Quantifying Weather and Climate Impacts on Health in Developing Countries (QWeCI)

Science Talk

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AN INTEGRATED FORECAST FOR MALARIA IN THE MIDDLE BELT OF GHANA

Basing Anthony Wihibeturo
Dept. of Microbiology, SMS, KNUST

seaneedawn@yahoo.com

SEVENTH FRAMEWORK PROGRAMME

Introduction

- Climate plays an important role in the transmission of infectious diseases like malaria which is an important cause of morbidity and mortality in developing countries.
- Changes in temperature, rainfall and relative humidity are expected to influence malaria by modifying the behavior and geographical distribution of malaria vectors and by increasing or decreasing the length of the life cycle of the parasite.
- Currently there are efforts to develop early warning systems that use weather monitoring and climate forecasts and other factors.
- Knowledge of climate variability and its influence on the incidence of malaria can be used to predict malaria occurrences and hence provide early warning system information to stakeholders for early planning, preparedness and response to prevent epidemics

Introduction Cont.

- Four strategies employed in malaria control globally (adopted by Ghana)
  - The first element is to provide drugs and treatment to those infected;
  - second is the implementation of sustainable and effective preventive measures, including vector control;
  - the third one is to prevent or detect and contain epidemics in high-risk areas;
  - fourth is to strengthen local capacities in research and development

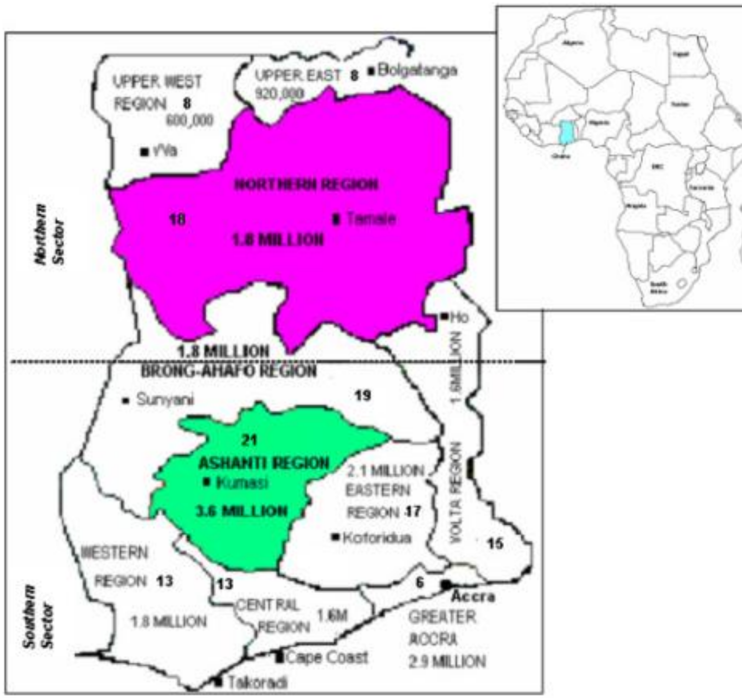
- In Ghana, malaria control undertaken throughout the year
  - Vector control is implemented mostly in the major rainy season when there is abundance of the vector
  - Strategies include mass spraying and provision of insecticide treated nets

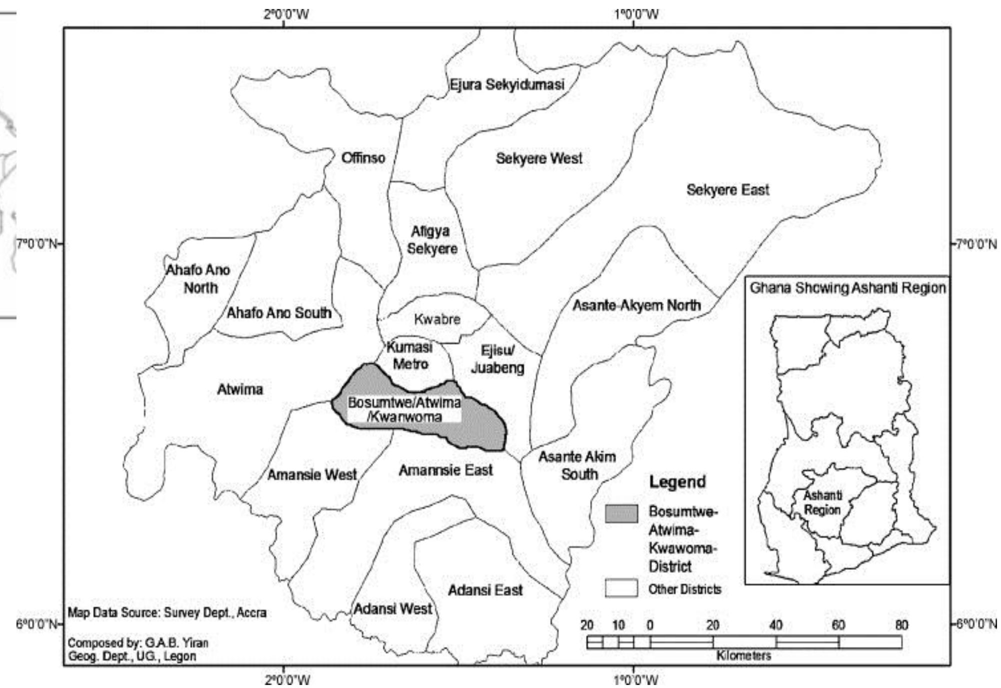
- By understanding the factors that drive mosquito abundance and the occurrence of malaria, future patterns of disease maintenance and transmission can be predicted.

Aim

- This study was aimed at investigating the impact of temperature, rainfall and relative humidity on malaria incidence in Kumasi, Ghana
- The study also sought to provide an integrated forecast for malaria in the middle belt of Ghana as an early warning system.

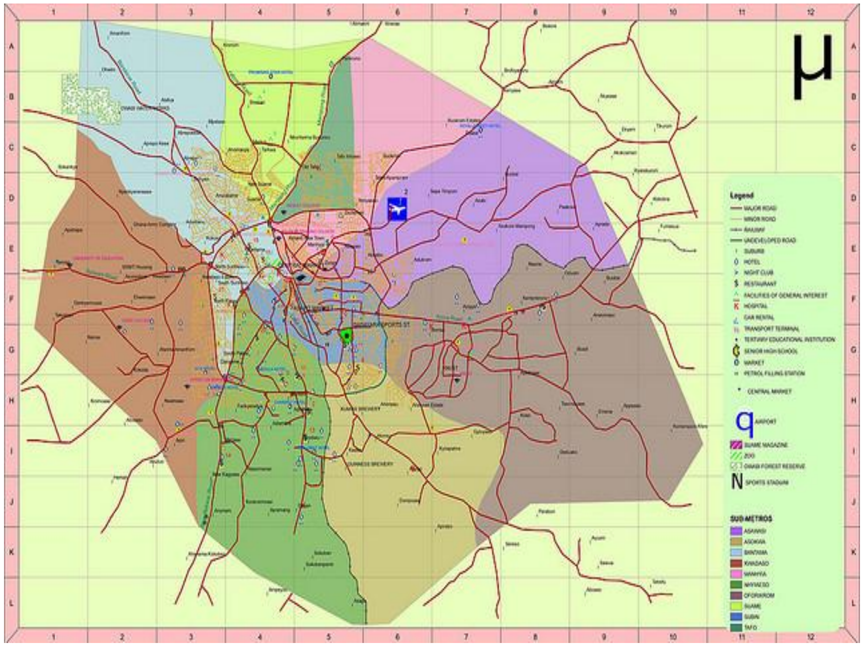
Study Area

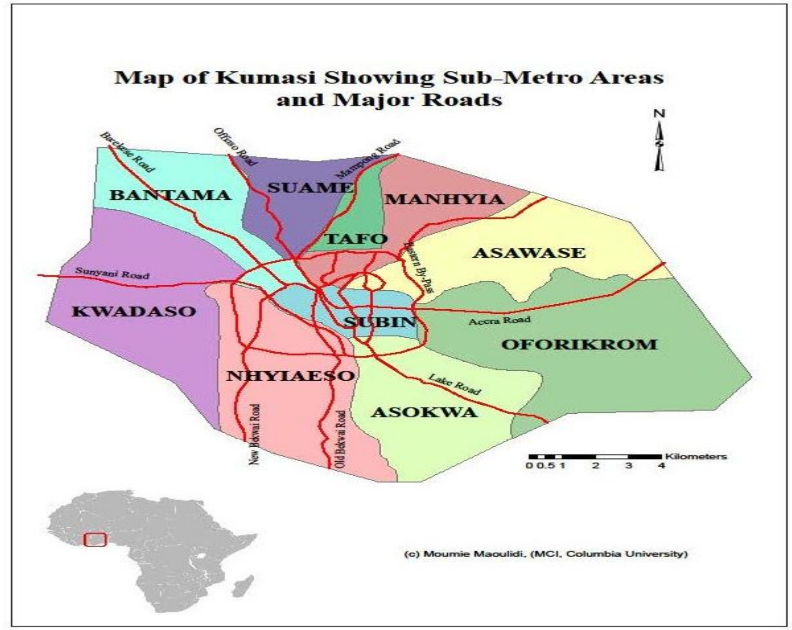




- The middle belt of Ghana is an area that covers the Ashanti region of Ghana and the southern part of the Brong Ahafo Region. This region is located in the transitional forest zone, with 27 administrative districts in the Ashanti region and 4 districts in the Brong Ahafo Region.

Study Area cont





- Kumasi is the capital of the Ashant Region and is about 270km north of the national capital, Accra with a population of 1,889,934. It is between latitude 6.35o – 6.40o and longitude 1.30o – 1.35o, an elevation which ranges between 250 – 300 metres above sea level with an area of about 254 square kilometres.

Methods

- Data on climatic variables from December 2009- February 2013 were obtained from the Owabi, Emena, Agogo, KNUST and Airport weather stations.
- Data on malaria cases from December 2009- February 2013 were obtained from Nkawie hospital (near Owabi weather station), Emena hospital and Kumasi South Hospital (near the KNUST Weather station) and Manhyia hospital (near Airport weather station) and Agogo Hospital (Near Agogo weather station
- Six communities were selected and sprayed for mosquitoes using the pyrethrum spray catch method.
- All mosquitoes were morphologically identified under stereomicroscope using keys (Gillies and Coetzee 1987).
- Using a hand lens, the blood digestion stage of each mosquito was determined and grouped as unfed, freshly fed, half-gravid, and gravid
- Host preference was determined by squashing fed mosquitoes on filter paper and testing using Human and bovine antiglobulin.

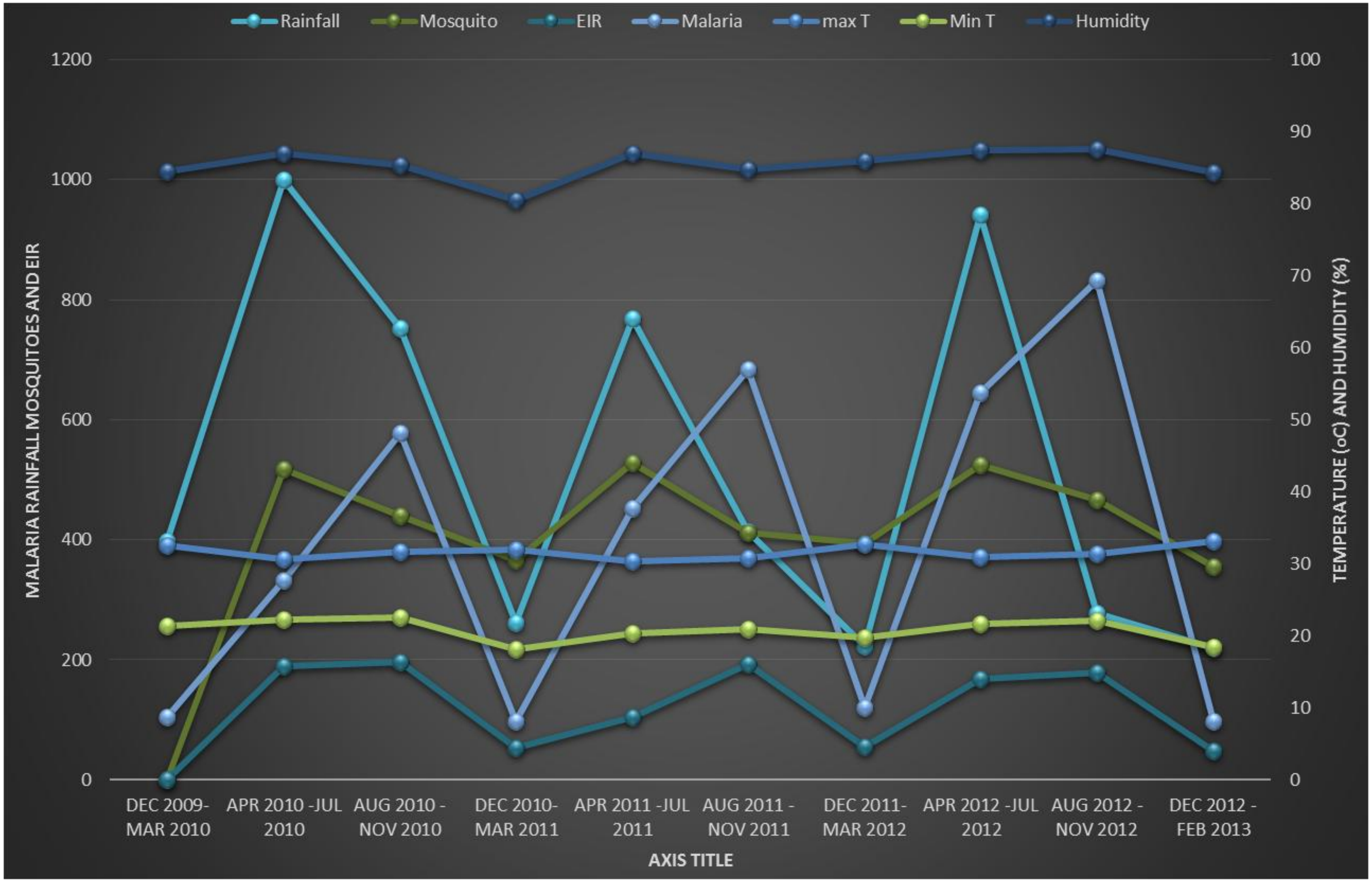
Methods cont.

- HBI = Number of Mosquitoes with Human Blood/ Total Number of Mosquitoes with blood
- HBR = Number of Mosquitoes with Human Blood/ Number of Occupants in the sprayed room
- Circumsporozoite proteins were determined using ELISA
- EIR= HBR xHBIx Sporozoite Rate infective bites/per person/night
- Ethical permission for the study was obtained from the Ethical Committee of the College of Health Sciences, Kwame Nkrumah University of Science and Technology, Kumasi.
- Data analysis was conducted with Microsoft Excel and Statistical Software Package, SPSS version (16.0). Pearson's correlation analysis was done to establish the relationship between climatic variables and malaria transmission.

Results

	max T	Min T	Rainfall	Humidity	Mosquito	EIR	Malaria
DEC 2009-MAR 2010	32.6	21.4	397.2	84.5	NO DATA	NO DATA	104
APR 2010 -JUL 2010	30.6	22.3	999.2	87	518	189.4	332
AUG 2010 -NOV 2010	31.6	22.5	752.6	85.3	440	196.1	578
DEC 2010-MAR 2011	31.9	18.1	261.3	80.5	366	53.6	98
APR 2011 -JUL 2011	30.4	20.4	768.5	87	528	104.9	453
AUG 2011 -NOV 2011	30.8	20.9	413.4	84.8	412	192.6	684
DEC 2011-MAR 2012	32.7	19.7	222.3	86	394	55.1	121
APR 2012 -JUL 2012	30.9	21.7	941	87.4	524	168.3	644
AUG 2012 -NOV 2012	31.4	22.1	278.1	87.5	467	178.4	832
DEC 2012 - FEB 2013	33.1	18.4	219.4	84.3	356	48.6	98

Results cont.



Results cont.

		APR-JUL	%		AUG-NOV	%		DEC-MAR	%		Total	%
	Mosquitoes caught	524			440			372			1336	
Mosquito Species	A. gambaie	287	54.8%		248	56.3%		116	31.3%		651	48.7%
	A. funestus	7	1.3%		21	4.7%		0	0.0%		28	2.1%
	Mansonella	56	10.7%		34	7.8%		41	11.0%		131	9.8%
	Culex	174	33.2%		137	31.2%		215	57.7%		526	39.4%
Blood Digestion	Un-fed	89	31.0%		98	39.5%		55	47.1%		242	37.2%
	Fresh fed	119	41.4%		89	35.9%		34	29.4%		242	37.2%
	Half gravid	44	15.5%		26	10.5%		10	8.8%		80	12.3%
	Gravid	35	12.1%		35	14.1%		17	14.7%		87	13.3%
Host Preference	HUMANS	182	92.0%		139	92.5%		54	88.9%		375	91.7%
	BOVINE	16	8.0%		11	7.5%		7	11.1%		34	8.3%

Results cont.

	UNITS	DEC-MAR	APR-JUL	AUG-NOV	AVERAGE
CSP		2.60	5.60	6.00	**4.70**
HBR	B/N	0.60	1.20	1.25	**1.00**
HBI	%	92.00	83.00	93	**91.00**
EIR	IB/P/MTH	4.31	16.70	20.90	**12.83**
EIR	IB/P/YR	**52.40**	**203.60**	**254.60**	**156.10**

Results cont.

		Correlation	Sig.
Pair 1	Min Temp & Human bite rate	.996	.001
Pair 2	Max Temp & Number of mosquitoes	-.984	.001
Pair 3	Max Temp & Circumsporosoite proteins	.858	.002
Pair 4	Humidity & Human bite rate	.878	.002
Pair 5	Rainfall & Number of mosquitoes	.863	.005
Pair 6	Malaria incidence & EIR	.987	.001
Pair 7	Malaria incidence & Humidity	.939	.003

Conclusion

- Correlation analysis of climate variables against number of mosquitoes showed a direct relationship between rainfall and number of mosquitoes caught.
- There was also an indirect relationship between maximum temperature and number of mosquitoes.
- Maximum temperature had a direct relationship to circumsporozoite proteins
- There was a direct correlation between minimum temperature and human bite rate.
- There was also a direct correlation between malaria incidence and Entomological inoculation rate
- This study finds a strong correlation between relative humidity and malaria incidence.

Conclusion cont

- Malaria transmission was highest in Asawasi which is an urban community with rural features with an Entomological Inoculation rate of 187.1infectious bites/person/ year in the dry season when other sites had rates of 54 187.1infectious bites/person/ year

- In Asawasi, basic social amenities are lacking, rooms are crowded with three or more people sleeping in one room, housing is of poor quality and the rooms are small.

- The rooms are poorly ventilated and the sanitation is inadequate. Residents store water in drums because there are no public water supply for individual households

- These create numerous breeding grounds for mosquitoes leading to explosive growth of mosquito vectors, increased exposure of residents to vectors due to poor housing and the potential for disease outbreaks.

- The results in Asawasi shows that although climate plays an important role in malaria transmission, socioeconomic and environmental factors also play an important role in malaria transmission.

Conclusion cont.

- In all the communities, Malaria transmission was highest in the minor rainy season, the period between August and November .
- Mosquitoes were abundant in the major rainy season between April and July, but had low circumsporozoite proteins which are necessary for transmission.
- Both Malaria incidence and the Entomological inoculation rate were highest in the minor rainy season.
- Human bite rates increased mostly during the minor rainy season due to an increase in night temperatures and probably due to human behavior or both.
- Most inhabitants were not using mosquito nets supplied because rooms were overcrowded, there was heat inside the nets or some didn't have beds and slept on the bare floor
- The result of this study indicates that climatic variables are relevant for malaria forecasting and control in Kumasi; it also shows that malaria transmission is caused by a multiplicity of factors including climatic, environmental and socioeconomic factors.
- Malaria control in the middle belt of Ghana should be intensified during the minor rainy seasons when there is intermittent rainfall, basic amenities should be provided in high risk communities and mass spraying or other alternatives should be used as vector control

Thank you