Epidemiology of malaria in irrigated parts of Tana River County, Kenya

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Abstract

Irrigation schemes introduced in areas of high malaria endemicity often amplify malaria burden especially if no mitigation or adaptation measures are implemented (Renshaw *et al.*, 1998). Thias study was conducted in Bura and Hola irrigation schemes in Tana River County to (i) understand the knowledge, attitude and practices of the community in relation to malaria control and transmission, (ii) determine malaria prevalence and the associated risk factors of infection and (iii) develop and validate a transmission model for analyzing the effects of irrigation on malaria burden. A cross sectional survey was conducted in 48 households where 160 people were screened for malaria parasites using Rapid Diagnostic Test. A deterministic model was developed and validated using field data. The community demonstrated good knowledge on causes, symptoms, transmission and control of malaria. The main malaria control measure was use of bed nets where one net was shared by two people. Only 12% of the households practice environmental management to control malaria. Treatment of malaria was mainly based on Artemether-lumefantrine (AL) which is freely available in the government health facilities. The prevalence of malaria was 5% with the clinical records showing a declining trend of malaria cases. Households located ≤5kms to the nearest facility had lower risk of malaria infection (OR=0.104, p-value=0.013) than those located >5kms. Household size was also associated with malaria infection (OR=1.685, p-value=0.022). The model predicted the observed prevalence data. The high usage of bed nets and AL could have led to the observed decrease in malaria prevalence despite the intensification of irrigated agriculture. The model developed could be used to predict the prevalence of malaria in this area enabling decision makers to implement appropriate control measures in good time.

Introduction

- The development of Bura and Hola irrigation schemes in Tana River County, Kenya (to enhance food security) might have escalated the baseline risk of the disease given that the area is infested with efficient mosquito vectors (*Anopheles gambiae* complex) (Mutero and Birley, 1987). This might be complicated further by high levels of poverty in the area (72%), literacy levels and insecurity that limit access to medical services.
- Land use changes such as irrigation affect microclimatic conditions that influence the abundance and survivorship of mosquitoes by creating standing water masses which increases humidity, hence better survivorship of mosquitoes (Patz *et al.*, 2005).
- The analysis of the potential for the irrigation to influence malaria transmission is fundamental for the prevention and control of the disease, for evidence-based guidance of health policy and planning, and for the promotion of intersectoral action.

Materials and Methods

- Questionnaires were administered to 48 randomly selected households where a maximum of five individuals per household were randomly sampled for malaria parasite screening.
- Questionnaire data were analysed using R software version 3.10.
- Model parameters were obtained from literature.
- Data on malaria prevalence for the year 2013 were obtained from the local hospitals and used for validating the model.
- Rainfall and temperature data during the year 2013 were obtained from weather station at Bura irrigation scheme.
- Figure 1 outlines the structure of the model. The model was implemented in MS Excel using difference equations.
- The Fuzzy distribution function was used to relate rainfall and irrigation patterns with oviposition and mortality rates of acquatic stages of mosquitoes.
- The model was fitted to malaria prevalence data obtained from the local hospitals by varying the parameters of the Fuzzy distribution function (Ermert *et al.*, 2011). Parameter values that gave the least variance between predicted and observed prevalence were used.

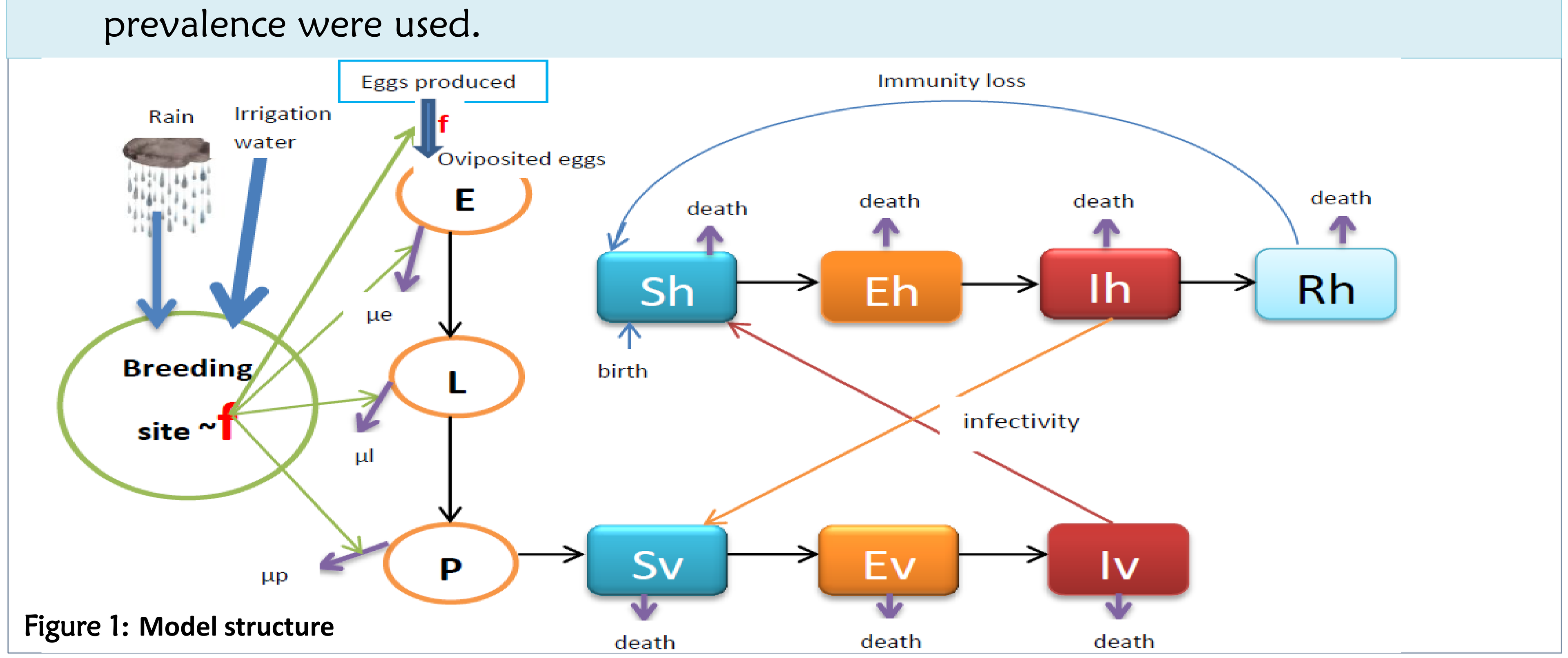

Figure 1: Model structure

Results and discussion

- Table 1 shows the results of KAP analysis.
- The household characteristics shows a poor community with high dependency level on the government. Poverty and poor housing conditions are associated with higher malaria cases (Graves *et al.*, 2009).
- Livestock keeping could have provided alternative sources of blood meal for the mosquitoes hence reducing blood meal index.
- The community demonstrated good knowledge of causes, symptoms transmission and control of malaria.
- Use of Insecticide Treated bed nets effectively reduces malaria transmission (Lengeler, 2004). Only a few households use environmental managements to control malaria yet its known that an Integrated Malaria Management package can successfully be used to eliminate malaria (Okech *et al.*, 2008), hence a need for education in this community.
- Malaria cases in Kenya have been decreasing since the introduction of free malaria drug (AL) in government health facilities in 2006 (MoH, 2012). Figure 2 shows a similar scenario in Bura and Hola irrigation schemes.

Table 1: Results of KAP analysis

Household demographics and characteristics	
Household size	6 people
Households keeping livestock	98%
Housing condition	90% built using muddy walls, earth wall and iron sheet roofs
Main source of water for domestic use	Irrigation water canals
Knowledge, control and treatment of malaria	
Percentage who knew causes ,symptoms and	89
Bed nets per household	3
Bed nets per person	0.5
Percentage who slept under bed nets the night before the survey	98
Main sources of bed nets	Government of Kenya
Percentage of households using environmental management such as draining stagnant water and bush clearing	12
Percentage of households sprayed with an insecticide (Indoor Residual Spray) within the last one year of the study.	40
Main health provider	Government health facilities
Percentage usage of AL	82

- Figure 2 shows the trend in malaria prevalence while Table 2 the significant risk factors from a logistic regression model. Malaria prevalence was 5%

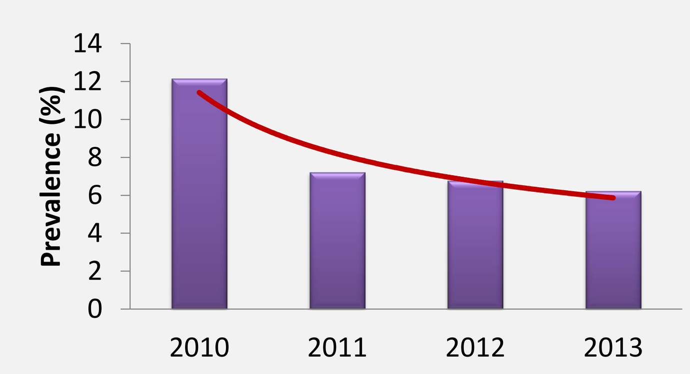

Figure 2: Trend of malaria prevalence in Bura and Hola between 2010 and 2011

Table 2: Results of a logistic regression model showing significant risk factors

Variable	Estimate	Odds Ratio	95% CI		P -value
			Lower	Upper	
Household size	0.522	1.685	1.126	2.800	0.022
Distance to nearest health facility (ref=>5km) ≤5km	-2.266	0.104	0.014	0.524	0.013

- Households located ≤5kms to the nearest health facility were at a lower risk of malaria infection compared to households located >5kms . Ownerships of bed nets was higher in households located ≤5kms to the nearest health facility than in households located >5kms. This, coupled with faster access to AL, could have explained the difference in the malaria infections. Larson *et al.* (2012) made a similar observation in Malawi indicating the important role that health services can play in preventing malaria transmission.
- For a unit increase in household size, the odds of having a person who had malaria infection increased by 68.5%. A similar observation was made by Ayele *et al.* (2012) where family size was significantly associated with malaria infection.
- Contrary to other studies (Ayele *et al.*, 2012; Sintasath *et al.*, 2005), age, sex, housing condition (main materials of wall, roof and floor), number of mosquito nets per person and IRS were not significantly associated with malaria infection.
- Figure 3 shows the output (predicted prevalence)of the deterministic model compared to the observed prevalence.

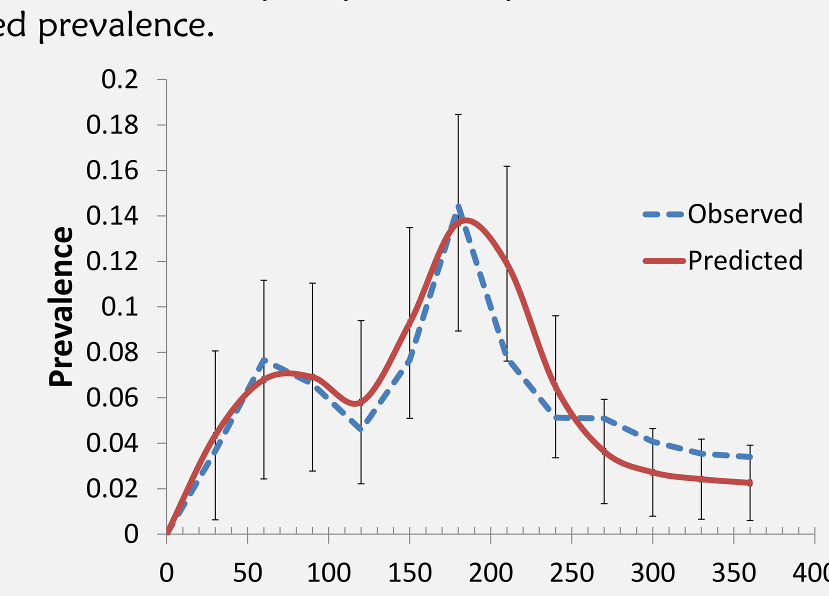

Figure 3: Predicted and observed malaria prevalence. Vertical lines show 95% confidence intervals

- The model fitted the data well and predicts an upsurge in the number of malaria cases 2-3 months after the rains or active irrigation. This supports findings published by Githeko and Ndekwa (2001) that suggest that malaria incidence lags onset of rains by 3-4 months.
- Data from non-irrigated areas and covering a longer period of time should be collected for more rigorous model validation and simulation of the impact of various interventions on malaria transmission.

Conclusion: The high usage of bed nets and AL could have led to the observed decrease in malaria prevalence despite the intensification of irrigated agriculture. The model could be used to predict the prevalence of malaria in irrigated areas of Tana River County. This would enable decision makers implement appropriate control measures in good time.

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