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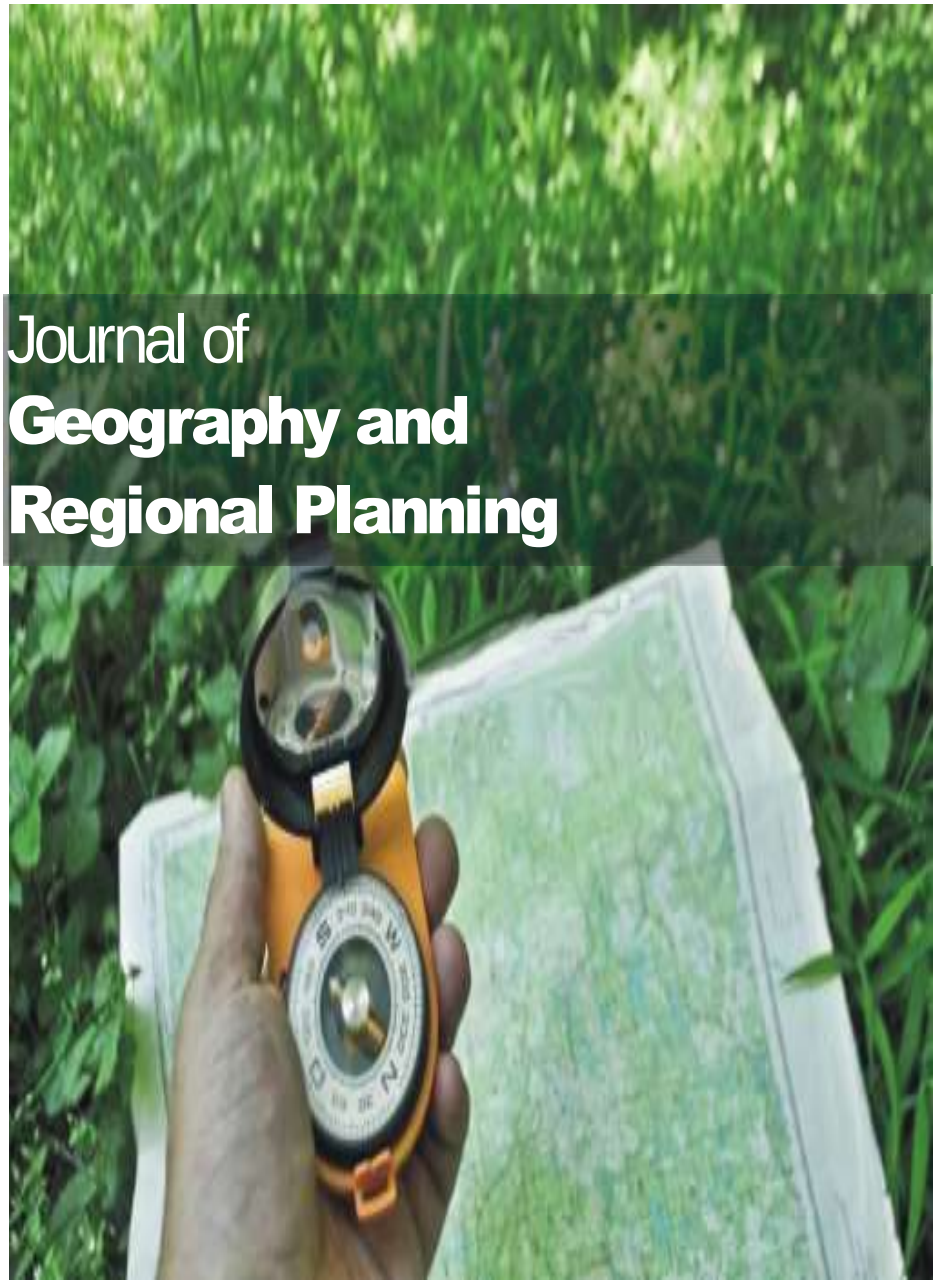

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Journal of Geography and Regional Planning

Full Length Research Paper

Malaria prone area analysis and mapping using geospatial tools: The case of Amibara and Gewane Woreda, afar region, Ethiopia

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Malaria is one of the most killer diseases in our planet earth. It is the primary cause of patient talks, admissions and demise every year in Ethiopia. It is important to reduce the transmission and effects of the problem identifying and mapping the malaria risk area using geospatial technologies. The general objective of the study is to analyze and map malaria prone areas using geospatial tools in Amibara and Gewanie Woredas of Afar Region. The specific objectives are to identify parameters that contribute to malaria hazard in the study area and to classify and map areas at risk of malaria. To achieve the stated objectives, the researchers employed spatial modeling technique particularly Weighted Overlay Analysis (WOA). Climatic data, topographical data and infrastructural data are the major data of the study. These data were processed and analyzed by ArcGIS, Erdas imagine, Idrisi, 3DEM terrain visualization and global mapper software. The result showed that the area is suitable moderately and marginally for malaria. From the total area of the study, 35 and 65% were moderately and marginally suitable for the occurrence of malaria respectively. Therefore, as malaria is one of the killer diseases the concerned bodies should use the technologies to prevent and control the transmission of malaria in the study area and there should be health package to prevent the diseases.

Key words: Malaria mapping, geospatial tools.

INTRODUCTION

Background and justification of the study

Malaria is one vector borne diseases that affect huge number of people in the world. Globally, in 2011 there were 243 million estimated cases of malaria disease. The vast common cases stayed in African Region with 85%, tailed by the South-East Asia with 10% and Eastern Mediterranean Regions 4% (WHO, 2016). Malaria is the 5th leading source of passing from infectious diseases in low-income countries and a worldwide community health

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problem. The public showed signs of malaria from one to two weeks later being chomped by an infected mosquito In Ethiopia, it remains the main public health problems; every year it is the foremost origin of outpatient discussions, charges and death. In most parts of the country its occurrence is seasonal, with uneven spread which advances it to the outbreak of epidemics. According to many researchers including FMOH (2013a) report, the broadcast patterns and strength vary significantly due to the large multiplicity in altitude, rainfall, and population movement within the areas below 2,000 m. Those areas are home to nearly 68% (52 million) of the country's population and conceal almost 75% of the landmass. In 2015, malaria was still the first leading cause of health problem accounting for 48% of outpatient consultation, 20% admissions and 24.9% inpatient deaths. The influence of malaria, in addition to its health, concerns a noteworthy barrier to communal and fiscal growth of the country. The disease causes debilitating damage to work force, reduction of income as well as school absenteeism for both the sick and family members who serve as care takers (FMOH, 2013b).

The transmission and spatial spreading of malaria in Ethiopia is mostly determined by the various eco-climatic settings. The most important climatic features that influence malaria transmission are temperature, rainfall, and humidity along with altitude, which is the most important variable. The chief malaria broadcast period in the country is from September to December, succeeding to the main rainy season from June/ July to September (FMOH, 2013a,b). As part of Ethiopia, Afar region is an area where malaria affects the lives and livelihoods of the pastoral and agro-pastoral communities. The problem is aggravated due to the various characteristics of the area. The temperature of Amibara and Gewanie woredas is favorable for the occurrence of malaria.

According to Amibara and Gewane Health Office (2015) malaria was the top disease responsible for high morbidity and mortality in the Woreda. Seasonal rain, over flow of Awash River during high rainy season, impounded water and geographic location which is typical for the breeding of mosquito contributed a lot to the prevalence of malaria. Presence of large and small scale irrigation schemes and presence of swampy area favor breeding of mosquito which will aggravate malaria prevalence in the area. Severity of malaria increases at the rainy seasons putting higher pressure on the activity of the local people whose livelihood is totally dependent on crop production and livestock rearing. It reduces labor, time for on farm follow up, livestock supervision and children school attendance.

Numerous studies used satellite imagery and GIS techniques to plot the scattering of vector species in diverse spatial scales such as the entire world, continent, national, regional, and even at small village level.

According to Gujju et al. (2017), in widespread areas, mostly in tropical and subtropical regions, this vector plotting is designed to improve vector control. As this study showed, remote sensing and geographic information system (GIS) are used to plot the dissemination of vectors at different spatial scale. Therefore, this study was able to identify and map the malaria risk areas by considering many geographical and environmental factors that make condition suitable for breeding site of mosquito in the study areas.

Climatic and topographic issues, particularly precipitation, temperature, altitude, and slope remain recognized to have a resilient effect on the ecology of this insect. GIS and remote sensing can be used to associate such variables with the dissemination of mosquito which is accountable for malaria. Therefore, GIS and remote sensing are the appropriate tools that aid malaria control and prevention system through assessing potential malaria risk level of an area (Karen et al., 2015).

OBJECTIVES OF THE STUDY

General objectives

The overall objective of the study is to analyze and develop map of malaria prone areas using Geospatial tools in Amibara and Gewanie Woredas of Afara Regional State, Northeast Ethiopia.

Specific objectives

(1) To identify the parameters that contribute to malaria hazard in the study area
(2) To classify and map areas at risk of malaria in Amibara and Gewanie areas
(3) To evaluate the suitability of an area for the occurrence of malaria.

LITERATURE REVIEW

Theory of malaria

In prehistoric Rome, as a moderate climate, mosquitos are seen in marshes and swamplands. People accused the unhealthiness in the parts of deterioration and decay that wafted out on the foul air. Hereafter, the name is derived from the Italian word, "malaria," or bad air. In 1880, inventors revealed that the real cause of malaria is this climatic condition. The naked organism is transmitted from person to person through the bite of a female Anopheles mosquito, which necessitates blood to nurture eggs. There are around 400 dissimilar species of Anopheles mosquitoes throughout the world, but only 60 of these are vectors of malaria under natural conditions,

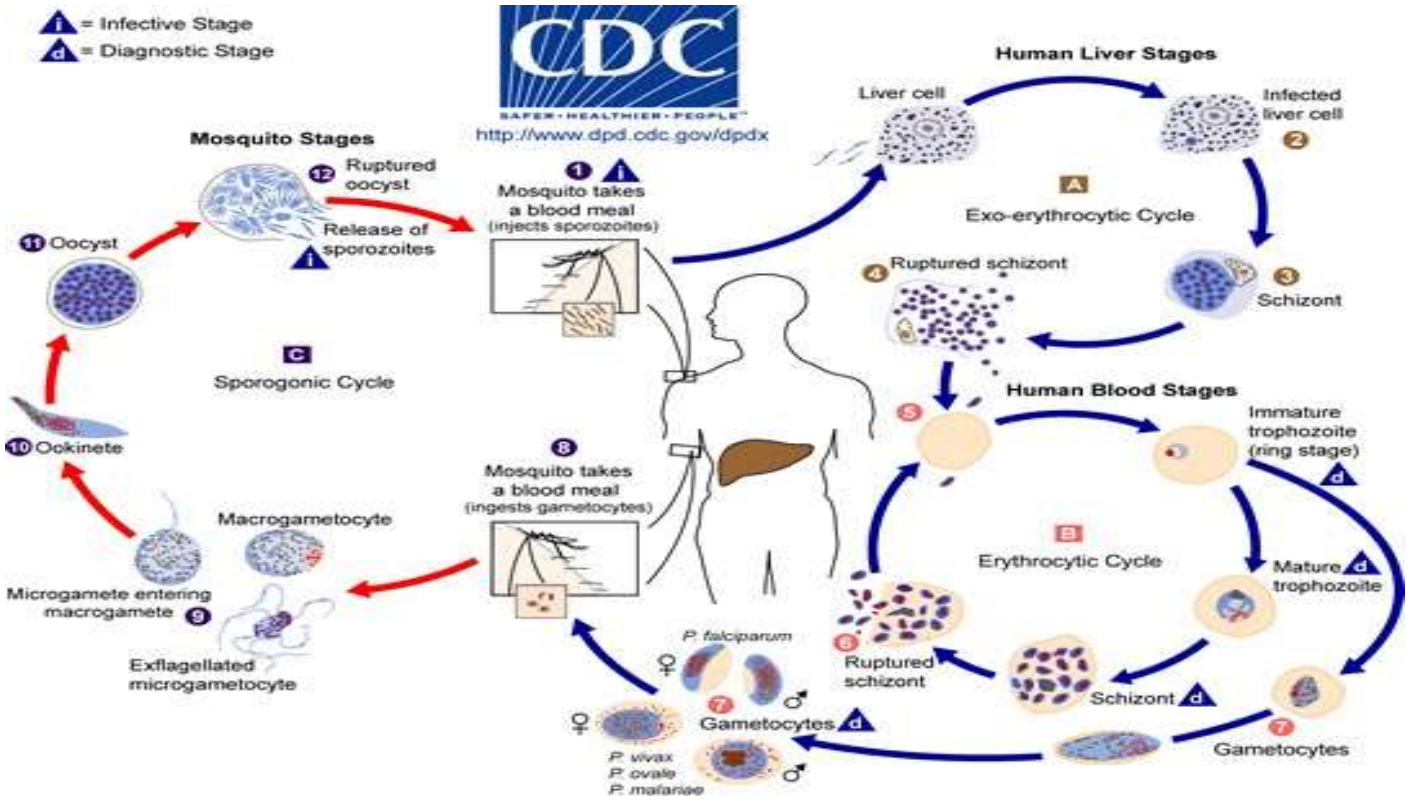

Figure 1. Stages of anopheles mosquito.
Source: Hubs for disease control and prevention, malaria life cycle (Grace, 2011).

and only 30 are vectors of major importance (Sivani, 2010; Abdulhakim, 2014) (Figure 1).

Global distribution of malaria

Regular decisive features of mosquitoes and their vector-borne diseases remain establish throughout the world, except in areas that are always frozen over. Roughly 75% of all mosquito species exist in in the world's steamy and subtropical regions (Gujju et al., 2017).

Causes of malaria

Malaria is introduced by a single-celled parasite from the genus *Plasmodium*. They yield malaria in various types of faunas and birdies, as well as in humans. The four *Plasmodium* species that contaminate persons are *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale and Plasmodium malaria*. Every bloodsucker has a unique presence under the optical microscope, and creates a different form of indications. *P. falciparum* is accountable for maximum malaria deaths, particularly in Africa. A person that is asymptomatic (no symptoms) for *Plasmodium malaria* can poison others, either through lifeblood gift or mosquito bites (WHO, 2016).

Factors determining the occurrence of malaria

Climatic factors

Climatic differences and extreme weather events have a reflective influence on infectious disease. Among the features studied, temperature and rainfall have a sturdiest association with malaria occurrence. Temperature, elevation and rainfall pattern remain easy to forecast and analyze malaria. The minimum threshold temperatures for organism growth of *P. falciparum* and P. *vivax* are 18 and 15°C, respectively (Sadie et al., 2015).

Terrain factors

Topographic factors are largely altitude, slope, and aspect. The way topographic issues impact vector-borne disease reclined through providing confident habitats appropriate for certain vectors. For example, grass land,

is appropriate for mice, vector of plague, and whereas wetlands are fit for snails and mosquitoes. Topographic patterns affect the spatial distribution of mosquitoes and susceptibility level of human immune system (Mahmoud et al., 2017; Gómez-Barroso et al., 2017).

Anthropogenic factors

Communicable diseases, like malaria, can appear from natural or human made changes to the environment. Outside the regular environmental causes, anthropogenic factors can impact the spreading of the disease by directly adjusting the behavior and geographical dissemination of the anopheles mosquitoes. Before the past two centuries, anthropogenic aspects like agriculture, irrigation, increase in population size, migration, and war have all influenced the spatial circulation pattern of malaria (Gómez-Barroso et al., 2017).

The role of remote sensing and GIS on malaria risk mapping

In the Global Malaria Eradication Programme "geographical reconnaissance" entailed the detailed and manual mapping of malaria vector breeding places unaided by computers implementation and monitoring operations. Since then, spatial technology has advanced greatly in parallel with progress in information technology to the extent that it is now possible to capture and manipulate an array of complex spatial information with relative ease and in real time (Saxena et al., 2009; Abiodun et al., 2015). The relevance of GIS technologies to malaria control lies in the fact that the global spectrum of malaria epidemiology is broad, and varies as the natural diversity of the parasite. The disease varies in its prevalence, intensity, seasonality and clinical features depending on a multitude of local determinants such as the prevalence, location and nature of water bodies. These in turn are affected by environmental factors such as climate, surface water distribution, elevation and prevailing flora and fauna in the area. Therefore, geographical, climatological and landscape aspects of a locality become significant factors of malaria distribution. However, with GIS tools it is possible to overlay accurate spatial maps of an area to examine the relationship between the parameters and aggregating them in order to enable new and critical insights to be made to the disease and its transmission localities (Abiodun et al., 2015; Gómez-Barroso et al., 2017). Plotting the worldwide spreading of malaria is inspired to outline populations at risk for fitting resource allocation to fight the disease. Currently, managing malaria is easier with the support of the malaria risk maps representing hot areas with threat factors. Generally, integration of geospatial tools with remote sensing imageries helps in the identification, depiction, observation and investigation of breeding habitats and mapping of malaria risk areas (Karen et al., 2015; Sadie et al., 2015).

Description and research method of the study

Description of the study area

The study was investigated in Amibara and Gewane woreda's of Middle Awash River in Afar National Regional State of Ethiopia. The area is found between 08°49'00" and 140°30' 00''N latitude and 39°34' 00" and 42°28' 00" E longitude. Geographic location of the study is seen in Figure 2.

Geographical setting

The study area is found in the middle awash valleys, where sugarcane and cotton farmstead have been proven by the government of Ethiopia. It is characterized by high temperature, from 25 to 35°C. Typically, the mean annual rainfall is less than 600 mm whereas May and June is the driest period of the year. The highest raining season accounts for 60% of the yearly total rainfall from July to September whereas slight rainy season appears in March and April which account for 20% of the total rain fall. From the total land area of the region, 826,573 ha and 294,106 ha areas are covered by Gewane and Amibara woreda respectively. Similarly from the total state plantation in the region, the study area constitutes 10, 608 ha of land, which is about 18% of the total state plantations in the region.

Vegetation types

The woods and bush vegetation type was found along the major perennial rivers. Gewane woreda constitutes riverine bush land. It is evergreen due to continuous water supply from the Awash River and browsed by the livestock during the dry season. Grazing and browsing of livestock in Amibara woreda is bush land. The study area covers a total of 64,087 ha, which is about 68% of the total open bush land cover in the region.

Population statistics

According to CSA (2008), the population of the region is 1,406, 383 of which 745, 839 are males and 661, 544 are females. Similarly, Amibara has a total population of 40,175 and Gewane has a population of 28,144.

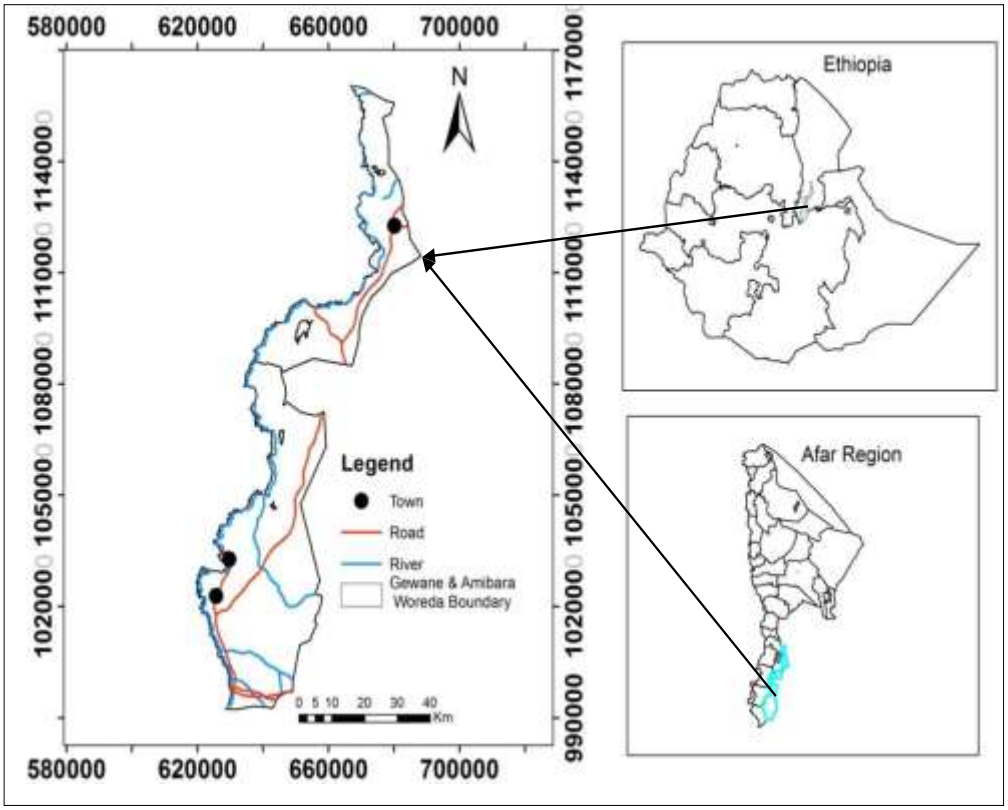

Figure 2. Study area map of Gewane and Amibara Woreda.

Socio- economic infrastructure development

Education

According to ANRSEB (2016), the schooling facilities in the state are normally insufficient and unevenly dispersed among zones. The majority of the straightforward schools and all of the senior secondary schools are located in zones 1 and 3. However, the participation level of the people is very minimal.

Health services

A health facility existing in the area is low in the country. There are 49 health posts, and 2 hospitals with 65 beds in the region. However, the supply of health facility in the region is not justifiable.

METHODOLOGY

Methods of data processing and analysis

The study used both remote sensing data and geospatial tools to process and analyze the parameters of the study. ArcGIS10.3, Erdas Imagine 14, DEM, Global Mapper and Idrisi32 tools are used. The final method of the data analysis used for the accomplishment of the research was weighted overlay analysis (WOA). However, factors ready for final overlay processing were applied. Before WOA application, reclassification and weight derivation were the main steps. Mathematically, the WOA used the summation of criterion cell values multiplied by their respective weight or percent of influence. The process is illustrated in detail in Figure 3.

RESULTS AND DISCUSSION

Factors of malaria risk

Different reasons exposed people to malaria. The spread of malaria varies due to temperature, river or water availability, elevation and slope. The criteria considered in this research are climate related (Rainfall and Temperature) and topographic related (elevation and slope). The maps of all parameters remained an input data for producing the final malaria risk maps of the study. Therefore, initial stage of the analysis was preparation of each criterion maps. Then the criteria were reclassified into three classes to map the most risk areas to the transmission of malaria.

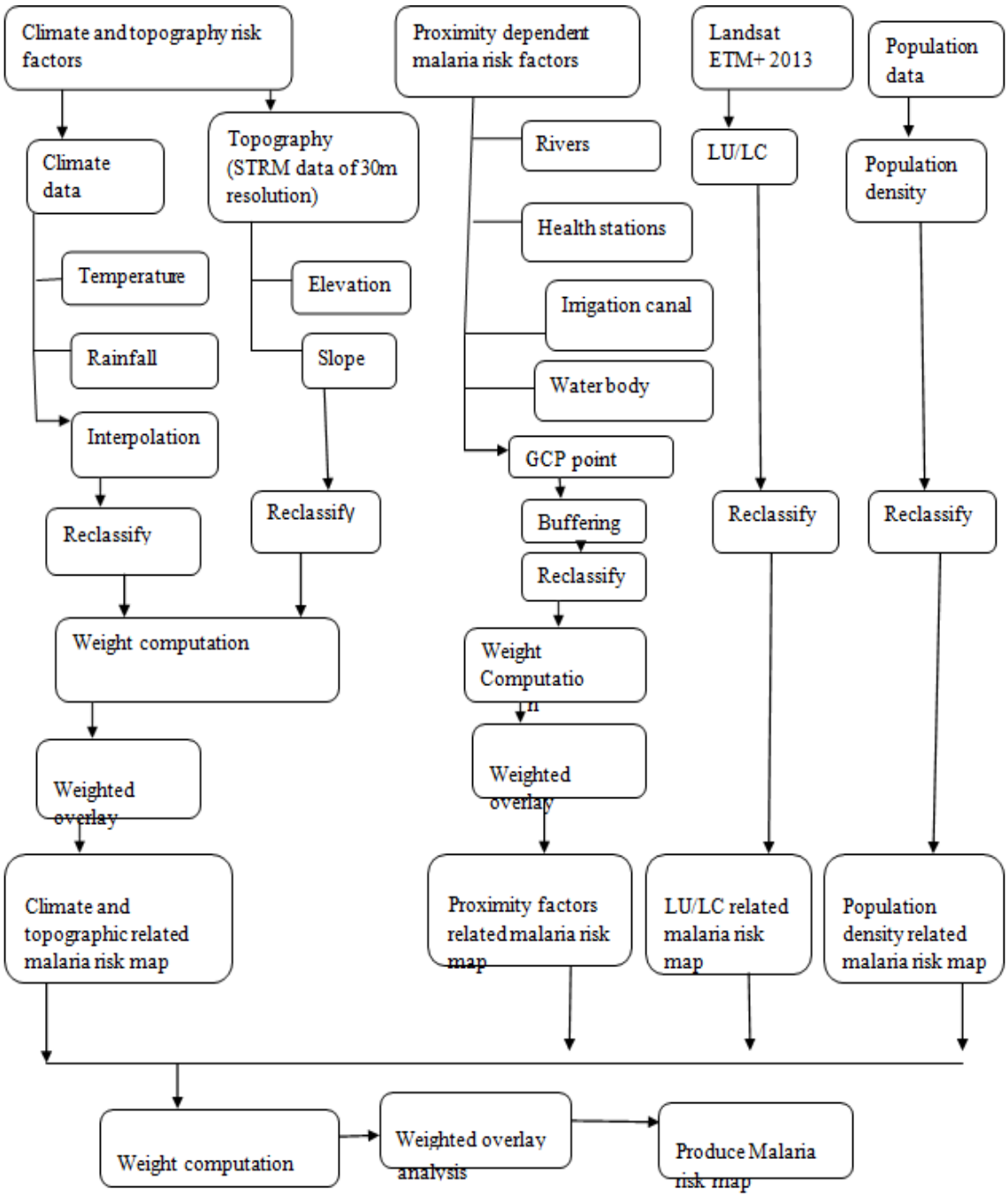

Figure 3. Work flow of the study.

Climate related risk of malaria

Climatic data of the study area were produced from gridded meteorological data. The gridded meteorological data are better than the interpolated meteorological data. This is because the gridded data are calibrated by the truth station and satellite data to reduce error.

Temperature related risk of malaria

The parasite plasmodium does not survive well below 15°C and in this case, it cannot transmit the disease due to dormancy of the parasite. As the temperature increases above 15°C up to 20°C the parasite starts to multiply slowly. Mosquito and plasmodium parasite starts

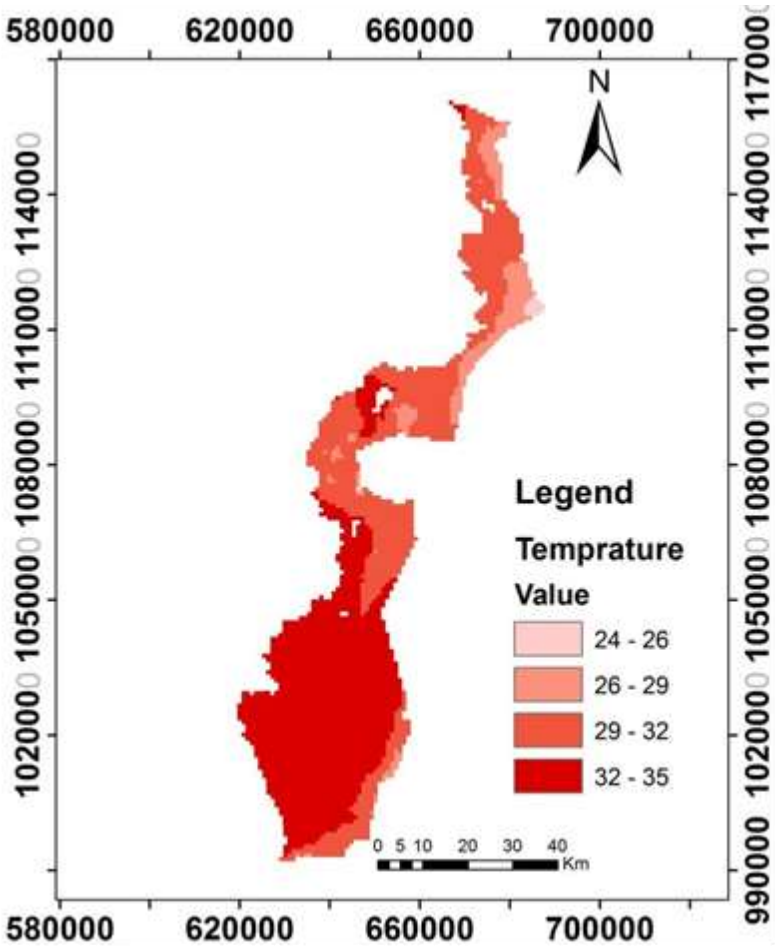

Figure 4. Temperature map of the study area.

to multiply at moderate, high and very high rate at 20 to 23°C, 23 to 25°C and 25 to 27°C respectively. However, as the temperature increases further, mosquito and parasite development starts to decline. Similarly, temperature values of 27 to 32°C and >32°C were associated with temperature related malaria risk levels of high and low respectively. As described in Figure 4, the temperature of the study area was from 25 to 35°C. These indicated that in the area there was malaria existence.

Rainfall related risk of malaria

Water bodies from rainfall, canals, rivers and other sources are important for mosquito to lay their eggs for breeding. Therefore, areas with high source of water are more suitable for mosquito breeding and the areas are under suitable condition. Even though an increase in temperature and rainfall increase mosquito breeding, it should be known that this is up to some maximum limit beyond which the relationship could be reversed. High rainfall destroys mosquito larvae from its stable habit. Accordingly, rainfall amounts of < 550, 550 to 700 mm and 700 to 1000 mm, respectively were seen (Figure 5).

Topography related risk of malaria

Topography of an area determines the elevation and slope of a particular area. This is turn determines the type of biological organisms and physical characteristics prevailing in that particular area. It also determines the prevailing microclimate. These factors together are helpful indicators for diseases causing vectors are prevailing in the area based on their natural requirement for their existence.

Elevation related risk of malaria

Elevation of the study area is derived from STRM data of

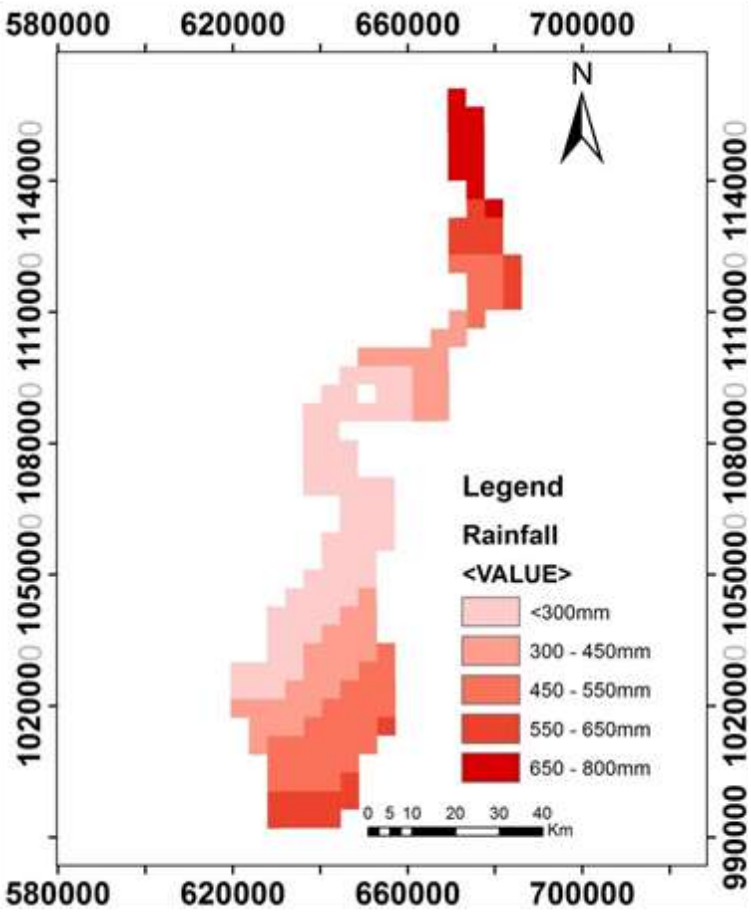

Figure 5. Rainfall map of the study area.

30m resolution. This is classified into four classes of 700 to 850m, 850 to 1000 m and 1000 to 1500 m above sea level. An elevation from 1000 to 1500 m was a safe area for malaria whereas in an area above 1500m it was decreasing (Figure 6).

Slop related risk of malaria

Slope of an area describes the relative verticality of a particular area. Area with higher slope is usually a typical characteristics of fragile, mountainous, and unstable physical area of the earth. This affects mosquito breeding in two ways: It does not support varieties of vegetation and animal population so that there could be low factors to favor mosquito breeding.

Secondly, unstable slope does not hold water at a particular place. But mosquitoes need still water to lay their eggs and progress to the next development cycle. Therefore, plain and gentle slopes favor mosquito breeding than sloppy areas. According to FAO (1976) and malaria experts of the study area, slope classes 0 to 5%, 5 to 8%, 8 to 15%, 15 to 30% and >30% are the appropriate classes to indicate the level of existence of watery body or marshy area and vegetation within a particular area. Accordingly, areas with 0 to 5% slopes have high probability to have water bodies and marshy areas and vegetation whereas as the slope increases this starts to decline. Therefore, areas with low and high slope classes are with high and low slope related malaria risk levels respectively. Based on this fact, slope classes 0 to 5%, 5 to 8%, 8 to 15%, 15 to 30% and >30% were seen associated with slope malaria risk levels of very high, high, medium, low and very low suitable respectively. The result showed that the area has a slope of 0 to 15% (Figure 7).

Reclassification of climatic factors

To know the suitability of an area for mosquito in terms of temperature, reclassification of the temperature values

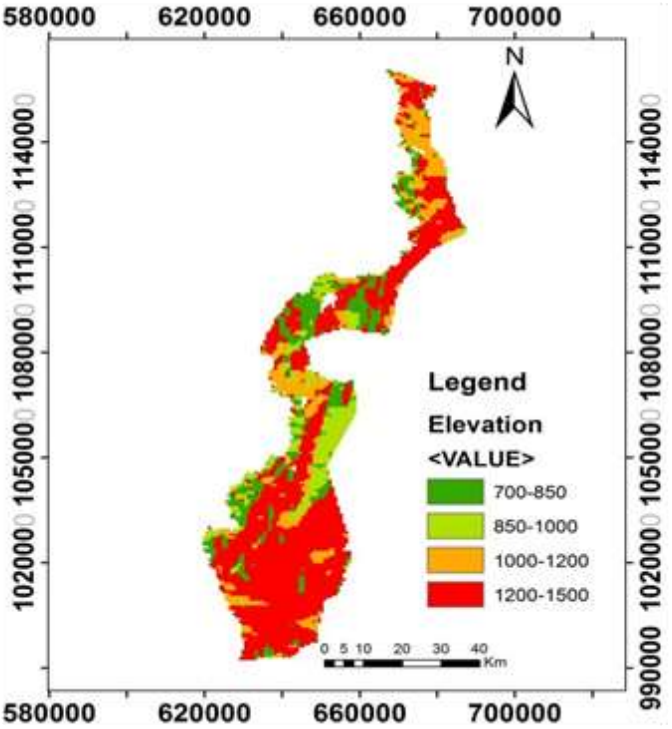

Figure 6. Elevation map of the study area.

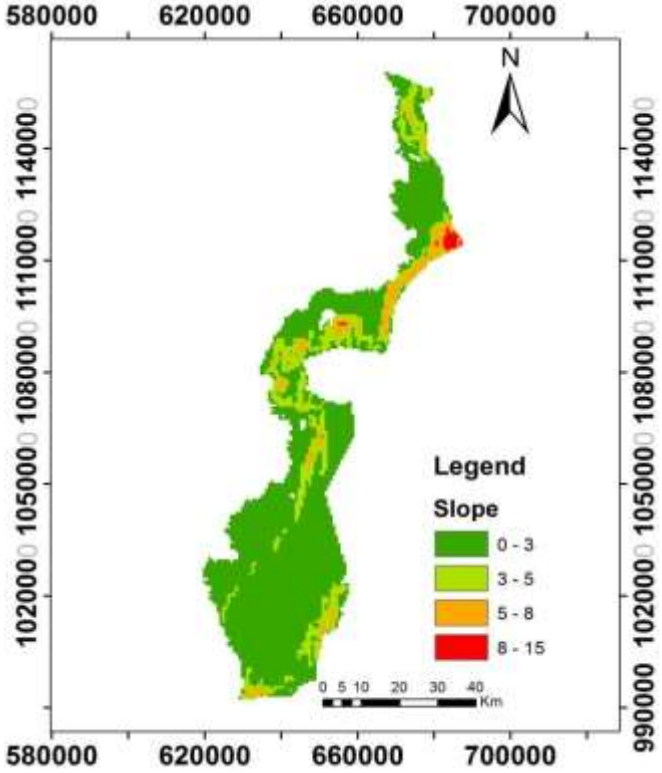

Figure 7. Slope map of the study area.

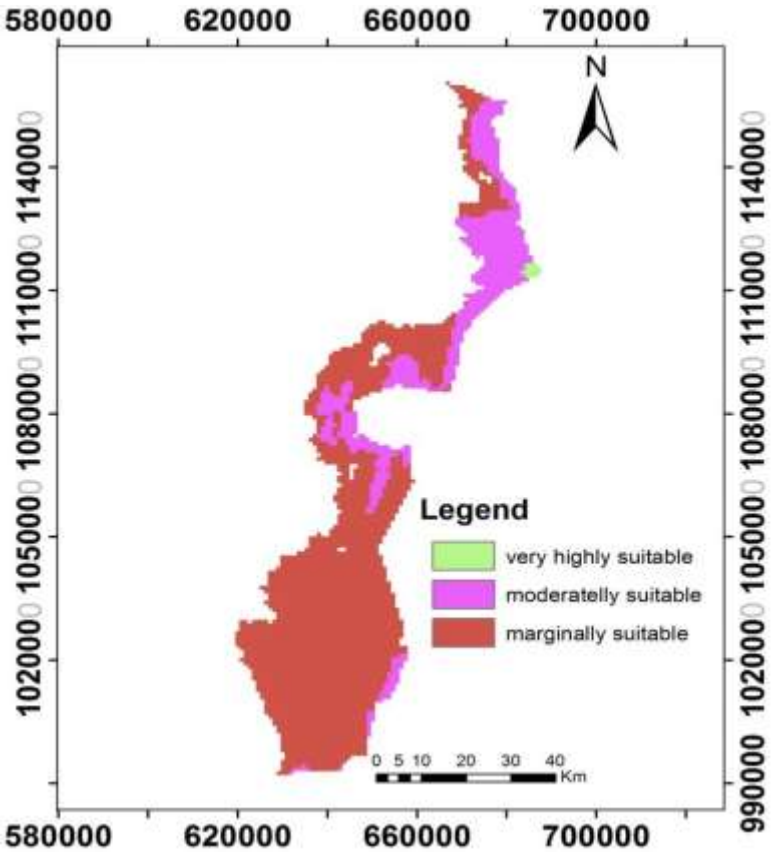

Figure 8. Reclassification of temperature map.

based on internationally recognized standards would be done (Figure 8). Figure 8 showed that most parts of the study area are marginally and moderately suitable whereas very small part of the area is very highly suitable for malaria in terms of temperature only. The temperature of the study area is very hot and difficult to duplicate themselves (Figure 9). Figure 9 illustrates that most of the areas are marginally and moderately appropriate for malaria production in terms of rainfall. The malaria reproduces itself in the area by the water comes from highland areas through flood in the area.

Reclassification of topographic factors

The area is moderately and highly suitable for malaria reproduction in terms of elevation point of view (Figures 10 and 11).

Proximity related malaria risk factors

Distance from rivers

Breeding of mosquito is related with different water sources. River is one among several of these. Mosquito requires still or slow moving water to lay its eggs and to complete its life cycle to be an adult. But river is not conducive for this since it disturbs and destroys the eggs and larvae during its movement with pressure in need of its stability. Water diverted from rivers for different purposes and in case of over flow becomes still and favors mosquito egg lying. This influences the particular area with increased mosquito breeding and malaria prevalence (Figure 12). Malaria risk availability of the area decreases as we go far from the rivers or water bodies since the existence of water body accelerates the reproduction of malaria in the area. This is shown in Figure 13.

Weighted overlay analysis

Malaria risk map of the study area illustrated in Figure 12 described that there is no malaria free in the area. The majority of the study areas fell in the marginal (65%) risk level. Moderate risk level covered about 35% of the study area. However, a small shift in one or more factors could lead from moderate to marginal malaria risk level.

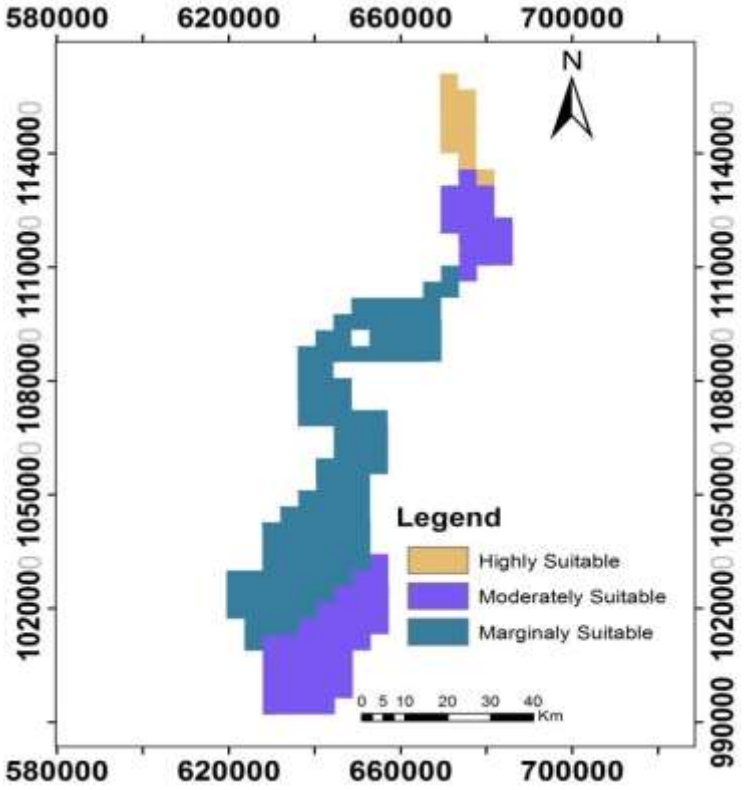

Figure 9. Reclassification of rainfall map.

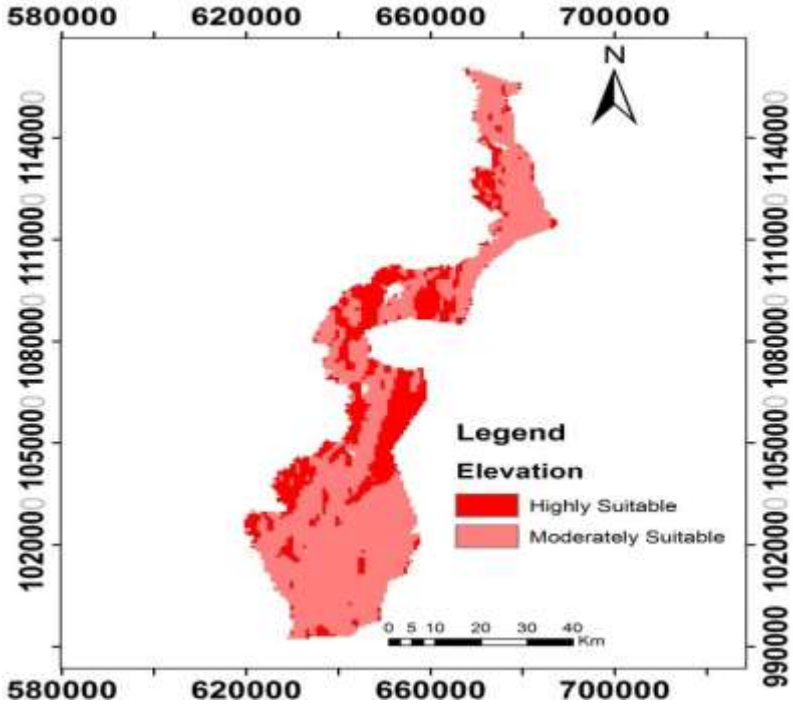

Figure 10. Reclassification of elevation map.

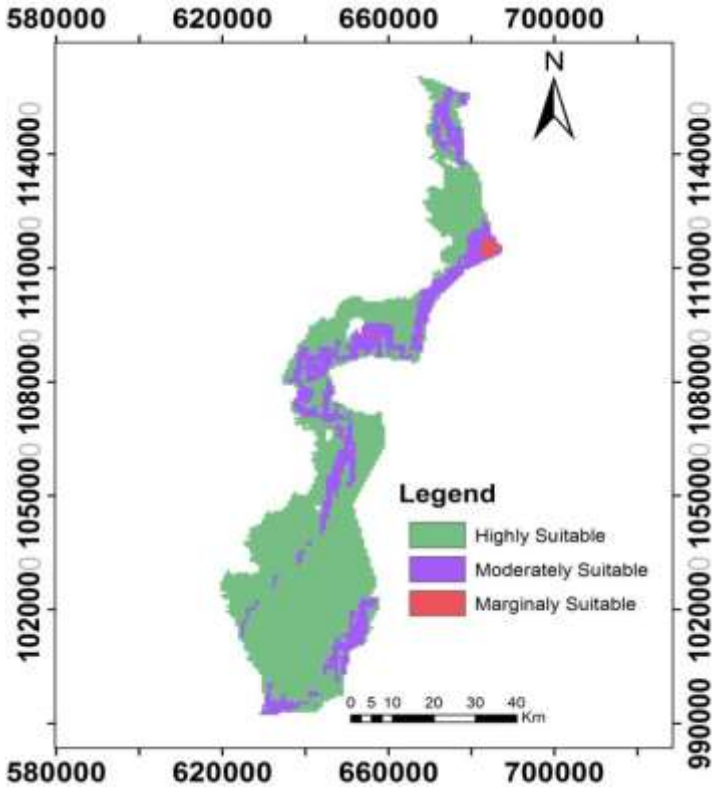

Figure 11. Reclassification of slope map.

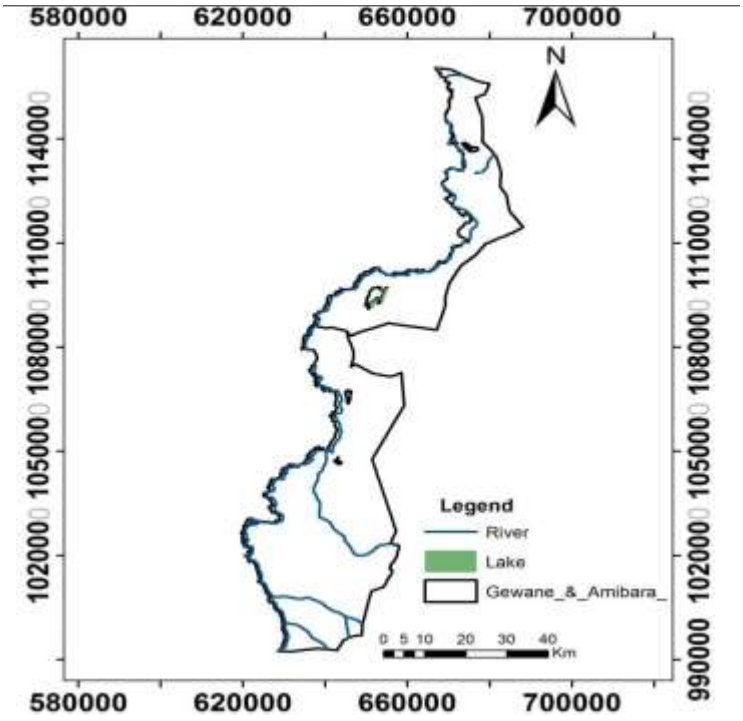

Figure 12. Water resource map of the study

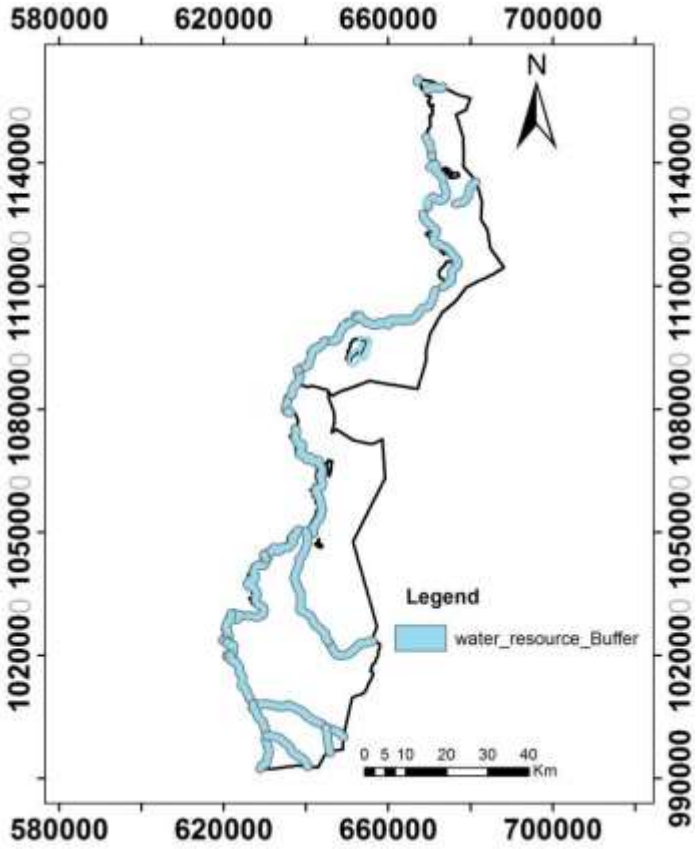

Figure 13. Water resource buffering of the study.

Therefore, these risk levels should not be ignored as it may happen based on some shift of conditions in favor of the risk factors (Figure 14). As Figure 14 weighted overlay analysis indicates most of the areas of the two woredas are marginally suitable for the occurrence of malaria and the remaining areas are moderately suitable. Therefore, the concerned bodies should give emphasis to prevent the occurrence of the diseases in the study areas.

Conclusion

In this study, geospatial data were used for identification, association, characterization, and final malaria risk map production for the study area. Accordingly, climatic and topographic factors, and proximity factors malaria risk level were come together to examine for their aggregate impact on malaria prevalence of the study area. Climate and topography factors of malaria risk mapping of the study area indicated that majority of the area fell under moderate malaria risk level. Proximity factors related malaria risk level is important indicator of malaria risk of a particular area. Related with this, high, medium and marginal risk levels were observed in the study area. Those areas, the rural parts, which are scarcely populated, take low risk level with regard to population density malaria risk. Malaria risk map of the study area showed that there is no area within Amibara and Gewane with malaria free risk level. Most areas fell under malaria risk level of high and medium with 7 and 93% of the total study area respectively. Low risk level is observed in negligible part. Kebele wise about 81% of the area which constitute about 17 kebeles fell in moderate malaria risk level. The other 19% occupied by 4 kebeles showed largely high malaria risk level with moderate risk level prevailing over smaller parts of them. Generally, GIS and remote sensing based malaria risk mapping consider appropriate mosquito harboring factors is a worthwhile technique to know the risk level and to enables public health officers in space and time to control and predict malaria spread over extensive areas. Moreover, the risk map can be valuable for public warning and awareness.

RECOMMENDATIONS

The researcher forwarded the following recommendations from the finding:

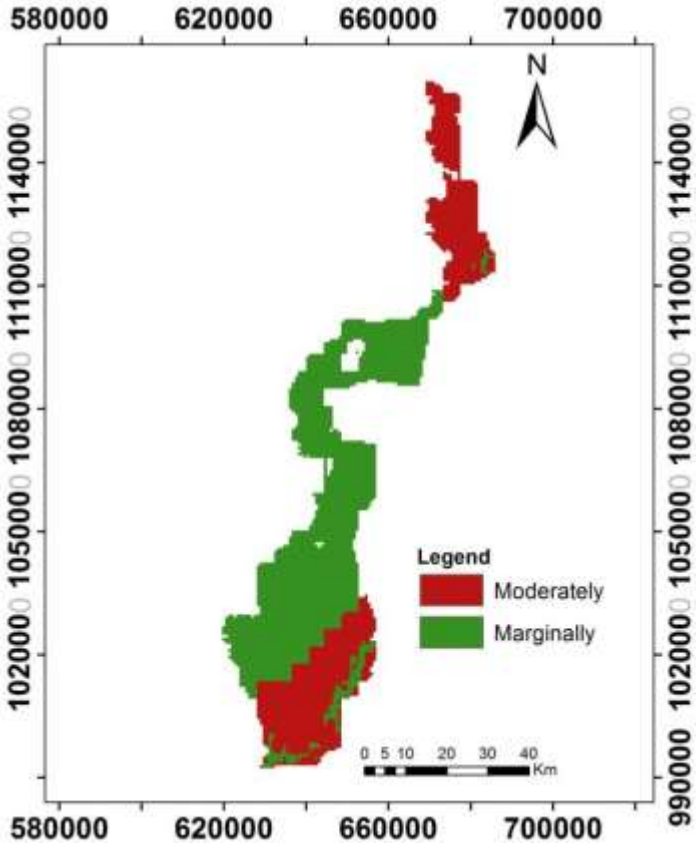

Figure 14. Malaria risk map.

(1) Malaria risk map of the study area indicated that most of the areas in this Woreda are with risk level of high and medium. But increases or decrease in value of one or more factors shift the situation to very high or other risk levels. Therefore, to make the information up to date, GIS and remote sensing based monitoring and early warning system should be integrated in malaria control and prevention activities in order to easily manage each activity towards alleviating malaria from the area.

(2) In connection with the newly developing canals for irrigation based agriculture purpose, there should be health packages to be served to the local community as part of the main project to prevent mosquito breeding and malaria prevalence. This could be through service delivery for the malaria victims, awareness creation on malaria prevention and control, and insecticide treated net delivery.

(3) Beyond the parameters used for malaria risk analysis in this study, other variables which can contribute to malaria prevalence like income level of the household, housing type, awareness level of the population and others can affect malaria prevalence. Therefore, it is better to integrate these factors with the already used parameters for better exactness.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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The role of productive processes on the implementation of differential advantage approach in Kenya "OVOP" projects

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The study sought to fill an information gap of streamlining productive processes in the implementation of differential advantage approach in Kenya OVOP projects. Since the adoption of One Village One Product (OVOP) movement has been faced with implementation challenges, inadequate resources, and capacities inhibiting its momentum in Kenya. Similarly, lack of political commitment, leadership and mutual cooperation among different actors in shared value of productivity, seems to be a major hindrance for OVOP drive in Kenya. It therefore suggest that lack of deep understanding of the critical role of productive processes for effective implementation of differential advantage approach was the study's knowledge gap tried to fill. The overall objective of the study was to examine the role of productive processes on the implementation of differential advantage approach in OVOP projects with the view of deepening our understanding requisite conditions for successive implementation process of the approach. The study took place in three pioneer districts adopted OVOP project: Nyeri North, Laikipia West and Yatta. The study unit of analysis was OVOP projects based on convergence and social development theories. The study was a descriptive case design. A sample of 72 individuals was selected through quota sampling on the ground of pre-specified characteristics. Questionnaires, interviews guides, FGDs and observations were used to collect quantitative and qualitative data. A literal replication analysis was also involved to confirm predicted propositions through pattern matching and generalizing results. The study recommended the establishment of county coordinating organ with chain champion and make Kenyan typical villages as OVOP units instead of current self-interest groups or projects. It was therefore hoped that the lesson provided may be useful for the implementation of rural development approaches to county governments and regional planners.

Key words: Industrial clustering, specialized industrialization, culture economy.

INTRODUCTION

One Village One Product (OVOP) is a development concept promoted by the Japanese government for facilitating rural economic development in developing countries. OVOP was popularly adopted in Japan in

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1980's and 1990's and successfully created an economic development model for rural areas. OVOP as a development model is aimed at producing competitive products utilizing local resources in which the area has a comparative advantage (Kurokawa et al., 2010).

OVOP movement was introduced in 2008 as a mentorship role in the Kenyan Vision 2030, that is, the identifying of projects and priorities were heavily based on workable solutions learnt from the South Asian "newly industrializing countries" which achieved rapid growth and also improved the lives of their people greatly in a span of 20 to 30 years. OVOP initiation in Kenya was through pilot projects, which were implemented in three phases. First phase was in 2008 in Nyeri North, Laikipia West and Yatta. The Ministry of Industrialization through OVOP national coordinating committee spearheaded the implementation of the initiative (Republic of Kenya, 2010).

OVOP usually started with a self-searching process by a community to increase the awareness of their own circumstances, to enhance understanding of a community's comparative advantages and disadvantages under the continuously changing socio-economic environment and to gradually build a consensus on joint actions, which led to a positive change in the community organization and production activities. OVOP, therefore, adopted a more participatory process, which strengthened the development capability of the community as a whole and, as a result, took a long time before the economic results became apparent (Haraguchi, 2008). OVOP movement was a kind of network formation of respective activities at community level (Nishikawa, 2007). According to Nishikawa (2008), if OVOP movement is firmly interwoven in rural development and local community, it hides potentials to contribute to the realization of pro-poor economic growth with a broad base. According to Haraguchi (2008), in essence, taking part in multiple stages along a value chain from production of raw materials, processing, selling and servicing, OVOP producers maximize their learning opportunities by collecting information, which goes beyond the usual price and volume, such as more qualitative aspects of product quality, distribution channels and promotion strategies.

According to Kurokawa et al. (2010), although attempts have been made to promote value-added activities that make use of local resources, their sustainability is not necessarily high. However, without coordination among government agencies in charge of the various related programmes, it is difficult for local people to obtain comprehensive information on available resources and services in their planning and implementation of OVOP activities. Collaboration and coordination should also be sought from local research institutions, including universities, which can contribute to the training of OVOP producers. Collaboration and coordination are also required among domestic public and private players.

According to Kurokawa et al. (2010), the original OVOP aims at developing community capabilities and strengthening cooperation among producers. The OVOP project should therefore support existing producers by upgrading technologies or facilitating cooperation as UNIDO (2001) added that in supporting different subsectors to overcome scale disadvantages and increase group productivity. Kurokawa et al. (2010), puts it that the government cardinal role in OVOP movement is facilitation of participatory processes and provision of technical and market information for better decision-making, building participants capacity, and strengthening bonding (organizational capacity, cooperation, collective action) and bridging (horizontal and vertical linkages) social capital of rural communities.

According to Haraguchi (2008), overlapping of the three areas (that is, sales promotion and administrative structures, production and community capacity building) must be considered to ensure a successful and sustainable OVOP project and achieve its objective-community development for poverty alleviation by producing differentiated products, by making use of local resources, and increasing value added. Notably from several literature reviews was that OVOP movement evolves out of partnership of inhabitant initiative as principal actor with other stakeholders who offer supplementary support to their activities. The process involves collective activities of all stakeholders in defining problems, searching for and implementing solutions and assessing values and practices together. In order to tap unique cultural resources, the inhabitant identity was essential in facilitating crucial structures processes and conducts necessary in sustaining mutual relationships within a group and with other actors.

In Kenya, community-initiated development has been hard to come by and whenever this happened, projects have largely evolved into shadows of their true potential or stalled altogether (Misati and Ontita, 2012). Concomitantly, even with the introduction of OVOP movement as a mentorship model, it has successful economic development model for rural areas in South Asian countries; however it is faced with numerous implementation challenges since its introduction.

According to Japan International Cooperation Agency (JICA, 2011), it is worthwhile noting that challenges inhibiting OVOP momentum in Kenya, such as inadequate resources and capacities are common across African countries. Moreover, OVOP program in Kenya has been faced with low awareness by government leadership; ownership of OVOP at high political level remains a challenge, poor institutional linkages, inadequate funding by the authorities, resource constraints (human and capital), systems not well established, limited product diversification, misunderstanding of the OVOP concept, weak governance structures within groups, the potential in some regions is limited due to the arid nature, capacity building amongst the people is still low and lack of buy in

support of governors under the new constitution were challenges of implementing OVOP in Kenya.

It therefore seems to suggest that lack of deep understanding of critical role of productive processes in the implementation of differential advantage approach in OVOP projects is a matter of concern. This paper aims to demonstrate that differential advantage approach in Kenya OVOP projects is likely to succeed with provision of effective productive processes. The paper therefore examines the role of productive processes on the implementation of differential advantage approach in OVOP projects with the view of deepening our understanding requisite conditions for successive implementation process of the approach. The study will examine in detail industrial clustering, specialized industrialization, innovative research and development and cultural economy as requisite factors of productive processes. Recommendations on the necessary intervention for improvement of productive processes in OVOP projects have been made.

MATERIALS AND METHODS

The study adopted qualitative descriptive case study approach. A single case with embedded units was used in assessing the importance of productive processes in the implementation of differential advantage model. The embedded units in pioneer pilot districts to implement OVOP movement, namely, Nyeri North, Yatta and Laikipia West, were considered in the study.

According to Ishak and Bakar (2014), the primary purpose of sampling for a qualitative researcher is to collect specific cases, events, or actions that can clarify or deepen the researchers understanding about the phenomenon under study. For that reason, qualitative researchers tend to use nonprobability sampling. OVOP movement was therefore used as a case to assess the importance of productive processes in differential advantage approach. The researcher chose a single case with embedded unit within the case being studied in order to increase result accuracy. Quota sampling method was applied in selecting three units or OVOP projects because of different characteristics of individuals in the three pioneer OVOP projects. The researcher began by mapping up the three pioneer districts with projects adopted OVOP movement in Kenya into quotas or units. The study started by determining how many cases gotten for each category as quota. The three units (OVOP projects) of case study were chosen into a sample on the ground of pre-specified characteristics so that the total sample has the same distribution of characteristics assumed to exist in the population being considered. One project from every quota will be purposively selected for the study on the basis of pre-specified characteristics. The selection of three projects was based on the following characteristics: projects that were established before the year 2008 and having met OVOP basic criteria and supported by OVOP program (financial or other capacity building). After scientific selection process, instruments were administered to the selected population of 72 individuals from whom were members of three OVOP projects and district industrialization officials. Each project was analyzed both qualitatively (interviews, observations and narratives) and quantitatively (matrix observations, questionnaires and demographical information). The analytical generalization through literal replication logic of multiple units in a single case was applied to predict similar propositions. The study preposition was that productive processes were important for successful implementation of differential advantage approach in OVOP Kenya projects.

RESULTS AND DISCUSSION

According to result in Table 1, most respondents in the three study cases neither agreed nor disagreed at 32.6% that the contribution of productive process in OVOP projects was sufficient followed by disagreed at 27.1%, agreed at 17.4%, strongly agreed at 15.3%, and lastly strongly agreed at 7.6%, respectively.

The study objective sought to establish the role of productive processes on rural development in OVOP projects. The result established that the productive processes in OVOP projects were not sufficient on rural development. The study revealed low efficiency and effective processes of production of goods and services in three OVOP projects. The result was associated with use of substandard technology, poor coordination and lack of necessary skills and attitude toward shared value of productivity. The result confirmed study proposition that productive processes were important on the implementation of differential advantage approach in OVOP projects. It was also revealed that provision of industrial clustering, specialized industrialization, innovative research and development and culture economy were some of requisite factors for successful productive processes in OVOP projects

Industrial clustering

Evident from the three OVOP projects studied revealed nonexistence of inter-firm linkages in production processes. According to Kurokawa et al. (2010), the effectiveness of OVOP projects should be measured by indicators such as the spatial connectivity in national and global value chains, brand-making and e-commerce on foreign cooperation in financing and management training, and coordinate activities. It has been argued that the main problem for small and medium enterprises (SME's) in developing countries is not their small size but their isolation, which hinders access to markets, as well as to information, finance and institutional support (Amyx, 2005). Design and management of products, processes, services and supply chains, acquisition, development and utilization of resources, operational structures and constraints in technology logistics in supply chains are some of the problems experienced by SME's (Shelly, 2006). The study revealed that both county and national governments had little effort of initiating industrial cluster all three studied counties despite having OVOP projects. Moreover, lack of supportive infrastructures, innovative technologies and mutual cooperation among relevant actors prevented harnessing OVOP and other SMEs initiatives.

According to Republic of Kenya (2008), the present characteristics of the Kenyan manufacturing sector show

Table 1. Contribution of productive processes in implementation of DAA.

Productive process	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Industrial clustering	11	21	21	13	6	72
Specialization	10	21	25	12	4	72
industrialization	14	18	21	12	7	72
Innovative R& D cultural identity	9	18	27	13	5	72
Total	44	78	94	50	22	288
Percentage	15.3	27.1	32.6	17.4	7.6	100

neither linkage nor specialization. Creation of dynamic clusters requires strong correlation among the factor conditions, related and supporting industries, and firm strategy, structure and rivalry. It is therefore important to strengthen linkages and specialization that will lead to competitiveness creation. It was evident from the study that despite county governments launching ambitious plans in establishing industrial clustering, the initiatives have not been embraced by other actors such as private sector and small scale organizations. It was evident that there exist weak inter-firms relationships in counties where every firm work in isolation. This had been believed to have emanated from lack of collective willingness in a shared value of productivity. For example according to Nyeri County Integrated Development Plan (CIDP, 2018), Nyeri CIDP (2018) County has one industrial park at Karatina and eight constituency industrial development centres. Laikipia CIDP (2013) county government had an initiative of developing ten SME parks/special economic zones in all urban centres. For Machakos CIDP (2015), Machakos County government entrenched OVOP model in its CIDP by initiating five cottage industries for production of local and export markets products using locally available raw materials. There were six county industrial development centres (CIDCs) projects in six constituencies or sub-counties with the aim of promoting SMEs or Jua Kali sector.

Overwhelm evident from the study revealed that OVOP projects would benefit a lot by being integrated in the industrial clustering. The study attested that OVOP projects would gain quality, efficiency, market, technology, and sharing knowledge among other advantage of industrial collaboration. The study concurred that inter-firms result into a lot of benefit from economies of scale, quality product, market access, branding and packaging among other advantage of collective activities. A conclusion was drawn from the study finding that industrial clustering in great extent is an initiative of government through provision of necessary incentives, infrastructures, leadership and coordination of collective activities by sharing value in productivity. With devolved system of government, industrial clustering becomes easier to make it a reality. Similarly, firms establish close, long-term working relationships with suppliers and customers, who depend on one another for much of their business, developing interactive relation-ships with partners who share information freely, work together when trying to solve common problems when designing new products, who jointly plan for the future, and who make their success inter-dependent (Spekman et al., 1998). However, it requires commitment of county leadership to appreciate the importance of regional industrial linkage to maximize production and income generation especially to SMEs and especially OVOP projects. The study therefore hoped that the presence of mutual cooperation, commitment and leadership on collective activities among the actors would be realized for sustainable industrial clustering.

Specialized industrialization

It was evident from the study finding that there was no meaningful specialized industrialization in all three studied counties. Although, three OVOP projects had identified the unique product that they were not able to maximize its differentiation. According to Matsui (2006), OVOP movement can be taken to mean specializing only on one product and then to upscale its production. Nishikawa (2007) added that OVOP movement is significant in that it promotes the production of local specialties (“mono zukuri”) and economic development. The study finding revealed that in all three OVOP cases, their enterprises were not customer or supply driven. The OVOP projects did not have direct contact with their consumer hindering them from benefitting from direct feedback information that necessitates their continuous improvement product and services. Despite the three counties having an ambitious plan of initiating specialized industrialization by promoting few products, the counties had competitive advantage; the move was still in pipeline. For example, most discussants agreed that integrating OVOP projects into national or global value, chain their products, that is, Rumuruti aloe vera, Kionyweni baskets or trout fish products would have benefited from direct contact with wide range of customers. They also benefit from information sharing through consumers’ feedback information on experiences of the product, thereby perfecting that market. According to Haraguchi (2008), although OVOP special emphasis is on product differentiation, it is sometimes considered a supply-driven

approach in which villages come up with products making use of their local resources and sell them to niche markets. More importantly, it is this embedding of the process of interactive learning in their activities that makes the OVOP an effective and sustainable rural development method. The absence of specialized industrialization in the three counties revealed to have been constrained of OVOP projects to sustain current competitive global market. Specialized industrialization believed to make firms to gain competitive advantage by sharing their experiences, knowledge, resources, risks and insulate them from stiff competition. Arguably, both large firms and small firms could sustainably be integrated into the market value chain in a win-win situation where every firm specializes in areas they are most competent in. Collaboration is based on mutual trust, openness, shared risk and shared rewards that yield a competitive advantage, resulting in better performance than it would be without the collaboration (Gekonge, 2006). Sustainable business linkages would be enhanced by establishing strong connections through smart contracts between SMEs and OVOP projects with large supermarkets and multinational companies sharing values in productivity. Moreover, a well-coordinated county backward-forward business linkages programme pre-requisite among all relevant stakeholders in productivity may be headed by the office of governor for successful specialized industrialization. According to Yamazaki (2010), OVOP deals with several linkages. The first is between producers and the market, the second is to connect business development with human and social development, and the third link is a social capital among different localities. These links are based on participation and initiatives of local actors while the prefectural government provides various technical and institutional assistances. The also established dysfunctional district OVOP committees in the three OVOP cases failed to provide steering coordination of the activities which was crucial for driving collective activities at district level. More so, establishment of SMEs industrial park, industrial clustering, inter-firm relation, incubation centres and village business development centres (VBDC) hoped to promote specialized industrialization. Chain champion was also necessary to provide leadership, commitment and mutual cooperation aspects of collective activities in productivity.

Innovative research and development

The study attested that despite the three studied counties having many promotions, research and educational institutions OVOP project rarely benefited from those initiatives. Arguably, innovation is the “genetic ability” of industrial districts (Piore and Sable, 1984; Bellandi, 1996), a vital condition for confronting continuous and discontinuous change through research and development, learning-by-doing, learning-by-using, entrepreneurship and the breaking up of the productive chain into many phases. The result also established that there were no meaningful inter-firms collaboration with OVOP projects and other SMEs with research and learning institutions for development purpose; for example, Karatina and Kimathi universities in Nyeri county, Machakos Technical University in Machakos county and Laikipia University in Laikipia county. As Republic of Kenya (2013) puts it that R&D or R and R in the country is mainly undertaken by the government with little contribution from the private sector. Further, there was weak linkage between production/service enterprises and research institutions to inform on research needs and a system for disseminating and absorbing the research output. The study, the learning and research institutions run parallel without having any partnership or collaboration with the community organizations in sharing information.

It was noted from the study that in three OVOP projects were non-functioning district OVOP committees which were supposed to provide coordinating inter-firm interaction for collective productive processes. For example, as Kurokawa et al. (2010) put it that collaboration and coordination should also be sought from local research institutions, including universities, which can contribute to the training of OVOP producers as shown by the example of Bunda College of Malawi. Notably from the finding was the absence of collective activities in promoting community initiatives or cultural identity through joint defining problems, searching for and implementing solutions and assessing values and practices together. Despite the establishment of National Productivity Council (NPC) as it is in Republic of Kenya (2013) to facilitate inter-sectoral coordination of policy and programmes initiatives of public and private sectors, and enactment, lack of creativity and innovative approach hinged on support, active participation, and cooperation of everybody and all relevant institutions in the country lead to its stagnation. A conclusion was drawn from the study that an innovative framework was critical for a dynamic interrelationship among multi-stakeholders such as scientists, research and educational institutions, government promotion bodies, manufacturer, commercial firms, large supermarkets, international consumers and small producers in a shared value for productivity. More so harnessing of unique local product, creation of appropriate technology through local research and technical institutions, identification and promotion and support of market outlet, protection against any exploitation and sustaining mutual relationships locally, nationally and international relation through continuous commitment in collective sharing information, fulfilling own obligations, upholding common values, practices and language would determine success of productive process.

Culture economy

The strong cultural identity in local product seems to be

the source of competitive advantage where local bared an emotional identity and historical experience with the product. It was overwhelmingly evident that the locals had long history and value of cultural product and practices such sisal basket weaving business or aloe vera medicinal herb provided strong identity on the enterprise. OVOP projects believed to be unique due to their originality and ingenuity features. According to Ray (2002), the culture economy idea, in essence, is about the strategic use of cultural resources in the pursuit of local socio-economic vibrancy. For example, basket weaving enterprises would gain more national and international market appeal by harnessing and amplifying its environmental benefit, strong historical experience and importance of the enterprise. The study concluded that with strong emotional connections and long experience on indigenous product and practices in OVOP projects derived an added advantage over other producers. The source of differential advantage emanated from cultural identity or local socio-economic vibrancy and learning curve of producing products such as baskets, trout fish or aloe vera lotion from local raw materials. According to Einarsson (2016), cultural behaviour describes, creates, preserves and disseminates human emotions and thoughts through the production of, among other things, cultural goods, ideas, sports, art, languages, religions and customs. For more effective production, the cultural strength for example Kionyweni basket or Rumuruti aloe vera production requires to be harnessed on an extensive global and value chain of productive processes to leap maximum advantage. For example in Rumuruti project, the study revealed that most members had a long historical value and usage of aloe vera as medicine to treat wounds, stomach ache or cure of pimples. The study established that most local SMEs especially OVOP projects produced and market their products in isolation, hence, faced with a lot of challenges such as quality, economies of scale, stiff competition among other constraints. It was therefore believed that with a proper backward and forward linkage between local indigenous knowledge and modern capitalist relations with shared common culture and infrastructures would ensure an effective production process in rural areas. According to Hassink (2004), reasons for success of Daegu's textile industry are shaped around the direct production arrangements like inter-firm relations. The down-stream process of textile industry was created and put in place through the networks involving not only producers, but also researchers, designers, government officials, traders, university, research centers, specialist agents, banks, chambers of commerce, designers. Provision of necessary infrastructures, conducts and mutual cooperation in supporting community initiatives would lead to competitive OVOP products in the global market.

A conclusion was drawn from the study that collective efforts by innovatively exploiting cultural identity (originality and ingenuity) achieve competitive advantage.

RECOMMENDATIONS

(1) There is urgent need of establishment of Village Business Development Centres which serves as focal point for implementation of differential advantage approach in OVOP projects. There is a need to consider a larger OVOP unit such as typical Kenyan village instead of assuming self-selected functional groups or projects as villages. The typical village "kijiji" with common assets and facilities such as shopping centres, church, school, networks, etc., which were easier being tapped for economic purpose. The village organ with common assets, structures and conducts could be central point of initiating OVOP product production, trainings, promotion, marketing and linkages or cooperation and collaboration with other institutions. The social capital in villages provides galvanization in an interactive organization for collective learning, marketing and production of unique products in OVOP projects.

(2) There is a need for all relevant ministries and county government led by the county government in establishing coordinating organ with full mandate and empowered to steer productive processes in counties. The established clustering of villages and inter-institutional framework, partnership and collaboration with the private sector, county government and donor organizations should provide supplementary support community initiatives such as physical infrastructures, extension services, industrial clustering, incubator centres, SMEs industrial park, village cybercafé or free internet telecentres common product branding and designing centres and online marketing or marketing website, international trade fair, etc.

(3) There is a need to identify chain champion of the productive processes preferably the county governors of respective counties. The chain champion will therefore provide necessary collective spirit in terms of leadership, commitment and mutual cooperation among different county stakeholders. Provision of mutual cooperation, incentives, leadership and commitment among relevant ministries and county government of District OVOP committees will facilitate collective activities of productive process. The study deduced that necessary production framework, infrastructures, incentives and common behaviours or conducts, that is, values, practices, norms, etc., were required for successful implementation of joined productive process. Successful productive processes encourage social learning where information sharing, defining problems, searching for and implementing solutions and assessing their solution collectively, thereby, gaining advantage over competitors.

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