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IDENTIFICATION AND MAPPING OF FADAMA RESOURCES EXPOSED TO PASTORALIST-FARMER CONFLICTS IN NAFADA TOWN, GOMBE STATE, NIGERIA

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ABSTRACT

Identification and mapping of Fadama resources exposed to pastoralist-farmer conflicts over the resources was undertaken. The availability of fresh grass (pasture), abundance of water and fertile soil in Fadama attract both the pastoralists and farmers. Competition for access and use of Fadama resources has been causing conflicts between farmers and pastoralists. The aim of the study was to undertake a geospatial analysis of Fadama resources that are exposed to farmers-pastoralists conflicts in the Nafada Local Government Area. A total of three villages were selected purposively. The spatial factors considered are Fadama farmlands, pasturelands, grazing reserves, cattle routes and water bodies, the target respondents for the work are pastoralists and farmers groups. Convenience sampling techniques were used to administer 162 questionnaires. Field Measurement, Observation and RS were also used in obtaining data. The data were analysed using overlay and descriptive statistics respectively. The findings indicate that the two small grazing reserves and water points may not be enough to accommodate the cattle population, and the stock routes do not connect to the grazing reserves. Almost 50% of the participants acknowledged the involvement of traditional rules in conflict management and identified verbal warning as the method of conflict resolution. The research concluded that there is a high likelihood that the pastoralists will encroach into Fadama farmlands for pasture, which may subsequently lead to further conflict in the study area. It was recommended that about 20-30 % of Fadama land should be set separately for grazing.

Keywords: *GIS and Remote Sensing, Natural Resource Mapping, Pastoralist-farmer Conflict, Resource Management Strategies and Nafada Fadama.*

INTRODUCTION

Fadama is waterlogged land that retains seasonal moisture, usually low-lying flood plains, having accessible shallow groundwater places (Umar, 2019). The land comprises different resources such as land, water, pasture, grazing reserves and stock routes. The available moisture makes Fadama abundant in pasture and suitable for dry and wet season farming, usually done either with rain-fed or irrigation along rivers (water bodies) (Jerome, 2017). In order to prevent conflicts between farmers and pastoralists, grazing reserves in Fadama

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are preserved for pastoral communities to use provided stock routes to feed their livestock (Gwary, Galadima, Mustapha, and Mai-Jir, 2018).

Fresh grass is available and found during both dry and wet seasons in Fadama areas (Christopher, 2018). Pastoralists visit those places to feed and water their livestock, along the way they experience blockage of cattle route (Burtali) or encroached grazing reserves by farmlands with no option for the stocks to enter into the farmland and sometimes due to a large amount of stock the pastoralist cannot control or stop the stock on feeding with what was planted in the farm which results in conflict (Suleiman, Ja'afar-Furo, Nasiru, Haruna and Ochi, 2016). According to Blench and Hassan (2003) and Blench (2004), most clashes in wetlands escalate when farmers deny animals access to water and pasture. Also, another aspect identified as a major cause of conflict captured by Jerome (2017) in his work, is the refusal of farmers to allow spaces for returning pastoralists.

The competition for Fadama resources between farmers and pastoralists in various parts of the world has normally generated a clash of interests which has continuously resulted in conflicts (Oli, Ibekwe and Nwankwo, 2018). In Kenya, for instance, clashes between farmers and herders resulted in property destruction and fatalities. Pastoralists claim that the cattle routes are blocked, preventing safe passage for cattle to watering points and dry-season grazing (Jerome, 2017; Umar, 2019). Due to lack of secured access, pastoralists are compelled to move to alternative lands which are in most cases the farmlands, which results in conflicts (Olaniyan, 2015).

In Nigeria, there are conflicts between pastoralists and farmers. For example, in Gayam Fadama, a section was excised for the grazing reserve and this portion of the grazing reserve was said to be a grazing resource in the dry season but with the development and expansion of the Fadama area into a grazing reserve, grazing animals stray into field crops causing crop damage which results in conflicts (Bello, 2020).

Farming and cattle rearing are communities' livelihood activities in Nafada town (Roger and Malam, 2005). Both farmers and pastoralists use Fadama resources for their economic development. The farmers usually plant along the river floodplain using shallow wells and boreholes for irrigation. At the same time, the visiting or indigenous pastoralists who visit the Nafada River or grazing reserves along their way with large cattle encroach or deviate into farmlands in search of pasture and water which always causes conflicts (Roger and Malam, 2005; Christopher, 2018).

Given the fact that Fadama resources are essential factors for pastoralists' and farmers' lives, as well as the need to preserve this resource and control resource conflict, there is a need for an organized system with the ability to perform spatial analyses and monitor the situation on the ground (Tešić, 2022).

Geospatial technology has played a vital role in the field of resource conflict management (Usman, 2014). Remote sensing and GIS have been used in vulnerability studies and proved to be useful tools for examining spatial conflict zones (Christina, Canute and Aisia, 2012) by either mapping resource conflict hotspots or mapping vulnerability zones. Conflict zone maps are used by the decision makers as guides during the planning of conflict resource management to avoid future conflict occurrence.

Babagana, et al., (2019) stated that conflict management was to remove the causes of the dispute and reconcile the two groups in such a way as to recover the social structure of society to its original state. Research conducted by Tuner, et al. (2017) on farmer-herder relations and conflict management in the agro-pastoral zone of Niamey Niger, stated that the ability of rural communities to prevent and manage resource conflict is largely based on the strength of the network of communication between rearing and farming interests and respect for the community leaders.

Centre for Peace, Diplomatic and Development Studies (CPDDS), University of Maiduguri (2012) researched resources conflict management mechanisms in Nigeria. The findings identified several conflict management institutions and mediation processes including various sections of the government, traditional and religious institutions, and non-governmental or civil society organizations. Abdurrahman, Ibrahim, and Umar (2017) stated that good governance, grassroots community-based activities, confrontation, negotiation, collaborations, mediation, adjudication, reconciliation, arbitration, and pastoralist to sedentary life, are all forms of conflict management strategies in Nigeria for alternative dispute resolution.

This project intended to use spatial technology to map Fadama resources exposed to pastoralist-farmer conflict and also provides strategies for conflict management.

MATERIALS AND METHODS

The Study Area

The study area is Nafada town Fadama area which lies between latitudes 11° 2' N to 11° 9' N and longitude 11° 16' E to 11° 24' E (Figure: 1). It has an average altitude of 306 m. It borders Fika LGA to the North, Yobe State, Dukku LGA Gombe State to the West, Funakaye LGA to the South and Gulani LGA Yobe State to the East (Ibrahim and Umar, 2020).

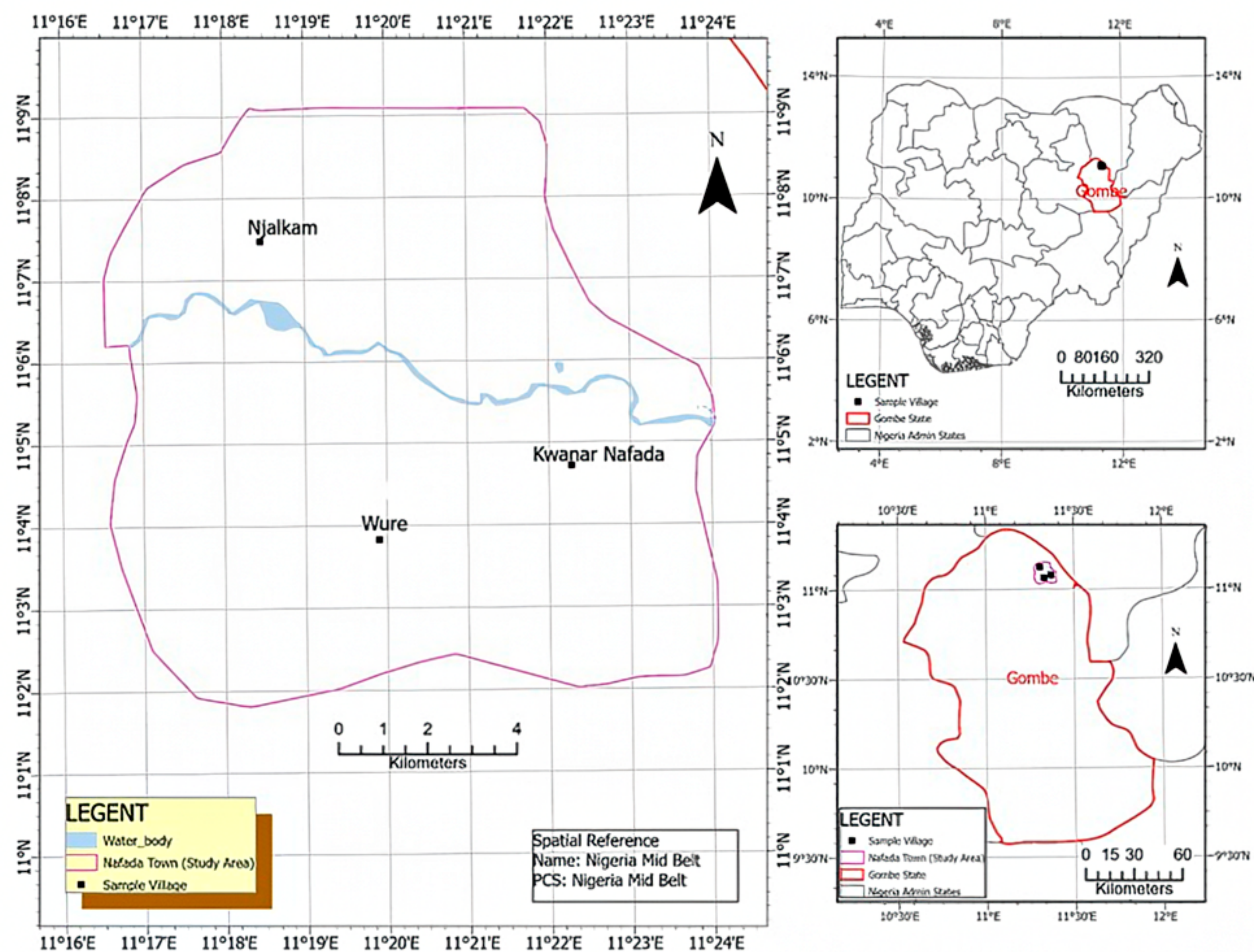


Figure 1. Maps of the Study Area

Source: DIVA-GIS, FUK GIS Lab and Gombe State Land and Physical Planning

The town average rainfall varies from 760 mm to 1000 mm annually, with the highest rainfall recorded during July and August. The rainy season lasts for three to four months (from June to September). Temperatures are high throughout the year, averaging from 25 °C to 28 °C (77°F to 82 °F) (Muhammad and Idris, 2016).

The hot, dry and dusty air that emanates from the Sahara is nowadays affecting the fertility of Fadama farmland, and pastureland productivity reducing the size and number of available drainages and rivers which both pastoralists and farmers use for their livelihood. The remaining resources have been shared by both pastoralists and farmers within the area, and joint utilisation of the resources usually causes a clash of interests which may result in conflicts (Umar, 2019).

The geology of Nafada town is largely classified as cretaceous sedimentary sandstone of the Bima formation. Other formations are made up of Fika shale that comprises blue-black gypsiferous with a thin limestone bed. There are granitic intrusions of the basement complex exposed at the surface (Isa, 2018). The relief is relatively flat land with streams that run from west to east (the River Nafada). Moreover, the upper part of Nafada landforms is developed in weakly consolidated sandy sediment of tertiary kerikeri formation. The villages

are sloppy consisting of cretaceous formation clay, where abundant pasture and Fadama farmlands are found (Mbaya, Abu, Makadi and Umar, 2019).

The relief and landform of Nafada have played a great role in shaping the River Nafada and the clayey soil present along its banks. This soil is grey in colour, rich in organic content and possesses significant water retention capacity as it goes through wet and dry periods. The river and soil zones enable the farmers to cultivate throughout the year, the soil is characterized by abundant pasture conditions with vegetative cover used by pastoralists for grazing (Jerome, 2017).

The River Nafada is a tributary to the River Gangola and a prominent hydrological feature in the study area. The upper course of the river as well as most of its tributaries are seasonal streams which fill rapidly in August and September. The river zone is used for farming, livestock rearing and fishing (Abdullahi, 2017).

The farmers utilise the Fadama riverbank zone to cultivate food crops, while the pastoralists bring their cattle to the water zones for grazing and watering purposes (Shehu, 2017).

The vegetation in Nafada town is described as a typical Guinea Savanna. As a result of topographic changes, rainfall patterns and edaphic factors, some distinct vegetation types are found within the study area. For instance: *Andropogon tectorum* in deep soil, *Monocymbium cerasiiforme* is frequent in poorer soils. Weeds such as *Hyperrhenia involucrata*, *Rottboellia exultata*, *Pennisetum subanquatum* and *Sporobolus pyramedialis* are often present in more disturbed areas in Fadama (Jerome, 2017). The major shrubs which pastoralists used for grazing recognized within the eastern Guinea Savanna vegetation zone, particularly in the Fadama area are: *Piliostigma thonningii*, *Annona senegalensis*, *Gardenia tenifolia* and various small leaved legumes of *Cassia* and *Acacia* species (Isa, 2018).

The common tree species include *Moringa Oleifera* (Zogale), *Tamarindus indica* (Tsamiya), *Acacia Albida* (Gawo), *Acacia senegalancies* (Dakwara), *cambratum species* and *shear butter* (Kadanya), *Vitex Doniana* (Dinya), *Balanites aegyptiaca* (Aduwa), *Hyphene the baica* (Kaba), *Piliostigma thonningii* (Kalgo), *Khaya Segalensis* (Madaci), *Borrasmus aethiopum* (Giginya), *Anilotica* (Bagaruwa), *Diospyros mespiliformis* (kanya), *Leiocarpus* (mark), *Ziziphus spina-chrisli* (Kurna), *Guiera Senegalenses* (Sabara) *silk cotton tree* (Rimi), *Adansonia digitata* (Kuka), and *Pekia bigloboza* (Dorawa) among others (Muhammad, Wali, Modibbo, 2016).

The dominant tribes of the Nafada community are Fulani and Hausa alongside other diverse tribes including Ganawa, Bolawa, Tera, Tangale and Waja (Muhammad, Wali, and Modibbo, 2016). According to the projected National population census in 2019, the population of Nafada town is estimated to be about 8,819 people. The main economic activities in the villages revolve around livestock rearing and agriculture, with Fadama cultivation serving as the primary source of livelihood for the communities. Some pastoralists are also involved in both farming and rearing, cultivating various types of crops such as maize, beans, soybeans, guinea corn, rice, millet and sorghum cultivated in the Fadama area (Adama, 2018). The settlement pattern in Nafada is a nucleated form with some dispersal mostly where pastoralists are found. Most of the pastoralist and farmer settlements are close to the River Nafada where the vast Fadama land and pastures are found. Pastoralists visit these areas for livestock rearing and watering. However, due to large numbers of cattle and the absence of a designated stock route, the cattle often stray into Fadama farmlands, thus resulting in disputes and sometimes conflict between the pastoralists and the farmers (Ibrahim and Umar, 2020).

Methods of Data Collection

Identification and Mapping of Fadama Resources

In order to map the conflict vulnerability zones, the following set of data comprising the Fadama Farmlands map, Vegetation (Pasture lands) map, and Water bodies (River, Pond and dams) map was utilised. These datasets were processed using LANDSAT 8 imagery captured on the 4th February, 2021 with a 30m spatial resolution obtained from Earth Explorer USGS. Then the stock route was represented in a line data shapefile and the historical farmers-pastoralists conflict hotspots were represented in a point data shapefile. The coordinates data for both the stock route and conflict hotspots were collected in the field. Grazing reserve data, in shape-

file data format, was collected from GIS Lab FUK, and sourced from the Nigerian Forestry Management Evaluation and Coordinating Unit (FORMECU). The Gombe State Village town map (in paper form) was collected from the Gombe State Land and Physical Planning Department.

Strategies for Management of Pastoralists and Farmers Conflicts

In addressing strategies for the management of Fadama resources conflicts, perception data was collected by administering one hundred and sixty-two (162) questionnaires to pastoralist and farmer groups.

Population and Sampling Procedure

The procedure for the determination of population and sampling in the research are presented in the following sections.

Sampling of Study Villages

Nafada town consists of 11 villages out of which three (Njalkam, Wure and Kwanar Nafada) were selected purposively due to their proximity, closeness and utilisation of the Nafada River and Fadama land (Figure 2). The selected villages are both farmer and pastoralist communities.

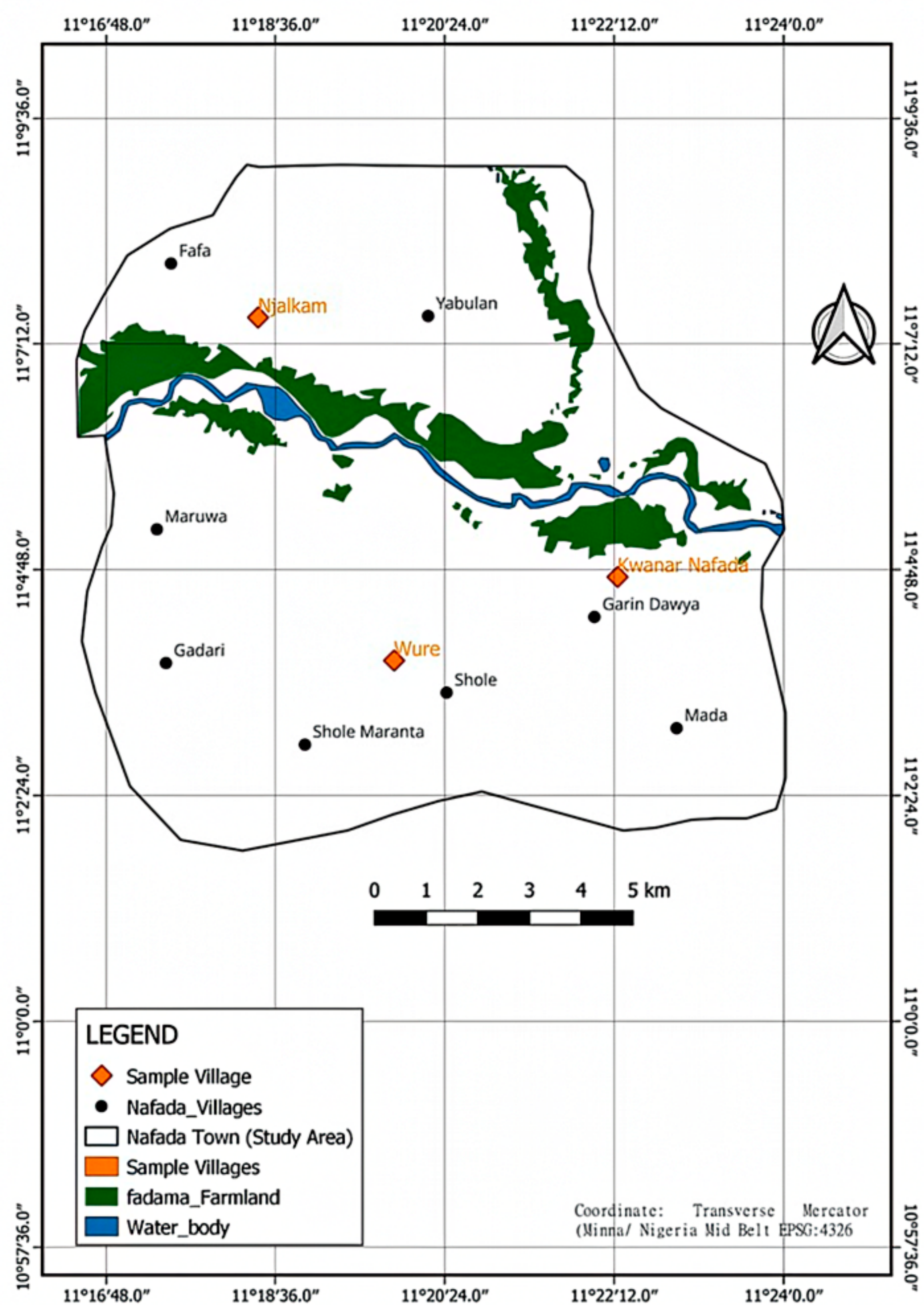


Figure 2. Selected Villages

Source: Authors' research

Population of Respondents and Sample Size

According to the heads of villages, the population of the villages are as follows; Kwanar Nafada (245), Wure (267) and Njalkam (302) (Table 1). Based on the fact that the population is small proportioned sampling techniques were used, where 20% of the population of each community was selected. This gives Kwanar Nafada (49), Wure (53) and Njalkam (60) participants, which is in line with Hagget et al. (1977) and Arlosoroff et al. (1987) in Rilwanu, (2014).

Table 1. Population of Respondents and Sample Size

Villages Selected	Population of Villages	Population Sample Size (20%)
Njalkam	302	60
Wure	267	53
Kwanar Nafada	245	49
Total	814	162

Source. Authors' research

Sampling of Respondents

The target respondents for this research work are the pastoralist and farmer groups. Convenience sampling techniques were used in the selection of available pastoralist and farmer group members. Structured questionnaires were administered to 30 pastoralists and 31 farmers in Njalkam, 26 pastoralists and 27 farmers in Wure and 24 pastoralists and 24 farmers in Kawanar Nafada making a total sample of 162 participants from all villages (Table 2).

Table 2. Sampling of Respondents

Villages Selected	Sample Size (20%)	Pastoralists	Farmers
Njalkam	60	30	31
Wure	53	26	27
Kwanar Nafada	49	24	24
Total	162	80	82

Source. Authors' research

Procedure for Data Collection

The research techniques for data collection are presented below.

Field Measurement

The stock route shapefile was obtained by tracking the cattle route using a handheld GARMIN GPS_{MAP 78S}, line geometry was selected, number and name were given to each route reading collected (adopted from Mohammed, 2017).

Procedure for Acquiring RS Image

LANDSAT 8 imagery with 30m spatial resolution was downloaded from Earth Explorer USGS with Path and Row (052-186) and 30% cloud cover. The acquired image date is the 4th February, 2021 because at that time Fadama area was in the dry season. During this time the healthy greenness of vegetation was prominently visible along with pastures and grass in other areas. Bands 1 to 7 of the image as well as the metadata file were downloaded.

The Land use / Land cover (LULC) maps of 1995 produced by the Nigerian Forestry Management Evaluation and Coordinating Unit (FORMECU) were obtained in a shapefile format. The data, including grazing reserve information, was collected from GIS Lab FUK using a flash drive. The data used a combination of Landsat multispectral, SPOT multispectral, JERS-1 Radar, and ERS-1 Radar data. Gombe State town and villages map shape-file were collected from the Gombe State land and physical planning Unit using a flash drive.

In obtaining Fadama resources thematic maps, LANDSAT 8 images were classified by employing the Normalized Difference Vegetation Index (NDVI) and supervised classification techniques. The following land use and land cover (LULC) classes were derived for Fadama Farmlands, Pasturelands, Water bodies and Settlement using QGIS 3.16.5. The spatial lite database was developed with the same coordinate system as the Landsat image. The raster images were converted to vectors to obtain vector thematic layers of feature data classes in the geo-database of the following; Fadama Farmlands, Pasturelands, Water bodies and Settlement vector layers. The stock route in vector format was also imported from the GPS into the QGIS 3.16.5 spatial-lite-database as adopted from Christina, et al., (2012). The study area boundary, Nafada town, was copied from the Gombe town shapefile, and the boundary was overlaid on FORMECU LULC vector datasets using Boolean operation (cliff) to obtain the study area grazing reserve. Six vector thematic maps were organized as follows: Fadama Farmlands vector layer, Pasturelands vector layer, Water bodies vector layer, Settlement vector layer, Stock route vector layer and Grazing reserve vector layer.

In examining the resources vulnerability map, stock route, grazing reserve, Fadama farmland and water body vector layers were overlaid with villages.

Questionnaire Administration

A questionnaire was administered with the assistance of three research assistants, one from each village. Strategies on how pastoralists and farmers manage conflicts over Fadama resources in the area were obtained by distributing 162 structured questionnaires to the respondents. A total of 160 questionnaires were retrieved while 2 questionnaires were missing.

Methods of Data Analysis

LANDSAT 8, visible and near-infrared bands were classified using the Normalized Difference Vegetation Index (NDVI) to clearly obtain Fadama farmlands and vegetation (Pastureland), the classification was done using this formula (i) as adopted from Mustapha, (2019).

$$NDVI = (NIR-R) / (NIR+R) \quad (i)$$

Where:

- NIR = Band 5
- R = Band 4

Then the NDVI was reclassified using Maximum likelihood Supervised Classification to obtain water bodies, settlements, Fadama farmlands and vegetation (Pasturelands) using the following formula (ii) as adopted from Isa, (2018).

$$g_i(x) = \frac{1n \cdot p(\omega_i) - \frac{1}{2}1n \left| \sum_j i \right| - \frac{1}{2}}{(x - m_i) \tau \cdot \sum_i^{-1} (x - m_i)} \quad (ii)$$

Where:

- i = class of each feature

- $x = n$ -dimensional data (where n is the number of bands)
- $p(\omega_i)$ = probability that class ω_i occurs in the image and is assumed the same for all classes
- $|\Sigma_i|$ = determinant of the covariance matrix of the data in class ω_i
- Σ_i^{-1} = its inverse matrix
- m_i = mean vector

Boolean operation was used to clip the grazing reserve map and stock route maps of the study area which are in vector in QGIS 3.16.5. The classified image was converted from a raster to a vector data model using a conversion tool in QGIS 3.16.5 to generate vector thematic maps of the following: Fadama farmland, vegetation (pastureland), water body, and settlement making a total of six vector-shape files.

The statistical measurement of the total area and length of the vector-shape files were calculated in kilometres, using geometry values by the use of a field calculator in QGIS 3.16.6. The following factors: Fadama Farmlands, Pastures land, Water bodies, and Grazing reserve area were calculated. The formula (iii) below was used in the field calculator to calculate area and convert it from metres to square kilometres as adopted from Ben (2017).

$$TA = \frac{\text{Geometry field (@Area)}}{1000000} \quad (\text{iii})$$

Where:

- TA = Total Area in Km^2
- @Area = Geometry field in Sq meters (default field)

The length of the river was measured using measurement tools sets in QGIS 3.16.6., kilometres were selected as the unit of the measurement, adopted from Ben (2017).

Percentage (%) for each factor total area was calculated. Using the following formula (iv), adopted from Musa (2020).

$$AP = \frac{FAS}{FTA} \cdot 100 \quad (\text{iv})$$

Where:

- AP = Area Percentage
- FTA = Factors total area size
- FAS = Factor area size

Strategies for Management of Pastoralists and Farmers Conflicts

For analysing the response data on ways farmers and pastoralists manage conflicts, the raw data was entered into Microsoft Excel and the result was transferred to SPSS 21 software packages. Descriptive statistics was used to analyse the perceptions data, specifically frequency counts and percentages were used and presented in tables. The percentage formula (v) below was used, as adopted from Musa (2020).

$$CRSP = \frac{NPF}{TNPF} \cdot 100 \quad (\text{v})$$

Where:

- $CRSP$ = Conflict Resolution Strategies Percentage

- *NPF* = Number of Pastoralists/ Farmers (Resolution Strategies)
- *TNPF* = Total Number of Pastoralists/ Farmers (Resolution Strategies)

RESULTS AND DISCUSSION

IDENTIFICATION AND MAPPING OF FADAMA LAND AND WATER ZONES

The land use and land cover (LULC) map provides the distribution and spatial pattern of different classes of LULC in the study area. The finding is similar to the work of Ostojić, Fekete and Mesaroš (2019) in the Analysis of Land Cover Changes in Bačka. Figure 3 shows the land use and land cover map of the following: Fadama farmlands, Pasture lands, Water bodies, Grazing reserves and Cattle routes. The map shows that the major water body is the River Nafada having a total length of 15,929 km and an area of 2,163 km² (Table 3) flowing from South-West towards North-East as shown in Figure 3. The LULC result further revealed that the pastures spread within the study area (Figure 3). The finding is similar to the work of Ibrahim and Umar, (2020) in the analysis of LULC change in Gombe State.

Table 3. Showing Fadama Resources Land Area and Length Size

S/N	Fadama Resources	Area (km ²)	Percentage (%)	Length (km)
1	Waterbody	2,163	3	15,929
2	Fadama lands	13,212	18	-
3	Grazing Reserve	1,185	2	-
4	Pasture land	56,355	77	-
5	Stock Route	-	-	33,906
	Total	72,915	100	

Source: Authors' research

Figure 3 shows that vast Fadama farmlands are close to the Nafada River, covering a total land area of 13,212 km² (18%) (Table 3) where agricultural activities are common. This finding conforms with the work of Ibrahim and Umar (2020) in the analysis of LULC change in Gombe State, who found the spatial pattern, distribution and size of different classes of LULC.

The results also show that there are only two grazing reserves located at the extreme north and southern part of the study area (Figure 3). The total size of the reserves is 1,185km² (2%) (Table 3) which is a relatively small size of the grazing reserves compared to the vast Fadama land areas stretching over 13,212km² (18%) (Table 3 and Figure 3). There is a high likelihood that the pastoralists will encroach into Fadama farmlands for pasture and this may subsequently lead to a conflict. The research finding is in agreement with the work of Gwary, Galadima, Mustapha, and Mai-Jir (2018) who explained that the lack of enough grazing reserves is one of the reasons why pastoralists encroach into farmland which always results in conflicts. Jerome (2017) stated in his work *Assessment of Conflict in Resource Use: Experience from an Irrigation Project* that encroachment of farmland by pastoralists is a result of a lack of adequate grazing reserves.

The results also show that pastureland covers the largest land area 56,355 km² (77%) (Table 3), after all, the pasture is more abundant in the Fadama area, which may attract more pastoralists to Fadama farmland. This finding conforms with the work of Blench and Hassan, (2003) on Fadama user conflicts in Taraba, Borno, Gombe and Bauchi State. The results reveal that the stock route has a total length of 33,906 km (Table 3). The route does not connect to the grazing reserves (Figure 3). Hence, the pastoralists use any available bare land, including pastureland and Fadama farmland, to move to grazing reserves and water points. However, this may probably lead to encroachment into Fadama farmlands and may lead to a conflict. This finding is not in line with Abdul's finding (2015) which describes that stock routes are provided to connect to the grazing

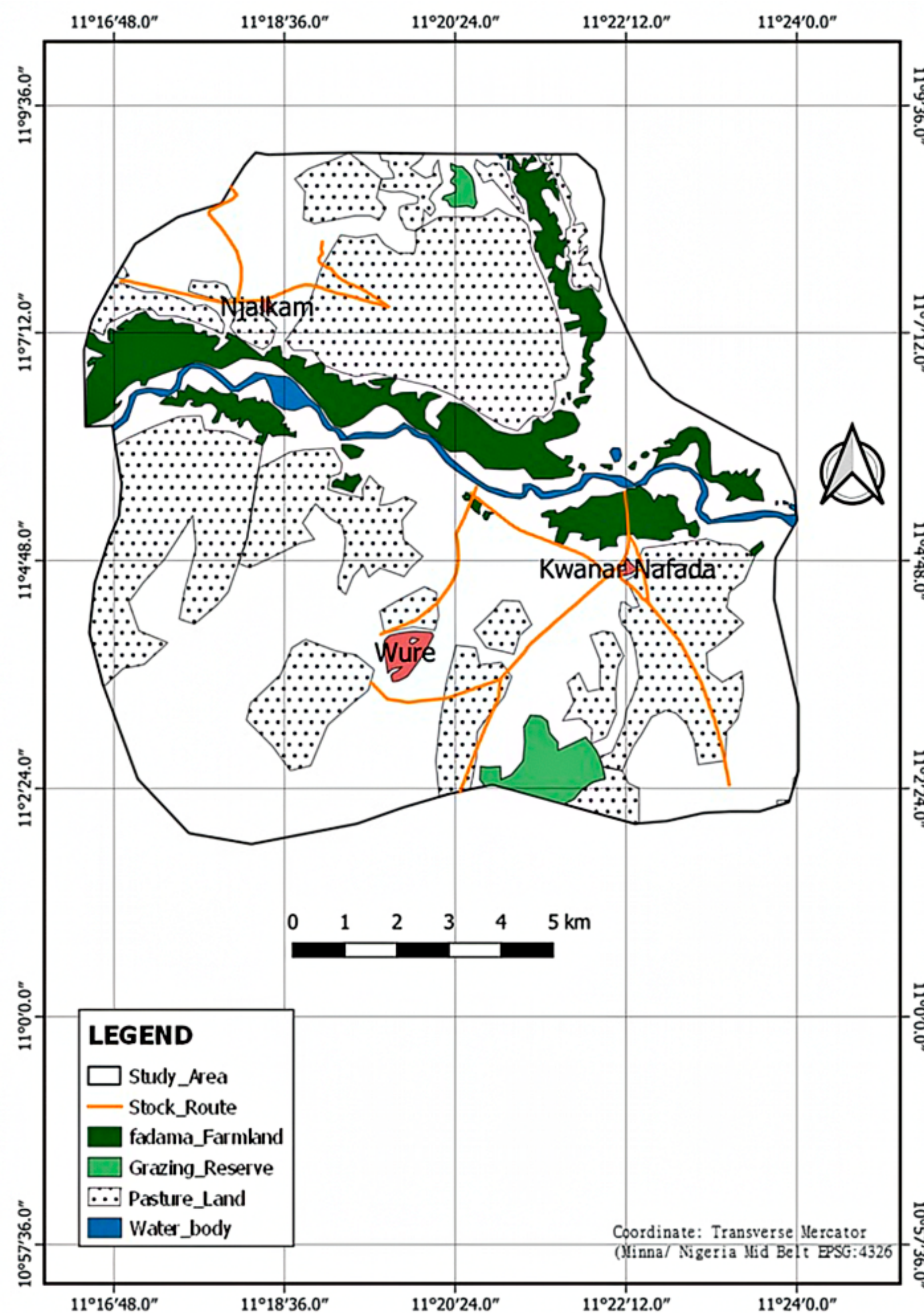


Figure 3. Overlaid of Spatial Factors Responsible to Herders-Farmers Conflict

Source: Authors' research

reserves. It may be concluded that disconnection of stock routes to grazing reserves results in cattle encroachments into farms which usually results in conflict between pastoralists and farmers.

STRATEGIES FOR MANAGEMENT OF PASTORALIST-FARMER CONFLICTS

The findings presented in Table 3 show that the majority of respondents from all the villages surveyed believe that traditional rulers are the institutions most involved in the management of pastoralist-farmer conflicts. For instance, Njalkam pastoralists (50%) and farmers (33%), Wure pastoralists (50%) and farmers (38%), Kwanar Nafada pastoralists (33%) and farmers (38%) identified traditional rulers as the most involved institution in handling these conflicts. This may be the result of the closeness between the masses and the traditional rulers. These findings align with Kawu's research (2018), which identified traditional rulers as more involved in managing resource conflicts.

Table 3 further revealed that courts are the least utilised institution in managing Fadama resources conflicts, with Njalkam pastoralists (0%) and farmers (3%), Wure, pastoralists (0%) and farmers (0%), Kwanar Nafada pastoralists (0%) and farmers (0%) reporting their involvement. Courts are considered as being inef-

fective in the way they manage conflicts. This result is in concordance with Abdu's research (2015) where he found out that police and courts involvement in conflict management is negligible.

Traditional rulers (villages' heads) are the major institutions that are the most successful in managing the conflict, probably this may be attributed to the fact that people live and respect their customs, traditions and leaders.

The respondents explained that:

"Farmer's Response: The Heads of the community are fathers to us; we respect them and follow them because they teach us the right way to follow".

"Farmer's Response: No, we do what our village head directed us".

"Pastoralist's Response: Even if the decision was not in your favour you have no option than to obey".

According to all the pastoralists and farmers, court involvement in conflict management seems to be minimal and considered as unsuccessful as indicated in Table 3. This may be attributed to the literacy level of the community in those institutions and probably because pastoralists and farmers have the perception that there may be injustice when managing the conflicts.

Some despondence said:

"Farmer's Response: There are no secondary schools here, this is the only primary school we have".

"Pastoralist's Response: I only went to Arabic school".

"Pastoralist's Response: We spend all our lives in a forest, only a few of us have the opportunity to go to Arabic school".

This result is not consistent with the findings by Isa (2018) who identified courts as the second to the last in the effectiveness of resources conflict management in Billiri Gombe State.

Table 3. Distribution of Institutions Involved in Managing and Resolving Pastoralist-farmer Conflicts

Institutions	Njalkam				Wure				Kwanar Nafada			
	Pastoralists		Farmers		Pastoralists		Farmers		Pastoralists		Farmers	
	F	%	F	%	F	%	F	%	F	%	F	%
Police	1	3	3	10	0	0	1	4	1	4	2	8
Courts	0	0	1	3	0	0	0	0	0	0	1	4
Traditional Rulers	15	50	10	33	13	50	10	38	8	33	9	38
Local Government Committee	2	7	3	10	0	0	1	4	2	8	1	4
Crop Farmers Association	3	10	8	27	4	15	6	23	4	17	6	25
Cattle Breeders Association	9	30	5	17	9	35	8	31	9	38	5	21
Other	0	0	0	0	0	0	0	0	0	0	0	0
Total	30	100	30	100	26	100	26	100	24	100	24	100

Source: Field Survey

The respondents identified strategies for managing pastoralist-farmer conflict within the villages. The results from Table 4 show the different methods of conflict resolution employed in managing and resolving the pastoralist-farmer conflict in the study area. Almost 50% of the population from both pastoralist and farmer groups in all the villages identified verbal warning as the most used method of conflict resolution within their area; Njalkam pastoralists (50%) and farmers (47%), Wure, pastoralists (38%) and farmers (46%), Kwanar Nafada (46%) and farmers (50%) respectively. This result is contrary to the findings of Sulaiman, Muhammad, and Agwu, (2018).

According to some respondents:

“Pastoralist’s Response: If any misunderstanding happened between us and farmers, the village head would call us and give us advice and tell us not to repeat the mistake”.

“Farmer’s Response: Even if they destroy our farmland they don’t have to pay anything, Sarki used to warn them not to repeat it”.

“Pastoralist’s Response: Sometimes we are both called to Sarki’s house to be warned and advised”.

“Pastoralist’s Response: Actually, if it’s not our fault, we are warned, while sometimes, if the damage was higher we used to pay some money for the damage”.

Table 4 further indicated that amicable resolution was the next method used, covering one-fourth of the respondent’s population, Njalkam pastoralists (23%) and farmers (26%), Wure pastoralists (27%) and farmers (35%), Kwanar Nafada pastoralists (33%) and farmers (25%) respectively. Payment of compensation was the second to the last method agreed upon by the pastoralists from all the villages (Wure 31%, Njalkam 23% and Kwanar Nafada 21%), and also some farmers from all the villages (Njalkam 17%, Wure 15% and Kwanar Nafada 12.5%). Table 4 also revealed that the reallocation of new plots was the strategy the least used in resolving pastoralist-farmers conflict. This result is similar to the findings of Moore, (2019).

The results show that verbal warning is the most employed resolution method in managing and resolving the pastoralists-farmer resource conflicts in the study area. The result acquired is attributed to the role played by the traditional institutions in managing pastoralist-farmer conflict, as referred to in Table 8.

Table 8. Distribution of Respondents by Ways Conflicts is Commonly Resolved and Managed

Method of Resolution	Njalkam				Wure				Kwanar Nafada			
	Pastoralists		Farmers		Pastoralists		Farmers		Pastoralists		Farmers	
	F	%	F	%	F	%	F	%	F	%	F	%
Verbal warning	16	54	14	47	10	38	12	46	11	46	12	50
Amicable resolution	7	23	8	26	7	27	9	35	8	33	6	25
Payment of compensation	7	23	5	17	8	31	4	15	5	21	3	12.5
Re-allocation of new plot	0	0	3	10	1	4	1	4	0	0	3	12.5
Others	0	0	0	0	0	0	0	0	0	0	0	0
Total	30	100	30	100	26	100	26	100	24	100	24	100

Source: Field Survey, (2021)

CONCLUSION

Since abundant fresh grass (pasture) is available and found during both dry and wet seasons in Fadama, coupled with the richness of water and fertile soil in the area it attracts both pastoralists and farmers. However, the competition on the use of Fadama land and water has been generating a clash of interest between the farmers and pastoralists which has continuously caused conflicts.

Therefore, this study found that the major water body of the study area is the River Nafada, surrounded by vast Fadama farmlands. The results also revealed that there are two grazing reserves located at the extreme north and south parts of the study area. The research findings discovered that pastureland covers the largest land area and is denser close to the Fadama area. However, the study revealed that the stock routes are not connected to the grazing reserves.

The results of the analysis also indicate that the majority of the respondents acknowledged the involvement of traditional rulers in conflict management within the study area. Furthermore, almost half of the pop-

ulation from both pastoralist and farmer groups identified verbal warning as the method of conflict resolution within their area.

The findings revealed that the two small grazing reserves and water points may not be enough to accommodate the cattle population, and the stock routes do not connect to the grazing reserves. Based on that, it was concluded that there is a high likelihood of pastoralists encroaching into Fadama farmlands for pasture and this may subsequently lead to further conflicts.

It was established that verbal warning was the most effective resolution method used in managing conflicts in the study area, while the court was the least utilised institution. It was concluded that most of the conflict management and resolution methods used in the study area were not accepted by the pastoralists and farmers because the methods used were ineffective.

RECOMMENDATIONS

1. Comparing the small size of the grazing reserves and the vast Fadama land and the fact that cattle routes do not connect to the grazing reserves in the areas, both farmers and pastoralists should be educated on the need to utilise grazing reserves, pasturelands, cattle route and water points appropriately by implementing a program supervised by locally-based institutions.
2. Since most of the conflict management methods used were ineffective and unsatisfactory for the respondents, therefore it is recommended that the State Government reviews the existing conflict management methods and introduces new more suitable strategies.

REFERENCES

- Abdurrahman, B. I., Ibrahim, M. and Umar, M. B. (2017). An Assessment of Farmer- Pastoralist Conflict in Nigeria using GIS *International Journal of Engineering Science Invention* 4(8): 2319-6726.
- Adama, W. (2018). *Analysis of Urban Sprawl Using Geospatial Techniques in Gombe North*, Gombe State, Nigeria. Unpublished Dissertation submitted to the Department of Geography Ahmadu Bello University Zaria
- Abudullahi, A.A. (2017). Assessment of River Gongola Resources on Livelihood and of Economy Pastoralists and Farmers, Gombe State *Journal of Social Psychology*. (15)16: 25–34
- Abdu, S. A. (2015). *Courses and Resolution of Conflict Between Cattle Herders and Crop Farmers in Katsina State*, Unpublished Thesis, Submitted to the Department of Geography Amadu Bello University Zaria, Nigeria.
- Blench, R. (2004). *National Resource Conflicts in North-central Nigeria: A Handbook and Case Studies*. London: Mandarins Publishing.
- Ben, B.I. (2017). Assessment of Land Use Land Cover on Urban Expansion: Geographical Perspective *Journal of Contemporary Research and Review* (45):345-556
- Blench, R. M. and Hassan, U. (2003). *Report on Fadama user Conflicts in Taraba, Borno, Gombe and Bauchi States*. Unpublished Report to the World Bank Post-Conflict Fund.
- Babagana, M., Zakar, Y., Hamidan, B.H. and Abdulaziz, H. (2019). Pastoralists Farmers' Conflicts in Jigawa State Nigeria: Causes, Repercussions and Solutions *International Journal of Contemporary Research and Review* 12(6): 234-256
- Bello, H. I. (2020). Fadama Resource Pastoralist / Farmers Conflict and its Effect on Socio-economic Development in Gayam. *Journal of Peace and Development*. (13)11: 243-258

- Christina, G. M., Canute, H. and Aisia, Z. L. (2012). *Participatory GIS in Mapping Local Context of Conflicts over Pastoral Resources: Case of Duru Haitemba Community Forest in Babati district, Tanzania*. Unpublished Thesis submitted to the International Institute for Geo-information Science and Earth Observation Centre for Peace Diplomatic and Development Studies (CPDDS) (2012). The Herders Farmers Conflict and Management Strategy in Maiduguri State, Nigeria. Paper prepared for the 12th Biennial Conference for the Study of Common Property
- Christopher, N. (2018). A Critical Analysis of Conflicts between Herdsmen and Famers in Nigeria: Causes and Socio Religious and Political Effects on National Development, HTS Teologiese Studies/Theological Studies *International Journal of Research in Chemistry and Environment* 4(9): 2072-8050
- Gwary, M. M., Galadima, B. K., Mustapha, S. B. and Mai-Jir, M. M. (2018). Access to Natural Resources: A Review on Contributory Factors to Conflict and Resolution Mechanisms among Natural Resources Users in Nigeria. *International Journal of Scientific Studies* 12(5): 30-42
- Ibrahim, N. and Umar, B. (2020). An Assessment of Land Use Land Cover Change in Gombe, *International Journal of Engineering Science Invention* 11(31): 23 – 29
- Isa, M. A. (2018). Effect of Vegetation Variation on Livelihood of Harders-Farmers in Gombe State, Nigeria *Journal of Social Sciences* 23(40): 15-18
- Jerome, O. G. (2017). *Conflict in Common Property Resource Use: Experiences from an Irrigation Project*, National Animal Production Research Institute, Shika ABU, Zaria, Paper prepared for the 9th Biennial Conference of the International Association for the Study of Common Property
- Kawu, B. (2018). The Causes and Consequences of Fulani Pastoralist-Farmers Conflict in Nigeria *International Journal of Innovation and Research in Educational Sciences* 34(5): 2349–5219
- Muhammad, M.I., Wali, U. and Modibbo, M.A. (2016). Flood Vulnerability Modelling in Nafada Local Government, Gombe State, Nigeria Using Remote Sensing and GIS Techniques. *Biogeosystem Technique Journal* 2016, Vol. (9)
- Mustapha, S. (2019). Assessment of Land Use Land Cover Change Detection of Ayetoro, Yewa LGA Ogon State, *Journal of Resource monitoring and evaluation* 67(89): 123234
- Moore, H. A. (2019). Solutions to Herders-Farmers Conflict in Bauchi: *International Journal of Business and Technopreneurship* Volume 10 (1): 101-112
- Mohammed, S.A. (2017). Community GIS Mapping Local Perspective, Herds- Farmers Conflicts, *Journal of Geo-information and Earth Observation*
- Mbaya, L.A., Abu, G.O., Makadi, Y.C. and Umar, D.M. (2019). Impact of Urbanization on Vegetation Cover in Gombe Metropolis and Environs *British Journal of Earth Science Research* 12(14): 34-56
- Muhammad, B. and Idris, A. I. (2016). Assessment of Rainfall Variability on Agriculture, in Gombe State: Geo-perspective. *Journal of Environmental Science* 8(12): 23-28
- Musa, A. A. (2020). Assessment of Perception on Economic Resource Use Conflict in Niger, Minna, Nigeria Nigeria <https://www.researchgate.net/publication> 6(8): 667-670
- National Population Commission (2006). Projected Population Census of 2006
- Ostojić, M., Fekete, R., Mesaroš, M. (2019). Geospatial Analysis of Land Cover Changes in Bačka from 1990. to 2018. *Zbornik radova Departmana za geografiju, turizam i hotelijerstvo*, 48-2, 97-111. <https://doi.org/10.5937/ZbDght1902097O>
- Oli, N. P., Ibekwe, C. C. and Nwankwo, I.U. (2018). Prevalence of Herdsmen and Farmers Conflict in Nigeria *Bangladesh e-Journal of Sociology*. 3(13): 171-189
- Olaniyan, A. (2015). The Fulani–Konkomba Conflict and Management Strategy in Gushiegu, Ghana. *Journal of Applied Security Research*, 10(3), 330-340.
- Rilwanu, T. Y. (2014). *Assessment of Groundwater Potential for Rural Water Supply in Part of Kano State, Northern Nigeria*. PhD. Unpublished thesis Ahmadu Bello University Zaria, Nigeria
- Roger, B. and Mallam, D. (2005). Natural Resource Conflict in North Central Nigeria, *Journal of the Social Sciences* 77(113): 3-9

- Suleiman, A., [Ja'afar-Furo](#), M., Nasiru, U. H. and Ochi, J.E. (2016). Farmers Socio-economic Factors Influencing Resource use Conflicts in a Typical Fadama Area in Nigeria: A Focus on Bauchi State, 8(9): 76-89
- Shehu, A. (2017). Assessment of Arable Farmers and Pastoralists Perception on Economic Determinants of Resource Use Conflict in Nafada Area of Gombe State, Nigeria [https://www.researchgate.net/publication/6\(8\):45-51](https://www.researchgate.net/publication/6(8):45-51)
- Sulaiman, A., Muhammad, R. J. and Agwu, E. A. (2018). Arable Farmers and Pastoralist Perception of Socio-economic Determinants of Resource Use Conflict in Fadama Area of Bauchi State, Nigeria [https://www.researchgate.net/publication/2\(4\):234-245](https://www.researchgate.net/publication/2(4):234-245)
- Tešić, D. (2022). Corine land cover change detection in Serbia and Bosnia and Herzegovina. *Zbornik radova Departmana za geografiju, turizam i hotelijerstvo*, 51-2, 98-110.
- Tuner, M. D., Ayantunde, E.D. and Patterson, K.P. (2017). Farmers-Herders Relations and Conflict Management in Agro-pastoral Zone of Niger Niamey international livestock Research Institute, BP 12404 Niamey, Niger
- Umar, A. M. (2019). Analysis of The Effect of Conflict Resolution Mechanism of Fadama II Project on Benefiting Rural Communities In Adamawa State, Nigeria. *International Journal of Innovative Agriculture & Biology Research* 7(3):11-17
- Usman, S.A. (2014). *Developing a Geo-database for Planning and Management of Kano University of Science and Technology Facilities and Infrastructure*, an unpublished thesis, Submitted to the Department of Geography Kano University of Science and Technology WUDIL

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