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Conservation Status of Vegetation in the Dryland of Northwestern Nigeria

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Abstract

Vegetation contributes to human and ecosystem existence is overwhelming. It provides food, raw materials and oxygen, as well as in exchange of water, energy, and nutrients. The study assessed conservation status of fifty plant species that were encountered in nineteen study locations in the dryland of northwestern Nigeria. Quantitative data for the assessment was obtained through quadrat sampling. The sampling was done at 100 x 100m^2 quadrat in nineteen locations identified on a line drawn diagonally along a north–south transect; which cover the major bioclimatic gradient of the study area. Relative densities of plants are used to categorise the fifty plants into five conservation statuses namely critically endangered, endangered, vulnerable, threatened and stable categories as found in IUCN Red lists version 3.1. Result show that the stable group (6%) consists of *Piliostigma reticulatum* (RD=21.02%), *Guiera senegalensis* (RD=12.40%) and *Azadirachta indica* (RD=10.32%) in order of decreasing relative densities. Vulnerable category (8%) consists of *Fadherbia albida* (RD=9.79%), *Ziziphus mauritania* (RD=8.16%), in decreasing order of relative densities. Threatened group (24%) consist of fourteen species. Notable species are *Balanite aegyptiaca* (RD=4.26%), *Adansonia digitata* (RD=2.47%), *Lannea acida* (RD=2.00%) and *Acacia seyal* (RD=1.60%) in decreasing order of relative density. Endangered group (44%) consist of twenty two species. Notable members are *Vitex doniana* (RD=0.14%), *Anogiessus leocarpus* (RD=0.19%), *Tamarindus indica* (0.38%) in order of decreasing relative density. Critically endangered group (18%) with nine plants comprises of *Albizia chivalieri* (RD=0.01%), *Butyresopermum parkii* (RD=0.09%), *Proposis africana* (RD=0.09%), and *Ficus iteophylla* (RD=0.09%) among others. The study concludes that there are lot of species in vulnerable, endangered and threatened categories. The study recommends that conservation status assessments and monitoring should be conducted regularly using local parameters so as to provide up to date information for the effective management of vegetation in the country and particularly the dryland of northern Nigeria.

Keywords

Conservation Status, Vegetation, Dryland, Northwestern Nigeria

1. Introduction

Vegetation is an important component of ecosystem that provides habitat for wildlife and maintains its functioning. Vegetation plays a key role in earth's surface-atmosphere interaction, the alteration of which affects the biogeochemical cycles [6]. Vegetation is not only a bond that links soil, climatic, hydrologic and other elements in the whole ecosystem [28], but also an indicator of global climate change through carbon cycle [14]. Vegetation forms the basis of our environment by releasing oxygen into the atmosphere and using sunlight, carbon dioxide and minerals to produce food. People and the rest of the living world depend upon this oxygen and food to survive [2]. Linking soil, atmosphere, and moisture [3], vegetation plays an irreplaceable role in maintaining climate stability, regulating the carbon balance, and reducing global-scale greenhouse gases [20]. Because of the unique importance of vegetation, countries throughout the

world are actively trying to conserve the resources through policies and controls. Since Rio Earth Summit in 1992, significant conservation changes which involve the protection of many areas and control of poaching for resources were made in the Nigeria [7, 4].

Despite its importance, vegetation still face intense pressures particularly from loss of genetic diversity and the threat, reduction, exclusion, or extinction of species in all ecosystems. Recent estimates show that 25% of all species could become extinct during the next 20 to 30 years [25]. Two thirds of the world's plant species are in danger of extinction with pressure from the growing human population, habitat modification and deforestation, over-exploitation, spread of invasive alien species, pollution and the growing impacts of climate change [23]. In the past four decades, individual populations of many species have undergone declines and many habitats have suffered losses of original cover [24]. And these losses particularly of plant species could greatly limit the options of future generations and exacerbate great danger to marginal areas [5]. This suggests that the dryland of Nigeria.

In recent years, discussions on priorities for species conservation have intensified. This gave rise to several approaches which are partly dominated by bio-geographical information. A number of studies on conservation status of plants have been carried out in Nigeria [1]. However, information on conservation status of Nigeria's plants is very limited although a lot of assessments are ongoing. Part of the challenges to lack of adequate information on status of plants is the neglect by researchers of the epicentre for diversity which is the dryland. This paper determines the conservation status of plants in the dryland of northwestern Nigeria using the International Union of Conservation of Nature (IUCN) categories in criteria version 3.1[11] with the hope that these findings may be used to manage the marginal environment and its vegetation resources. This categorisation does not indicate conservation actions are required for all species. Therefore, only plants that fall under threat, vulnerable and extinct categories require necessary and urgent conservation actions from relevant bodies and agencies.

There are inevitable gaps in this study as the focus is not to claim to have covered all of the criteria currently required to represent conservation status. However, by bringing the available information together, it is hoped that findings of this study on plants status will help agencies to decide where research efforts and policy focus is required so as to manage plants for their essential roles to human wellbeing and our planet.

2. Conservation Status

Conservation status of a species is an indicator of the likelihood of plant species continuing to survive either in the present day or the future. Conservation status indicates whether the group still exists and how likely it is to become extinct in the near future. Many factors are taken into account when assessing conservation status: not simply the number of individuals remaining but the overall increase or decrease in the population over time, breeding success rates and known threats.

Extinction occurs when the mortality (and emigration) rate is greater than the birth (and immigration) rate for a sufficiently long time that the population size reaches zero. When used in the context of the IUCN Red List, a taxon is classified as vulnerable when facing a high risk of extinction in the wild in the immediate future [12]. Endangerment is the exposure to risk. When it comes to living organisms, and used in the context of 'endangered species', it generally means the risk of the species becoming extinct [17]. A species is threatened when it is believed to be in danger of extinction.

3. Study Area

Northwestern Nigeria is composed of three distinct geographic entities: Sokoto-Rima Basin, the Kano Region and the North Central Highlands [29]. Of the Nigeria's total area of 923,768 km^2, northwestern region occupies a total of 226, 662 km^2. The dryland of Nigeria constitute the Sudan and the Sahelian savanna with typical low rainfall and sparse vegetation. [18] noted that in Nigeria, the drylands are located north of latitude 12°N.

The study area lies within latitudes 12°N and 14°N and longitude 3°E and 10.35°E. It covers six states namely: Jigawa, Kano, Katsina, Zamfara, Sokoto and Kebbi. This study only covers Jigawa, Katsina, Zamfara and Sokoto (Figure 1).

Climate of northwestern Nigeria is the tropical wet and dry type. It is coded as 'Aw' by Koppen in which distinctive wet and dry seasons are caused by the fluctuations of the ITCZ (Inter-tropical convergence zone) or the ITD south to north to bring rainy season and north to south to bring dry season. The ITCZ separates humid maritime (mT) air mass originating from the Atlantic Ocean and dry desert air mass (cT). The ITCZ follows the apparent movement of the sun, (northwards in April – July and southwards in September – October).

The vegetation type of northern Nigeria is of the West African type which follows the pattern of rainfall distribution. The northwestern Nigeria falls within Sudan Savanna zone of Nigeria, distinguished by large expanse of grasslands with widely spaced trees of varying heights and diversity. The Sudan savanna belt is found dominating the Sokoto Plains across to the Chad Basin, covering over a quarter of the country's land area. It is found in places with rainfall of about 600-1000 mm and 4 – 6 months of dry season. The vegetation is made up of grasses 1-2 m high and often stunted trees. Some of the most frequent trees in this environment are acacia, doum palm, and the baobab. Others include *Parkia biglobosa, Adansonia digitata, Khaya senegalensis, Fadherbia albida, Tamarindus indica*, and *Borassus aethiopum, Proposis africana, Balanite aegyptiaca, Acacia nilotica* and exotic species *Azadirachta indica, Eucalyptus camaldulensis and Cassia simmea*.

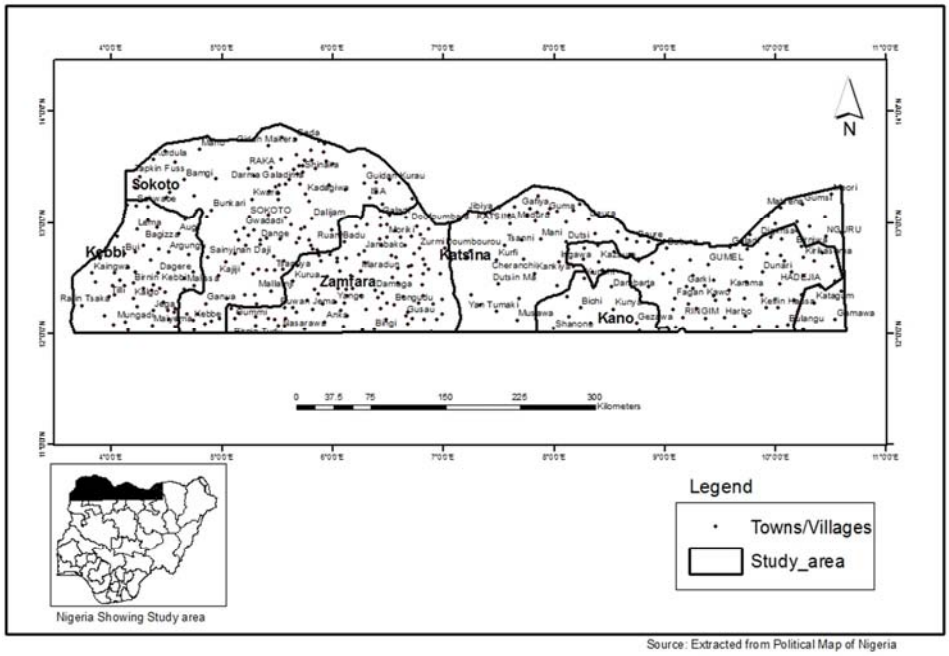

Figure 1. *Map of the Dryland of northwestern Nigeria.*

4. Research Methods

This section consists of the following units: data types, sampling of study locations, procedures for data collection and data analysis.

4.1. Sampling of Study Locations in Northwestern Nigeria

Sampling of study villages was done using belt line transect method so as to capture the villages on either side of the line [8]. The line transect was plotted on a classified map of the study diagonally from the bottom right corner (latitude 12°N and longitude 10.8°E) to the top left corner (latitude 14°N and longitude 4.5°E) northwards. The locations extend from Chana in the West to Abonabo in the East. The nineteen locations selected for the study are: Abonabo, Chiromari, Meleri, Asayaya, Dankira and Mairobi (Jigawa State), Garki, Garni, Daneji, Jani, Maje, and Bugaje (Katsina State), Bugawa, Dutsi and Bazai (Zamfara), Gundumi, Modawa, Daraye and Chana (Sokoto State) (Figure 2).

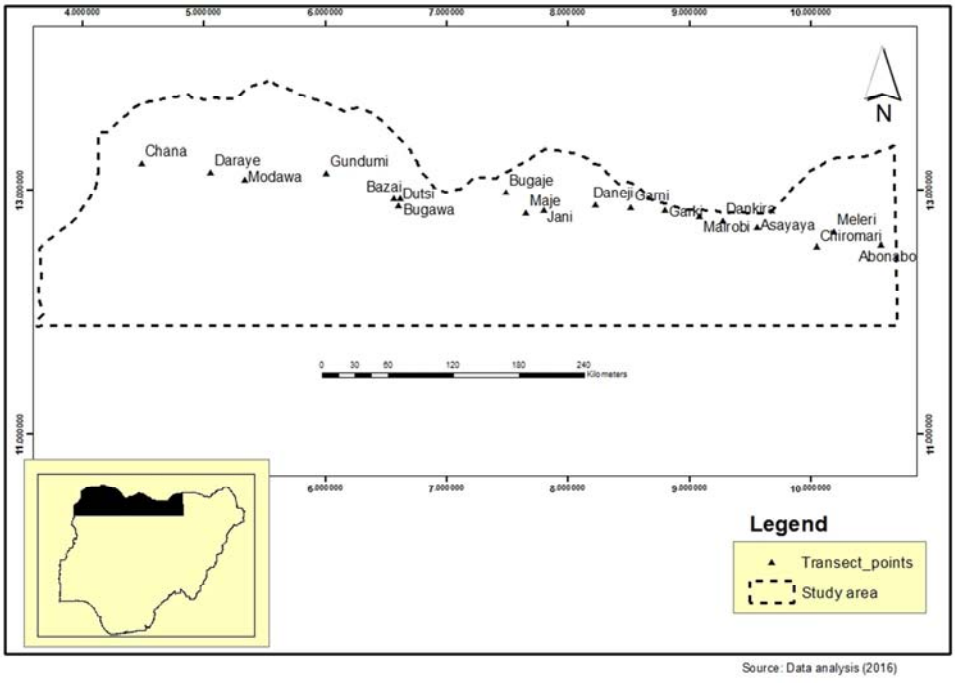

Figure 2. *Study Locations in the Dryland of Northwestern Nigeria.*

4.2. Procedures for Data Collection

Data for the study was obtained from sampling of vegetation in 100 x 100 m^2 quadrat. The choice of this size is based on suggestion that quadrat should be large enough for differences related to vegetation to become apparent [13]. A total of nineteen quadrats were laid across the dryland of northwestern Nigeria. Sampling involved: quadrat laying, inventorying, identification and recording of species. Samples of unknown were collected on pressers and transported to herbarium of Department of Biological Sciences of Bayero University Kano for identification. Local names of plants were also collected. Sample was conducted in January to March 2016.

4.3. Procedures of Data Analysis

Data was analysed in Microsoft Excel for density and relative density to determine the conservation status of vegetation in line with [19].

$$(1)\ \text{Density} = \frac{\text{Number of individuals of a species}}{\text{Size of quadrats studied}}$$

$$(2)\ \text{RD} = \frac{\text{Number of individuals of a species}}{\text{Number of all individuals counted}} \text{ X } 100$$

Where RD= Relative Density

5. Result and Discussion

5.1. Conservation Status of Plants

Status assessment in conservation has its roots in the late 1890s when researchers began to use population monitoring as a means to determine how populations of different species change overtime [26]. The International Union of Conservation of Nature (IUCN) Red List Categories and Criteria are widely used for its objective and authoritative system for assessing the global risk of extinction for species [16]. The Red List, introduced in 1994, is a list of species which have been evaluated against quantitative criteria to identify the extinction risk of species [27]. Currently, the IUCN Red lists categories and criteria version 3.1 are widely used (IUCN, 2012). The aim of conservation status assessments is to provide information and analyses on the status, trends and threats to species in order to inform and catalyse action for biodiversity conservation [21]. The criteria have five categories of statuses namely: extinction (EX), critically endangered (CR), endangered (EN), threatened (T) or vulnerable (VU).

According to [19] relative densities of species can be used to categorise plants into conservation statuses. In this study, fifty plants are categorised into critically endangered (CR), endangered (EN), threatened (T) or vulnerable (VU) in line with IUCN categories and stable (S) (Table 3). Extinction was not assessed due to limited data.

Stable category consists of *Piliostigma reticulatum* (RD=21.02%), *Guiera senegalensis* (RD=12.40%) and *Azadirachta indica* (RD=10.32%). Vulnerable category consists of *Faidherbia albida* (RD=9.79%), *Ziziphus mauritania* (RD=8.16%), *Acacia nilotica* (RD=4.40%) and *Balanite aegyptiaca* (RD=4.26).

Threatened category with fourteen species and notable plants are *Balanite aegyptiaca* (RD=4.26%), *Adansonia digitata* (RD=2.47%), *Lannea acida* (RD=2.00%) and *Acacia seyal* (RD=1.60%). Endangered category with twenty two species comprises of notable members like *Vitex doniana* (RD=0.14%), *Anogiessus leocarpus* (RD=0.19%), *Tamarindus indica* (0.38%). Critically endangered category with nine species comprises of *Albizia chivalieri* (RD=0.01%), *Butyresopermum parkii* (RD=0.09%), *Proposis africana* (RD=0.09%), *Ficus iteophylla* (RD=0.09%) among others (Table 3).

Table 1. *Conservation Status of Vegetation.*

Botanical Names	Life forms	RD (100%)	Status
Piliostigma reticulatum	Tree	21.02	Stable
Guiera senegalensis	Shrub	12.40	Stable
Azadirachta indica	Tree	10.32	Stable
Faidherbia albida	Tree	9.79	Vulnerable
Ziziphus mauritania	Shrub	8.16	Vulnerable
Acacia nilotica	Tree	4.40	Vulnerable
Balanite aegyptiaca	Tree	4.26	Vulnerable
Adansonia digitata	Tree	2.47	Threatened
Calatropis procera	Shrub	2.19	Threatened
Securinega virosa	Tree	2.10	Threatened
Cassia sieberiana	Tree	2.00	Threatened
Lannea acida	Tree	2.00	Threatened
Acacia seyal	Tree	1.60	Threatened
Annona senegalensis	Shrub	1.49	Threatened
Sesbania dalzielli	Shrub	1.23	Threatened
Sclerocarya birrea	Tree	1.15	Threatened
Combretum micranthum	Shrub	1.08	Threatened
Perguleria tomentosa	Herb	1.08	Threatened
Hyphaene thebaica	Tree	1.02	Threatened
Mitragyna inermis	Tree	0.94	Endangered
Parkia biglobosa	Tree	0.88	Endangered
Dichrostachys cinerea	Tree	0.80	Endangered

Botanical Names	Life forms	RD (100%)	Status
Terminalia avicennoioides	Shrub	0.75	Endangered
Alyscicarpus vaginalis	Tree	0.57	Endangered
Acacia macrostachya	Tree	0.57	Endangered
Waltheria indica	Shrub	0.57	Endangered
Ziziphus spina-christi	Tree	0.52	Endangered
Indigofera tictora	Shrub	0.52	Endangered
Diosphyros mespiliformis	Tree	0.42	Endangered
Tamarindus indica	Tree	0.38	Endangered
Rogeria adenophylla	Herb	0.38	Endangered
Commiphora africana	Tree	0.33	Endangered
Ficus thonningii	Tree	0.28	Endangered
Hyphaene thebaica	Tree	0.24	Endangered
Diospyros mespiliformis	Tree	0.24	Endangered
Bauhinia rufescens	Shrub	0.24	Endangered
Anogiessus leocarpus	Tree	0.19	Endangered
Bauhinia rufescens	Tree	0.19	Endangered
Combretum lamprocarpum	Tree	0.19	Endangered
Vitex doniana	Tree	0.14	Endangered
Ficus iteophylla	Tree	0.14	Endangered
Bauhinia rufescens	Tree	0.09	Critically Endangered
Lonchocarpus cyanescens	Tree	0.09	Critically Endangered
Prosopis africana	Tree	0.09	Critically Endangered
Ficus spp.	Tree	0.09	Critically Endangered
Butyrospermum paradoxa	Tree	0.09	Critically Endangered
Cassia singuena	Shrub	0.09	Critically Endangered
Ficus sycomorus	Shrub	0.09	Critically Endangered
Feretia apodanthera	Shrub	0.09	Critically Endangered
Albizia chevalieri	Tree	0.01	Critically Endangered
		100%	

RD=relative density

This study reveals great variations interms of species conservation status in the dryland of northwestern Nigeria. From its findings, *Piliostigma reticulatum and Azadirachta indica* are stable in the study area. The ornithophilic seed dispersal of *Azadirachta species* may be responsible for its stability in the study area as similar findings of [22] suggested. In India, ornithophilic seed dispersal character which is known with *Azadirachta indica* is responsible for its stability. *Adansonia digitata* is threatened in this study. [10] reported that the species is threatened in the whole Sahelian and sub-Sahelian zone. *Butyrespermum parkii* and *Anogeissus leiocarpus* are endangered according to findings of this study. These species were listed as endangered by [9]. An important browse species *Bauhinia rufescens* (browse species) is also endangered in the study area. This was also reported by [15] that the plant is endangered in Senegal because of gnarling by browse animals. *Albizia chevalieri* is highly critically endangered across the study locations.

5.2. Proportion of Plants in the Status Categories

Figure 3 show that highest percentage of plants is found in threatened and endangered conservation status categories. This is not surprising as it was reported that about 0.4 and 8.5% of 7895 plant species from 338 families and 2215 genera identified in Nigeria fall under threatened and endangered statuses [7]. [1] also reported that of 164 red list plants in Nigeria, 18 and 15 fall under 'endangered' and 'critically endangered' categories.

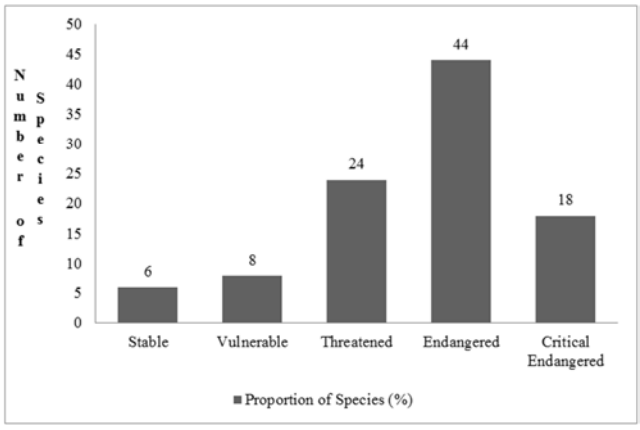

Figure 3. *Proportions of Plants Conservation Statuses Categories.*

Implication of this is persistent decrease in overall plant productivity across the dryland of northwestern Nigeria which could exacerbate the vagaries of climate in the study area and may lead to agro-habitat degradation and unsustainable natural resource extraction.

6. Conclusion

This study reveals that the greater numbers of species are found in threatened and endangered categories. This shows that most species that were encountered in the study locations are at risk of extinction. Therefore urgent conservation action is required to restore the widespread loss and degradation of native species. This categorisation does not indicate

conservation actions are required for all plant species. Therefore, only plants that fall under threatened, vulnerable and endangered categories require necessary and urgent conservation actions from relevant bodies and agencies. However, different species have different degrees of resilience and tolerance to environmental perturbations of the area and therefore not every plant is worth protecting at a time. Relevance should be an integral part of the conservation actions to be taken.

Recommendations

1. This study recommends deeper understanding of the drivers of vegetation change such as climate change, deforestation and agriculture and their implications for dryland biodiversity.

2. The task of assessing Nigeria's flora is almost impossible without broader participation from local communities and natural resources planners. Therefore the study recommends that integrated assessments should be conducted to compile a list that distinguishes species conservation statuses for Nigeria without going through the formal process of applying the more detailed and time-consuming IUCN Red List criteria. Use of the IUCN Red List may require additional effort and may not be feasible for many taxa, given the financial constraints in the country.

3. Strengthening governance and rights over natural resources particularly land and trees are required through working with communities to formalise tenure arrangements where appropriate. This can be an entry point for building confidence between communities and the State and developing appropriate institutional relationships for effective conservation of resources.

Appendix

Table 1a. *Study Locations in Northwestern Nigeria.*

Villages	LGAs	State	Coordinates	
			Nothings	Eastings
Abonabo	Gurri	Jigawa	$12^0 33^I 25.3^{II}$	$010^0 34^I 45.8^{II}$
Chiromari	Malammadori	Jigawa	$12^0 32^I 31.8^{II}$	$010^0 03^I 15.5^{II}$
Meleri	Kirikasamma	Jigawa	$12^0 39^I 39.5^{II}$	$010^0 11^I 41.1^{II}$
Asayaya	Maigatari	Jigawa	$12^0 42^I 00.7^{II}$	$009^0 33^I 28.6^{II}$
Dankira	Sule tankarkar	Jigawa	$12^0 44^I 49.6^{II}$	$009^0 16^I 43.1^{II}$
Mairobi	Sule tankarkar	Jigawa	$12^0 47^I 00.0^{II}$	$009^0 05^I 01.1^{II}$
Garki	Baure	Katsina	$12^0 50^I 29.3^{II}$	$008^0 48^I 09.2^{II}$
Garni	Zango	Katsina	$12^0 51^I 48.4^{II}$	$008^0 31^I 20.4^{II}$
Daneji	Dutsi	Katsina	$12^0 52^I 50.3^{II}$	$008^0 13^I 41.2^{II}$
Jani	Mani	Katsina	$12^0 50^I 14.5^{II}$	$007^0 48^I 10.1^{II}$
Maje	Rimi	Katsina	$12^0 49^I 02.7^{II}$	$007^0 39^I 15.6^{II}$
Bugaje	Jibia	Katsina	$12^0 59^I 25.5^{II}$	$007^0 29^I 23.2^{II}$
Bazai	Shinkafi	Zamfara	$12^0 56^I 06.4^{II}$	$006^0 34^I 06.6^{II}$
Bugawa	Shinkafi	Zamfara	$12^0 56^I 06.5^{II}$	$006^0 37^I 07.1^{II}$
Dutsi	Zurmi	Zamfara	$12^0 52^I 35.0^{II}$	$006^0 36^I 26.4^{II}$
Gundumi	Goronyo	Sokoto	$13^0 08^I 31.8^{II}$	$006^0 00^I 38.4^{II}$
Modawa	Kware	Sokoto	$13^0 05^I 42.5^{II}$	$005^0 20^I 15.8^{II}$
Daraye	Wamakko	Sokoto	$13^0 08^I 55.3^{II}$	$005^0 03^I 32.8^{II}$
Chana	Gudu	Sokoto	$13^0 13^I 19.7^{II}$	$004^0 29^I 17.2^{II}$

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