Evaluating the impacts of the development of irrigation schemes in arid and semi-arid areas in Kenya on ecosystems biodiversity and its capacity to regulate infectious diseases

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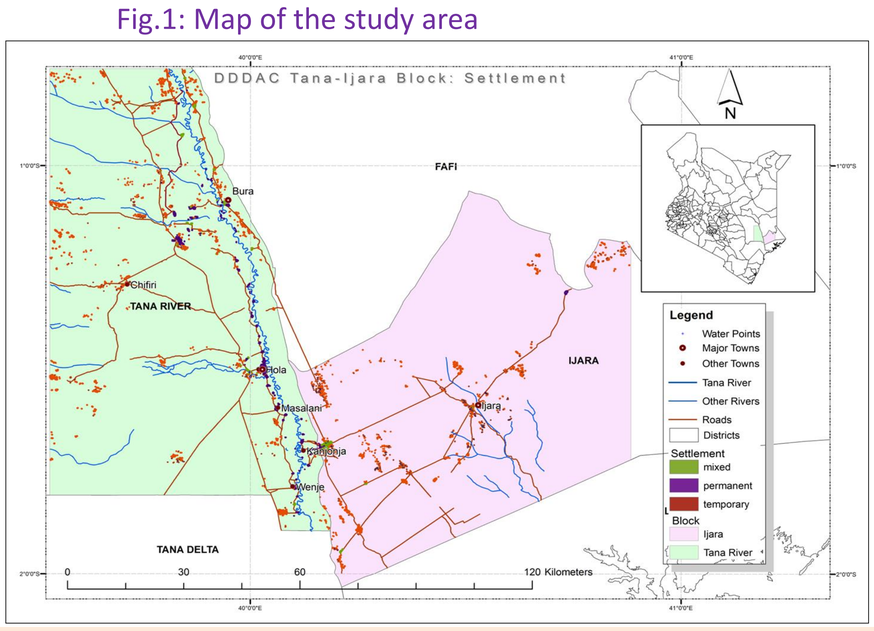
Introduction

- Intact ecosystems maintain a stable biodiversity and processes that support the production of a range of ecosystem services. Anthropogenic land use changes cause transformation of these systems , leading to a decline in their capacity to control disasters such as floods, landslides, infectious disease epidemics, etc.
- This study assesses linkages between land use, climate and biodiversity changes on human health and wellbeing by evaluating the effects of the development of irrigation schemes on the emergence and transmission of vector-borne diseases such as Rift Valley fever (RVF), malaria, West Nile virus and other arboviruses in the coast and northeastern Kenya
- The study site is illustrated in Fig. 1 while the conceptual framework, adapted from the Millennium Assessment (2005), is shown in Fig. 2
- The results presented include analyses on historical data on ecological changes that have occurred in the region since the 1970s, when the schemes were developed, to the 2000s. They also include predictions that have been generated from a dynamics systems model for RVF

Fig.1: Map of the study area



The study sites:

- ***Ijara district, Garissa County*** is an area where pastoralism is the main livelihood activity. It represents a site that has slow or minimal land use changes
- ***Bura and Hola irrigation schemes, Tana River County***, has two of the main irrigation schemes along Tana River, Kenya. It represents a site with substantial land use changes

Emerging results

Biodiversity changes

- There has been a gradual decline in population densities of a number of wild mammals especially in the irrigated areas (Fig. 3)
- Participatory studies suggest that the populations of rodents and baboons have increased in irrigated areas, and so there is a risk of them acting as reservoirs for zoonotic diseases

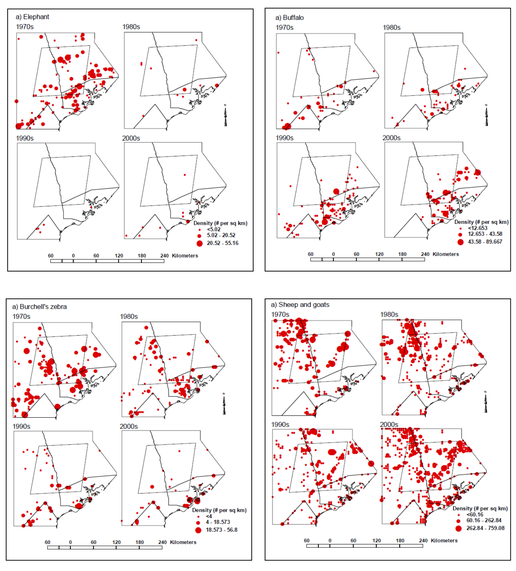


Fig. 3: Changes in large mammal populations between 1970s – 2000s

- Entomological studies have also been done to compare the types of mosquito species that are found in irrigated and non-irrigated areas. Trapping was done using CDC miniature light trap shown in Plate 1.

Plate 1: CDC miniature light trap used for mosquito sampling

- Results obtained from initial surveys suggest that:

- Most of the adult mosquitoes sampled in irrigated areas during the dry season were floodwater *Aedes* mosquitoes: *Aedes (Ae) mcinthoshi* and *Ae sudanensis*. These are known to be the primary vectors of RVF
- During the same season, no adult mosquitoes were trapped in the non-irrigated areas and there were no breeding sites observed in these areas
- Larvae were also sampled from the irrigation canals and other breeding sites in the irrigated areas and reared to adults at the Kenya Medical Research Institute (KEMRI) laboratory in Nairobi. These larvae emerged to *Anopheles* spp. and *Culex* spp. mosquitoes. More work is being done to identify *Aedes* spp. from these breeding sites.

In general, the irrigated areas have a lower diversity of mammalian hosts and a higher population density and diversity of mosquito species

RVF transmission dynamics

- A dynamic systems model has been developed and used to simulate RVF transmission dynamics in the two study sites described in Fig. 1.
- The model integrates hydrology, vector, host and socio-economics parameters and it is driven by daily precipitation obtained from the Tropical Rainfall Measuring Mission (TRMM). Predictions for the Ijara study site are represented in Fig. 4 while those for irrigated areas in Tana River are given in Fig. 5. Simulations are provided for the period: Jan 2005 (day 0) to June 2010 (day 2000).

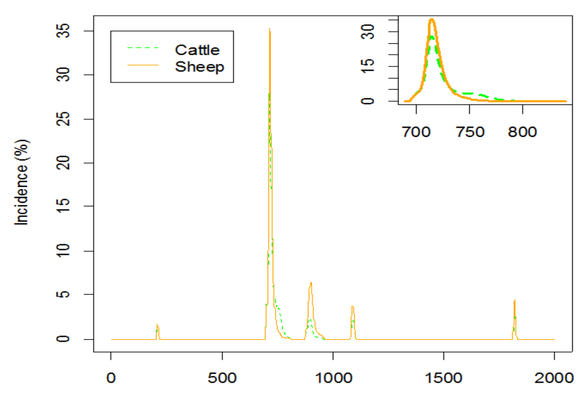


Fig. 4. Predicted RVF outbreaks in Ijara in cattle and sheep for the period Jan 2005 to June 2010

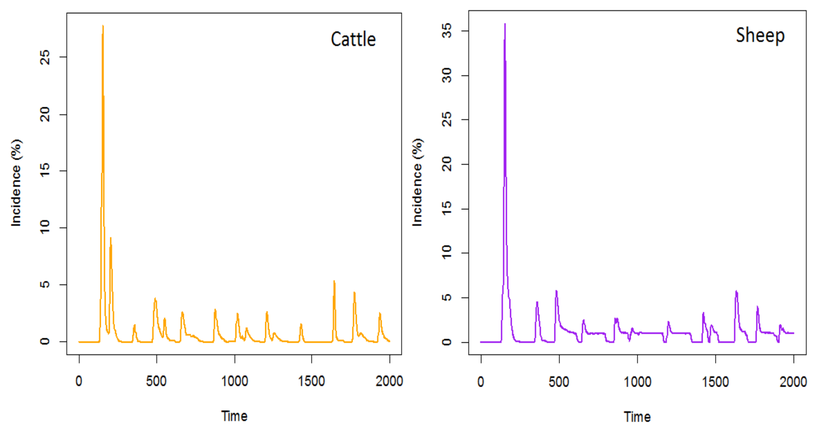


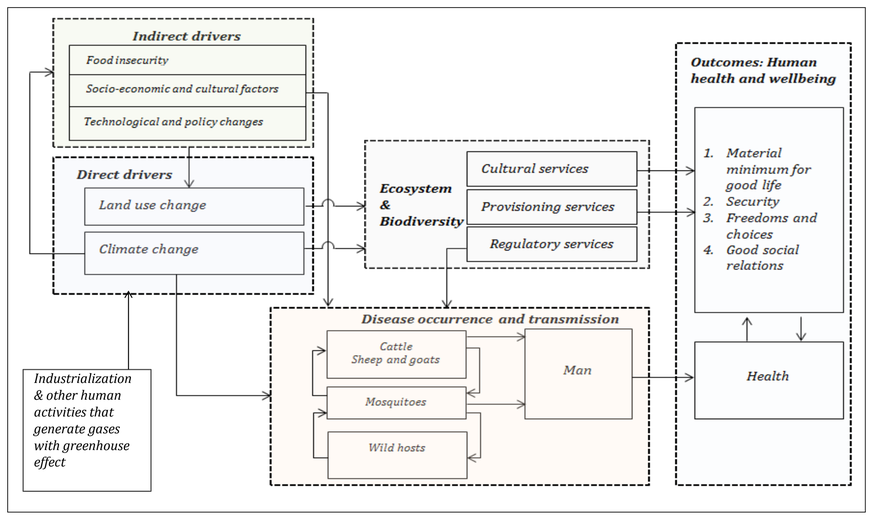
Fig. 5. Predicted patterns of RVF occurrence in irrigated areas of Tana River county in cattle and sheep for the period Jan 2005 to June 2010

- The model suggests that irrigated areas are likely to sustain an endemic transmission of RVF following an initial epidemic, if standing water masses are maintained so as to support the development of mosquito vectors
- The changes in the host diversity demonstrated in Fig. 3 is likely to change the patterns of transmission of zoonotic pathogens in the region given that rodents and baboons are likely to play a bigger role in the maintenance of zoonotic pathogens in irrigated areas while big mammals contribute more to these transmission dynamics in the pastoral areas.

Reference

Millennium Ecosystem Assessment, (2005). Washington, DC, Island Press

Fig.2. Conceptual framework illustrating key linkages between land use and climate change, biodiversity and human health and wellbeing



Public health dimensions

- Medical records for most of the febrile diseases that were treated at the local hospitals and dispensaries over the period 2007 to 2012 were obtained and analysed. The distribution of cases classified as malaria and brucellosis are shown in Fig. 6 and 7, respectively.

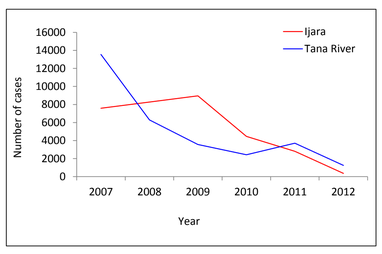


Fig.6. Distribution of cases classified as malaria in the two study sites

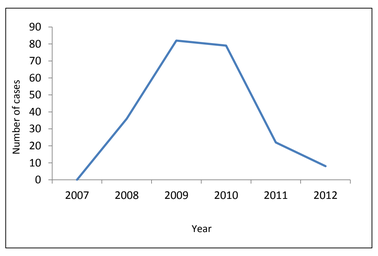


Fig.7. Distribution of cases classified as brucellosis in Ijara

- In general, the data suggests that there has been a gradual decline of cases diagnosed as malaria, with Ijara district having a slightly lower number of cases than Tana River County
- Cases diagnosed as brucellosis have also been declining and no such cases were obtained from hospitals in Tana River County
- No RVF cases have been reported in both sites in the period considered
- The local hospitals report three diseases (malaria, brucellosis and typhoid) as the main causes of febrile illnesses in people. The study will investigate whether there are other pathogens that cause similar illnesses in the area, and their distribution by land use.
- Information generated would be used to build capacity on differential diagnosis of febrile illnesses among the health service providers in the local hospitals.

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