EMPRES WATCH

emergency prevention systems

Climate models predict increased risk of precipitations in the Horn of Africa for end of 2008

FAO and WHO warn countries in Africa and the Arabian Peninsula that Rift Valley Fever may strike again at the end of 2008

1. INTRODUCTION

Rift Valley Fever (RVF) is an arthropod-borne viral disease associated with high rates of abortion and neonatal mortality in ruminants and influenza-like illness in humans that may progress to neurologic, ocular, or hemorrhagic disease and death. The vast majority of human infections result from direct or indirect contact with the blood or organs of infected animals. Human infections have also resulted from the bites of infected mosquitoes. Ruminant infections occur in areas of high competent vector populations. Adult animals may be asymptomatic or develop mild disease that is typically first noted with the occurrence of abortions in the flock but some breeds, especially local ones, are more resistant to disease. Neonatal and young animals are more severely affected with a high mortality rate. The disease is transmitted by several different types of arthropod vectors (*Culex*, *Aedes*, *Anopheles*, *Mansonia*, *Eretmapodites*, *Culicoïdes*), with mosquitoes of the *Aedes* genus serving as the virus reservoir in nature through transovarial transmission. These infected eggs can survive through years of drought or desiccation. During increased precipitation, low-lying mosquito-breeding habitats are flooded, and the reservoir vectors re-emerge. Then the virus is amplified in domestic ruminant hosts, additional arthropod species can transmit the virus to other susceptible hosts including man. This increase of viral activity initiates a rapid spread of the disease.

RVF has been documented in most sub-Saharan African countries, as well as Egypt and the Arabian Peninsula. The virus occurs in a variety of ecotypes and can spread to new geographic areas with animal movement. Previously affected areas must be considered endemic. In rainforest ecological zone, such as central African countries, the disease can be observed regularly with low incidence of disease. In semi-arid and arid regions of the Horn of Africa, large epidemics of RVF occur following periods of unusually high rainfall and flooding in 5 to 15 year cycles that have been associated with global climatic events and especially El Niño. Once spread to a new area, RVF can cause significant disease and economic loss in an immunologically naïve animal population. This scenario has occurred several times in newly affected areas, such as the emergence of RVF in 1977 in Egypt or in 2000 in the Arabian Peninsula.

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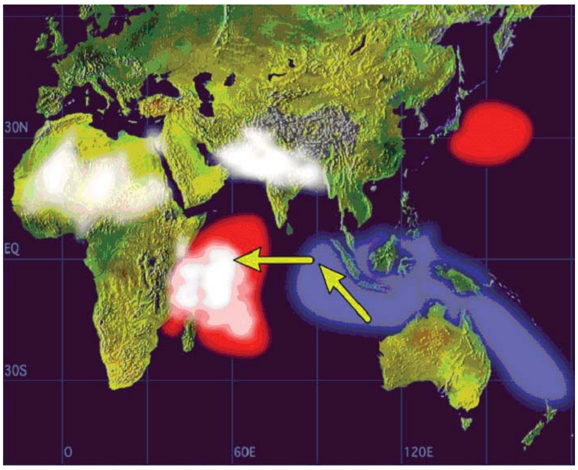
2. CLIMATIC FORECASTING OF DISEASE

The disease ecology of RVF in East Africa has been extensively studied. Following a period of persistent, heavy rainfall, the breeding habitats of *Aedes* floodwater species, such as the temporary ground pools known as *dambos* in Kenya, become flooded and promote the hatching of mosquito eggs. Eggs lain by RVF infected females harbour the virus and produce adult mosquitoes capable of infecting vertebrate hosts and propagating disease outbreak.

Historical data regarding sea-surface temperatures (SST) have found an association between anomalous SST, where the difference between weekly SST and historical average SSTs is measured, and heavy rainfall in East Africa. Concurrent positive western Indian Ocean SST anomalies and equatorial Pacific SST anomalies have occurred in conjunction with significant disease outbreaks in 1982-3, 1997-8, and 2006-7. Such events have also been associated with *El Niño* events and more recently with a positive Indian Ocean Dipole (IOD) event, which may occur in concert with or independent of an *El Niño* event. A positive IOD occurs when the Western Indian Ocean experiences abnormally high sea-surface temperatures and the Eastern Indian Ocean shows abnormally low sea-surface temperatures, causing a change in trade wind patterns to concentrate precipitation over the North Western Indian Ocean and bordering land areas (Figure 1). Such positive IOD events have been linked to prolonged heavy rainfall in East Africa and subsequent positive anomalies in vegetation indices, leading to disease outbreaks of Rift Valley Fever due to a surge in vector populations in flooded areas.

Figure 1. Schematic diagram of SST anomalies (red shading warming; blue cooling) during a positive IOD event



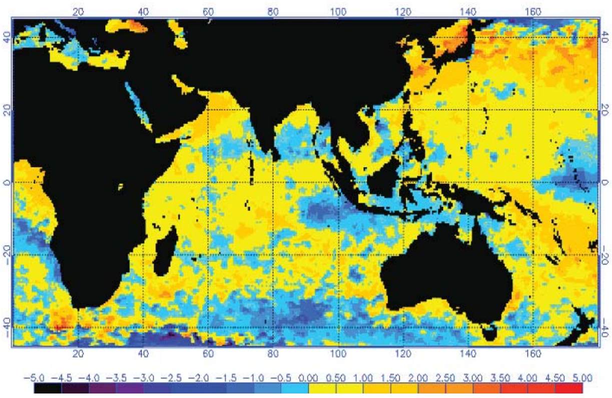
White patches indicate increased convective activity. Arrows indicate wind direction. Positive Indian Ocean Dipole (IOD) characterized by decreased sea-surface temperatures over the eastern Indian Ocean and elevated sea-surface temperatures and precipitation over the western Indian Ocean, resulting in increased East African precipitation.

Source: The Frontier Research Center for Global Change
http://www.jamstec.go.jp/frcgc/research/d1/iod

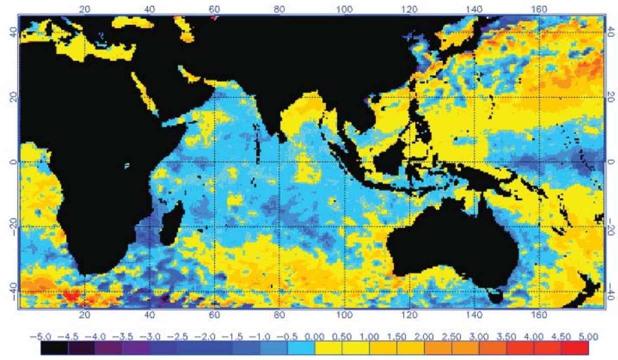
3. RECENT WARNING MESSAGE

The Frontier Research Center for Global Change (FRCGC), Japan, has issued a warning of a strong positive Indian Ocean Dipole (IOD) event for 2008 based on the predictive climatic models developed by the FRCGC. This would be a highly unusual occurrence as it would be the third consecutive appearance of the IOD. The appearance of a positive IOD and subsequent heavy rainfall in East Africa was linked with a RVF outbreak in 2006 and 2007 in Kenya, Tanzania, Somalia, Sudan, Comoros and the Republic of South Africa. Madagascar were also strongly affected at the end of 2007 and 2008, but recent investigations suggest that the outbreak really started in the south of the country during spring 2007. The 2006 IOD was associated with *El Niño* phenomena and resulted in extensive flooding and RVF outbreaks in 2006 and the first part of 2007. WHO estimates reported 1000 human infections with 323 deaths in Kenya, Somalia,

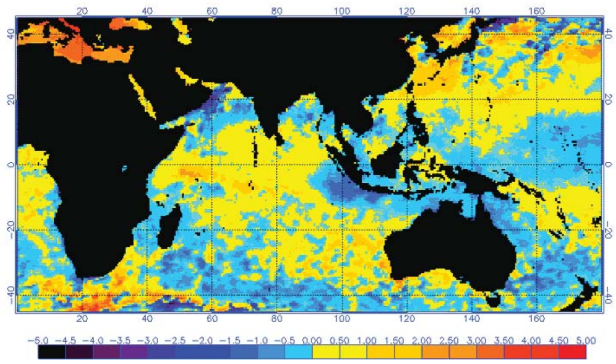
Figure 2: Sea-surface temperature anomalies from the NOAA National Environmental Satellite



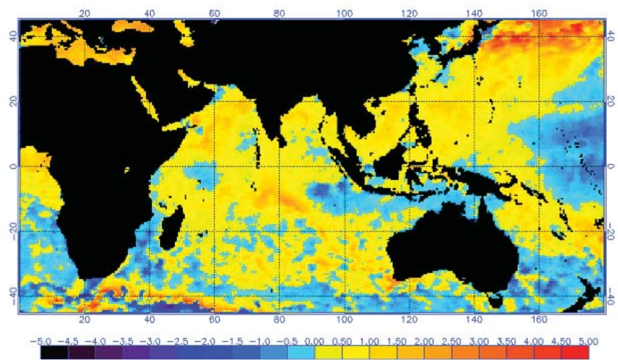
SST anomaly for the week of **October 4, 2007** in degrees Celsius for the eastern hemisphere during the positive IOD event, which resulted in increased rainfall in areas of East Africa and subsequent RVF activity in Kenya, Somalia, Tanzania, and likely Madagascar. Note the increased SST in the Western Indian Ocean (yellow) together with the decreased Eastern Indian Ocean SST off the northern coast of Australia (blue). Positive IOD events typically begin in June and peak abruptly in October, and are associated with increased precipitation in Eastern Africa. Increased rainfall is associated with RVF outbreaks in several East African countries.



SST anomaly in degrees Celsius in **April of 2008**, prior to the typical period in which a positive IOD occurs. Temperatures in the Western Indian Ocean were within or below the normal range of historical values.



SST anomalies in degrees Celsius for **July 7, 2008**. Increased temperatures in the Western Indian Ocean near East Africa with decreased temperatures in the Eastern Indian Ocean around Malaysia are suggestive of a positive IOD, which might result in increased precipitation in East Africa and outbreaks of diseases transmitted by arthropods, such as RVF.



SST anomalies in degrees Celsius for **September 8, 2008**. The positive IOD is confirmed, with a picture very similar to figure of **October 4, 2007**.

Data and Information Service (NESDIS)
http://www.osdpd.noaa.gov/PSB/EPS/SST/climo.html

and Tanzania. The following autumn, a RVF outbreak in White Nile, Sudan was associated with a positive IOD and *La Niña* phenomenon, resulting in 698 human cases and 222 deaths according to WHO reports. A similar IOD is forecasted for late 2008, which may result in above average rainfall in some East African states during the rainy season.

4. RISK OF EMERGENCE OR RE-EMERGENCE OF RVF

Much of Kenya has experienced below-average rainfall during the 2008, and it is unknown how this will influence vector emergence in the event of predicted increased rainfall. Recent viral circulation has resulted in more animals being exposed to the virus and gaining immunity upon having survived infection, which can be passed on to offspring via colostral immunity. A higher level of herd immunity should impact the potential for further disease spread by reducing the livestock population capable of viral amplification. This might lessen the severity of an outbreak in non-naïve areas, but the risk remains very high for not-yet affected areas.

The predicted positive IOD gives a lead time of 5 to 6 months before the forecasting of a disease outbreak. It is possible that climatic conditions may change during this period that would influence the occurrence of disease. Since 2001, FAO and WHO together with national authorities in Africa and the gulf countries and international scientific institutions are working in close collaboration on forecasting systems for RVF outbreaks. FAO, WHO and their partners are using scientific information from real-time forecasting centers to implement appropriate preventives strategies, surveillance and laboratory scheme and disease control recommendations. Existing disease forecasting models, such as RVF risk maps developed by the NASA Goddard Space Flight Center, will be closely monitored by WHO and FAO epidemiologists to evaluate continued risk as the time of predicted outbreak nears. The RVF risk mapping initiative conducted by NASA/GSFC integrates vegetation indices (NDVI), SST of both the Pacific and Indian Oceans, and rainfall anomalies and compares them to historical data for the area. This approach predicted the Kenyan RVF disease with 95-100% accuracy and a lead time of about 2 months, and will be integral in evaluating continued threat of outbreaks. Combining IOD forecasting with NDVI predictions will increase the amount of time between warning and disease compared to NDVI forecasting alone. This would allow time for vaccination campaigns to be enacted prior to disease outbreaks to give animals immunity and decrease the chance of iatrogenic disease dissemination.

5. LIMITATIONS AND ASSUMPTIONS

The maps presented in this report depict sea-surface temperature trends that are suggestive of a positive IOD, which might increase precipitation in East Africa similar to what has been observed in previous years of positive IOD. These maps cannot, however, predict specific regions or areas of East Africa in which rainfall will be sufficiently increased to cause flooding of RVF vector habitats. Livestock stakeholders and public health officials need to evaluate local conditions and historical vector responses to rainfall events when identifying regional mitigation and prevention strategies. Prior herd exposure needs to be considered in prevention and surveillance regimes.

6. WHO AND FAO RECOMMENDATIONS

WHO and FAO encourage countries at risk to prepare themselves in cases of an epidemic. WHO and FAO encourage authorities to:

- develop a joint comprehensive health education programme with objective to inform the public but also target at-risk professions (farmers, veterinarians, slaughter house personnel) Public health messages for risk reduction should focus on:

  - reducing the risk of animal-to-human transmission as a result of unsafe animal husbandry and slaughtering practices. Gloves and other appropriate protective clothing should be worn and care taken when handling sick animals or their tissues or when slaughtering animals

  - reducing the risk of animal-to-human transmission arising from the unsafe consumption of fresh blood, raw milk or animal tissue. In the epizootic regions, all animal products (blood, meat and milk) should be thoroughly cooked before eating

  - the importance of personal and community protection against mosquito bites through the use of impregnated mosquito nets, personal insect repellent if available, by wearing light coloured clothing (long-sleeved shirts and trousers) and by avoiding outdoor activity at peak biting times of the vector species
- Implement Standard precautions in health care settings. A WHO Aide–memoire on Standard Precautions in health care is available at: http://www.who.int/csr/resources/publications/standardprecautions/en/index.html
- Heighten animal and human RVF surveillance and diagnostic
- Strengthen Human and Animal health collaboration. Public health and veterinary services should intensify their collaboration during surveillance and prevention activities
- Implement appropriate vector control program based on entomological surveys

7. SPECIFIC FAO RECOMMENDATIONS

- The FAO encourages countries at risk to implement and increase surveillance strategies, including the use of sentinel herds and vector monitoring. In countries that have experienced RVF outbreaks in the recent past, the level of immunity of the herd must be appreciated when evaluating outbreak potential

- Veterinary services should be alerted to watch for any signs compatible with RVF and implement proper disease control and personal protection strategies. Early warning signs of a disease event would include abortions in small ruminants at any stage of pregnancy, any hemorrhagic fever in ruminants or humans, peracute fever and deaths in neonatal animals, and icterus and impaired hepatic function in ruminants of any age
- Animal slaughter should not be conducted on any animal, sick or healthy, during a RVF outbreak, and the use of protective equipment must be promoted
- Personal protective equipment, including glove, glasses and a face mask should be also worn at all times in slaughter during the treatment of sick animals or necropsy
- In at risk areas, careful vaccination of susceptible animals should be considered as an option prior to any observed disease. However, vaccination is not recommended in the event of known RVF circulation, as improper vaccination techniques can promote viral spread and worsen the outbreak of disease. Attenuated live vaccines have been shown to provide protective immunity for up to three years following a single inoculation, although use of these vaccines has been associated with abortions. Inactivated vaccines appear to have fewer side effects, but require annual application for effective flock immunity and thus are less useful in an outbreak scenario. The sequential use of the inactivated vaccine followed by the live vaccine can reduce the negative effects of the live vaccine alone
- Importing countries of meat or animals from RVF risk areas should not apply trade restrictions if disease surveillance is in place in countries/zones at risk with negative results. The OIE standards clearly separate "RVF infection free country or zone" from "RVF infected countries/zones without disease". In the first case, the country is out of the historical distribution area, a surveillance program is in place, and 4 years have elapsed since the last epidemic. In the second, the country is considered free but disease has not occurred in humans and animals in the past 6 months and climatic changes predisposing to outbreaks of RVF have not occurred during this time. A third classification is "RVF infected country/zone with disease", meaning clinical disease in humans and animals has occurred within the past 6 months. Even in presence of disease or infection, the OIE Terrestrial Animal Health Code accepts trade of ruminants and meat from infected countries if certain specific conditions of quarantine or vaccination are met. This is based on timely and prompt notification of infection or disease to the OIE

8. FOR MORE INFORMATION

The IOD predictions and monitoring systems were developed and provided by the Frontier Research Center for Global Change (FRCGC). The information contained herein is provided as a public service, with the understanding that the FRCGC/JAMSTEC Climate Variations Research Program makes no warranties, either expresses or implied, concerning the accuracy, completeness, reliability or suitability of the information. Website: http://www.jamstec.go.jp/frcgc/research/d1/iod/

The SST anomaly maps were obtained from the National Oceanic and Atmospheric Administration's (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS). The NOAA/NESDIS operational SSTs are provided twice a week in near real-time using both day and night retrievals from satellite infrared radiometers. Nighttime SST observations have been used to eliminate the diurnal variation caused by diurnal solar heating at the sea surface. Maps and additional information can be found on their website: http://www.osdpd.noaa.gov/PSB/EPS/SST/climo.html

Information and analyses from the Rift Valley Fever Monitoring Group is available on their website at http://www.geis.fhp.osd.mil/GEIS/SurveillanceActivities/RVFWeb/indexRVF.asp

Information on Rift Valley fever disease in human together with a Fact sheet in English, French and Arabic is available on the WHO website: http://www.who.int/csr/disease/riftvalleyfev/en/index.html

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