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Geographic Information System as a Tool for Rural Livelihoods Enhancement Planning (Case Study of Alosylat Region -Shareg Alnil-Sudan)

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Abstract: This study proposes a bottom-up rural livelihood planning system, using GIS as a participatory planning tool. A comprehensive livelihood planning emerges from a comprehensive understanding of the livelihoods situation. Lack of community participation toward decision-making and preparation of rural development planning in urban centers outside the affected villages in Sudan causes policy failure in livelihoods development. The Participatory Geographic Information System (PGIS) potential has been recognized. It can be extremely useful if it is applied to the development of sustainable livelihoods and the reduction of poverty in a participatory approach. However, as a result of a lack of information about public knowledge, data sharing, and geospatial data, Sudan has been slow to adopt this technology. In this research, by using the Participatory Rural Approach and the Geographic Information System (GIS) as a geographic database, planning, and monitoring tool in qualitative methodology, we can gain an understanding of the conditions of rural livelihoods in order to enhance the rural livelihoods planning with the help of the Livelihoods-Framework and Livelihoods Enhancement Action Plan techniques.

Keywords: *GIS for rural development, GIS for Livelihoods planning, GIS for economic development, PGIS for rural development, GIS for development planning*

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INTRODUCTION

As a global society, we have access to more information than our forefathers. We, as a global society, are living during an age of wide spread research, rapidly changing technology, in depth investigation, speculation and tidbits of trivia. It is essential that we use appropriate tools (manual and technological) resources (human, animal and environmental) and base decision making that will affect the lives of thousands, perhaps millions, on accurate data and/or strong evidence. Utilization of this method will ensure productivity and avoid the waste of time energy and resources. The impact of information technology on socio-economic is huge and sustainable development is unthinkable away from a knowledge-based society.

The fundamentals of geography show the importance of space for any object or phenomena. Thus development planner must use spatial planning to plan or manage activities. It is at this point that the GIS becomes a powerful tool for planning and decision making as it has the capability to replicate the digital image map and numerical information about spaces and localities. Moreover it has the ability to store visualize, analyze and integrate the spatial data. Because of its multiplicities of functions, the GIS has continued to progress as an effective tool for planning and decisions making (Arunplod, 2019; Campagna & Deplano, 2002).

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The project planning for livelihoods development must be based on the current reality of the community with regard to income, expenditure, employment, risk capitals and the contexts related to the household, community and surrounding area. The best approach to a deeper understanding of the available resources and assets of the community is to include the knowledge of the local people to assess, analyze and plan. This process leads up to Livelihoods Enhancement Action Plan (LEAP). The LEAP uses social and resources map, livelihoods, and trade in/trade out analysis (Works and Wages get money to the village/Works and wages taking money out of the village), local market analyses, income, expenditure, risk, and gender (Akshara Network, n.d.). Here we can be observed plainly the role of Geographical Information (GI) to produce evidence that there is high demand for the GIS research as a management and monitoring tool in the livelihoods development planning.

According to the definition by Hanson and Abresch (2014) PGIS developed from the blending of Participatory Learning and Action (PLA) methods with Geographic Information Technologies (GIT). PGIS combines a variety of geo-spatial information management tools and methods to represent peoples spatial knowledge in either virtual or physical formats. The PGIS integrated with LEAP tools will enhance the rural livelihoods planning (Quan, Oudwate, Pender, & Martin, 2001).

EXISTING SYSTEM

Top-Down rural development planning is an existing planning system which is used for rural development in Sudan which keeps the decision makings process at the planner level without taking advice from local people in rural area.

There are a number of problems associated with this existing system .The lack of the participation of community and stockholders in decision-making in the current system results in the inadequate acquisition of information, which is the reason for the failure of most policies in Sudan, including livelihood development planning (El Harizi, Zaki, Prato, & Shields, 2007; Sutiono, 2018).

Lack of geospatial data in the existing system is one of the problems that prevent a full implementation of GIS in economic development planning (Ali, 2009).

Most of the plan for rural development in the current system is prepared in urban centers outside the affected villages and imposed upon those communities without knowledge of village realities.

PROPOSED SYSTEM

This study is proposed bottom -up rural livelihood planning system, using GIS as participatory planning tool.

The proposed system objective

The basic objective of the proposed system outcome is enhancing the planning of rural livelihoods by using GIS as a geographic database, planning and monitoring tool (Case study of Alosylat region- Shareg Alnil- Sudan).

The specific objectives of the proposed system outputs are to:

- Generate information about the rural livelihoods situation based on current reality from local knowledge (participatory manner) using the LEAP tool to acquire non-spatial primary data.
- Integrate non-spatial primary data with spatial secondary data to acquire spatial rural livelihoods information using GIS (Figure 1).

The proposed system study area

The case study of the proposed system carried out in the three villages of Alosylat region, Alhoyla village, Algwaz village, and Alhsnab village of Shareg Alnil locality in Khartoum state of Sudan (Figure 1, 2, 3, 4).

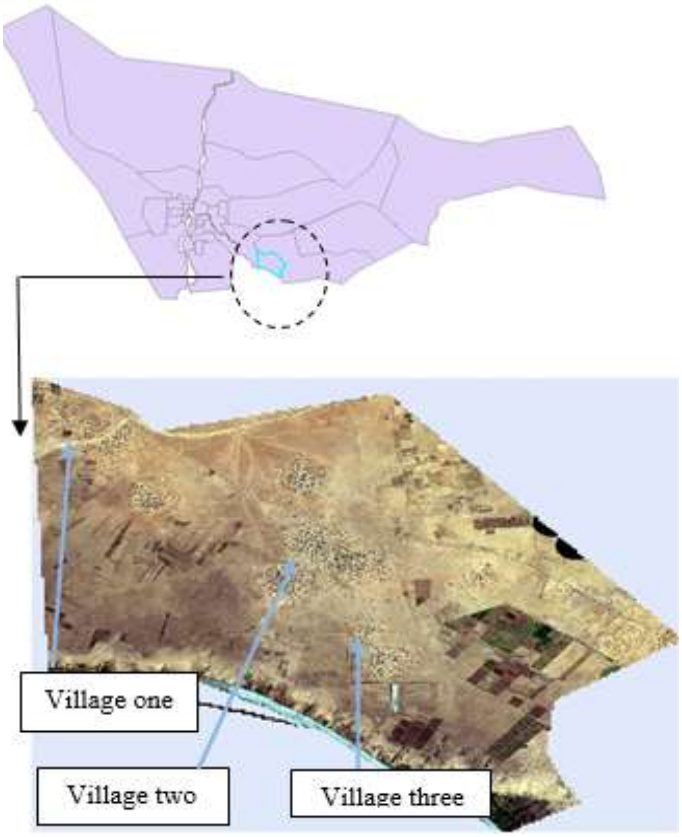

Figure 1 *Maps. a) Khartoum state (Source: Sudan Ministry of Federal Health) b) Alosylat region (Source: Nokia Ovi Maps)*

Table 1 *Dimensions*

West	32.804784	East	32.939667
North	15.430915	South	15.298017

Village one: Alhoyla village: The longitude and latitude Global Positioning System (GPS) coordinates of Alhoyla village is 32.828394 15.395920 respectively (Figure 4).

Figure 2 *Alhoyla village (Source: Nokia Ovi Maps)*

Village two: Algwaz village The longitude and latitude GPS coordinates of Algwaz village is 32.860199 15.372307 respectively (Figure 3).

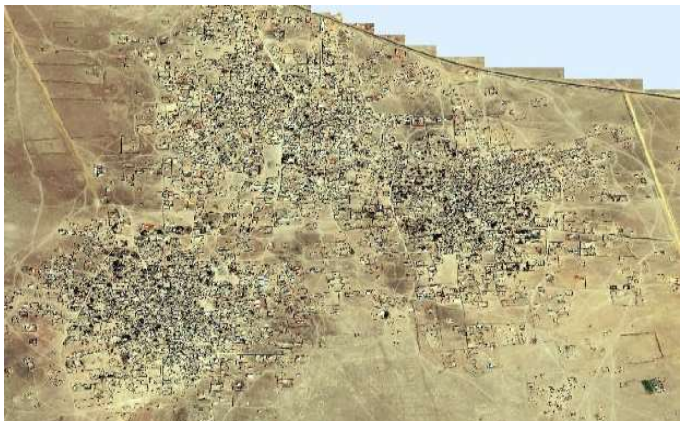

Figure 3 *Algwaz village (Source: Nokia Ovi Maps)*

Village three:- Alhsnab village The longitude and latitude GPS coordinates of Algwaz village is 32.876904 15.349819 respectively(Figure 4).

Figure 4 *Alhsnab village (Source Nokia Ovi Maps 2016)*

The Proposed System Methodology

The two steps data collection process

a. Primary data: The qualitative research method was used to collect the primary data (non-special data) and completed by using the LEAP tool which was used for the Participatory Rural Approach or PRA (named for an increasing number of participatory approaches and techniques that assure local knowledge and enable local people to make their own appraisals). These participatory tools include semi-structured and structured interviews, group discussion, and transect walk to collect data, observing, asking, listening, looking and identifying zones. By walking the field, spatial data such as land use, settlement pattern and peoples perception of these could be investigated and discussed in detail. The villager could use markers to draw on large sheets of paper colored markers could be used to identify different aspects of the map. If villagers are unfamiliar with the use of writing instruments, they could draw maps on the ground with a stick.

The GPS has been applied, data was derived from the PRA stage for validation and accuracy of information gathered in regards to locating service centers, housing units, digitizing road networks, and obtained precision points for geocoding satellite images (Figure 5).

b. Secondary data: Satellite data has been generated by free datasets portals and Google Earth, and DG sat free satellites used to collect secondary data (special data), in addition to the survey maps, census data published by the Sudan National Survey Authority, Khartoum Federal Ministry of Health and Statistics Authority (Figure 5).

Data processing: After collecting primary and secondary data, some computer software was used to process the data.

The spatial knowledge of the people was presented in the form of layer maps and supplemented by Geo-spatial or map based information management tools, ranging from satellite imagery, sketch maps, aerial photographs, and the GPS.

The data processing software programs are Google Earth, Microsoft Excel, Microsoft Access, ArcMAP 10.2.2, ARC Catalog 10.2.2, and SASPlanet (Figure 5).

Data analysis: After data is processed and stored in ArcGIS 10.2.2 as spatial data, the ArcGIS 10.2.2 analysis tool was used for data analysis (Figure 5).

Information presentation: ArcGIS 10.2.2 have been presented the people spatial knowledge in the form of layers maps (Figure 5).

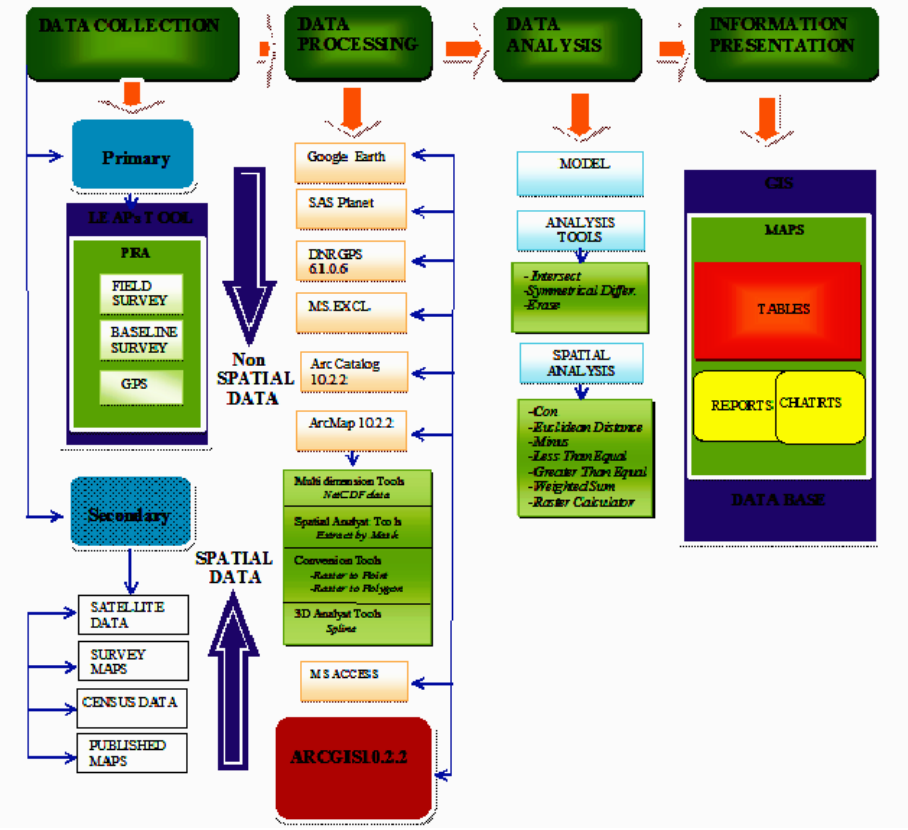

Figure 5 *Algwaz village (Source Nokia Ovi Maps 2016)*

RESULTS

Social Map Analysis

"A social map is a map that is drawn by the residents and which shows the social structures and institution found in an area . It helps us learn about social and economic difference between house" (Sontheimer, Callens, & Seiffert, 1999).

The GIS integrated all the social map information [the number of families and households, population, poor data, housing particulars, livestock, infrastructure, pensioners and institutional aspects] for the three villages and stored it to one geo database system in layers as show in the Figure 6. This helps to enhance rural livelihoods planning and decision making as the poverty declination continues to be very hot issues in political argumentation in most developing countries (Sunderlin et al., 2005; Cao, Wang, Song, Chen, & Feng, 2010), UNDP adopts sustainable livelihoods to serve poverty reduction (Yadav, Lal, & Lal, 2014). The planner needs to know the degree of poverty for all three villages before he initiates priority livelihood planning or managing activities. Use the integrated information of the social map and quarrying in this geodatabase system enables the planner to identify which village has the most extensive rate of poverty and to visualize the poor houses on a geo referencing map. In addition, it will enable the planner to analyze characteristics associated with poverty by using a related feature in ArcGIS. To make a poverty correlation map, planner could join together several tables for the same village such as the poor houses, education, health, vulnerable, livelihoods and other indicating tables.

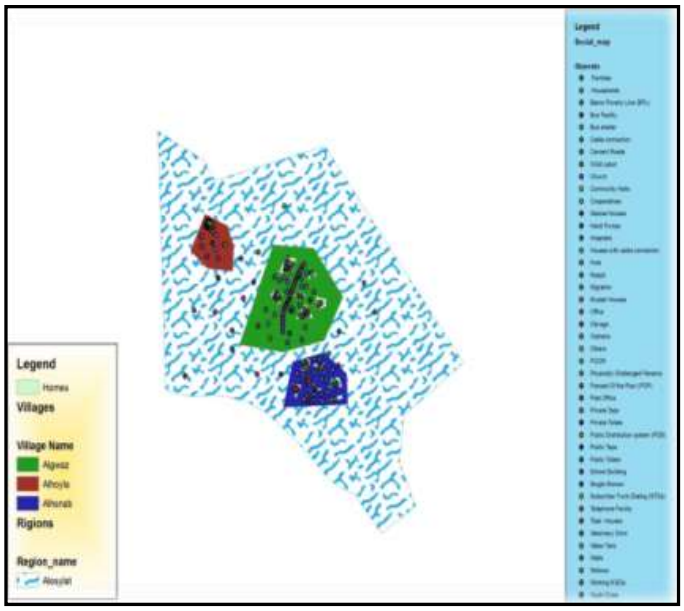

Figure 6 *Social Map Analysis*

Resources Map Analysis

"The resource map is a tool that helps us to learn about a community and its resource base. The primary concern is not to develop an accurate map but to get useful information about the local perception of resources" (Sontheimer et al., 1999).

The resource map is an indicator of a different type of capital that makes livelihoods strategies possible (Bebbington, 1999).

The GIS integrated all local knowledge of natural resource information [such as the total type of land (in acres), important crops with number of acres, type of the soil and natural resources for the three villages] and stored it to one geo database system and layers, as show in the Figure 7.

The planner can use the geo-database quarry to analyze, to create a symbolic map and to visualize the distribution of resources by type (land by type of soil, irrigation sources, crops grown, and type of forest produce available etc.) in all the three villages before initiating the preparation of livelihoods strategies.

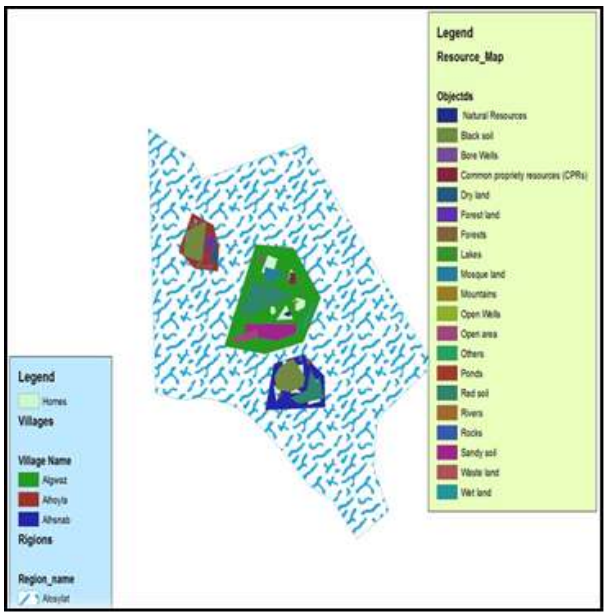

Figure 7 *Resources Map Analysis*

Livelihoods Map Analysis

The livelihoods maps enable the community to identify the major livelihoods and the areas in which these livelihoods need additional support. Reardon et al. (1998) found an average share of 42% of non-farm income in total rural household incomes in Africa.

Income diversification is the livelihood strategies core in rural areas in African countries (Barrett, Reardon, & Webb, 2001).

Non-farm livelihoods is the most successful way to reduce poverty and increase of household income (Barrett et al., 2001; Lanjouw & Feder, 2001; De Janvry, Sadoulet, & Zhu, 2005; World Bank, 2009; Haggblade, Hazell, & Reardon, 2010; Jacquelyn, 2010). To enhance non-farm livelihood planning is to set up the financial, social, human and physical capital of the society in order to make it less depends on natural resources. Here is where the power of GIS integrates all the livelihood diversification information for the three villages and stores it into one geodatabase system and layers it, as show in the Figure 8.

The planner can use the Geo- database for livelihood strategies; he can also use quarry and analyze in ArcGIS to visualize the livelihoods diversification location on the map for the purpose of creating a suitable place that is accessible for a professional training center and the financial and social institutions to support them.

By using the Geo-database feature in Arc GIS, the planner can create a correlation symbology map between the livelihood of low-income maps, education, health, vulnerable, social maps.

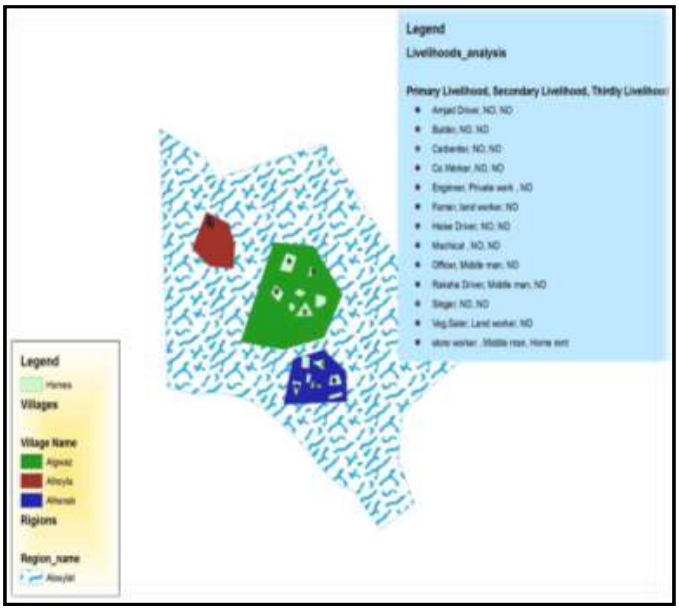

Figure 8 *Livelihoods Map Analysis*

Trade-In and Trade-Out Analysis (Wages Bring Money into the Village and Wage/Work taking Money out of the Village)

The engagement of the rural household with the market is a good capability for rural livelihoods development and poverty reduction (Bebbington, 1999).

Trade-in and trade-out analysis outlines the flow of commodities and services in and out of the village for the purpose of creating a market for high commodities and service demands (commodities and services out of the village). GIS integrated all the trade-in and trade-out for the three villages and stored it into one geo database system and layers as show in the Figure 9.

This helps the planners and decision-makers who use the system to analyze and quarry to visualize on the map, a suitable place for a market [for the three villages] to enhance the household engagement.

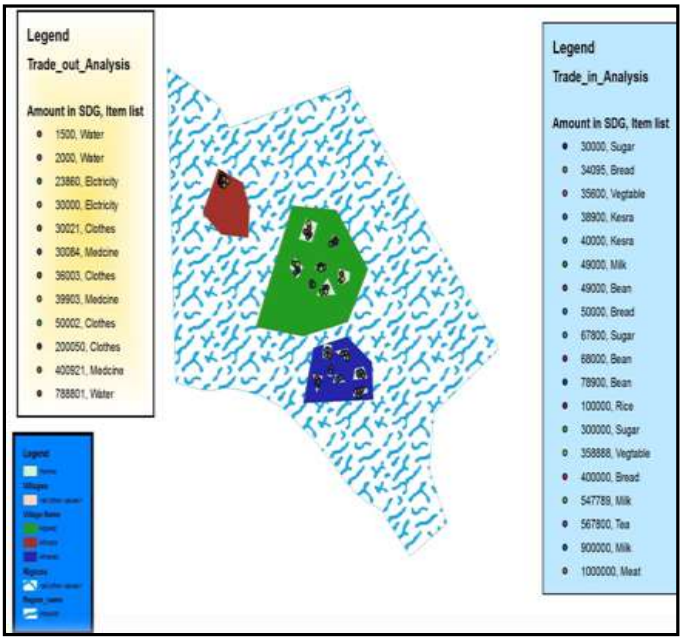

Figure 9 *Trade-In and Trade-Out Analysis*

Vulnerability Analysis

The vulnerability analysis depicts a profile of the vulnerable people in the village. It aims to depict the risks and dangers faced by the village and coping mechanisms people use in risk management.

GIS integrated all of the vulnerable peoples information and coping mechanisms for the three villages and stored it into one geo database system and layers as show below on Figure 10, 11, 12, 13, 14, 15, and 16. The planner needs to be familiar with the condition of the vulnerable peoples lives and what coping mechanisms they use for risk management before managing activities or planning for them. The geo-database enables the planner to quarry, analyze local vulnerable peoples information and coping mechanisms in order to create vulnerabilities and coping mechanisms maps for the three villages. It enables planner to identify a location and create a suitable capacity building plan , based on the local peoples coping mechanisms.

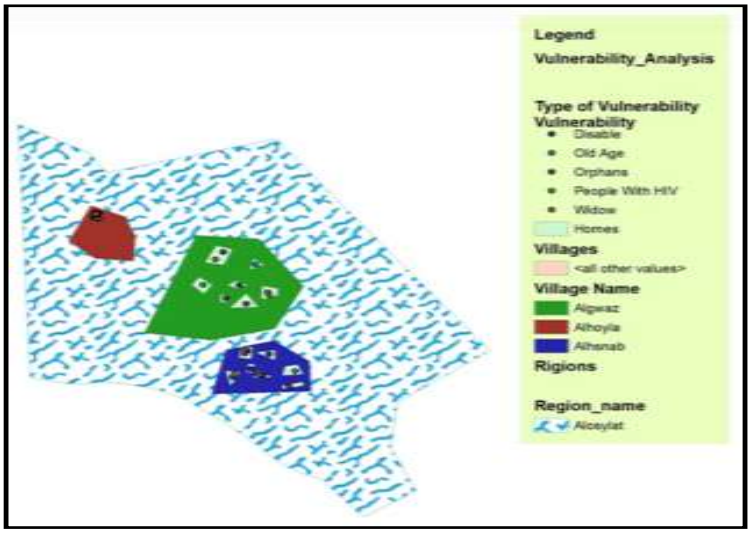

Figure 10 *Social Map Analysis*

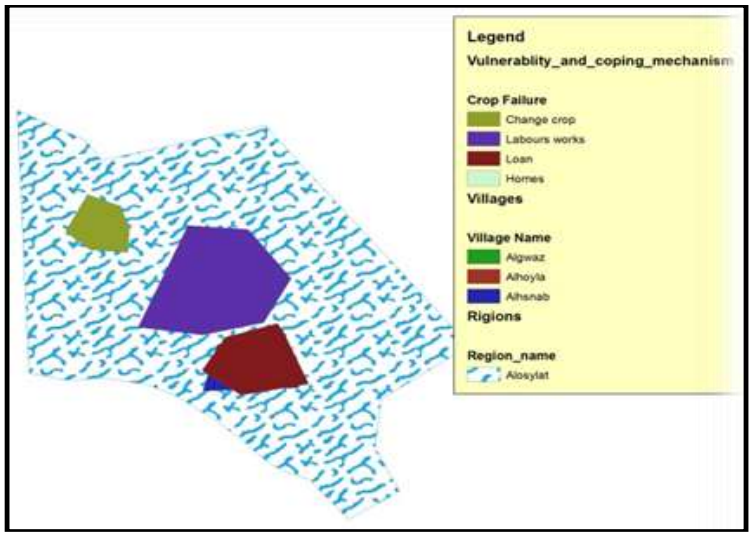

Figure 11 *Vulnerability Analysis*

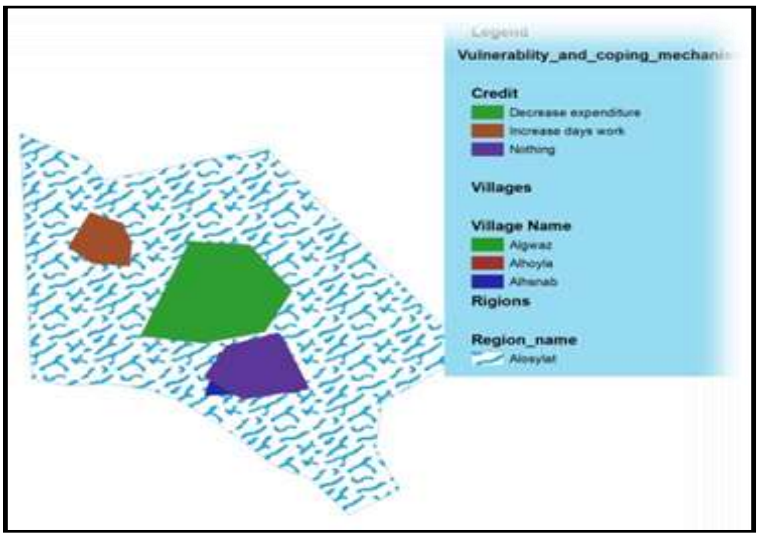

Figure 12 *Vulnerability Analysis*

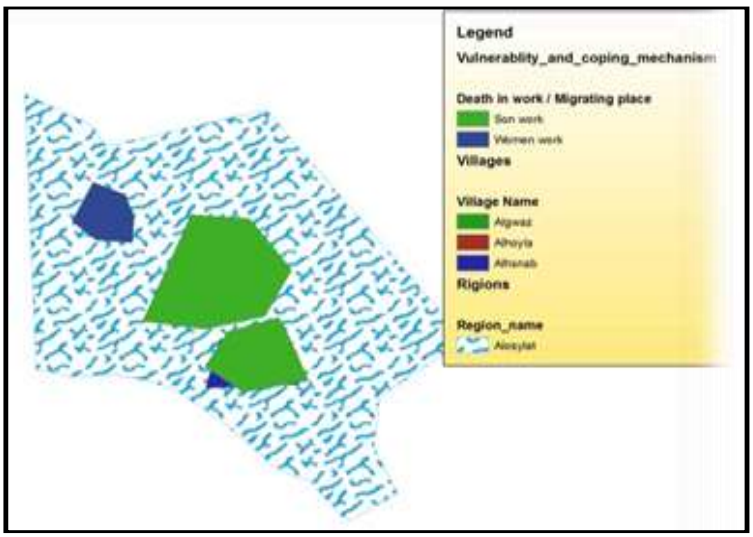

Figure 13 *Vulnerability Analysis*

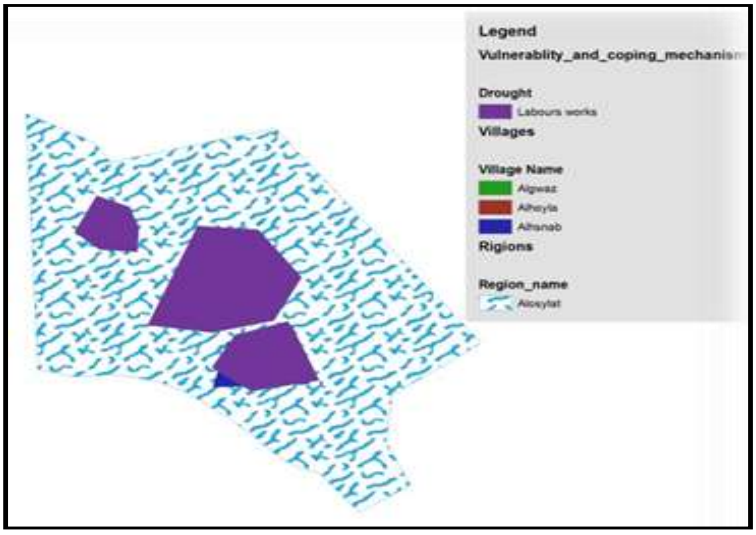

Figure 14 *Vulnerability Analysis*

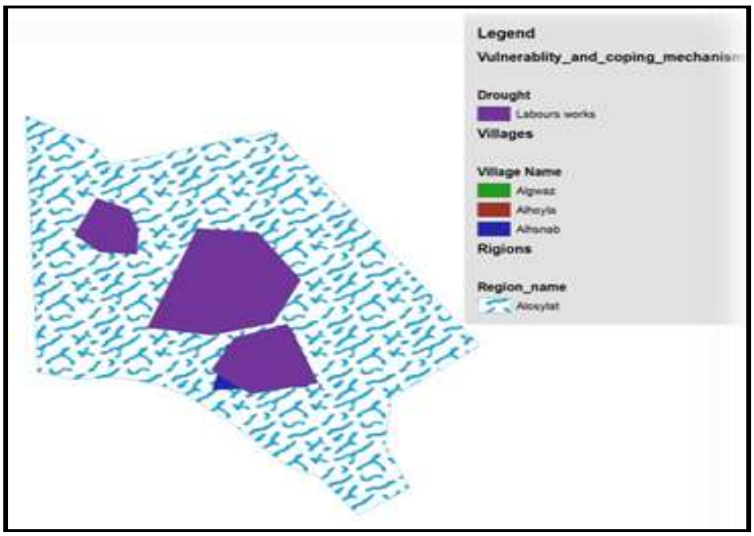

Figure 15 *Vulnerability Analysis*

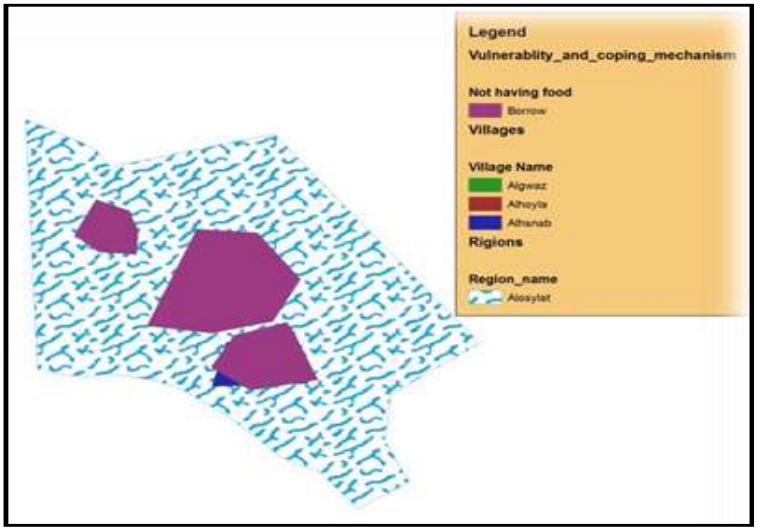

Figure 16 *Vulnerability Analysis*

CONCLUSION AND IMPLICATIONS

The findings of this study will benefit society because bottom-up planning plays a vital role in the success of the livelihoods development policy. This process can be used in addition to village and micro level planning systems as well as planning at the regional and national levels. The greater demand for Electronic Governance (E-Governance) in Sudan justifies the need for research of GIS. Local level planners, development practitioners and government officials that apply the recommended approach derived from the results of this study will be able to enhance their plan and decision making for livelihoods development.

The study will eliminate gaps in knowledge in livelihoods development by integrating information of the LEAP tool with participatory GIS.

This study will help other researchers to use the same approach to cover additional regions in Sudan. The system has the potential to store unlimited villages numbers).

The same study may be used to establish a web-GIS.

Its recommended that future research to use the same approach to study additional villages and micro level planning systems as well as national and regional planning in Sudan.

Since this study had only focused on integrating some of the LEAP tools with PGIS, its recommended that future research be carried out on others LEAP tools (Income and Expenditure Analysis , Market Analysis, 24-Hour Analysis, 365-Day Analysis, Seasonality Analysis, Migration analysis, Credit Analysis, Health/Disease Analysis, Education analysis, Institutional Analysis, Enterprise Mapping Analysis, Education and Health Ranking Analysis, Demand Estimation Analysis, and Climate Change Analysis).

Its recommended that future research to use the same study with web-GIS to establish a Geospatial Livelihoods Village Information System in Sudan

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