulations for the control of dogs. Because it is endemic it is usually not subject to immediate reporting to OIE, but in 2009 Angola reported a marked increase in rabies as an exceptional epidemiological event that was apparently brought under control by vaccination within a month of reporting (Appendix 1 Table 21). Routine reporting reveals frequent outbreaks or continuous presence without quantification in all the countries analysed (Appendix 1 Tables 6, 20).

Control is usually achieved by vaccination of dogs. Not much information is available on coverage in the KAZA countries, but certainly they face the same challenges that have been described in recent publications that indicate coverage generally falls short of what would be necessary to prevent outbreaks (Gummow *et al.* 2010, Mkhize *et al.* 2010, Van Sittert *et al.* 2010). The challenges are largely related to vaccinating dog populations that are poorly controlled and usually have a rapid turnover, as well as uncontrolled movement of dogs. Vaccination has been used successfully to protect African wild dogs against rabies (Hofmeyr *et al.* 2006) and strategies have been developed for delivery of oral vaccines to wild dogs as parenteral vaccination is often impractical (Knobel *et al.* 2003, Prager *et al.* 2011, Vial *et al.* 2006).

1.5 Rift Valley fever (RVF)

Rift Valley fever (RVF) is a disease of mammals caused by a *Phlebovirus*. The pathogencity varies according to species and age. Its main effects are seen in sheep and goats and to a lesser extent in cattle in the form of abortions and increased neonatal mortality, which can be extremely high in sheep. Animals that die of RVF have widespread haemorrhages and severe pathological changes in the liver. RVF is also a zoonosis that usually manifests as a mild febrile disease but in a small number of cases can cause retinal damage, or frequently fatal neurological disease or haemorrhagic fever.

RVF outbreaks have occurred in a number of African countries from South Africa to Mauritania and Egypt, as well as Madagascar. Since 2000 outbreaks have occurred on the Arabian Peninsula in Saudi Arabia and Yemen.

RVF is transmitted by various species of mosquitoes and in an outbreak in which many animals have a high viraemia can probably be transmitted by any mosquito. It is non-contagious and strictly mosquito-transmitted in livestock. Humans are usually infected by contact with fluids, in particular blood, from carcasses of animals that have died of RVF, although they can also be infected by bites of mosquitoes. Large outbreaks are linked to particular climatic conditions, usually to flooding after a period of drought, when there are very large numbers of mosquitoes. The virus is believed to be maintained in dormant stages of mosquitoes of the genus *Aedes* (Swanepoel & Coetzer 2004). However, the epidemiology has not been fully elucidated and high levels of seropositivity in wildlife as well as domestic livestock in some areas may indicate some involvement of mammalian maintenance hosts as well. Outbreaks are generally sporadic, and there may be intervals of 20 or more years between outbreaks in a particular area; however, outbreaks may also occur in consecutive years as has happened in southern Africa, mainly South Africa, since 2008. However, the 2008 and 2009 outbreaks in the eastern part of the country were caused by a different lineage of virus (C) from the 2010 and 2011 outbreaks, which were associated with lineage H virus first reported from Caprivi in 2004 (Grobbelaar *et al.* 2011). A large number of outbreaks occurred in South Africa in 2010 and 2011; in both years the greatest number of outbreaks occurred between March and May (Fig. 1).

In the SADC region major outbreaks have only been recorded in Tanzania (2007) and South Africa (2010 and 2011), as well as in Madagascar. In addition to South Africa, Botswana and Namibia reported RVF as exceptional epidemiological events to OIE in 2010, and Namibia reported three oubreaks in April to June 2011 (Appendix 1 Tables 20, 21, 22). The outbreaks occurred in the southern parts of the countries that were experiencing similar weather conditions to South Africa. In 2011 Namibia reported a separate outbreak in the north of the country which has not yet been resolved. Routine disease reporting reveals little activity, with, apart from the exceptional events reported, presence of the disease in DRC in the first half of 2007 and in 2009 and 2010 and a more or less continuous suspicion of its presence in Malawi (Appendix 1 Tables 7, 20). During the South African outbreaks a number of wild species were affected on game farms.

RVF is notifiable in Angola, Namibia, Zimbabwe, Mozambique, South Africa and Tanzania. South Africa makes a distinction between ‘controlled’ and ‘notifiable’; notifiable diseases must be reported but are

not controlled by state intervention. Thus owners of livestock are responsible for vaccinating their animals, although government may assist by vaccinating animals of poor farmers in the event of an outbreak. One of the major problems for control of RVF is its sporadic occurrence, which acts as a disincentive for vaccination as well as for vaccine production in the kind of quantities that are needed for a major outbreak. Although the weather conditions likely to produce outbreaks are predictable, there is usually not enough time to vaccinate large numbers of animals to enable them to mount an adequate immune response before the outbreak starts, let alone to produce the amount of vaccine that would be required for a successful vaccination campaign. The rather high number of human cases recorded during the 2010 RVF outbreaks in South Africa, namely 242 cases of which 26 were fatal, may raise awareness of the need to protect livestock against RVF regardless of whether or not an outbreak is considered likely.

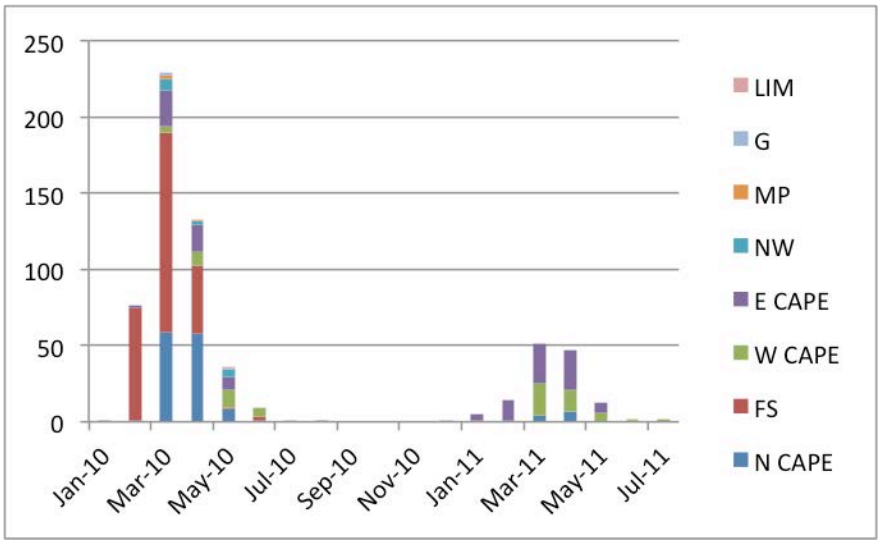

Figure 1. Rift Valley fever outbreaks in South Africa 2010 – 2011 (compiled from data on i-EMPRES). Key to South African provinces: LIM = Limpopo, G = Gauteng, MP = Mpumalanga, NW = North West, E Cape = Eastern Cape, W Cape = Western Cape, FS = Free State, N Cape = Northern Cape

1.6 Trypanosomosis (tsetse transmitted)

Bovine trypanosomosis, or nagana, is caused by species of *Trypanosoma* (*T. congolense, T. vivax, T.brucei*) that are transmitted by tsetse flies. Trypanosomosis is characterised by intermittent fever that coincides with the presence of parasites in the blood, followed by anaemia, loss of condition, reduced productivity and often death.

Three major fly belts determine the distribution of trypanosomosis in southern Africa (Connor & Van den Bossche 2004). The KAZA TFCA falls partly in the *Glossina morsitans centralis* fly belt, covering western Zambia, parts of western Angola, the Kwando River drainage area in Caprivi and the Okavango Delta in Botswana.

African trypanosomes, with the exception of *T. equiperdum*, which causes dourine in equines and is sexually transmitted, are transmitted predominantly by tsetse flies (*Glossina* spp.). They can also be transmitted mechanically by other blood-sucking flies. Lengthy coevolution has resulted in a stable relationship between many species of wild animals, tsetse flies and trypanosomes. A wide variety of domestic species can be infected and only certain trypanosomes are highly pathogenic. Cattle are most often seriously affected, but there are areas where pig production is impossible owing to the presence of *T. simiae.* Human sleeping sickness is caused by *T. brucei rhodesiense* in southern and eastern Africa; this subspecies occurs in cattle but is less pathogenic for them than *T. congolense* and *T. vivax.*

Disease caused by trypanosomes was first recognised in 1880 in India, and in 1895 Bruce published the important information that 'tsetse fly disease' or 'nagana' in cattle was caused by trypanosomes in what was then Zululand (Connor & Vand den Bossche 2004). The relationship between wildlife, tsetse flies and trypanosomes became evident after large numbers of wildlife died of rinderpest in the 1890s, as well as millions of cattle, and nagana disappeared with the tsetse flies, left without hosts to feed on. Tracts of land that had been unsuitable for cattle production due to nagana became available and cattle were introduced in large numbers, but by 1929 – 1931 wildlife and tsetse fly populations had recovered and trypanosomosis once again threatened cattle production. Efforts to control trypanosomosis by eliminating wildlife started in 1932 (Connor & Van den Bossche 2004), and often have targeted wildlife habitats as well as to some extent wildlife, although it was soon realised that killing wild animals for that purpose was neither effective nor acceptable. Livestock within or adjacent to the fly belt are at risk of infection. Trypanosomosis is also of concern for human health at the wildlife interface. *T. brucei rhodesiense* has recently been reported in African buffalo in the Luangwa Valley, Zambia (Anderson *et al.* 2011).

Reporting for trypanosomosis is patchy. Botswana did not report trypanosomosis to OIE in the study period but did report its presence to AU-IBAR in 2007 and 2010 (Appendix 1 Tables 8, 23). Eradication of tsetse fly from the Okavango Delta by a combination of aerial spraying and sterile insect technique (SIT) was envisaged in the Ninth National Plan for Botswana (Thomson & Penrith 2010). Trypanosomosis was last reported to OIE by Namibia in 2005, although the WAHID data indicate uncertainty in 2009, 2010 and 2011 (Appendix 1 Tables 8, 20) and it appears as present there in the 2010 yearbook. The disease is endemic in the remaining countries, but in South Africa is confined to the northern part of KwaZulu-Natal Province, which falls in the *G. austeni/G. brevipalpis* fly belt shared with southern Mozambique.

Trypanosomosis is a notifiable or controlled disease in all the countries in this analysis. There is no vaccine and management therefore depends on vector control and chemotherapy for affected cattle, which are often beyond the resources of poor cattle owners. Several countries have special regulations that include measures to control tsetse flies. The older legislation for tsetse control sometimes includes destruction of wildlife as well as vegetation, but such drastic measures, in particular destruction of wildlife, are not included in more modern laws. Aerial spraying with insecticide has proven effective and is carried out in Caprivi and the Okavango Delta. The broader environmental impacts of this approach, however, are not clearly understood.

It has been estimated that the enormous projected cost of eradicating tsetse flies and trypanosomosis from the African continent would be amply compensated by the financial benefits over the next 20 years, but it would require area-wide approaches using biological control measures that would include SIT and biopesticides, which might be difficult to implement (Reichard 2002). In 2000 the African Union launched the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC), supported by the African Development Bank. Success of the campaign will require and likely depend upon the commitment of national governments at the highest level (http://www.africa-union.org/Structure_of_the-Commission/dep.Pattec.htm, accessed 7 November 2011). Tsetse flies, and with them trypanosomosis, have been eradicated from the island of Zanzibar but the continental situation is more challenging (Reichard 2002). The ability of tsetse flies to spread from residual pockets was demonstrated in southern Africa after rinderpest decimated wildlife and cattle populations in the 1890s; as cattle and wildlife populations increased, the flies began to spread and by 1931 were estimated to be spreading at a rate of 2500 km^2 annually (Connor & Van den Bossche 2004). The lack of a vaccine and the expense and difficulty of implementing alternative strategies have meant that in practice in post-colonial times control efforts have been largely dependent on donor-funded projects, which raises the question of whether control could be sustainable without external funding.

2. Bovine diseases

2.1 Bovine brucellosis (*Brucella abortus*)

Bovine brucellosis caused by *B. abortus* is an erosive disease affecting reproduction, with the most common manifestation being abortions during the first parity. It is also a zoonosis.

Bovine brucellosis occurs worldwide although many countries have eradicated it or otherwise claim to be free of it. Information available from WAHID indicates that some African countries report absence of the disease, but the accuracy of such reports may be questionable where no surveillance for the disease is specified. The presence of brucellosis in less developed countries may go unnoticed, including in humans in areas where fever is more likely to be attributed to malaria.

Bovine brucellosis is a venereal disease and is also spread by contact with or ingestion of infected material. Transmission to humans is usually via birth fluids during assisted births or handling infected reproductive tracts and the disease usually occurs in people who work with animals, but it can also be transmitted by drinking milk that has not been subjected to heat treatment (pasteurization or boiling).

Brucellosis can affect wild species as well as domestic livestock; southern African wildlife species from which it has been documented include African buffalo, eland (*Taurotragus oryx*) and waterbuck (*Kobus elipsiprymnus*) (Godfroid 2002). Game ranching has probably contributed to its emergence in wildlife (Godfroid 2002), but the infection is most likely to have originated in domestic cattle. In North America there are reservoirs in bison and elk in some national parks that sometimes spill over into cattle (cattle having introduced the disease originally), and in southern Africa the African buffalo is believed also to be a potential reservoir for *B. abortus* (Godfroid 2002).

Although bovine brucellosis is on the OIE list of diseases that should be reported and features in the legislation of all the KAZA countries and their neighbours with the exception of Malawi and Tanzania, notification of its occurrence to OIE in routine reporting is generally absent from reports from 2006 to 2010; all the countries except Zambia and Malawi reported it to be present in 2005 (Appendix 1 Table 9). It is uncertain whether reporting was not required from 2006 onwards, but bovine brucellosis remains an OIE-listed disease. Reporting of brucellosis (all types without distinguishing between them) to AU-IBAR was more consistent, with Malawi being the only country that did not report its presence from 2005 to 2010 (Appendix 1 Table 23).

Control of brucellosis is generally the responsibility of livestock owners, although there may be voluntary schemes for its eradication operated by the government (e.g. South Africa). Heifers are vaccinated at the age of four months with a live vaccine that confers lifelong immunity. Vaccines that elicit cellular immunity but not humoral immune responses are also available and have the advantage that they do not complicate serological surveillance.

2.2 Bovine tuberculosis (*Mycobacterium bovis*)

Bovine tuberculosis caused by *Mycobacterium bovis* is an erosive disease of cattle that can affect many other species including humans, and concerns are increasing in terms of human disease because of the high level of infection with HIV in many SADC countries. The main target in cattle is the respiratory system and in cattle the most common lesions are tubercular pneumonia and pleuritis with involvement of the regional lymph nodes, but other systems may also be affected.

Bovine tuberculosis occurs worldwide although it has been eradicated or is reported to be absent from many countries (WAHID). It is likely to be under-diagnosed in cattle in countries that do not test live animals and where only a small percentage of the cattle are subjected to inspection at slaughter.

The most important epidemiological features of bovine tuberculosis are that it can affect multiple species, it may be inapparent in a herd particularly if the condition of the animals is generally poor, and the bacteria are shed in milk. Raw milk can therefore be a source of infection for humans.

Mycobacterium bovis is an emerging pathogen of free-ranging wildlife that poses challenges in terms of diagnosis and management (De Lisle *et al.* 2002). Infection of African buffalo in KNP in South Africa has resulted in various other species, including predators and scavengers, becoming infected (Keet *et al.* 1996), and there have been fears for serious effects on the lion population in particular.

Bovine tuberculosis is reportable to OIE and features in the legislation of all the countries included in the analysis with the exception of Tanzania. It appears in the routine reports (Appendix 1 Table 10) from all the countries except Botswana and Zimbabwe; Botswana reported absence for 2005 – 2008 and provided no information for 2009, 2010 and 2011 (Appendix 1 Tables 10, 20). Zimbabwe reported absence for the entire period with the exception of 2006, when no information was submitted, but it appears in the 2009 yearbook as present in that country (Appendix 1 Table 23). Namibia reported it to be present in 2006 only. Angola reported outbreaks or presence of disease throughout the period and so did Zambia, with the exception of 2005, when no information was provided. DRC, Malawi,

Mozambique and South Africa reported outbreaks or presence of disease throughout the period. Tanzania reported no disease for 2005, 2007 and 2008, provided no information for 2006, and presence of the disease for 2009, 2010 and the first half of 2011; on the other hand the only yearbook that includes Tanzania in the countries positive for BTB is 2007.

Control of BTB relies on surveillance of live cattle using the tuberculin skin test or the gamma interferon assay as well as inspection of carcasses at slaughter. Herds can be cleared of infection by systematic removal and slaughter of infected animals. Testing for bovine tuberculosis in wildlife presents problems because using the tuberculin skin test requires the animals to be handled twice in a period of three days; in addition, the range of reactions to tuberculin have not been standardized for most wildlife species. Attempts are being made to optimise the gamma interferon assay used in cattle for use in African buffalo so that the animals would only need to be sampled once (Michel *et al.* 2011). Culling of infected buffalo is currently not undertaken unless animals are visibly affected.

2.3 Contagious bovine pleuropneumonia (CBPP)

Contagious bovine pleuropneumonia (CBPP) is a respiratory disease of cattle caused by *Mycoplasma mycoides* subsp. *mycoides* SC. In naïve populations it manifests as severe acute serofibrinous pleuropneumonia that can be fatal, or animals recover slowly. Sequesters containing viable mycoplasmas may be present in the lungs of recovered animals. In endemic areas CBPP is generally mild or subclinical. Calves under the age of six months may only develop arthritis of the carpal and tarsal joints, but in naïve herds pleuropneumonia has been observed in calves as young as three months of age (Thiaucourt *et al.* 2004).

CBPP has occurred worldwide and was introduced into Africa from Europe, but it has been eradicated everywhere with the exception of sub-Saharan Africa and some countries in the Near and Middle East (Thiaucourt *et al.* 2004). It is currently present in three of the KAZA countries (Angola, Namibia and Zambia). It distribution in Namibia is limited to the Northern Communal Areas (NCAs) and in Zambia to the Western Province, i.e. the areas adjacent to Angola. It is endemic in DRC and Tanzania.

Its host range is restricted to domestic cattle. The most important route of infection is direct transmission during contact between infected and susceptible cattle, mainly via aerosols. Transmission is rapid during the peak of an outbreak when infection pressure is high but is much slower when infection pressure is low in the initial and later stages of an outbreak, making it difficult to detect. The incubation period is variable and can be up to three months, but is short during epidemics in naïve populations. The role of animals with sequesters in transmission of CBPP, if any, is unknown but is unlikely to be important since rupture of a sequestrum would be required for the organisms to be released.

There is no evidence that any wild species can develop a productive infection even under experimental conditions, but as a disease targeted for eradication by OIE/FAO that is apparently endemic in three of the KAZA member countries, partly within the KAZA TFCA, it is possible that control measures could impinge upon conservation. For example, failure to control CBPP in Angola or Zambia could result in

pressure to use livestock fences to protect neighbours. An outbreak in one of the free countries could also impact livelihoods that depend upon cattle, and this could in turn impact wildlife.

None of the KAZA countries or their neighbours reported CBPP as an unusual epidemiological event between 2005 and 2011. Angola, Namibia and Zambia reported outbreaks every year from 2005 – 2010 and Namibia and Zambia in the first half of 2011 as well (i.e. for which routine reporting data are available). Botswana and Zimbabwe are recognised to be free of the disease. Among the neighbouring countries it is endemic in DRC and Tanzania (Appendix 1 Table 11), and absent from Malawi, Mozambique and South Africa, all of which are considered free of the disease..

CBPP features in the legislation of all the KAZA countries and their neighbours. Cross border movements of infected cattle are responsible for outbreaks in countries that are free of CBPP, as happened in Botswana in 1995 and also in Tanzania in 1990. In CBPP-free countries, management focuses on preventing incursion by movement control, but this has failed to prevent the spread of CBPP from Angola into northern Namibia and western Zambia. The outbreak of CBPP in Botswana in 1995 was introduced with infected cattle from Namibia. The outbreak was eradicated by massive culling of all the cattle north of cordon fences, some of which were erected specifically to control the outbreak and prevent further incursions (Amanfu *et al.* 1998, 2000). The massive cull was found to have had a negative impact on public health and rural livelihoods and it was suggested that the approach is not reasonable for Africa (Hamsten *et al.* 2010, Mullins *et al.* 2000). It is not applied in countries where the disease is endemic. Vaccination for CBPP is carried out in Angola, Namibia (NCAs) and Zambia (Western Province and the Kazangula District of Southern Province) but for various reasons that include both procurement and delivery problems coverage is not regarded as satisfactory, particularly in Angola and Zambia. This is reflected in vaccination statistics supplied to OIE and was also apparent from a survey undertaken in 2010 under the AU-IBAR VACNADA project. A major problem for delivery is the short period available for administration after the 100-dose freeze-dried vaccine has been reconstituted, as poor infrastructure makes it difficult to reach sufficient cattle before the vaccine is considered to have deteriorated to the point where it is no longer usable. A primary vaccination with either of the currently available vaccines achieves only 40 – 60% protection but this improves to 80 – 85% if the animals are revaccinated a year later (Thiaucourt *et al.* 2004). There is no doubt that the presence of CBPP in Angola and Zambia results in outbreaks of CBPP in the Northern Communal Areas of Namibia and poses a threat to Botswana.

2.4 Lumpy skin disease (LSD)

Lumpy skin disease (LSD) is a nodular dermatitis of cattle caused by a *Capripoxvirus* that is closely related to the virus that causes sheep and goat pox. It is usually a non-fatal disease whose main importance is the damage caused to hides, but mortality can be as high as 10% (Coetzer 2004). The lesions, which consist of necrotic infarcts, are not confined to the skin and may be present in the mucosa of the upper digestive and respiratory tracts and the genital tract. Lesions on the udder can cause a severe drop in milk production and inhalation of necrotic material from the upper respiratory tract can lead to pneumonia that may be fatal.

LSD is widespread in sub-Saharan Africa including Madagascar, and outbreaks have been reported in Israel and the Arabian Peninsula (Bahrain) although the latter outbreak was not confirmed virologically. In 2008 it was the disease most often reported to AU-IBAR. LSD is endemic in most of the SADC countries including the KAZA member states.

There are large gaps in our knowledge of the epidemiology of LSD. Direct transmission has proven difficult under experimental conditions and it is believed that transmission is largely by vectors, although no biological vector has been identified. Recent research has suggested that ixodid ticks may be involved in transmitting the virus (Tuppurainen *et al.* 2011).

Various wild species including giraffe and impala are susceptible to experimental infection with the virus, and a serological survey of a wide range of African wild species found a low percentage of (10% or less) of giraffe, impala, springbok, kudu, waterbuck and reedbuck positive (Babiuk *et al.* 2008).

In spite of its endemicity, Mozambique in 2006 and Namibia in 2009 reported a marked increase in incidence of LSD as an exceptional epidemiological event (Appendix 1 Tables 21,22). Routine reporting shows it to occur frequently in all the countries, with outbreaks or presence reported annually for the entire period by all of them (Appendix 1 Tables 12, 20).

Namibia is the only country in the region in which it is not listed specifically in the current legislation. LSD can be controlled by vaccination, which is usually the responsibility of the owner.

2.5 Malignant catarrhal fever (MCF) (wildebeest-associated)

Malignant catarrhal fever (MCF) or bovine malignant catarrh is a disease of cattle and occasionally other species caused by alcelaphine *Herpesvirus* 1 (AlHV-1). Cattle develop multi-systemic disease that results from vasculitis in multiple organs, in particular the eye, kidney and brain. MCF was believed to be invariably fatal in cattle but serological surveys have suggested that some cattle survive, presumably after developing only mild or subclinical disease (Reid & Van Vuuren 2004).

Wildebeest-associated MCF occurs or has occurred wherever the natural hosts of the virus are present. It is therefore present throughout southern and eastern Africa where wildebeest occur and has also occurred elsewhere in zoological collections, although the causal agent was not always confirmed as AlHV-1 (Reid & Van Vuuren 2004).

The natural hosts of the virus are blue and black wildebeest (*Connochaetes taurinus taurinus, C. t. albojubatus, C. gnou*), which show no signs of MCF. The epidemiology of the disease has not been fully elucidated but wildebeest calves may be infected *in utero* or become infected by other calves during the first few months of life. Although the long and variable incubation period complicates determination of the time of natural infection, seasonal patterns of disease occurrence and the fact that calves shed large amounts of virus suggest that cattle usually become infected during the wildebeest calving period. Direct contact is apparently not necessary for infection and transmission is believed to have occurred over considerable distances; 800m has been reported in South Africa (Reid & van Vuuren 2004).

MCF is currently not on the list of diseases that should be reported to OIE. In the SADC region it is a controlled disease in Namibia and a notifiable disease in Mozambique, South Africa and Zimbabwe. Routine reporting to OIE revealed two outbreaks followed by confirmed presence of MCF in Namibia in 2007 and unquantified presence of MCF in Zimbabwe in the first half of 2008. South Africa reported 60 outbreaks in 2006, 74 in 2007, 1 in 2008 but no information is available for the other years (Appendix 1 Table 13). Outbreaks in South Africa are usually associated with game ranching rather than the interface between wildlife reserves and farmland (Reid & van Vuuren 2004). MCF was only covered in the Animal Health Yearbooks for 2006 and 2007, and was only reported by Botswana and South Africa (Appendix 1 Table 23).

There is no vaccine and the only way to control the disease is for livestock owners to keep their cattle away from areas frequented by wildebeest during the calving season. Lifting of restrictions on movement of wildebeest in South Africa in 1993 resulted in an increase of MCF in cattle in areas that experienced a large influx of wildebeest (Reid & Van Vuuren 2004).

2.6 Theileriosis (*Theileria parva*) – East Coast fever and Corridor disease

East Coast fever (ECF) and Corridor disease (CD) are both caused by *Theileria parva*. Although the parasites causing the two diseases are morphologically, genetically and antigenically indistinguishable, CD is transmitted from African buffalo, in which it is asymptomatic, to cattle, and is more acute and rapidly fatal than ECF. It is therefore assumed that the agent of ECF is cattle-adapted, although it nevertheless causes serious and if untreated fatal disease in cattle, while the CD agent is buffalo-adapted. Because it is not possible to distinguish between the agents of the two diseases, a diagnosis of CD is based on a link with African buffalo, the severity of the disease, and the fact that examination of lymph node and blood smears reveals very few organisms, as opposed to ECF, where organisms are usually easily found (Lawrence *et al.* 2004a,b).

The distribution of CD is wider than that of ECF, which does not occur in Namibia, Botswana or South Africa, but both diseases occur in Zambia and countries to their north. A third form of theileriosis, 'January disease' or 'Rhodesian theileriosis' occurs in Zimbabwe (Lawrence *et al.* 2004c). As a result, in reporting the disease no distinction is usually made between them or they are all referred to as one and the same. This creates confusion to the extent that some reports indicate the presence of ECF in countries where it definitely does not occur, like South Africa. The OIE and AU-IBAR reports are therefore unhelpful in determining the distribution of the two diseases but with the exception of Namibia, Botswana and South Africa it can be assumed that both are endemic in at least parts of the remaining countries in the analysis where the tick vector occurs.

Theileriosis is a tick-borne disease. The principle natural vector is the brown ear tick *Rhipicephalus appendiculatus* but *R. duttoni* and *R. zambeziensis* have proven to be important locally. A range of other ticks may transmit *T. parva.*

No wildlife involvement exists for ECF but CD is an interface disease on account of transmission from buffalo to cattle. CD apparently has no adverse effect on buffalo. Fatal theileriosis caused by novel species of *Theileria* has been reported in sable and roan antelopes (*Hippotragus niger, H. equinus*),

greater kudu (*Tragelaphus strepsiceros*) and common grey duiker (*Sylvicapra grimmia*) in southern Africa (Nijhof *et al.* 2005).

The OIE reports indicate that Botswana and Namibia reported theileriosis to be absent throughout the study period. Angola reported it as present but not quantified in 2005, absent in 2009 and 2010 and submitted no information about it from 2006 – 2008. Zambia, DRC, Malawi and Tanzania are endemically infected with ECF and reported it to varying degrees throughout the period (Appendix 1 Table 14); DRC reported it to be present and Malawi did not include information about it in the first half 2011 report (Appendix 1 Table 20). Some additional unpublished information is available about theileriosis in Mozambique because one of the authors (MLP) was at the diagnostic laboratory in Maputo from 2002 to 2006. ECF was regarded as endemic in the northern part of Tete Province but the rest of the country was free. In 2004 an outbreak of ECF occurred in Nampula Province, probably as a result of the accidental introduction of infected ticks. In 2005 cattle died in Gaza Province and CD was diagnosed; a small group of African buffalo that had apparently escaped from the KNP was subsequently located in Gaza Province. These were the theileriosis outbreaks reported to OIE in 2005. In 2007 outbreaks were reported in Maputo Province and these are most likely also to be CD as a result of buffalo contact.

Control of ECF depends upon vaccination and tick control, and in some countries where these activities are no longer supported by official government programmes they have largely broken down. Vaccination against ECF involves an infection-and-treatment regimen and has exacting cold chain requirements (Lawrence *et al.* 2004a), which may largely explain why owners are reluctant to implement it. CD provides another reason to separate cattle from African buffalo, including in areas where the buffalo are not infected with FMD, as was historically the case in KZN Province of South Africa where CD was first reported (the name is derived from the Corridor that used to separate the Hluhluwe and Imfolozi conservation areas).

3. Caprine and ovine diseases

3.1 Peste des petits ruminants (PPR)

Peste des petits ruminants (PPR) is a disease of sheep and goats caused by a *Morbillivirus* that is closely related to the virus that caused rinderpest. The virus causes a mucosal disease that affects both the respiratory and gastro-intestinal tracts, and is often fatal, particularly in naïve populations.

Historically confined to West Africa and the Middle East, PPR was of no interest in Africa south of the equator, but in the last decade the distribution area of PPR has increased markedly. PPR occurs in the majority of West African countries and extends east and northwards to Egypt, Sudan, the Horn of Africa, Uganda, Kenya and most recently Tanzania. It is present in the Near and Middle East and southern Asia from Turkey and the Arabian Peninsula to India and Bangladesh (Rossiter 2004).

Apart from sheep and goats, clinical disease has been reported in camels (Khalafalla *et al.* 2010) and water buffalo (Govindarajam *et al.* 1997). The virus can infect cattle and pigs without causing disease. Transmission of the virus occurs mainly via direct contact and possibly by aerosols. Maintenance of the

virus depends on the availability of large populations of susceptible animals with a high degree of contact, as there is no long-term carrier state, and movements of livestock play a crucial role in the spread of the disease (Rossiter 2004).

Some wildlife species are susceptible to infection and develop clinical and fatal disease. This has chiefly been demonstrated in outbreaks that have occurred in zoological collections (Rossiter 2004). A survey of grey duiker in Nigeria revealed that 10.5% of 38 animals were positive to antibodies to PPR virus (Ogunsanmi *et al.*2003).

Outbreaks occurred in Arusha (Ngorongoro) in Tanzania in 2009, reported as an exceptional epidemiological event to OIE (Appendix 1 Tables 21, 22). The follow-up reports indicated that the event started in December 2008 and was resolved by April 2009, but routine reporting reveals that the disease is now considered endemic in Tanzania. PPR is also endemic in DRC (Appendix 1 Tables 15, 20). In a recent release the OIE declared PPR to be a threat to the entire SADC region. PPR is currently notifiable in Angola, DRC and Mozambique has recently been named as a priority TAD for SADC (SADC Livestock Technical Committee, Nov 2011) and is on the list of controlled diseases in South Africa (and presumably also in Tanzania since its incursion).

Recommended disease control measures include quarantine of infected animals, movement control and vaccination. Disease control is complicated by the management and distribution of small ruminant populations in rural areas that make access to the whole population difficult, and by the ease with which small ruminants can be moved over long distances.

4. Equine diseases

4.1 African horse sickness (AHS)

African horse sickness (AHS) is a multisystemic disease of equids caused by an *Orbivirus* that is often serious and fatal in horses. Various forms of the disease are described: an acute respiratory disease that is rapidly fatal, a subacute form with extensive oedema in which the cause of death is heart failure, or milder disease from which horses usually recover. A combination of the acute and subacute forms is often observed.

AHS is endemic in eastern, central and most parts of southern Africa and has been reported sporadically from West and North Africa; it has occasionally also been reported from the Middle East and Spain due to introductions from Africa.

AHS is a vector-borne disease transmitted by midges of the genus *Culicoides.* The most important species in southern Africa are *C. imicola* and *C. bolitinos* (Coetzer & Guthrie 2004). The target hosts are equids. The pathogenic effects are seen in horses. Donkeys are much more resistant, infection usually being subclinical, and it has been suggested that donkeys could act as a reservoir of the disease. Severe and fatal disease has been recorded in dogs that have ingested infected horse meat (Coetzer & Guthrie 2004).

Zebras are refractory to the pathogenic effects of the virus and a continuous transmission cycle between zebras and *Culicoides* in the KNP has been described (Barnard 1993). The potential of such a reservoir to cause disease would only be realised if horses were also present and available for infection. Information about the exact location of outbreaks of AHS from 2005 to 2010 is incomplete but where the administrative area is given (Botswana, South Africa) there is no indication that AHS outbreaks are linked to wildlife.

South Africa reported outbreaks of AHS as unusual epidemiological events in 2006 and 2011 because they occurred in the AHS protection and surveillance zones (Appendix 1 Tables 21,22). Outbreaks elsewhere in the country are covered only in the routine reports (Appendix 1 Tables 16, 20). Among the KAZA countries Angola reported 2 outbreaks in 2009; Botswana reported outbreaks in 2005, 2008 and 2009 and from then on reported that the situation was unknown; Namibia reported outbreaks in all years except 2007; Zambia and Zimbabwe did not report any occurrence of AHS during the period. Of the neighbouring countries, DRC, Malawi and Tanzania reported no outbreaks, Mozambique reported unquantified occurrence in the second half of 2006 and South Africa reported many outbreaks in all the years.

The importance of AHS is related to the importance of horses in the culture and economy, and it is therefore of greater importance in South Africa, Lesotho, Swaziland, and probably Senegal and North Africa. AHS is specifically mentioned in the animal health legislation of Angola and Zimbabwe among the KAZA countries and DRC, Mozambique and South Africa among their neighbours. It requires reporting outbreaks to OIE, where it was formerly a List A disease. AHS is also of interest as an example of the difficulties created by the use of disease free zones to enable export. South Africa has a lucrative racehorse industry that includes breeding high quality racehorses for export. The breeding farms are generally situated in high-lying areas with very cold winters where activity of the vector is lower than in warmer parts of the country, but the fact that the entire country was regarded as infected with AHS was a constraint for the industry. Based on data suggesting that midge populations were comparatively low, an AHS-free zone was established in the metropolitan area of Cape Town, surrounded by a surveillance zone and a protection zone, from which unvaccinated horses could be exported. Unfortunately in 1999 and in 2004 outbreaks of AHS in the surveillance zone resulted in 2-year bans on export of horses that cost the industry approximately US$ 8.2 million per year. Surveys following the outbreaks demonstrated that the main vector of AHS, *Culicoides imicola*, was far more abundant in the surveillance area than in the surveys in 1985 – 1986 on which the establishment of the free and surveillance areas was based (Venter *et al.* 2006). On this basis vaccination of the horses in the surveillance zone was recommended, but this would be unacceptable in terms of the conditions of the free zone. However, the finding that the continuation of the free zone was controversial in view of the large numbers of vectors present has been confirmed by further outbreaks in the designated areas.

AHS is controlled by vaccination and it is also recommended that horses should be stabled in insect-proof stables during the hours of dusk to dawn when the midges are active.

5. Porcine diseases

5.1 African swine fever (ASF)

African swine fever (ASF) is one of the most feared diseases of pigs. It manifests as an acute haemorrhagic fever with high mortality and is caused by a unique DNA virus, *Asfivirus*, the only known member of the family *Asfarviridae.* Subacute and chronic forms have been described, mainly in Europe, but are not commonly seen in Africa (Penrith *et al.* 2004).

ASF is present or has been reported from most sub-Saharan countries where pigs are kept, including some of the islands that form part of the region. In 1957 and again in 1960 it reached Portugal from Angola and subsequently infected several European countries as well as Cuba, Haiti, Dominican Republic, and Brazil. It was eradicated from all except the Italian island of Sardinia, where it is considered endemic. In 2007 ASF was diagnosed in the Republic of Georgia with subsequent spread throughout the Caucasus as well as alarming spread in Russia, where it appears to have become endemic (S. Dudnikov, pers. comm. 2011).

ASF is endemic in warthogs (*Phacochoerus africanus*) in most countries of eastern and southern Africa, with a sylvatic cycle occurring between neonatal warthogs and ticks of the *Ornithodoros moubata* complex that live in the warthog burrows and can transmit the virus to domestic pigs. It is also endemic in domestic pigs in many sub-Saharan African countries where *Ornithodoros moubata* lives in pig shelters and also where there are large enough continuous populations of pigs to sustain circulation of the virus. Infected domestic pigs are potent sources of virus and transmission commonly occurs through direct contact or by consuming the flesh of pigs that have died of ASF. Secondary transmission by humans or fomites is probably common, and mechanical transmission by stable flies (*Stomoxys calcitrans*) but not by other biting insects has been demonstrated.

Warthogs are impervious to the pathogenic effects of the virus, as are other African wild pigs (bush pigs [*Potamochoerus* spp.] and giant forest hog [*Hylochoerus meinertzhageni*]). Warthogs are unable to transmit the virus directly to domestic pigs but transmission occurs when infected *Ornithodoros* feed on the blood of domestic pigs. No role in natural infection has been demonstrated for bush pigs or giant forest hogs (the latter have a restricted distribution range and are unlikely to come into contact with domestic pigs).

Among the KAZA countries, ASF outbreaks are associated exclusively with warthogs in Botswana and Namibia. This was also the case in Zimbabwe, but the last outbreak there was reported in 1977. Warthog involvement has never been documented in Angola, where outbreaks are generally associated with movement of infected domestic pigs and their products. ASF is endemic in domestic pigs in the Eastern Province of Zambia and the adjacent areas of Malawi and Mozambique, in association with *Ornithodoros* ticks that live in pig shelters. Outbreaks in the rest of the country have been associated with movement of pigs and pig products. ASF is endemic in all the neighbouring countries, but in South Africa it is restricted to a defined zone in the north-eastern part of the country, mainly in Limpopo Province, in which the sylvatic cycle occurs. The remaining countries all have endemic ASF in domestic

pig populations; the sylvatic cycle has been demonstrated to occur in Tanzania and very recently in Mozambique, while the situation in that respect in DRC appears to be unknown.

Namibia reported ASF outbreaks in 2008 and 2009 as exceptional events (Appendix 1 Tables 21, 22), and indicated that it was present but no details were available during the first half of 2011. This is surprising and may refer to an uncertain situation following the 2009 outbreak in the Northern Communal Areas. The 2007 outbreak involved a small number of pigs on a farm near the centre of the country, but the 2009 outbreak involved larger numbers of pigs in the Northern Communal Areas close to the border with Angola. Although it was stated above that all outbreaks of ASF are associated with warthogs, cross-border pig movement from Angola cannot be excluded as a possible source of infection, as the disease is prevalent there (M. Ventura da Silva, pers. comm. 2011). Zambia reported ASF outbreaks in 2006 and 2007 as exceptional events because they occurred outside the Eastern Province. According to the routine reporting (Appendix 1 Tables 17, 20) Angola suffered outbreaks of ASF in all years from 2005 to 2010, Zambia suffered outbreaks in 2008, 2009 and 2010 in addition to 2006 and 2007, and there were no outbreaks reported by Botswana or Zimbabwe. Among the neighbours, DRC, Malawi and Mozambique reported outbreaks or presence of the disease throughout the period. South Africa reported low numbers of outbreaks within the infected zone each year from 2005 to 2008 and presence during 2009, with no outbreaks reported for 2010. Tanzania reported outbreaks of ASF as unusual epidemiological events in 2008 and 2010, and in routine reports in 2006 and 2009 as well as in 2008 and 2010. The 2010 outbreak started in December 2010 and has not been resolved, with further outbreaks in the same district (Mbeya) being reported at regular intervals during 2011.

While its devastating effects on rural pig keepers in Africa are often underplayed or neglected, there is no doubt about the attention that it receives when its high potential for transboundary spread introduces it into other continents. ASF features prominently in the legislation of all the KAZA countries and their neighbours. There is no vaccine and therefore preventing outbreaks depends on the application of biosecurity measures. Confinement of pigs in pig-proof facilities is effective in preventing transmission of the ASF virus from warthogs via warthog-associated *Ornithodoros.* Simple biosecurity measures, like restricting access to the pigs and not feeding swill that could contain pork, if strictly enforced, are capable of preventing transmission by other means. When an outbreak occurs, it is generally recommended that stamping out of infected and in-contact or dangerous contact pig herds with destruction of the carcasses should be undertaken. This approach is likely to fail if the disease has become widespread, as enormous resources will be needed to stamp out large number of pigs in multiple areas in the shortest possible time. Stamping out can actually serve to spread ASF as pig producers move their pigs to avoid having them destroyed, particularly if market-related compensation is not available. Avoiding movement control measures like road blocks is usually relatively easy with small livestock species. Damage limitation on the part of the producers often includes pre-emptive killing of pigs and sale of meat. Since the pigs may be incubating the virus or in the early stages of clinical disease much of the meat may be infected, and movement of meat is even more difficult to control than movement of live pigs. It is clear from the relatively few OIE immediate notifications of outbreaks that many countries do not attempt stamping out. With the exception of South Africa and Namibia, where the outbreaks are warthog-associated and usually involve a single farm, the number of animals

destroyed even where stamping out is implemented suggest that a modified stamping out procedure is applied. In countries where ASF is endemic, stamping out is rarely considered.

6. *Avian diseases*

6.1 Avian influenza (H5 and H7) (AI)

Avian influenza (AI) is caused by members of the genus *Influenzavirus* A (family Orthomyxoviridae). So far all the isolates that are highly pathogenic in poultry have been members of H5 and H7 genes (Capua & Alexander, 2009). However, not all H5 and H7 viruses are highly pathogenic.

Highly Pathogenic Avian Influenza (HPAI) is a peracute or acute disease of poultry characterised by respiratory disease, diarrhoea and high mortality. HPAI gained notoriety after human deaths were recorded during an outbreak of H5N1 AI in Hong Kong in 1996, and has taken centre stage since the start of the H5N1 pandemic that swept through Asia from 2003, reaching Europe and Africa and resulting in more than 500 human cases with more than 300 deaths. However, a large number of AI virus subtypes (combinations between the many H and N genes) occur in free-living bird populations and are evolving continuously, especially in species associated with bodies of water.

Avian influenza viruses occur worldwide. In Africa HPAI occurred in Egypt, Nigeria, Ghana, Togo, Benin, Cameroon, Cote d'Ivoire, Niger, Sudan, Burkina Faso, and Djibouti. The only African country that has recorded significant human mortality is Egypt. Highly pathogenic AI caused by H7 subtypes has occurred in Europe, Canada and Asia. AI caused by H5N2 has been reported in ostriches in South Africa and Zimbabwe.

AI viruses are transmitted by direct contact and aerosol droplets. Water-borne transmission has been demonstrated, and secondary transmission may occur via humans and fomites.

H5N1 AI has affected wild birds as well as domestic poultry and there is some evidence that the virus can be spread by migrating wild birds, as some may be sufficiently resistant to it to be able to reach their distant destinations carrying the virus with them. Differences between the viruses from the outbreaks in South Africa suggest new introductions into the ostrich flocks and the most likely source would be wild birds, with Egyptian geese *(Alopochen aegypticus*) being most important, followed by a number of other wild ducks and geese (Abolnik 2010). However, it is widely accepted that movement of domestic poultry and poultry products has probably been the main cause of spread of the disease.

Southern Africa has remained untouched by the H5N1 pandemic, but outbreaks of H5N2 AI have occurred in Zimbabwe (2005) and South Africa (2006, 2011) in farmed ostriches (Appendix 1 Tables 18, 20-22). No cases in either domestic poultry or humans have been recorded in either country. However, the outbreak in Zimbabwe in 2005 resulted in trade bans on all poultry and poultry products by some countries, including Zambia. The outbreaks in South Africa are reported to have caused serious damage to the ostrich industry, which is largely an export industry.

The emergence of the highly pathogenic H5N1 influenza is too recent for AI to be incorporated in the legislation of most countries but should be considered a notifiable disease in view of the level of

awareness and capacity building created in the region in the wake of the panic created by the rapid spread of the pandemic and the fact that in some countries (Egypt, Indonesia, Vietnam) the case fatality rate in humans was high, although the number of people infected was not. Control measures applied have largely been massive culling of poultry, and this is now applied when low pathogenic H5 and H7 viruses are detected as well, for fear of mutation that will lead to greater virulence. On the other hand, Alhaji & Odetokun (2011) postulated that free-ranging poultry in Nigeria are probably at lower risk of infection with highly pathogenic H5N1 virus than small commercial flocks owing to exposure to low pathogenic viruses through contact with wild birds. Vaccination has been used in some countries where the disease has become endemic. This approach has been reviewed and is considered by FAO to play a useful role in reducing infection and preventing human infection when properly implemented (Domenech *et al.* 2009).

6.2 **Newcastle disease (ND)**

Newcastle disease (ND) was, until the advent of highly pathogenic H5N1 AI, the most important disease of poultry worldwide, and it remains the most important poultry disease in the SADC region. It is included in this report because of its importance in rural poultry as well as in commercial poultry and the fact that probably all species of birds can be infected and transmit the disease. ND is caused by *Rubulavirus* (avian *Paramyxovirus* 1). The viruses are classified as velogenic, mesogenic and lentogenic on the basis of their pathogenicity. Velogenic viruses cause severe disease ranging from sudden death with no premonitory signs to multisystemic disease with high mortality. Mesogenic viruses cause respiratory disease and a drop in egg production, while lentogenic viruses may induce respiratory disease in fully susceptible young birds.

ND viruses occur worldwide and can probably infect all species of birds. Infection is usually by ingestion or inhalation of the virus. The role of aerosols, used for mass vaccination, has not been clarified in natural infection. Faeces are a potent source of virus and therefore humans and fomites can play an important role in transmission of the virus.

Individual outbreaks have been traced to outbreaks among wild birds, including migratory birds, as well as contamination of feed by feral pigeons.

Botswana reported an outbreak of ND in commercial poultry near Gaborone in 2005 as an exceptional epidemiological event (Appendix 1 Tables 21,22). Routine reporting indicates that ND is endemic in all the countries included in the analysis and all experience regular outbreaks (Appendix 1 Tables 19, 20). In 2008 it was the TAD that caused the highest number of livestock deaths in Africa (AU-IBAR 2008).

ND features in the legislation of all the countries included in the analysis. It is usually controlled in commercial farms by vaccination and there are various programmes for vaccination of rural poultry with thermotolerant vaccines in the region, including in Angola, Malawi, Mozambique, South Africa and Tanzania.

7. Other diseases not listed by OIE

7.1 Canine distemper virus (CDV)

Canine distemper virus (CDV) is a *Morbillivirus* that affects carnivores; a related virus (phocine distemper virus) affects seals. CDV is not listed by OIE as it does not affect food animals. Canine distemper is a severe multisystemic disease that usually culminates in neurological disturbances and death.

CDV occurs worldwide and is probably one of the most important causes of mortality in dogs in unvaccinated populations. It is likely to be widespread in all unvaccinated dog populations in and around the KAZA TFCA.

The disease is highly contagious and a wide range of carnivores can be infected. Transmission is by direct contact and via aerosol droplets. The virus is unable to survive for long outside the host but some infected dogs may shed virus for several months.

The importance of CDV at the wildlife/domestic animal interface is recognised worldwide because of its ability to infect a wide range of wild carnivores, some of which are highly threatened species like the Ethiopian wolf (*Canis simensis*) and African wild dog (*Lycaon pictus*).

There is no information on the level of occurrence of CVD in domestic dog populations, but some devastating outbreaks in wildlife have been reported, with the loss of entire packs of African wild dogs and significant numbers of lions in the Serengeti ecosystem (Cleaveland *et al.* 2007). The effects of CDV in wild populations appears to be variable, as a survey for antibodies to various carnivore viruses revealed that lions in the Kgalagadi TFCA and Okavango Delta in Botswana had antibodies to CDV without disease having been reported (Alexander *et al.* 2010). The same study reported seroconversion to CDV in African wild dogs in the Okavango Delta with no apparent ill effects. Seroconversion has also been reported in Ethiopian wolf (Laurenson *et al.* 1998). However, an outbreak of neurological disease in lions in the Kgalagadi TFCA in 2010 was initially suspected to be rabies but samples proved negative for that disease and it now seems certain that it was CDV although confirmatory laboratory diagnosis is lacking. Typical 'chewing gum fits' associated with CDV were observed and filmed in lions in the Kgalagadi (M. Hofmeyr, pers. comm. 2010) and high mortality was reported. Cleaveland *et al.* 2007 also noted the variability in pathogenicity of CDV in lions. CDV has been associated with disease in captive cheetah but a serological survey in free-ranging cheetah on farmland in Namibia where there was contact with domestic dogs found antibodies in several healthy cheetah sampled (Munson *et al.* 2004). Because of the potential for serious losses among rare species there is no doubt that CDV is an interface disease of concern owing to the presence of unvaccinated dog populations in close proximity to conservation areas.

CDV has virtually disappeared in urban dog populations where most of the dogs are vaccinated. Attempting to protect any wild species by vaccination is challenging, and while it may be necessary in the case of rabies, applying vaccination for CDV in wildlife may not be necessary (Prager *et al.* 2011), particularly if it can be relatively easily controlled in dog populations at the interface by vaccination.

DISCUSSION

The collection of information and analysis of the status of selected diseases in the KAZA countries and their immediate neighbours has revealed that the information available in the public domain is incomplete and, in many cases, difficult to interpret. The information in the main databases consulted emanates mainly from the national veterinary authorities and its quality depends on the sources of information that are available to them, their ability to submit timely reports, and the accuracy with which the information is incorporated into the databases – in large part a function of the resources a government has invested in animal disease surveillance. Given resource and capacity limitations in many countries, the gaps in reporting quite likely reflect genuine gaps in the knowledge of the official veterinary services about the status of some of the diseases in their countries. The paradox that countries with better surveillance for diseases and good reporting are likely to appear more 'diseased' must be borne in mind. Only when scientific evidence of absence of a disease can be provided does this claim really become credible.

With the exception of highly pathogenic H5N1 AI, CBPP, ECF and PPR, all the selected diseases are present or potentially present in all 10 countries, even if only in a wildlife reservoir. Similar findings are presented by Cumming & Atkinson (in press) for a selection of diseases that includes 13 of the diseases covered in this report as well as heartwater and echinococcosis. The possibility that the pandemic H5N1 virus is present in wild birds cannot be excluded. However, to date a survey undertaken at sites in Botswana, Mozambique, South Africa and Zimbabwe failed to detect any highly pathogenic H5N1 virus, and phylogenetic analysis of influenza A viruses from wild birds in South Africa found no genetic evidence of Asian HPAI H5N1 (Abolnik *et al.* 2010, Cumming *et al.* 2011). Other diseases that are present in wildlife reservoirs with rare or no manifestation in domestic livestock are ASF in warthogs in Botswana and Zimbabwe, probably due to low domestic pig populations and confined husbandry systems, AHS in zebras and possibly donkeys in countries where there are few domesticated horses, and MCF in wildebeest (Appendix 1 Tables 1 and 24). As far as transboundary transmission of diseases within the region is concerned, the endemic presence of CBPP in Angola and Western Zambia constitutes a threat to Botswana and is responsible for spill over of infection that causes regular outbreaks in Namibia in spite of vaccination. It appears that uncontrolled FMD in Zimbabwe poses a threat to Botswana, Mozambique, South Africa and theoretically to Zambia as well.

Increasing the interface between humans, domestic animals and wildlife in KAZA may expose wildlife to increased risk from bovine brucellosis, bovine tuberculosis, rabies and canine distemper virus. Infection in wildlife can largely be prevented by the control of these diseases in their domestic hosts. Bovine brucellosis, rabies and canine distemper can be effectively controlled by vaccination, but bovine tuberculosis is more problematic as there is no vaccine. Elimination of bovine tuberculosis requires a testing programme with slaughter of infected animals. Given the unfortunate results of the infection of African buffalo with bovine tuberculosis in the KNP with subsequent spill over to other species, some of them rare, as well as the fact that the zoonotic potential of *M. bovis* is likely to be increased for people with HIV/AIDS, the investment in such a programme in cattle in interface areas would be well worth while.

The need to mitigate the risk of transmission of FMD from buffalo to cattle as well as via cattle from countries where it is not well controlled is evident and will be discussed in detail in another report. The estimated relative importance of the selected diseases is summarised in Table 3.

Table 3 Estimated relative conservation, socio-economic and/or zoonotic importance of the selected diseases for KAZA TFCA

Disease	Relative importance			Motivation
	High	Medium	Low	
Anthrax		X		No events of concern reported but potential exists for human infection
Bluetongue			X	No events of concern reported
FMD	X			Impact on trade
Rabies	X			Fatal zoonosis; threat to wildlife
RVF		X		Increased activity in region
Trypanosomosis		X		Differing levels of tsetse control
Brucellosis		X		Zoonosis; potential for buffalo reservoir
BTB	X			Lack of information, potential threat to wildlife, zoonosis
CBPP	X			Merging of infected/uninfected countries
LSD			X	Widespread, endemic
MCF			X	Individual animals affected
Theileriosis		X		ECF a possible threat to cattle in Botswana and Namibia
PPR			X[2]	Known infected areas far from TFCA
AHS			X	Low horse population
ASF			X	Low pig population
AI H5, H7			X	Has only affected farmed ostriches in two SADC countries
ND			X	Widespread, endemic
Canine distemper		X		Threat to wildlife but seroconversion reported in Okavango delta

The highest number of outbreaks reported as exceptional events to OIE from 2005 – 2011 concerned FMD (20 reports), RVF (7 reports) and ASF (6 reports) (Appendix 1 Tables 21,22). FMD was reported by all countries except Tanzania, RVF was reported by Botswana, Namibia, South Africa and Tanzania, and ASF by Namibia, Zambia and Tanzania.

CONCLUSIONS

- Published information on the selected diseases including major TADs is incomplete for most countries in the study.
- Reporting on FMD by some countries in the region (for example Botswana and Namibia) has been timely and accurate and appears to provide a true reflection of the situation, an

[2] This status may change as the disease is showing a marked capacity for spread but no changes are reflected in the official disease reports.

imperative dictated by the export trade in beef. Reporting on FMD elsewhere in the region however has been less rigorous and is less likely to reflect the true situation on the ground.

- Apart from FMD, diseases of particular concern for KAZA countries include CBPP for cattle, and bovine brucellosis, bovine tuberculosis, rabies and canine distemper where wildlife shares habitat with domestic animals.
- PPR has been identified by SADC as an immediate threat to the entire region. Although the only countries that have officially reported that the disease is present are DRC and Tanzania, seropositive goats were found in Zambia near the border with Tanzania, thus bringing the infection closer to the KAZA area. Since the DRC shares extensive borders with Angola and Zambia, it is not unlikely that improved surveillance in those countries might reveal further unwelcome information about this serious disease of small ruminants.
- Specific evaluation of the efficacy of control measures applied by the various countries was not possible but the reports of diseases indicate that much more is needed for effective control.
- Disease outbreaks, in particular FMD and RVF, appear to be increasing in the region. Although some of this may be due to improved reporting, FMD is widely recognised to be on the increase in SADC countries and this is attributed at least in part to loss of effectiveness of vaccination.

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APPENDIX 1 TABLES – DISEASE INFORMATION

Table 1 Presence/absence of selected diseases as reported to OIE AND/OR AU-IBAR 2005 - 2011

	ANT	FMD	RAB	RVF	TRY	BRU	BTB	CBPP	LSD	MCF	THE	PPR	AHS	ASF	HPAI	ND
ANG	+	+	+	-	+	+	+	+	+	-	+	-	+	+	-	+
BOT	+	+	+	+	-	+	-	-	+	+	-	-	+	+	-	+
NAM	+	+	+	+	?	+	?	+	+	+	-	-	+	+	-	+
ZAM	+	+	+	-	+	+	+	+	+	-	+	_	-	+	-	+
ZIM	+	+	+	+	+	+	-	-	+	+	+	-	-	-	+O	+
DRC	+	+	+	+	+	+	+	+	+	-	+	+	-	+	-	+
MAL	+	+	+	?	+	?	+	-	+	-	+	-	-	+	-	+
MOZ	+	+	+	+	+	+	+	-	+	-	+	-	+	+	-	+
RSA	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+O	+
TAN	+	+	+	+	+	+	+	+	+	-	+	+	-	+	-	+

+O = reported in ostriches

Acronyms and abbreviations

AHS	African horse sickness	ANG	Angola
ANT	Anthrax	ASF	African swine fever
AU-IBAR	African Union Inter-African Bureau for Animal Resources	BOT	Botswana
BRU	Bovine brucellosis (*B. abortus*)	BTB	Bovine tuberculosis
CBPP	Contagious bovine pleuropneumonia	DRC	Democratic Republic of Congo
FMD	Foot and mouth disease	HPAI	Highly pathogenic avian influenza
LSD	Lumpy skin disease	MAL	Malawi
MCF	Malignant catarrhal fever	MOZ	Mozambique
NAM	Namibia	ND	Newcastle disease
OIE	Office International des Épizooties – World Organisation for Animal Health		
PPR	Peste des petits ruminants	RAB	Rabies
RSA	South Africa	RVF	Rift Valley Fever
TAN	Tanzania	THE	Theileriosis
TRY	Trypanosomosis	ZAM	Zambia
ZIM	Zimbabwe		

Tables 2 – 19 Information from OIE WAHID on selected diseases 2005 - 2010

Multi-species diseases

Table 2	Anthrax
Table 3	Bluetongue
Table 4	Foot and mouth disease
Table 5	Administrative divisions where FMD occurred per country per year
Table 6	Rabies
Table 7	Rift Valley fever
Table 8	Trypanosomosis

Bovine

Table 9	Bovine brucellosis
Table 10	Bovine tuberculosis
Table 11	Contagious bovine pleuropneumonia
Table 12	Lumpy skin disease
Table 13	Malignant catarrhal fever
Table 14	Theileriosis

Caprine and ovine

Table 15	Peste des petits ruminants

Equine

Table 16	African horse sickness

Porcine

Table 17	African swine fever

Avian

Table 18	Avian influenza (H5, H7)
Table 19	Newcastle disease

Key

	No disease present (absence clearly indicated)
	No information supplied
	Not reported as either present or absent in that month during a period when outbreaks occurred
+	Disease presence reported
?	Suspicion of disease but no lab confirmation
7	Number of reported outbreaks

Table 2 Anthrax

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
2005													**2006**											
ANG		1				2	2	1	1			1	+	1	1	5					+	+	3	
BOT	2						1	1												1			1	
NAM		1					2	5	5	6	7	1								1	+	4		
ZAM														1					1					
ZIM	29	16	8	6	5	7	4	4	18	12	4	6												
DRC							+												+					
MAL																								
MOZ						2	1						+											
RSA									1					1	1		1	3				1		1
TAN	2	1	4	1	1	1		1	1	1	1													
2007													**2008**											
ANG																								
BOT				1																	1			
NAM							1	8								+							1	
ZAM		1						2		1			2	2	1				1				1	
ZIM	9	2			4	2		3	1	4	1	2	1	3	3	15		1	4	1	1	12	9	
DRC	+																							
MAL																								
MOZ																				1				
RSA	2								1	3	2			1				2	1	1			2	
TAN	1			3		2	2		1	4			+						+					
2009													**2010**											
ANG	1	1									1				+									
BOT																								
NAM	4	2		1	2		1	1		1	1	2	1	2	1	2	1		1	1	1			4
ZAM	2				1	1		1			2		1						1	1		2	1	
ZIM	1	1			2			2	7	2	2	3	3	8	3					2		3	2	3
DRC	+						+						+						+					
MAL																								
MOZ																			?					
RSA	3	1	1			1			1		2		1	42	25			1	14	27	68	23	2	2
TAN	+						1	1	2					1	2						1			

Table 3 Bluetongue

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG																								
BOT													1											
NAM																1								
ZAM																								
ZIM																								
DRC																								
MAL							?									?						?		
MOZ																								
RSA	6	1	7	1	2	1				1	2		3	9	10	6	1			1			1	1
TAN																								
	2007												**2008**											
ANG																								
BOT													1											
NAM							+									+								
ZAM																								
ZIM													?	?	?			?						
DRC																								
MAL			?						?							?						?		
MOZ																								
RSA		1				1	1			1		2	11	16	18	1	2							2
TAN																								
	2009												**2010**											
ANG																								
BOT																								
NAM				+										1			2	1					2	
ZAM																								
ZIM																								
DRC																								
MAL			?						?							?						?		
MOZ																								
RSA	2	5	39	43	12				1			2	3	3	7				1					1
TAN																								

Table 4 Foot and mouth disease

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG																								
BOT[1]								1																
NAM																								
ZAM															+?						+?			
ZIM	1	1			1	6	8																	
DRC				4						1							12		1					
MAL										+						+						+		
MOZ																								
RSA																				+		+		
TAN	9	3	3	6	2	3		2	1	2		3												
	2007												**2008**											
ANG																								
BOT				+						1						7		1	1			1		
NAM											5		4	3	1	7	1	6	3	4		3	1	
ZAM									+					1			1	3	2	1			1	
ZIM		1	1		2													1						
DRC															?						?			
MAL				+					+							+					2	1	1	
MOZ																								
RSA																	1	1						+?
TAN	3	1	2	3	2	5	5	13	7	7	6	3	1	5	1	4	3	7		3	2		1	
	2009												**2010**											
ANG		1																1	1					
BOT																			1					
NAM																1								
ZAM	4	5	3	4			1	1				1									1			
ZIM									2		4						1	3	3	1	1		+	
DRC				+						+						+						+		
MAL				+?						1						+						+		
MOZ																					8			2
RSA									2	2									2	2		1	1	
TAN	4	2	1	1	2	1	1	5	4	2			3	2	8	1	3	3	2	6	7	9	4	3

[1] No information for 2006 was available from OIE but the AU-IBAR Yearbook for 2006 reported that Botswana experienced 4 outbreaks of FMD in 2006. The number for South Africa (2) tallied for the two sources. DRC reported 9 outbreaks to AU-IBAR as opposed to 13 to OIE.

Table 5. Administrative divisions where FMD occurred per country per year (source OIE WAHID)

Country	2005	2006	2007	2008	2009	2010	2011
Angola					Cuando-Cubango		
Botswana	Kasane	Selibe Phikwe, Kasane	Maun	Maun, Kasane, Ghanzi		Kasane	Maun, Francistown, Selibe Phikwe
Namibia			Caprivi[2]	Caprivi[3], Kavango		Caprivi (Kabbe, Impalila Island)	
Zambia				Southern (Mazabuka), Lusaka, Northern, Western, Central	Southern, Western	Northern	
Zimbabwe	Masvingo, Matabeleland North		Masvingo, Matabeleland South, Midlands	Masvingo	Masvingo, Matabeleland South	Masvingo, Matabeleland N, Matabeleland S	Matabeleland S
DRC		Nord-Kivu, Sud-Kivu				Sud-Kivu (FAO)	
Malawi				Southern	Southern		
Mozambique						Gaza, Maputo	
South Africa		Limpopo, Mpumalanga		KNP, Limpopo, Mpumalanga	Mpumalanga	KNP, Limpopo	KZN, Gauteng
Tanzania	Arusha, Dodoma, Iringa, Kagera, Kigoma, Kilimanjaro, Lindi, Mara, Mbeya, Mwanza, Pwani, Rukwa, Ruvuma, Shinyanga, Tabora, Tanga		Arusha, Dar-es-Salaam, Dodoma, Iringa, Kigoma, Kilimanjaro, Manyara, Mara, Mbeya, Morogoro, Mwanza, Pwani, Rukwa, Shinyanga, Singida, Tabora, Tanga	Arusha, Dar-es-Salaam, Dodoma, Iringa, Kagera, Kilimanjaro, Mara, Mbeya, Rukwa, Singida, Tabora, Tanga	Arusha, Dar-es-Salaam, Dodoma, Kagera, Kilimanjaro, Mara, Mbeya, Morogoro, Mwanza, Rukwa, Ruvuma, Singida, Tabora, Tanga	Iringa, Kigoma, Mara, Mbeya, Mwanza, Rukwa, Shinyanga, Tanga	

[2] Nankuntwe, Musii, Isize, Malindi, Limai

[3] Kwalala-Katima Mulilo, Ngoma, Mutilika, Kabbe, Liangwe, Mudelele, Mahundu, Kisika, Kalala, Mudaniko, Schuckmannsburg, Zilitene, Ikumwe, Masikili, Mukasa, Isuswa

Table 6 Rabies

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG		1			1	2						1	2	1	2		2		+	+	+			
BOT	2	3		2		2	9	6	3		3	2	1	1	1		2	2	4	1	3	7	2	1
NAM	18	13	13	8	6		22	24	28	40	29	15	29	25	19	21	25	11	1	5	3	6	7	2
ZAM													3	4	4	3	3	1	6	2	2	2	1	2
ZIM	25	11	14	12	22	21	14	16	10	25	38	26												
DRC							+												+					
MAL	2	3	4	6	1	2	14						1						3					
MOZ	2	3	4	1			3						1				2	1	3					
RSA	21	13	24	23	45	14	27	30	21	28	25	19	29	10	21	18	20	32	78	47	73	54	49	41
TAN	6	7	5	7	2	4	9	7	6	5	12	12												
	2007												**2008**											
ANG	5		6			4	2	4	2	5			1	4			1	1		3	2	3	1	1
BOT	2	3		2	3	6	4	10	3	13	1	1	4	4	2	5	3	12	1	6	2	11	11	6
NAM	14	7	12	11	7	8	5	1	1	3	2	1	2	5	7	4	1	1	2	2	3	1	3	1
ZAM	7	8	6	3	2	1	6	5	1	6	3	2	15		12	12	10	10	12	16	6	4	5	4
ZIM	9	8	8	10	17	7	4	16	17	11	7	7	11	6	10	12	14	8	+					
DRC	+						+						+						+					
MAL	1	4	1		1		3	4	3	7	1		1	1			2	2	+					
MOZ	1		1		4	1	1	1				1	1	2		2	2		2	2	1	1	1	
RSA	53	48	44	77	47	39	+	57	+	1	+	26	38	41	24	38	46	45	47	63	35	53	36	22
TAN	1	3	3	5	5	2	6	13	9	15	18	7	1	1	3	2	4	4	4	4		2	1	2
	2009												**2010**											
ANG	1	5	1		1				1			1	+	+	+	+	+	+	?					
BOT	10	6	1	6	3	3		5	4	1			3	4	2	3	3	2	5	2	1	2	1	1
NAM	14	10	11	15	11	5	5	5	5	2	2	5	19	15	31	33	30	27	8	4	3	2	1	2
ZAM	12	15	10	20	9	11	8	12	5	12	5	6	15	12	9	10	14	6	6	8	3	2	5	6
ZIM	1	7	9	4	2	4	4		3		1	3	16	13	26	12	13	17	3	8	7	5	4	4
DRC	+						+						+						+					
MAL	1	2			1	4	3	+	1	1	2	1	4	2	4	3	5	1	1	3	1	2	4	
MOZ			2		1		1	1						1	1	2			1	1			1	
RSA	45	37	42	41	49	35	46	49	62	44	40	32	33	23	26	33	45	25	30	26	44	52	43	21
TAN	1	1		2	1	1			2	2	3	1	2	1	3	2	2	2	1	1		1	1	

Table 7 Rift Valley fever

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												2006											
ANG[4]																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC																								
MAL							+?								+?						+?			
MOZ																								
RSA																								
TAN																								
	2007												2008											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC	+																		+					
MAL	+?						+?						+?						+?					
MOZ								+?					+?						+?					
RSA													3	7	5	8	5	3						
TAN	6	3	7	3																				
	2009												2010											
ANG																								
BOT																	1							
NAM																	7	6						
ZAM																								
ZIM																			+					
DRC	+						+						+						+					
MAL	+?						+?						+?						+?					
MOZ																								
RSA		6	4	7	2	2				18		1	2	77	233	132	36	9	1	1				1
TAN																								

[4] According to the AU-IBAR Yearbook for 2006 Angola reported a single outbreak of RVF in 2005

Table 8 Trypanosomosis

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG	+						1	5							1									1
BOT																								
NAM							+																	
ZAM													5	6	7	3	2	1	2	3	3	2		
ZIM	5	2	4	2	2	12	15	3																
DRC							+														+			
MAL							+						+						+					
MOZ	2					1	7								1		1	2	1					
RSA																		2			5	3	4	
TAN	+	+	+	+	+	+	+	+	+	+	+	+												
	2007												**2008**											
ANG	+		+			1																		
BOT																								
NAM																								
ZAM		1	1	2	2	2	6	5	4	2	2	1	10	7	8	5	5	5	5	4	5	1	3	3
ZIM		2	9	5	4	2	4	3	1	2	5	1	4	12	8	2	2	1	+					
DRC	+						+						+						+					
MAL			1							1			+						+					
MOZ	1					1			1	1					3			1			1	1		
RSA	2		2	1	9							1	2				1			3	3		1	
TAN	10	8	7	20	6	9	15	18	32	15	25	16	7	8	7	3	10	3	5	1	2	3		2
	2009												**2010**											
ANG				1												1								
BOT																								
NAM	?						?						?						?					
ZAM	9	11	9	13	9	9	11	11	8	9	9	8	6	9	9	11	13	3	11	10	6	3	4	2
ZIM	2		2	5	3	4		2	1									4	1	1	1	1	2	
DRC	+						+						+						+					
MAL					1		1								1	1								
MOZ					1			1				1			1	1	2		?					
RSA				1						3	3			1	2	2			?					
TAN	3	5	3	1	2	1	3	3	4	2	2		3	2	3	3	5	2		1	1	2	3	

Table 9 Bovine brucellosis

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												2006											
ANG	+						+																	
BOT		1	3	1				2	3															
NAM						1	1	2	1		1													
ZAM																								
ZIM			1	1	2	2			1		3													
DRC							+																	
MAL																								
MOZ		1		1		+	6																	
RSA	30	28	28	23	44	52	29	18	35	25	17	14												
TAN	+		+			1			1	+														
	2007												2008											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC																								
MAL																								
MOZ																								
RSA																								
TAN																								
	2009												2010											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC																								
MAL																								
MOZ																								
RSA																								
TAN																								

Table 10 Bovine tuberculosis

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG						1	1					1		2	3				+	+	+		+	+
BOT																								
NAM													+						+					
ZAM													+						+					
ZIM																								
DRC	+						+						+						+					
MAL	+	1	+	+	+	+	+						+						+					
MOZ							2									1	2		+					
RSA	2	6	1	5	3	1	1	1	1	3	1	1	1	1		2			1		1			
TAN																								
	2007												**2008**											
ANG					+	1			1				1	1	1	1	1			2		3		
BOT																								
NAM																								
ZAM								1					2		1	1	2							1
ZIM																								
DRC	+						+						+						+					
MAL	+	+					+	+	+	+	+		+						+					
MOZ	1			1	1	1	1		5	2			2	3	1	5			3	1	1	1	2	
RSA	2	1			3	2			2	2			2	1	1	1	3	1						1
TAN																								
	2009												**2010**											
ANG	1						1		1					1		+	2					+		
BOT																								
NAM																								
ZAM	2	2	3	2		2		4		2			2	2	3	1	2		1	1	1		1	
ZIM																								
DRC	+						+						+						+					
MAL					+	+	+	+		+						1			+	+	+	+	+	+
MOZ		3		4	3		1		2	1		1	1	5	3	4	3	3	1	5	4	4		
RSA	2	2	2	6	3	2	11		1	2	1	1	3	10	2	4	2	3	2	5	3	7	3	2
TAN	+						+						+						+					

Table 11 Contagious bovine pleuropneumonia[5]

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG	3	2	2			8	6	1	5	4	1	2	8	4	6	2	5	2	+	+	+	+	+	+
BOT																								
NAM	1								3						1			2	1					2
ZAM													1	2	1		1	1	6					
ZIM																								
DRC	+						2	1	1							1	3		2	1	1			
MAL																								
MOZ																								
RSA																								
TAN	2	2	1		2	1	+																	
	2007												**2008**											
ANG	8		+	6	+		5			1			9	1	1	1		3		3	3	2	1	
BOT																								
NAM			1						+								1						1	
ZAM	2	3	1	2	2	1	1	1	1	1			2	1	4	4		2	3	4	1			
ZIM																								
DRC	+						+						?						+?					
MAL																								
MOZ																								
RSA																								
TAN	1		+	1	2	4	3	6	5	5	1	3	2	1		1	2	1	4		1			
	2009																							
ANG	6	3						1		1				1	1	1	+	1	1	1		+		
BOT																								
NAM			1	1						1								1		1				1
ZAM	2	6	2	4	3	2	3	2	3	1			2	1	1		2	2	2	1			1	
ZIM																								
DRC	+?						+						+						1					
MAL																								
MOZ																								
RSA																								
TAN	2	1		1	1		1		1				1				1		+					

[5] According to the AU-IBAR Yearbook for 2006 Angola reported 70 outbreaks (2nd highest out of 13 countries reporting CBPP). The 6 outbreaks in Namibia tally with the reports to OIE.

Table 12 Lumpy skin disease

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG		1	2			1	1	1					4	4	2	1	4			+	+	+	1	3
BOT				6		4						2	2	6	1	1	4	9	5	2			1	26
NAM		2	3	16	4	8						5			5	1	3	1			5	1		
ZAM													7	8	7	8	6	4	2	3	2	2		1
ZIM	11	30	22	8	20	13	22	24	14	10	13	11												
DRC							+						+						+					
MAL	2	+	1	2	2		2						12						+					
MOZ		2			1	1	+							3		1	1	1	+					
RSA	4	4	1		1				1	5		1	6	9	19	31	27	11	10	1	8	2	10	22
TAN	8	24	4	21	11	10	19	11	13	8	7	2												
	2007												**2008**											
ANG	2			1		1							1	1						2	1		1	
BOT	1	6		7	3	1	1	1			3	3	1	4	1	3	3		1	1				1
NAM	1	8	10		4		+..						7	1	1	9	23	23	4	2	2		3	1
ZAM	6	7	6	3	1		7	8	3	4	4	3	12	17	18	13	11	9	7	6	3	2	5	
ZIM	132	127	133	115	119	90	42	28	12	4	7	4	119	223	187	116	38	33	+					
DRC	+						+						+						+					
MAL	1	9	13								1	2	5						+					
MOZ	1	5	1	2	2			5	1	1			2	2	2	1								
RSA	45	40	16	13	26	11	6	1		6	6	59	19	84	14	12	9	2	2	2	1	2	1	5
TAN	8	4	11	14	8	6	12	6	9	9	5	7	2	2	2	3	3	3		1	1	1		1
	2009												**2010**											
ANG	3	3	4						1		1			+	1	2	+	2		1		+		
BOT				2	3		1			1					4	3	1	3	1	1	2		1	
NAM	3	9	45	27	8	2	2	1				1	2				1	2		1	1		1	
ZAM	18	18	19	19	10	5	7	6	3	5	6	7	11	12	11	14	15	3	12	8	7	3	7	5
ZIM	44	17	78	50	43	19	8	3	15	9	29	35	24	90	61	63	19	37	42	28	34	21	41	17
DRC	+						+						+						1					
MAL		1	1	1			+								3							1	1	
MOZ			1						1		1				1				1					
RSA	9	10	12	3	8	3	1			1	6	1	9	9	4	13	6	1		2	5	3	3	1
TAN	1			1	1		1	1	2	2	1	2	2		1	1	1	2	1	2		1	1	

Table 13 Malignant catarrhal fever

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												2006											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC																								
MAL																								
MOZ																								
RSA													1	3	5	5	6	7	3	8	6	14	1	1
TAN																								
	2007												2008											
ANG																								
BOT																								
NAM			1			1	+																	
ZAM																								
ZIM													+											
DRC																								
MAL																								
MOZ																								
RSA	4	3	7	11	14	4	4	8	5	9	4	2						1						
TAN																								
	2009												2010											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC																								
MAL																								
MOZ																								
RSA																								
TAN																								

Table 14 Theileriosis

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG	+						+																	
BOT																								
NAM																								
ZAM													10	11	10	9	7	5	4	5	5	4	2	1
ZIM	13	32	15	7	1	2			2	1														
DRC							+																	
MAL	+	+	+	+			5						+						+					
MOZ					1	3	1						+						+					
RSA	+																							
TAN	+	+	+	+	+	+	+	+	+	+	+	+												
	2007												**2008**											
ANG																								
BOT																								
NAM																								
ZAM	4	6	8	3	2	1	8	9	4	7	5	8	16	15	21	11	16	13	11	10	9	5	8	8
ZIM	7	21	8	1									23	9	1	1	4	1	+					
DRC							?						?						?					
MAL			1	2			+																	
MOZ	1		1	3	1	5	3	1	1						4				+					
RSA																								
TAN	46	33	33	31	8	16	47	48	48	43	43	41	14	16	13	12	16	7	9	12	3	3		5
	2009												**2010**											
ANG																								
BOT																								
NAM																								
ZAM	22	20	21	19	18	18	18	19	12	15	13	11	19	19	19	19	20	8	22	16	13	7	11	7
ZIM	1	4	2	1	2			1				2	8	16	9	2	2	2	1					2
DRC	?						+						+						+					
MAL					1		+									2								
MOZ							+?																	
RSA																								
TAN	13	11	3	4	4	1	4	12	7	3	4	4	11	10	12	11	8	5	2	2	6	5	7	1

Table 15 Peste des petits ruminants

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC	?									1					1							+		
MAL																								
MOZ																								
RSA																								
TAN																								
	2007												**2008**											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC	+												+						+					
MAL																								
MOZ																								
RSA																								
TAN																								1
	2009												**2010**											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC	5							2					+						+					
MAL																								
MOZ																								
RSA																								
TAN		2					+										1	1	+					

Table 16 African horse sickness

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												2006											
ANG																								
BOT			1					1																
NAM					1									1	1		3							
ZAM																								
ZIM																								
DRC																								
MAL																								
MOZ																			+					
RSA	20	20	35	127	36	2	1		1		1	2	14	37	110	77	62	16						
TAN																								
	2007												2008											
ANG																								
BOT													1											
NAM													2			5	1							1
ZAM																								
ZIM																								
DRC																								
MAL																								
MOZ																								
RSA	9	8	11	17	5	2	1					7	24	83	137	88	40	5	1			3		3
TAN																								
	2009												2010											
ANG	1				1																			
BOT	1						?						?						?					
NAM			2	6					1							1	1	2	1		1		2	1
ZAM																								
ZIM																								
DRC																								
MAL																								
MOZ																								
RSA	10	30	86	91	46	16		1		1			6	13	17	45	14	21	2	+		8	10	
TAN																								

Table 17 African swine fever

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG						2			1				1	1	1					+	+			
BOT																								
NAM	1																							
ZAM													3								+			
ZIM																								
DRC				+			6	2	2	4	11	1				2	1		6		2	4	10	1
MAL	5	+	3	2	+	1				13						12					5			
MOZ	2	1	1		3	1				8				4	5	1	1	1			1			
RSA							1														1			
TAN	1									+?														
	2007												**2008**											
ANG				1						1			2							9	1	3	1	
BOT																								
NAM																						1		
ZAM											4				4	1	3		2	2	1			
ZIM																								
DRC				+						+						+					+			
MAL	3	1			1		1	2	2	5	4	2				14					+			
MOZ	1	1	1	1			2	1	2	1	1			3		1	1	1	2	1	1	1	1	
RSA							1							2										
TAN														2	1		1							
	2009												**2010**											
ANG	1				1						1		1	1										
BOT																								
NAM			1	14			1									+					+			
ZAM	2	2	3	1	2		3	2	1	2		1	1						1	1	1		1	1
ZIM																								
DRC				+						+						+					+			
MAL			1				2		1	1		1	3	3	1	1	2	1	5	2	2	8	2	5
MOZ	1	2	1	1				2					2		1	1	2	2	1		2			
RSA				+						+														
TAN				+						+						+								1

Table 18 Avian influenza (H5, H7)

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												2006											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM	+										2[6]													
DRC																								
MAL																								
MOZ																								
RSA																		1[7]						
TAN																								
	2007												2008											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC																								
MAL																								
MOZ																								
RSA																								
TAN																								
	2009												2010											
ANG																								
BOT																								
NAM																								
ZAM																								
ZIM																								
DRC																								
MAL																								
MOZ																								
RSA																								
TAN																								

[6] H5N2 in ostriches

[7] H5N2 in ostriches, W Cape

Table 19 Newcastle disease

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	2005												**2006**											
ANG	+								1				4			1			+	+	+			
BOT								3	4		8	3		2	1		2					1	2	
NAM		1	1				+						+						2				1	3
ZAM													6	3	1	2	6	2	6	4	4	5	1	
ZIM	6	8	2		2	5	18	17	26	10	12													
DRC	+						+						+						+					
MAL							1						+						1					
MOZ	1	2			1	1	7									4			1					
RSA	3	3	6		2	46	12	33	29	18	13	10	11	7	7	8	11	18	22	18	4	9	5	6
TAN	+	6	11	1	10	14	3	8	4	8	12	14												
	2007												**2008**											
ANG			1	1						1			4								1	12		
BOT								1				1												
NAM							1				1		1				1		2			1		
ZAM	1	2	5	1	5	3	13	13	8	14	8	6	14	13	9	15	9	12	14	14	13	7	8	8
ZIM	1	4	4					3		1	1	1	3	2					+					
DRC	+						+						+						+					
MAL				1					1				+						+					
MOZ	1		1	1		1									1		1				2			
RSA	4	5	6		2	8	7	11	8	8	7		5	5	6	5	5	1	2	5	7	12	11	
TAN	5	4	4	9	9	8	15	15	16	20	13	11	4	5	6		5	2		5	2	3		2
	2009												**2010**											
ANG						2							1											
BOT										1	1				1				+					
NAM			1					1		1	1		?								2	2		
ZAM	15	14	6	10	9	18	17	17	15	20	10	11	14	15	15	11	11	8	17	18	12	16	8	7
ZIM			2				4			2	1							1				3	1	
DRC	+						+						+						+					
MAL	+						+									1						1		
MOZ			1	1			+								1	1		1				1		
RSA	1						5	4	4		1	2		4	3	3	2	4		7	2	1	1	
TAN	4	2	1	3	4		2	1	2	2	2	2	3	2	3	4	7		1	2	1	2		

Table 20 Diseases reported to OIE by five countries for January to June 2011[8]

	J	F	M	A	M	J	J	F	M	A	M	J	J	F	M	A	M	J
	Anthrax						**Trypanosomosis**						**Peste des petits ruminants**					
BOT																		
NAM	0	0	0	1	0	1	?											
DRC	1	0	0	0	0	0	17						23					
MAL																		
MOZ							?											
	Bluetongue						**Bovine tuberculosis**						**African horse sickness**					
BOT																		
NAM	0	1	1	3	3	0							0	0	8	8	6	0
DRC							6											
MAL	?						+	+	+	+	+	+						
MOZ							1	3	3	2	2							
	Foot and mouth disease						**Contagious bovine pleuropneumonia**						**African swine fever**					
BOT		1		1	1													
NAM												1	+					
DRC	2						6						35					
MAL						1							10	1	3	1	2	1
MOZ	0	0	0	0	1	0							2	1	3	2		
	Rabies						**Lumpy skin disease**						**HPAI**					
BOT	1	1	1	1	4		6	3	4	1	2							
NAM	29	15	21	13	13	11	0	2	5	0	8	4						
DRC	+						4											
MAL	2		2	2	1	4					1							
MOZ				1				1	2	1								
	Rift Valley fever						**Theileriosis**						**Newcastle disease**					
BOT													+					
NAM				1	1	1												
DRC	+						+						14					
MAL	+?																	2
MOZ													+					

[8] Bovine brucellosis and malignant catarrhal fever omitted as neither disease was reported in the two preceding years or more

Table 21 Summary of diseases associated with exceptional epidemiological events that were reported to the OIE in 2005-2011

Country	2005	2006	2007	2008	2009	2010	2011
Angola	-	-	-	-	FMD,RAB	-	-
Botswana	FMD,ND	FMD	FMD	FMD	-	FMD,RVF	FMD
Namibia	-	-	FMD	ASF,FMD	ASF,LSD	FMD,RVF	FMD,RVF
Zambia	-	ASF	ASF	FMD	-	FMD	-
Zimbabwe	AI	-	-	-	-	FMD	-
D R Congo	-	FMD	-	-	-	-	ANT
Malawi	-	-	-	FMD	FMD	-	-
Mozambique	-	-	LSD	-	-	FMD	-
S Africa	-	AHS,FMD, AI	-	FMD,RVF	AFB,EHV-1 FMD,RVF	FMD,RVF	AHS,FMD,HPAI, RVF
Tanzania	-	-	RVF	ASF	PPR	ASF	-

AFB – American foulbrood (bees)
EHV-1 – equine abortion

Table 22 Data (number of outbreaks) from weekly, emergency and follow-up reports to OIE for 2011

	ANT	FMD	RVF	CBPP	LSD	AHS	ASF	HPAI
ANG		1						
BOT		4						
NAM		1	15[9]					
ZAM		5						
ZIM		5						
DRC	1			1				
MAL								
MOZ		11			4			
RSA		47	135			45		**44**
TAN							7	

RSA AHS – 03/11 – 06/11

TAN ASF – continuation of outbreak that started in December 2010

ANG FMD – started in 2009, Cwando Cubango province, continuing

BOT FMD – Ngamiland zone 2d (resolved); Zone 6 on Zimbabwe border (continuing); Selibe Phikwe, Zone 7 (continuing)

MOZ FMD – continuation of 2010 outbreaks, Bilene

RSA FMD – Kwa-Zulu Natal

ZAM FMD – border with Tanzania

ZIM FMD – Matabeleland South on Botswana border

NAM RVF – Widespread; newest outbreaks in the NCAs (central)

RSA HPAI – H5N2 in ostriches, E Cape

[9] Note that the report for January – June 2011 for Namibia indicates that three outbreaks occurred, one per month from April until June, while the emergency and follow-up reports reflect the number of foci within an outbreak area but refer to them as 'number of outbreaks', hence the discrepancy between the figures in Table 20 and this table, which shows 15 outbreaks representing 3 foci in one outbreak area and 12 in another.

Table 23 Animal disease data from country reports, AU-IBAR Pan African Animal Health Yearbooks

Country	2005	2006	2007	2008	2009	2010
Angola	ASF,CBPP,LSD,ND, RAB,RVF,THE,TRY	AHS,ANT,ASF, BTB, CBPP,LSD,ND,RAB, RVF,TRY	ANT,ASF,BTB,CBPP, LSD,ND,RAB,TRY	ANT,ASF,BTB,CBPP, LSD,ND,RAB,TRY	AHS,ANT,ASF,BTB, CBPP,LSD,ND,RAB, THE,TRY	ANT,AST,BRU,BTB, CBPP,LSD,ND,RAB, TRY
Botswana	AHS,BRU,FMD,LSD, ND, RAB	ANT,BRU,BT,FMD, LSD,MCF,ND,RAB	ANT,BRU,FMD,LSD, MCF,RAB,TRY	ANT,BT,FMD,LSD, RAB	AHS,BRU, LSD, ND, RAB	BRU,FMD,LSD,ND, RAB,RVF,TRY
Namibia	CBPP,LSD,ND	BT,CBPP,LSD	ANT,ASF,BRU,CBPP, FMD,LSD,ND,RAB	AHS,ANT,ASF,BRU, CBPP,FMD,LSD,ND, RAB,THE	AHS,ANT,ASF,BRU, BT,CBPP,FMD,LSD, ND, RAB	AHS,ANT,BRU,BT, CBPP,FMD,LSD,ND, RAB, EVF,TRY
Zambia	ASF,BRU,CBPP,LSD, ND,RAB,THE,TRY	ASF	ANT,BRU,BTB,CBPP, LSD,ND,THE,TRY	ANT,ASF,BRU,BTB, CBPP,FMD,LSD,ND, RAB, THE, TRY	ANT,ASF,BRU,BTB, CBPP,FMD,LSD,ND, RAB,THE,TRY	ANT,ASF,BRU,BTB, CBPP,FMD,LSD,ND, RAB,THE
Zimbabwe	AI,FMD,ND,TRY	-	BRU,ANT,FMD,LSD, ND, RAB,TRY	ANT,BRU,BT,FMD, LSD, ND,RAB,THE, TRY	ANT,BRU,BTB,FMD, LSD,ND,RAB,RVF, THE,TRY	ANT,BRU,BT,FMD, LSD,ND,RAB,THE
DRC	ASF,CBPP,PPR	FMD	ANT,ASF,BRU,BTB, FMD,LSD,ND,RAB, THE,TRY	ASF,BTB,ND,PPR, RAB,RVF,TRY	-	CBPP,LSD,ND,PPR
Malawi	ASF,LSD,ND,RAB, THE	AHS,ASF,BTB,LSD, ND, TRY	ASF,BTB,LSD,ND, THE,TRY	ASF,FMD,LSD,ND, RAB	ASF,FMD,LSD,ND, RAB,THE	ASF,LSD,RAB,TRY
Mozambique	ASF,BRU,LSD,ND, RAB,THE TRY	AHS,ASF,BRU, BTB, LSD,ND,RAB,THE, TRY	ASF,BRU,BTB,LSD, ND,RAB,THE,TRY	ASF,BRU,BTB,LSD, ND,RAB,THE,TRY	ASF,BRU,BTB,LSD, ND,RAB,THE,TRY	ASF,BRU,BTB,FMD, LSD,ND,RAB,THE, TRY
South Africa	AHS,AI,ASF,BRU,BT, LSD,ND,RAB	AHS,ANT,ASF,BRU, BT,BTB,FMD,LSD, MCF, ND,RAB,THE,TRY	AHS,ANT,ASF,BRU, BT,BTB,LSD,MCF, ND, RAB,THE	AHS,ANT,ASF,BRU, BT,BTB,FMD,LSD, ND, RAB, RVF,THE,TRY	AHS,ANT,BRU,BT, BTB,FMD,LSD,ND, RAB, RVF,THE,TRY	AHS,AI,ANT,BRU, BT,BTB,FMD,LSD, ND,RAB,RVF
Tanzania	BRU,CBPP,FMD,LSD, ND, RAB,THE,TRY	ANT,CBPP,FMD,LSD, ND,RAB,RVF,THE, TRY	ANT,BRU,BTB,CBPP, FMD,LSD,ND,RAB, RVF,THE,TRY	ASF,CBPP,FMD,LSD, RAB,THE,TRY	ANT,CBPP,FMD, LSD, ND,RAB,THE,TRY	ANT,ASF,CBPP,FMD, LSD,ND,PPR,RAB, THE

Table 24 Summary of status of selected diseases in KAZA and neighbouring countries

Disease	ANG	BOT	NAM	ZAM	ZIM	DRC	MAL	MOZ	RSA	TAN
ANT	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic
BT	Not reported	?Endemic	?Endemic	Not reported	Uncertain, ?endemic	Not reported	Uncertain	Not reported	Endemic	Not reported
FMD	Endemic in buffalo in KAZA area	Endemic in buffalo	Endemic in buffalo	Endemic in buffalo and cattle	Endemic in buffalo	Endemic in cattle and probably buffalo	Endemic in buffalo	Sporadic due to cattle moved from ZIM; probably endemic in buffalo	Endemic in buffalo	Endemic in cattle and buffalo
RAB	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic
RVF	Outbreaks occur sporadically; the virus is probably endemic in vertebrate hosts and vectors in all the countries									
TRY	Endemic	Eradicated	?Endemic in NCAs	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic in N KZN	Endemic
BTB	Endemic	Absent	Uncertain	Endemic	Not reported	Endemic	Endemic	Endemic	Endemic	Reported as if endemic in 2009 & 2010
CBPP	Endemic	Absent	Endemic in NCAs; controlled by vaccination but incursions from ANG	Endemic in Western Province	Absent	Endemic	Absent	Absent	Absent	Endemic
LSD	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic
PPR	Absent	Absent	Absent	Absent	Absent	?Endemic	Absent	Absent	Absent	Endemic since 2009
AHS	Occasional	Occasional	Occasional	Not reported	Not reported	Not reported	Not reported	Occasional	Endemic	Not reported
ASF	Endemic	Endemic in warthogs	Endemic in warthogs	Endemic in E Province, sporadic elsewhere	Endemic in warthogs; no outbreaks since 1977	Endemic	Endemic	Endemic	Endemic in warthogs	Endemic in warthogs

Disease	ANG	BOT	NAM	ZAM	ZIM	DRC	MAL	MOZ	RSA	TAN
HPAI	Never reported	Never reported	Never reported	Never reported	H5N2 ostriches (occasional)	Never reported	Never reported	Never reported	H5N2 ostriches (occasional)	Never reported
ND	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic	Endemic
BRU[10]	Unknown	Endemic	Endemic	Unknown	Endemic	Endemic	Unknown	Endemic	Endemic	Endemic
MCF[11]	Unknown	Never reported[12]	Endemic in wildebeest[13]	Unknown	Endemic in wildebeest	Unknown	Never reported	Never reported	Endemic in wildebeest	Unknown

[10] Information for 2005 only but it is likely that bovine brucellosis is endemic in all the countries listed
[11] Information incomplete, some countries submitted information between 2006 and 2008
[12] Reported to be absent during the periods when information was submitted
[13] This is assumed if the disease has been reported as present at any time

The Wildlife Conservation Society's Animal & Human Health for the Environment And Development (AHEAD) Program is a convening, facilitative mechanism, working to create enabling environments that allow different and often competing sectors to literally come to the same table and find collaborative ways forward to address challenges at the interface of wildlife health, livestock health, and human health and livelihoods.

We convene stakeholders, help delineate conceptual frameworks to underpin planning, management and research, and provide technical support and resources for projects stakeholders identify as priorities. AHEAD recognizes the need to look at health and disease not in isolation but within a given region's socioeconomic and environmental context.