Spatial distribution of malaria indicators in Ethiopia in 2009-2013

Berhanu Berga[1]

Universitat Jaume I Institute of the New Imagining Technologies
Master in Geospatial Technologies

Email: -berhanuslu@gmail.com, Spain.
berhanuslu@gmail.com

Abstract

Background: Malaria is one of the leading causes of morbidity and mortality in developing countries including Ethiopia. This study examines the spatial and temporal pattern of malaria distribution to generate useful spatial distribution of malaria indicators to support decision making concerning malaria control and monitoring in Ethiopia.

Methods: spatial statistics tools like spatial Autocorrelation, Global Moran's I index and Getis- Ord Gi* were used for analysis by using ArcGIS Software. We examine the global and local pattern of malaria indicator distribution in 77 zone and 679 woredas in Ethiopia using malaria data collected by Ethiopian Public Health Institute from 2009-2013.

Result: Map of all malaria indicators were extracted based on their statistical significant during the study period. During 2009-2013 total malaria cases, total malaria inpatient, total malaria death, total malaria suspected and p.falciparum distribution were non- significant. During 2009-2013 cold spot category exhibited downward trend whereas high risk and hot spot category exhibited upward trend. During 2012-2013 all malaria indicators such as total malaria cases, total malaria outpatient, total malaria inpatient; total malaria death, total malaria suspected, and p.falciparum and p.vivax distribution were clustered.

Conclusion: Malaria hot spot and high risks are displayed as risk maps that are useful for controlling and spatial targeting of malaria prevention and control measures against the disease. The study recommended priority control in 29 hot spot and 51 high risk reporting zones. The result of this study can be used as an input for the future work by integrating with altitude, temperature and humidity.

Keywords: Hot spot, cold spot, spatial statistics, malaria distribution

1 STATEMENT OF THE PROBLEM AND JUSTIFICATION

Malaria is a leading cause of morbidity and mortality in Ethiopia .Annually about 70,000 malaria mortality and 5-6 million clinical malaria cases in non epidemic year and over 600,000 confirmed cases are reported from health facilities[6].So far there is no research or study has been conducted on spatial distribution of malaria indicators in Ethiopia. Therefore it would very difficult for the government   to plan, better decision making, and allocation of resources at zones or woredas level in controlling of malaria epidemic in the country.

1.1 SOURCE OF DATA

The data which used for this study were collected by EPHI(Ethiopian Public Health Institute) .The data were collected from all zone, region, woreda health centers and hospitals of the country. Since the data I used for analysis was secondary data ,data preprocessing was done by EPHI . Here ,the results of microscopic examination were recorded including the malaria cases ,malaria type P.falaciparum ,malaria type P.vivax admitted by malaria case and clinical cases are treated as malaria .population size for each woredas ,zone and region where obtained from Central Statistical Agency (CSA,2007 and CSA ,2009).This study focuses on malaria indicators variables that are relevant to malaria distribution .

1.2 GIS AND SPATIAL ANALYSIS

First , we used local Moran's I test statistics[22] to examine the presence or absence of local spatial autocorrelation using the number of malaria cases between pairs of zone and woredas at varying distance lags for each of the five specific time periods, 2008/9–2013/14 (September-August). In this context, Local Moran's I statistics is defined as follows:

$$I_i(d) = (x_i - \overline{x}) \sum_{wij}^{n} wij(d)(xj - \overline{x}),\ j \neq i)$$

Where the mean is the average number of malaria cases in zone, x*i* and x*j* are the number of malaria cases at zone *I* and *j*, respectively, and wij is the spatial weight matrix based on the defined distance lags (in km) between zone *i* and zone *j* (where *Wij*(d) = 1 if the distance between zone *i* and *j* is within *d*; otherwise *Wij*(d) = 0). The mean local Moran's I values were plotted as a function of distance lags (km) for each specific time period. In this case, large and positive mean Moran's I values (higher than zero), indicate presence of significant clustering while negative values (less than zero) indicate dissimilar or variable patterns, and values equal to zero indicate presence of a random pattern.

Second , local Gi* statistics[23].were calculated for each zone and woreda based on the spatial weights using different threshold distances (d) as described above.

$$Gi*(d) = W_{ij}(d)x_j / \sum_i x_j$$

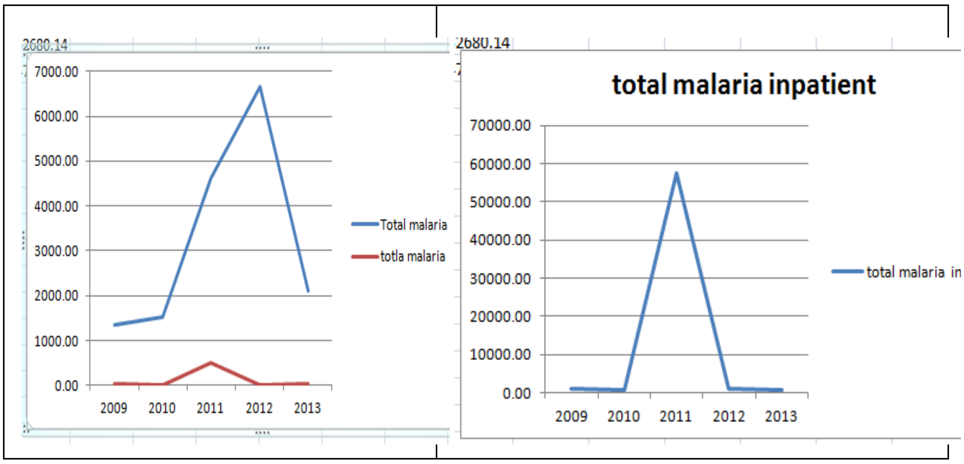
Where, w*ij* is a spatial weight matrix at a given distance lag in kilometers (d) (w*ij*(d)) is 1 when the distance from zone *j* to i is within *d*, otherwise $w_{ij}(d)$ is 0). The presence of local clustering of malaria cases in the study zone (hotspot areas) were determined using Z-score values. A high and positive Z score value, >1.96, indicate that the zone *i* is surrounded by relatively high malaria incidence zone , whereas a high but negative Z-score value indicates that the Zone *i* is surrounded by relatively low (cold spot) malaria incidence villages. Z-score values ≥-1.96 and ≤1.96 indicates presence of a variable or random distribution.

2 RESULT AND DISCUSSION

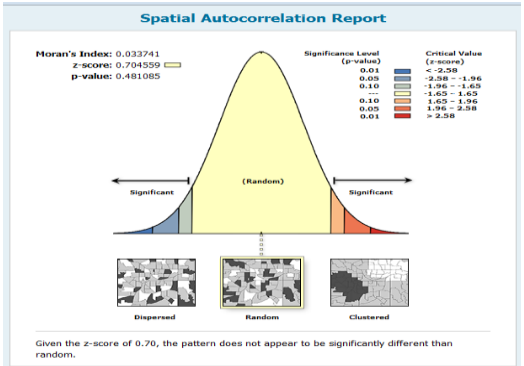
The temporal variation in malaria distribution over five year study period (2009-2013) was noted by malaria indicator and year.

Fig.2 presents the temporal variation in the yearly number and relative proportion of malaria indicators over a period of five contiguous years (2009 to 2013). The average (standard deviation) number of total malaria clinical and confirmed cases per year was about 126.24 standard deviation .Higher malaria indicator incidence above normal, is observed from 2009-2013, with a peak during the year 2012. As it is observed from the graph that in 2011 very high malaria inpatient were recorded and the same year the death rate due to malaria was relatively very high.

Figure 1. Yearly distribution of malaria indicator incidence from 2009 to 2013 in Ethiopian zone, Ethiopia.



Source: own statistical computation



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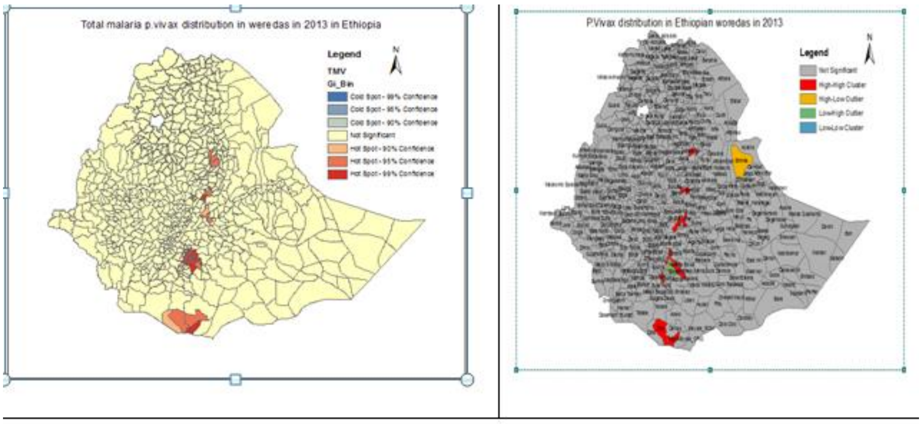
Source: own spatial statistical computation

Figure 2. depicts Morans I Index and Z-score indicating pattern of malaria indicators as shown in figure for total malaria cases was found to be 0.03 with z-score being 0.70 which is non significant indicating random pattern of malaria distribution

3 LOCAL MORAN'S I AND HOTSPOT TEST FOR MALARIA INDICATORS INCIDENCE AT WEREDA LEVEL

Wereda level analysis was done only for year 2013 malaria indicators due to data unavailable at wereda level from2009-2012. Wereda level analysis allows us to do hot spot and moran's I analysis for oromiya ,Tigray and Amhara region. According to the result the distribution of plasmodium vivax in Ethiopia in 2013 was towards the rift valley since there are a lot of lakes in the rift valley the occurrence of malaria are also very high.

Figure.3 depicts the distribution of plasmodium vivax malaria type distribution in 2013 at wereda level in the country .Accordingly to the result the plasmodium vivax distribution was towards the rift valley since there are a lot of lakes in the rift valley the incidence of the malaria disease is very high.Knowing the incidence of the p.vivax distribution allows the policy makers or government to allocate medicine, prevent and control the disease from the rift valley. Fig.3 (a) depicts the result of hot spot analysis and Fig.7 (b) depicts the result of Moran’s I test. Both results show the same distribution of p.vivax distribution in Ethiopia around the rift valley.



Source: own spatial statistics computation

Figure 3. (b) Is standardized local Moran’s I and hot spot (Fig.3(a) depicts values showing clustering of p.vivax incidence in 679 weredas in Ethiopia .

4 CONCLUSION

This study was aimed at producing malaria risk maps of Ethiopian at weredas level so that it can help to improve the management and control of malaria disease .The malaria risk map was produced depending up on spatial statistics results such as hot spot, high risk and cold spot .

During 2009-2013 cold spot category exhibited downward trend whereas high risk and hot spot category exhibited upward trend .

In this study the hot spot and high risk zone and woredas were identified during the study period. Due to short period of time I didn’t incorporate different variables like temperature, altitudes and humidity with hotspot and high risk categories for further analysis.

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