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GIS-SUPPORTED CHARACTERIZATION AND GEOGRAPHICAL TARGETING INTERVENTIONS IN PROJECT DISPLACED COMMUNITIES IN DUTSE, NIGERIA

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ABSTRACT
The establishment of Federal University Dutse led to the displacement of some villages in the project site. The post construction impacts on these communities require urgent directing of interventions. The study analyzed the social problems associated with Communities' displacement and employed geospatial techniques in geographical targeting of interventions in Dutse Jigawa State Nigeria. Results of the analysis show that almost all communities are deprived of essential amenities including good roads, elementary schools, pipe borne water, primary health care, telecommunication and farmlands. Spatial analysis gave insight to the relative needs and level of poverty amongst the displaced rural communities in Dutse. The facilities and the most central locations for them namely: Gurungu, Maidobi and Hausawa were easily determined from the geospatial analysis. The study found GIS mapping very useful in revealing the relative magnitude of social challenges and the intervention needs among project affected communities.

Keywords: Project Displacement, Community resettlement, Geographic targeting of interventions, Spatial analysis, Federal University Dutse

INTRODUCTION

Deracination of human enclaves is one of the most prominent costs in human development (UN, 2014; UNDP, 2015). Development projects particularly construction of infrastructures have been reported to disrupt locales of millions of people in the past (Mares, 2012; Sahoo *et al*., 2014). Spatial re-design of human settlements is therefore often required before and after major developmental projects to mitigate likely impacts of project-induced community displacements. Where this fails, the negative project impacts do obliterate the planned benefits (Ochuo, 2014; Mi *et al*., 2014; GPFD, 2015). Project impacts can be highly deleterious (Yntiso, 2008) with ripple effects on socio-cultural and economic lifestyle of people (OlliLehtonen and Okkonen, 2016; Shoaib, and Ariaratnam, 2016). The impacts of community displacement on different households may vary in magnitude and time. Communities often grapple with gross impoverishment and disempowerment with particular consequences on women and children. In practice, appropriate palliatives are introduced and project affected persons are catered for with good Resettlement Action Plans (Olawepo, 2008; Wang and Wall, 2008).

The Federal University Dutse (FUDutse); a Federal Government University in north-west Nigeria (NUC, 2020) displaced several villages when it was established in 2012. The negative impacts of this development on the six communities namely: Gurugu, Bulori, Maja, Kargo, Hausawa and Sharifai include estrangement from water points, from health facilities, farmlands, religious centres, markets and other vital resources which existed in their previous settlements. The current lifestyle change is therefore directly connected to the displacement from the original locations. It therefore became crucial to deploy palliatives to cushion the effects of the lifestyle changes amongst the rural people (White *et al*., 2017 and Jimenez *et al*., 2018).

Geographic Information System (GIS) and Satellite remote sensing were usedas a spatial decision support tool in assessing project impacts and targeting of interventions (Gebreslasie, 2015; Polash and Mrinal, 2016). While satellite remote sensing data provided the synoptic view in evaluating the project impacts, Geographical information systems provided essential spatial analysis and required decision supports for directing interventions in the project areas.

The study's aim is to test the veracity of integrating spatial technologies namely; Satellite Remote Sensing, Global Positioning Systems and Geographical Information System in rapid assessment of impacts of displacement of enclaves on human socio-economic life and as a spatial decision support for precise deployment of interventions. The study used the communities displaced from permanent campus site of the Federal University in Dutse (FUDutse) as a case for determining the intervention needs of the project affected persons.

Study Area

Federal University, Dutse (FUDutse), located East of Dutse town lies between Latitudes 11^0 41'10" and $11^0$44'00" as well as between longitudes $9^0$21'00" and $9^0$24'00". The climate of the area is generally described as sahelian; with annual rainfall of 300 to 400 mm per annum and average annual temperature of 21.2^{o}C in January to 30.9^{o}C in June. The area is covered by Aeolian desert sand and iron rich lateritic soil. The attendant environmental challenges of the area include drought and desertification. Low level of education and rustic nature of the predominantly farming communities underpins the seemingly persistent poverty in the land (Abaje *et al*, 2014; NAERLS and FMARD, 2020). The project area is presented in figure 1 below.

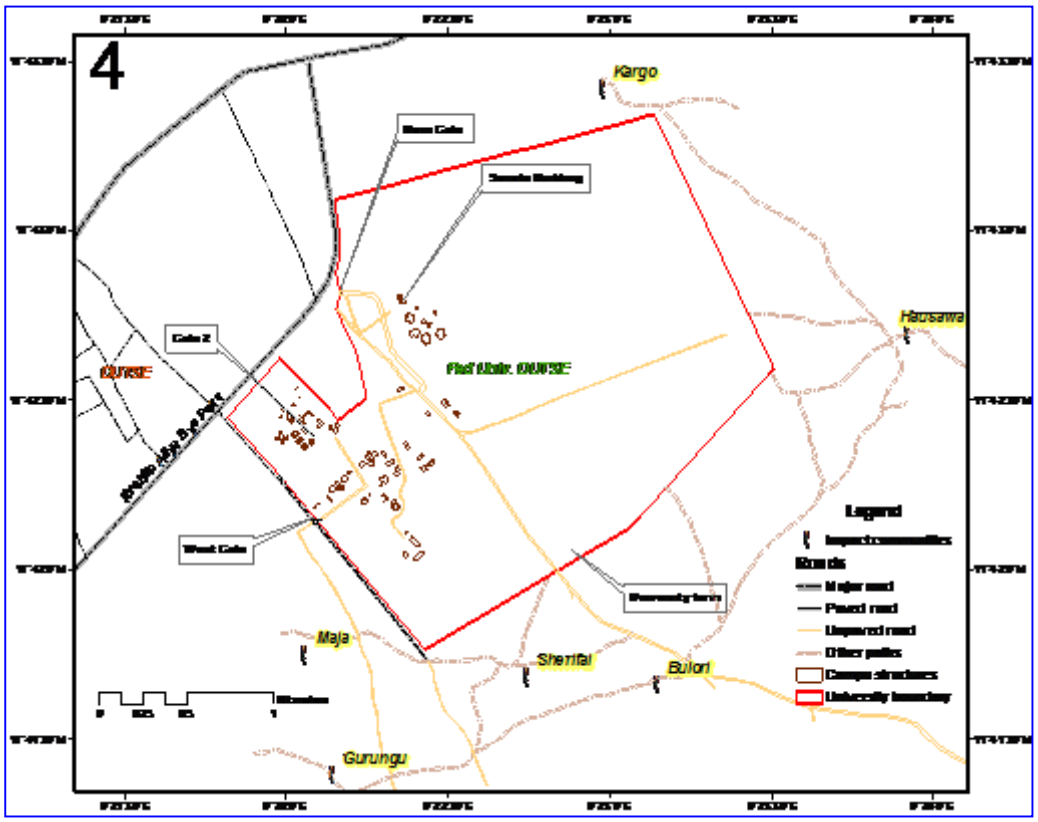

Fig. 1: Layout of University campus and spatial distribution of impacted communities.

MATERIALS AND METHOD

Satellite Remote Sensing, Global Positioning Systems and Geographical Information Systems were integrated to create an interactive map of the displaced communities. The respective attributes of each enclave provided basis for comparison particularly with respect to infrastructure needs. This assisted in developing a decision support system for effective targeting of interventions to displaced communities.

Materials used

The materials used for the study include a hand held Global Positioning System (GPS) receivers, filed notes and questionnaires. The hand-held GPS was set to Minna datum Geographic coordinates, WGS 1984.

Survey instrument

For the purpose of comprehensive baseline data structured close-ended questionnaire/interview guides on android devices were used to elicit information from the farmers in the area.

Data types and data acquisition

The data used were of both primary and secondary sources. Primary source data included field observations along with geographical coordinates of the respective locations visited. The hand held GPS receivers were used with structured interview guides and field observations for data collection. 20 farming households in each of the respective displaced villages around Federal University, Dutse were selected by random sampling techniques. A baseline survey was conducted to obtain data from the randomly selected rural farming households. The sample size of 120 respondents comprising of male and female farmers were interviewed

The secondary data included a recently acquired50cm resolution ortho-rectified natural color Satellite imagery with 0% cloud cover from Digital Globe covering 42sqkm of Dutse township and surrounding villages.

Image processing

The satellite image was geo-referenced in geographic coordinate systems. The image was subjected to 'on-screen' digitizing at a scale of 1: 10,000 to produce the base map which captures essential features such as the University boundary, roads and structures on the image. GPS field coordinates of other land features were later overlaid as point features on the digitized map.

Capturing line and point features

Geographic locations of important land features such as water points, schools, clinics, were obtained using the GPS and the coordinates were recorded in a spread sheet (Micro-soft excel), and the other attributes were attached to each coordinates in separate columns.

Spatial analysis

Spatial analysis includes simple distance analyses to reveal relative access of the communities to basic infrastructures. Concentric rings of equal distances around a feature give an idea of the relative distances of other neighboring features. Buffers gives the Euclidean distances (which is the length of a line segment) between two points in Euclidean space. The relative distances of each community to existing social amenities were calculated in straight line distances in order to reveal the level of deprivation and distance travelled to gain access to essential facilities. Other analyses were presented inform of bar chart on maps.

RESULTS AND DISCUSSION

The outcomes of investigation reveal the characteristics of the study area in terms of settlement pattern, quality of infrastructures and location of facilities such as good roads, markets, water sources, elementary schools and health facilities, deprivation from basic needs and suggested interventions. The reports from recent assessment of

infrastructures in and around Dutse allude to the submission of the present study. Murtala and Nafiu (2021) reported that most of the residents in Dutse are deprived of drainage, water, toilets and proper sanitary conditions. This gives an inclination of the condition of roads, health facilities potable water in the rural settings.

Demographic characterization

Although, the precise population will await the outcome of the next census, simple guestimates from remote sensing of building footprints suggest that about the 2,000 to 3,000 people inhabits the 6 villages altogether. This conjecture is from the assumption suggesting average household size of about 3 of which almost all were male headed. This is in consonance with Weber *et al*. (2018) and Mossoux *et al*. (2018). The estimated populations of displaced settlements with respective average household sizes are presented in table 1.

Table 1: Estimated population and average household size of displaced communities

Settlements	No of Household	Population Households	Average Household size
Bulori	100	200	2
Gurungu	53	159	3
Hausawa	150	300	2
Kargo	120	360	3
Maja	150	900	6
Sharifai	200	800	4

Projections for the next five years based on previous enumeration suggest that population of the displaced communities could exceed 13,200. Future human population based on the present population is given by the equation:

$$Z_t = PPn * t$$

Where Z_t is the number of people at a future time =
PPn is Present Population and
t is period under consideration
Z_t is the population of people at a future time which is obtained by multiplying present population by (base of the natural logarithms raised to (rate of natural increase /100 * time period).
Figure 2 is the chart of projected number of households and community population in nearest future.

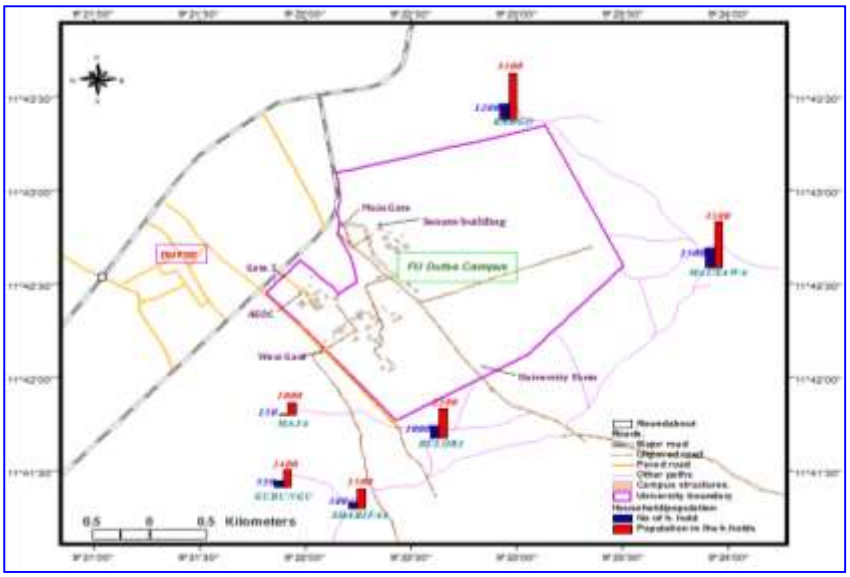

Fig. 2: Projected household number and community population in nearest future.

Pressure on resources around the Federal University Dutse in future could lead to unnecessary agitations and conflicts; which is not good for a learning environment (Justino, 2011; Ujoh, 2014). By implication, the University must take interventions to the displaced communities (Chile and Black, 2015; Rela *et al*., 2020). Since the displaced communities are still located in the immediate surroundings of the University, extension outreaches from the University will be made easy; particularly leveraging on the communal existence in the communities. Village and household heads can be summoned or reached easily with gestures from the University. Most of the villages are of nucleated settlements pattern with crops grown around the enclaves. This is evidence of communal relationship amongst the settlements. An example of this is the bird eye view of Kargo village.

Plate 1: Satellite image of Kargo showing farm plots around the enclave

With regards to proximity to the University, Sharifai the closest village is only about 1,124.88 km and 1,156.50 kilometers from the senate building, while Madobi; the farthest is about 4,310.40kilometers in direct (Euclidean) distance to the senate building. The table 2 below summarizes these proximities.

Table 2: Euclidean distances of villages to the university

S/N	Villages	Euclidean Distance from AEOC (Km)	Euclidean Distance from New Senate building (Km)
1	Kargo	2.64	2.02
2	Hausawa	3.56	2.69
3	Madobi	5.05	4.31
4	Bulori	2.05	1.60
5	Sharifai	1.12	1.16
6	Maja	1.28	1.59
7	Gurungu	1.86	2.15

Characterization of socio-economic attributes

The people of the area are predominantly farmers and in most instances are experiencing crop failure and poor yield due to marginal soils. Thepoor returns from the landis depicted by the photograph below.

Plate 2: Poor crop performance on farms in the area

The displacement of farmers from their original locations has made them to settle for less fertile agricultural lands. Interventions require that farmers are trained on best eco-friendly agronomic practices. Farmers' livelihoods in the area are derived from proceeds from the land.

Geo-ecological characterization

The elevation of the study area ranges from 433 to 478 meters above mean sea level. The relief reveals opportunity for interventions on comparative physical advantages. For example, water logged inland valleys would provide resources for rice cultivation and recessional and irrigated agriculture at onset of dry season (Comptour *et al*., 2018).

The isolines from the contour map shows that the western portion of the study area surrounding Maja, Sherifai and Gurungu communities have a relatively gentle slope, implying its ability to retain much water during the rains; making the area appear waterlogged and possibly good for water loving crops. Other areas may however experience soil erosion and formation of gullies rather than water logging because of the steeper slope and soil nature.

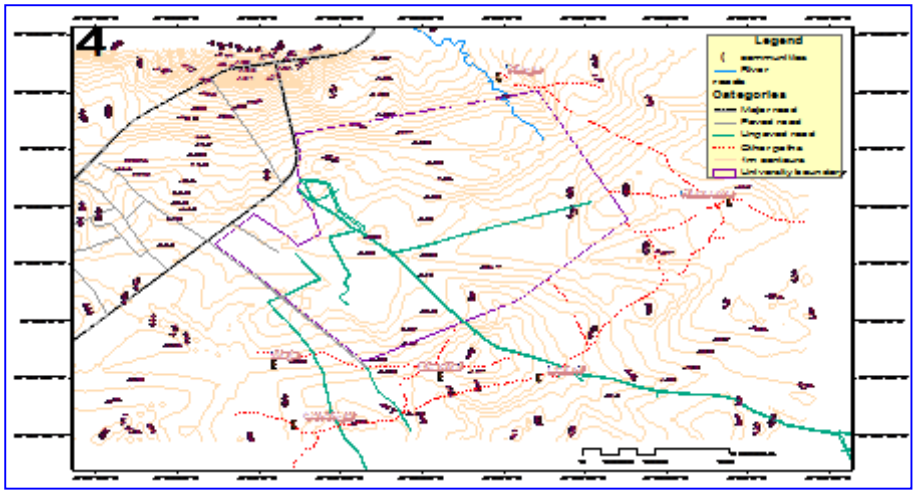

Fig. 3: Contour Map of the study area

Hausawa has the lowest elevation, the central portion of the University lies on the lowest level of 433 meters in the area while Kargo has the highest elevation of 453 meters.Maja is on elevation of 443m while Gurungu, Bulori and Sharifai are on 445 meters. The terrain model in figure 5 below better describes the topography.

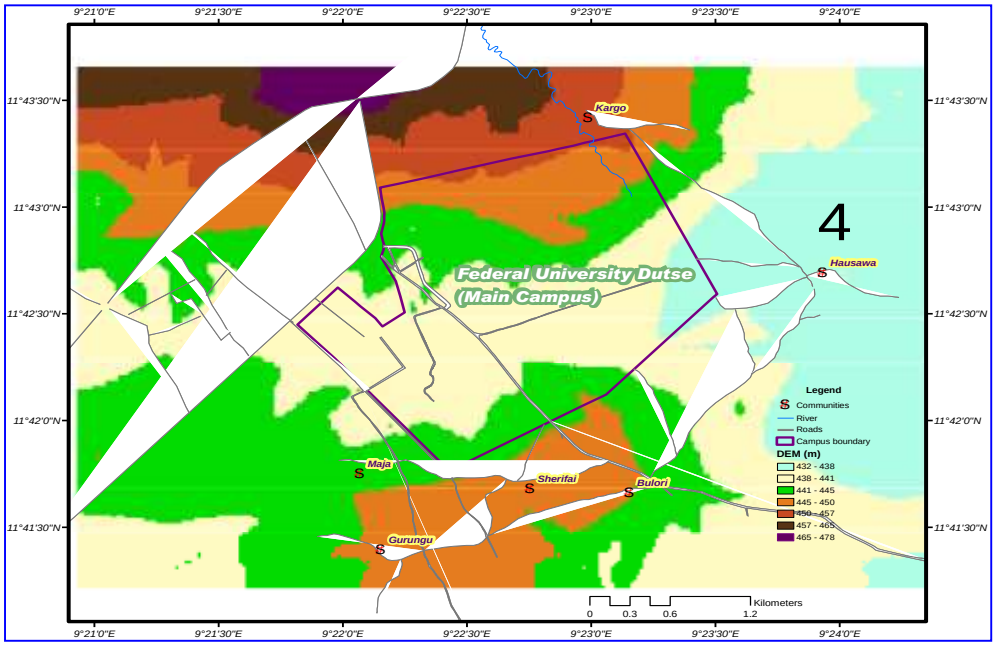

Fig. 4: Digital elevation model of the area

Deprivation of communities from essential facilities

In table 3, the relative availability of infrastructures and facilities in the area are presented. Bulori and Maja communities are without any physical amenities and as such are the poorest of all communities studied. While Bulori and Maja are regarded as the poorest in terms of lack of basic infrastructures, Kargo would be relatively the richest. Interms of targeting of interventions with regards to infrastructures, Bulori and Maja should top the list.

Table 3: Relative availability of infrastructures in the communities

Community	Infrastructural facilities by communities					
	Elementary Schools	Potable water	Electricity	Good road	Health facilities	GSM Mast
Kargo	2	0	0	1	1	0
Hausawa	0	0	0	1	0	0
Bulori	0	0	0	0	0	0
Sharifai	1	1	0	0	0	0
Gurungu	0	5	0	0	0	0
Maja	0	0	0	0	0	0

The comparison on the chart below places Bulori and Maja above other communities on the intervention list.

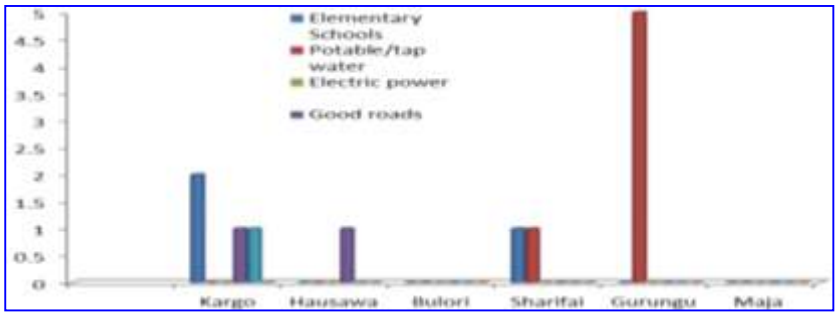

Fig. 5: availability of infrastructures in the communities

Basic amenities

Most people in the area lack access to portable water, electricity, good roads, and even schools. Pipe-borne borehole water and are rare; many have resolve to hand-dug wells. Reader's attention is drawn to the photograph below.

Plate 3: Typical water wells in some communities. (note the well with vehicle tyre on the right)

Access to health facilities

The figure below reveals distance to health care. Women in villages like, Kargo and Hausawa will travel at least 3 kilometers on foot to have access the closest health facility in the University campus.

Community	Population	Distance (Km)
Kargo	3,500	2.52
Hausawa	3,500	3.51
Bulori	2300	2.5
Sharifai	1500	1.92
Maja	1000	1.94
Gurungu	1400	1.28

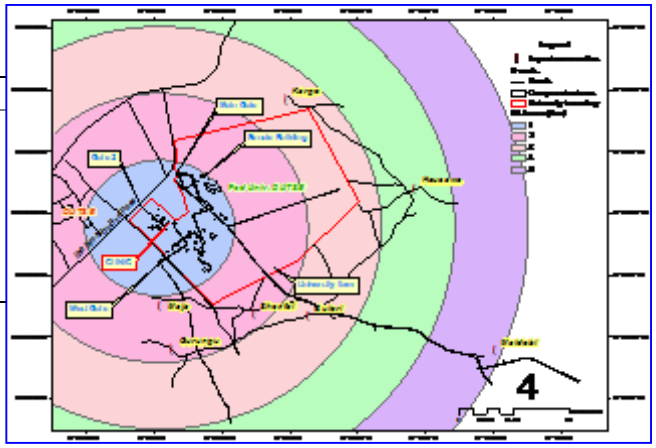

Fig. 6: Distance to health facilities

Access to water

Table 4: Distribution of water sources and types in all communities

Name of community	Hand dug wells	Bore holes	Tap water
Kargo	1	1	0
Hausawa	2	1	0
Bulori	1	0	0
Sharifai	1	0	0
Gurungu	3	2	4
Maja	3	0	0

The above table in spatial perspective portrays access to water points. The distance covered by women and children in the respective villages to fetch water is presented by the Euclidean distance analysis below.

Community	Population	Distance to water e
Kargo	360	< 500m
Hausawa	300	< 500m
Bulori	200	< 500m
Sharifai	800	< 500m
Maja	900	< 500m
Gurungu	159	< 500m

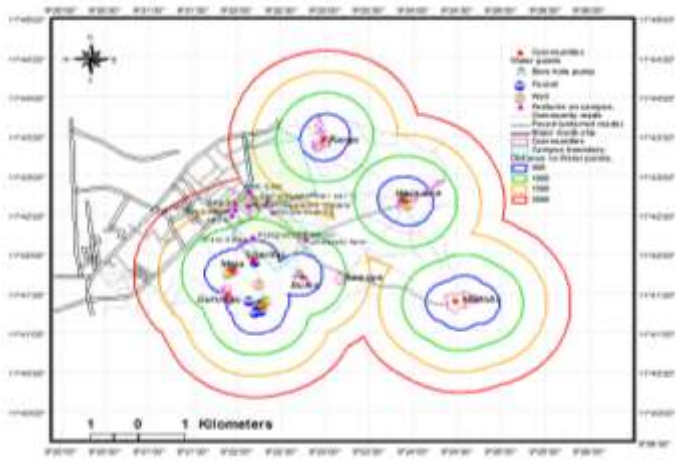

Fig. 7: Minimum distance travelled by people to get water

Almost all communities have hand dug wells as such they travel less than 600 meters to access water. However, communities like Kawaye, Maja, Sherifai, Gurungu, and Kargo may travel 1 to 2 kilometers to access borehole or potable water. Ideally, people should not travel far to have access potable water ((Nygren *et al*., 2016; Anthonj, *et al.*, 2018). The plate below depicts the conditions of faucets fore borehole water in the area.

Plate 4: Only two out of 5 water faucets in Gurungu and Sharifai are functional

Kargo, Hausawa, Sherifai and Bulori have borehole facilities; have borehole water although very few of the water faucets have water running from them as shown in the plate above. Water interventions programme could take-off from rehabilitation of the dry taps by reticulating water from overhead tanks at Bulori to Gurungu, Maja and Kawaye. The boreholes however must be motorized. The figure below depicts the displaced villages and the availability of potable water.

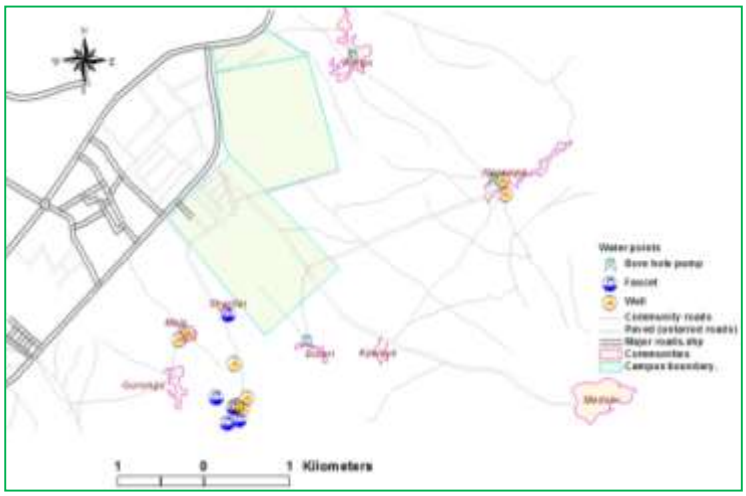

Fig. 8: Map of water facilities and the respective communities

Intervention needs and targeting amongst communities

Robinson (2003) noted that, while victims of displacement by natural or man-made disasters have always received sympathetic attention and become the general focus of international aids. This however has not been true for victims of development-induced displacement. The consequences of project induced displacement may even be comparably ominous. For several people around the world displacement as a result of development projects has been costly with respect to their homes, livelihoods, health, and even lives. The deprivation of the people from basic needs such as water, health, food, education and good roads must be reduced by special intervention project. This is an important way the people will feel the positive impact of the University. The study has highlighted the intervention needs of the communities to include potable water (motorized borehole), Clinics and health facilities, Fertilizers and alternative soil renewal, Good roads (grading of roads) and Schools outreach programmes. Facilities like Banks, Police station could also be attracted to the area by the University

Further study could be carried out on the intervention needs of the project-affected people by the extension and economics department of the University. Efforts could also be directed at seeking research grants that will bring impact oriented projects sponsored by agencies like International Fund for Agricultural Development (IFAD), United Nations Development Project (UNDP), and Global Environmental Facility (GEF) and so on to the people. Federal University, Dutse could set up an agricultural market outlet on the University D farm which would be opened to the communities around.

CONCLUSION

The United Nation Millennium or Sustainable Development Goals clearly specifies eradication of hunger, poverty and illiteracy as either in the medium or short term goals. Geographical targeting of interventions amongst rural communities of Africa should be done to agree with these goals. It is however, important to note that development of a robust spatial decision support system is required, for effectively directing viable interventions among competing communities. Mapping portrays the distribution and relative magnitude of social problems, while developing Geographic information systems (GIS) creates entity relationship which will spatially guide decision making.

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