



World Food Programme

SAVING LIVES
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NIGERIA 2021

SATELLITE IMAGERY ANALYSIS



Cropland change analysis in hard-to-access areas

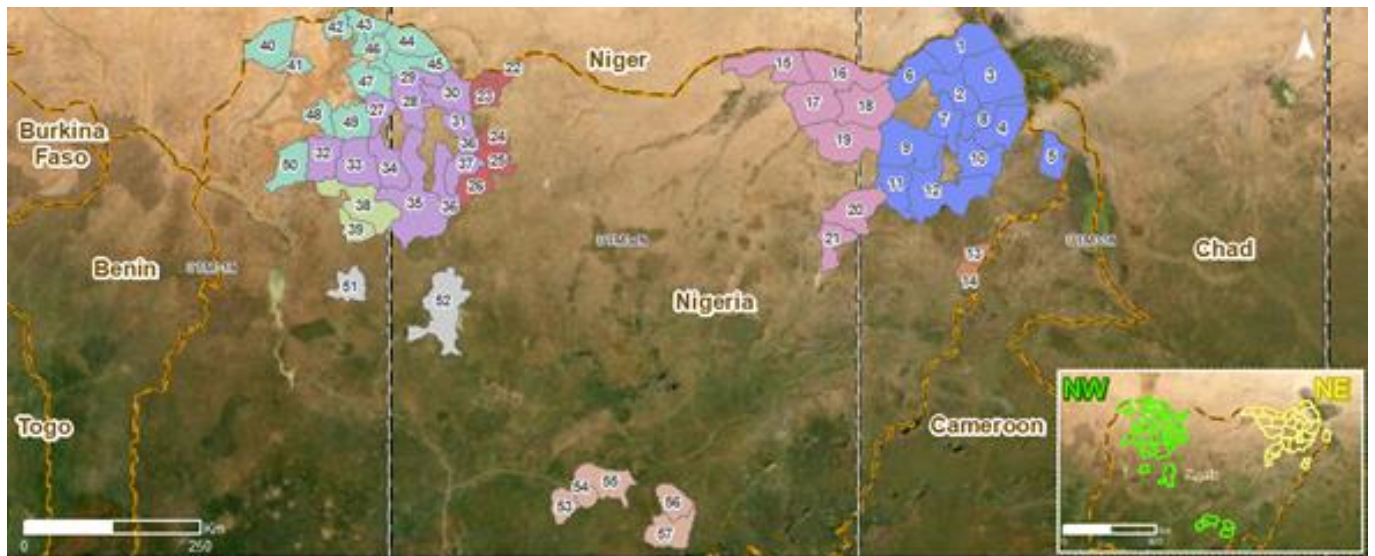
The security context in Nigeria is hampering agricultural monitoring and national food security analyses. In order to better assess the impact of insecurity on agriculture in hard-to-reach areas, WFP proposes to include the use of high-resolution satellite images in the analyses, in collaboration with the European Commission's Joint Research Centre (JRC) and the Copernicus Emergency Management Service (CEMS). This enables to overcome access constraints and territory vastness; it evaluates cropland changes in hard-to-reach areas of Nigeria, comparing 2021 with the previous year and with a reference year before the onset of violence and insecurity. The resulting products complement the information available on cultivated agricultural areas, traditionally collected through field surveys.

This note briefly describes the methodology of the analysis and presents the main results, providing an overview of the post-harvest situation in 2021 in 57 LGAs in Nigeria, with regard to the security incidents that have occurred since the beginning of the year. Finally, this document proposes ways in which these products can be used in the Cadre Harmonisé process (contributing factors) and targeting activities for humanitarian emergency response.

Methodology

The analysis was performed between different reference time-periods (2010-2021, 2017-2021, 2020-2021), that vary depending on the AOI. The 57 Local Government Areas (LGAs) spread between nine Nigerian States: 36 LGAs are located at the north-western region of Nigeria and 21 LGAs at the north-eastern, near lake Chad (see Map 1). For each year of interest, high-resolution satellite images (ASTER L1T, Landsat Legacy, Landsat 8 and Sentinel-2, ESA/Copernicus) acquired between June 15 and October 15 are processed to detect cultivated land

for each year of interest (current, previous and baseline) - this theoretically covers the agricultural season, from land preparation to early stages of harvesting. The temporal (few days) and spatial (10-30 meters) resolutions of those satellite imageries allows the detection of fields of any size and results at locality scale. Using a semi-automated method developed by WFP for this analysis, over 12,259 localities were covered, assigning to each village the associated degree of cropland change in its surroundings between 2021 and the previous year. Last, the population affected by the cropland change is estimated.



Nigeria States		World
Adamawa	Kebbi	Country borders
Benue	Niger	Zones UTM
Borno	Sokoto	
Katsina	Yobe	
	Zamfara	

AOIS	10-Mala	20-Guiba	30-Zumi	40-Gudu	50-Kebbe
1-Adamam	11-Kaga	21-Gulani	31-Birnin Magaji	41-Birji	51-Kontagora
2-Guzamala	12-Konduga	22-Ibbia	32-Gummi	42-Ibela	52-Shiroro
3-Kukawa	13-Madagali	23-Batsari	33-Bukkuyam	43-Gada	53-Ower West
4-Marfe	14-Michika	24-Dan Musa	34-Anka	44-Sabon Birni	54-Makurdi
5-Kala/Balge	15-Yusufari	25-Kankara	35-Maru	45-Isa	55-Guma
6-Mobbar	16-Yunusari	26-Faskari	36-Gusau	46-Goronyo	56-Likum
7-Nganza	17-Bursari	27-Bakura	37-Tsafe	47-Rabah	57-Katsina-Ala
8-Monguno	18-Gendam	28-Maradun	38-Wasagu/Danko	48-Shagari	
9-Magumeri	19-Tarmua	29-Shinkafi	39-Sakaba	49-Turata	

Map 1: AOI overview [EMSN113 Technical Report V1] (Copernicus EMS © 2022 EU)

Two types of maps are available with a slightly different way of presentation the crop change dynamic per locality. The first type of maps produced shows in red, orange, yellow and green the following dynamics per locality:

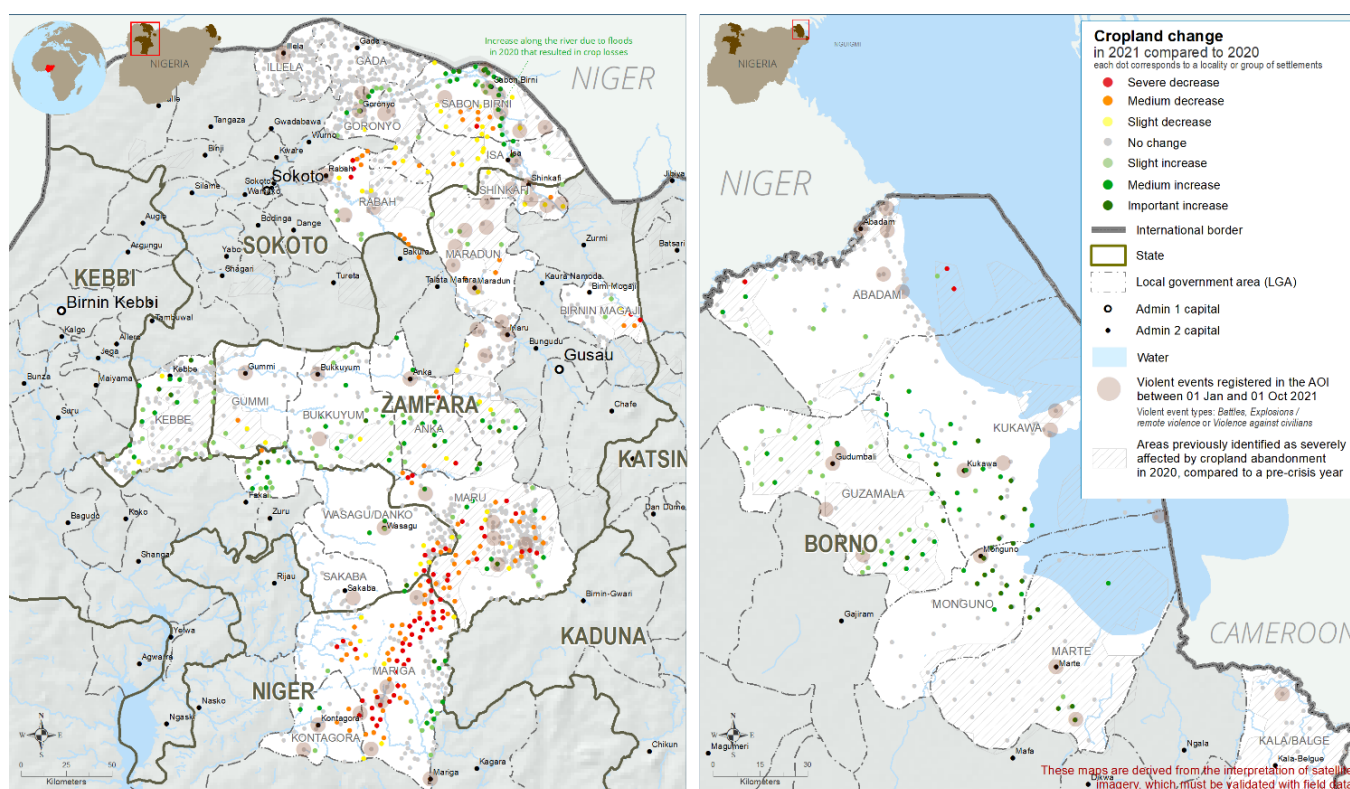
- **Severe decrease** (>50% area loss) in 2021 versus 2020
- **Medium decrease** (25%-50% area loss)
- **Slight decrease** (<25% area loss)
- **Slight increase** (<25% area gain)
- **Medium increase** (25%-50% area gain)
- **Significant increase** (>50% area gain).

Populated sites where no visible change was detected are represented in grey, including areas with no visible agricultural activities in both years. These categories are the result of a visual interpretation of satellite-derived composites, that could not be validated with field data.

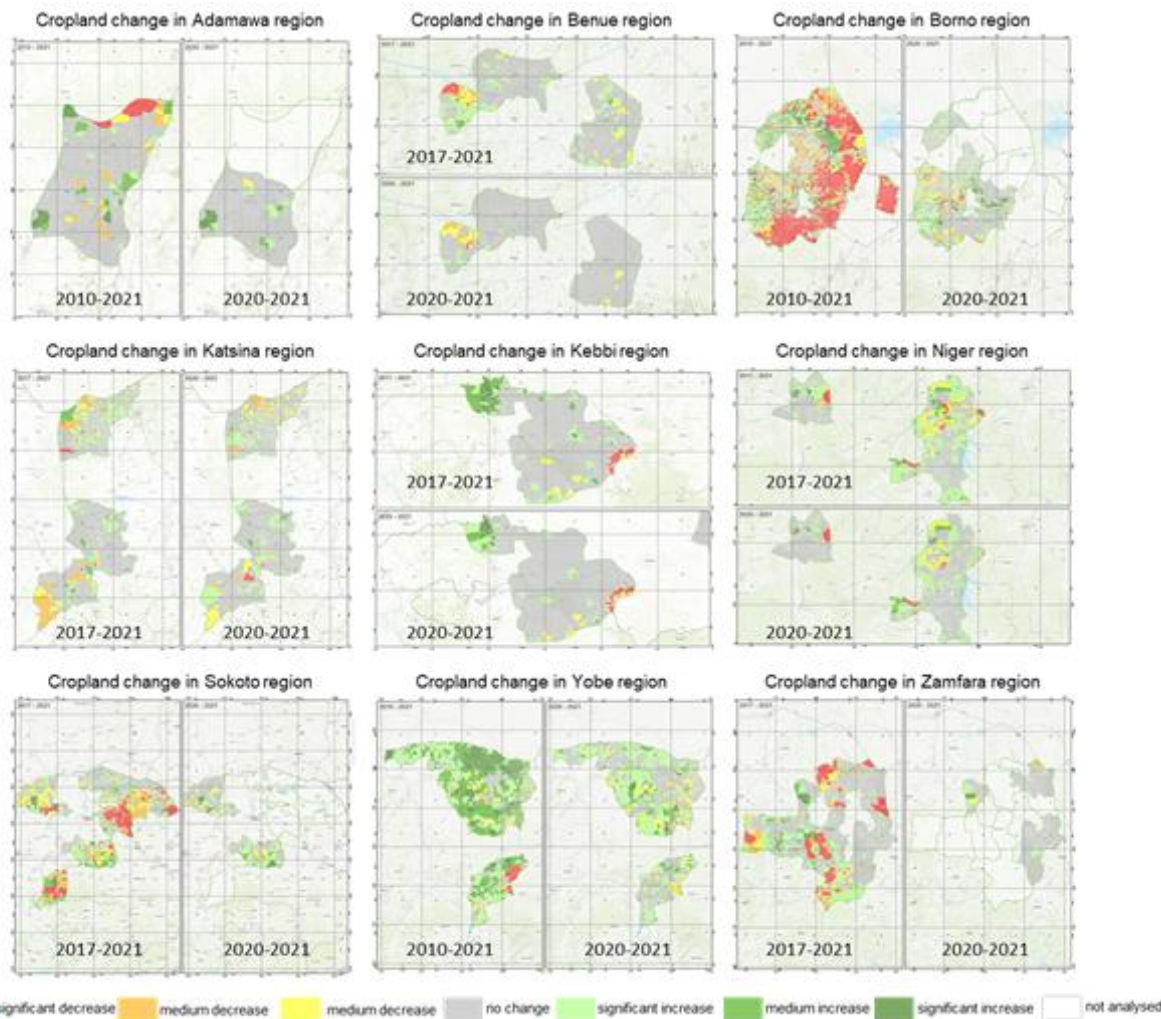
Finally, violent events registered in the area between January 1 and October 1, 2021 (source: ACLED) were included in the maps to assess any link between crop abandonment and recent insecurity in certain areas.

A second type of map (see Map 3 for reference) uses the same colour code used in Map 2 but applies it to the area surrounding the locality that is considered as of influence regarding cropland change dynamics. These maps present the change between the pre-crisis year (2010 or 2017 according to the AOI), 2020 and 2021.

The map below illustrates the overall situation of cropland in Borno, Sokoto, Zamfara and Niger states in the last year. Detailed maps are provided below for particularly affected areas in the north-eastern and north-western parts of Nigeria.



Map 2. Cropland change 2020/2021 in hard-to-reach areas identified for the analysis ahead of Nov 2021 CH exercise (© 2021 WFP)



Map 3. Cropland change in 9 states for all the analysed timeframes [EMSN113 Technical Report V1] (Copernicus EMS © 2022 EU)

Main results

The context varies throughout the country; while the region of Borno has been the scene of violence for over 10 years, the security context in the north-western states has started deteriorating more recently, in the last past years.

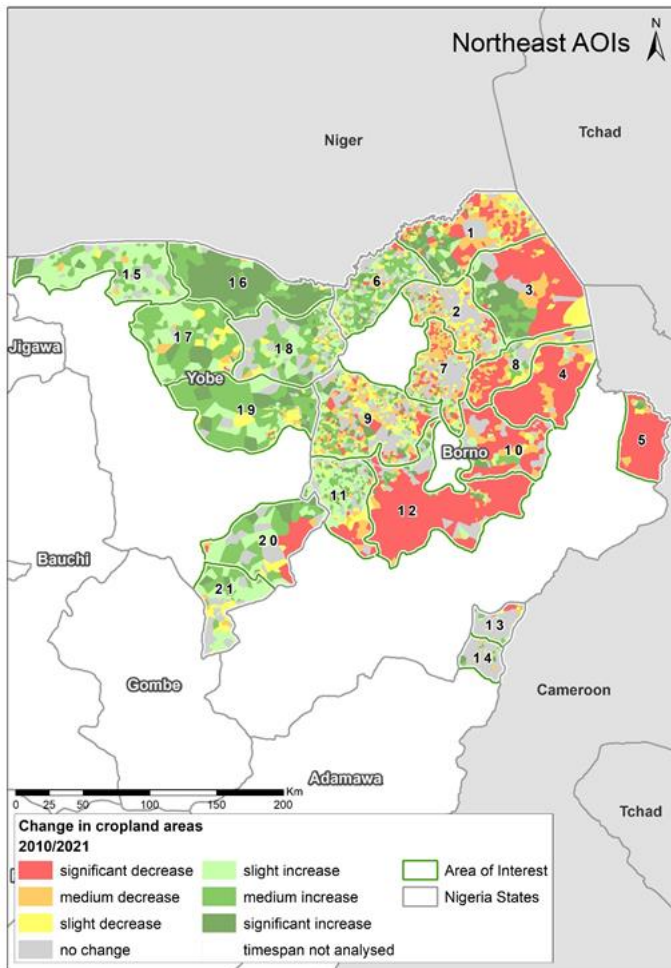
Borno, Yobe and Adamawa States

LGAs from the Borno, Yobe and Adamawa states were analysed for 2010-2021 and 2020-2021. Nine LGAs located in Borno state: 01-Abadam, 02-Guzamala, 03-Kukawa, 04-Marte, 05-Kala/Balge, 06-Mobbar, 07-Nganzai, 08-Monguno and 09-Magumeri, two LGAs located in Adamawa state: 13-Madagali and 14-Magumeri and seven LGAs from the Yobe state: 15-Yusufari, 16-Yunusari, 17-Bursari, 18-Geidam, 19-Tarmua, 20-Gujba and 21-Gulani were analysed. Since 2010, violence has increased in relation to non-state armed group insurgencies and counterinsurgency operations. Borno state – at the epicentre of the crisis in north-eastern Nigeria – is most affected by severe humanitarian access restrictions. The conflict has caused significant destruction of infrastructure, killed thousands of people and displaced millions. Insecurity has also had a severe impact on the agricultural sector, with limited access to the land and population displacements leading to a significant decrease in cultivated areas and crop production.

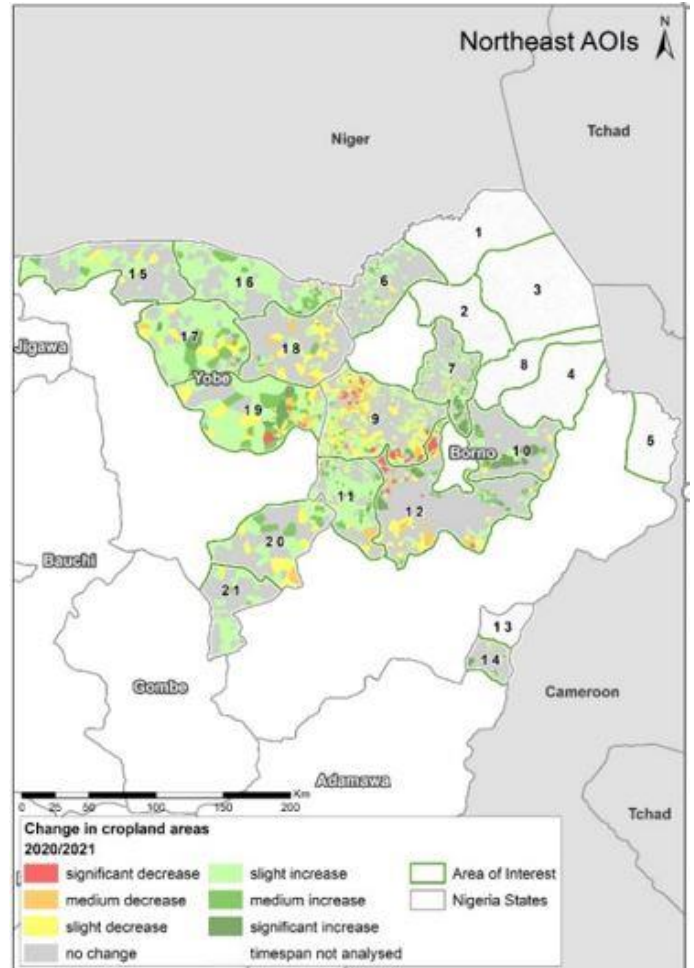
Pre-crisis compared to current season: 2010 / 2021

The LGAs included in the Borno region are the ones most affected by cropland loss between 2010 and 2021, and this corroborates the fact that more intense terrorist attacks by the Boko Haram took place in that region since 2009. Another interesting fact is that the Yobe region, a State that shares a border in the east with the Borno state, has seen their cropland activity increasing between 2010 and 2021. A reason that could explain this cropland increase is the flux of displaced persons leaving Borno towards the Yobe State.

The areas most affected by significant cropland decrease in the NE region are the LGAs belonging to the Borno State. Showing a significant decrease, we have: 4-Marte with 91%, 5-Kala-Balge with 72% and 12-Konduga with 68%. Almost all LGAs in Borno show cropland loss between 2010-2021, exceptions are for 11-Kaga and 6-Mobbar where a number of cropland areas are increasing (positive trend). The Adamawa State is the one where no evident change was detected in the cropland areas (13-Madagali and 14-Michika both with 90%). In the Yobe State, the trend is positive (i.e., increase), as it can be seen for 15-Yusufari to 21-Gulani.



Map 4. Borno, Yobe and Adamawa state analysis for 2010-2021 [EMSN113 Technical Report V1] (Copernicus EMS © 2022 EU)



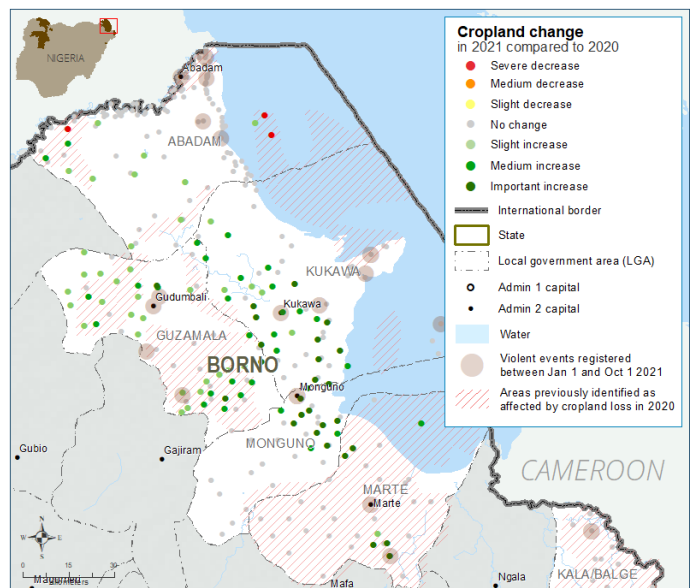
Map 5. Borno, Yobe and Adamawa state analysis for 2020-2021 [EMSN113 Technical Report V1] (Copernicus EMS © 2022 EU)

Last year compared to current season: 2020 / 2021

When looking only for the most recent period of analysis (2020-2021), no significant changes are visible for 13-Madagali and 14-Michika in the Adamawa state, where most of the regions have the same agriculture activity. The LGAs analysed in the Borno and Yobe state regions are more dynamic in cropland change patterns, where Yobe provide a clear positive (increase) change trend. For the NE AOIs, there are some exceptions to this general No change trend, namely, AOI 19-Tarmua in the eastern side of the Yobe State, with the lowest No change value (5.7%), and with 65% of cropland increase. Another AOI with a low No change value is 17-Bursari (26%), also with an increase trend (62%). The same dynamic can be seen for AOI 11-Kaga with 32% No Change and a 64% cropland increase. Also, AOIs 9-Magumeri, 16-Yunusari and 20-Gujba have percentage of No change < 70%, and a balanced or positive trend when comparing the amount of increase or decrease in cropland in those AOIs.

Map 6 shows the localities for which a severe decrease in cultivated land areas was detected in 2021 compared to 2020 (in red). Green symbols represent localities in which an increase in agricultural land use was observed (the darker, the more significant). Recent satellite images show significantly more cultivated fields in 2021 compared to 2020 in most of Kukawa, and to a lesser extent in Monguno. Recovery of agricultural

activities could be seen in 2021 in localised parts of Guzamala, most of which had been significantly affected by cropland abandonment until this year (compared to the early 2010s, before the start of the crisis). Such areas are highlighted by a pink striped symbol in the map. Most of Marte LGA's cultivated lands have remained abandoned except for a few localities where agricultural recovery could be observed (5 to 10



Map 6. Cropland change 2020/2021 in hard-to-reach LGAs of Borno state, analysis ahead of Nov 2021 CH exercise (© 2021 WFP)

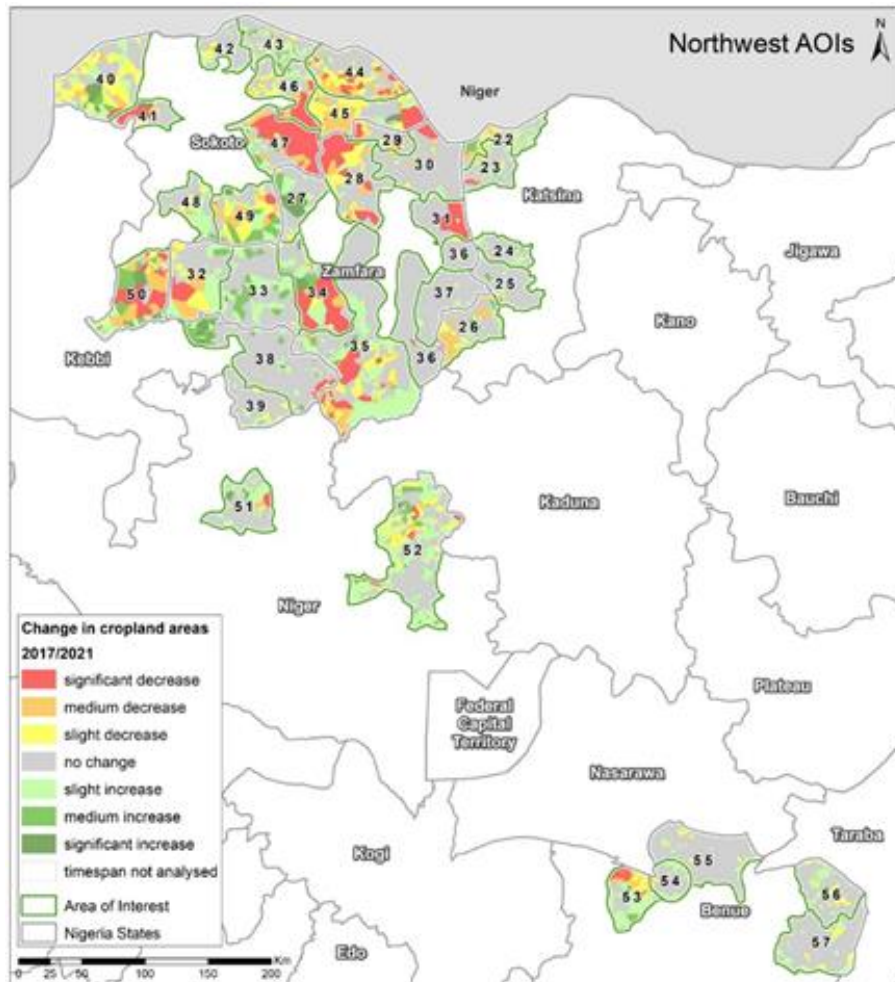
kilometres south of Marte town). Severe loss of cultivated lands occurred in 2021 in a few localities of Abadam (NW close to the border with Niger and on some islands on Lake Chad). No assumption on cropland change can be provided for Kala/Balge LGA (Local Government Area), as cloudy conditions made the interpretation of satellite imagery difficult.

Katsina, Sokoto, Zamfara, Kebbi and Niger

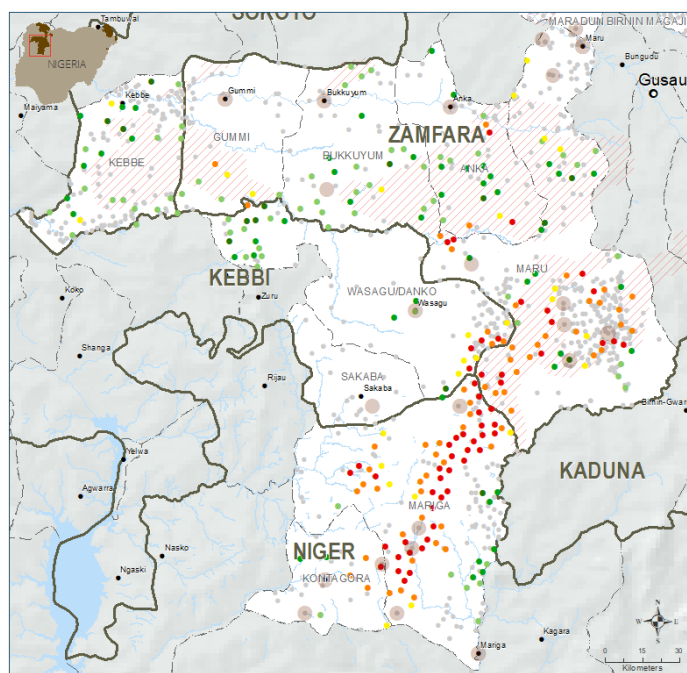
For the 2017-2021 timeframe the LGAs analysed are spread between five Nigerian states located in the northwest of Nigeria: Sokoto, Katsina, Kebbi, Zamfara, Niger and Benue (Map 7). In north-western Nigeria, the security crisis has escalated since 2019. Several parts of Zamfara and Sokoto states were already identified in 2020 as heavily affected by cropland abandonment (highlighted in Map 8 with a pink striped symbol), most probably due to population displacements or movement restrictions compelling farmers to cultivate in limited areas around their settlements.

Pre-crisis compared to current season: 2017 / 2021

The results obtained for this timeframe show that the vast majority of the LGAs in these states present a No change trend - the cropland area, in general, did not change between 2017 and 2021. From the 36 LGAs analysed, two of them represent a different pattern from



Map 7. Sokoto, Katsina, Kebbi, Zamfara, Niger and Benue state analysis for 2017-2021 [EMS113 Technical Report V1] (Copernicus EMS © 2022 EU)



Map 8. Cropland change 2020/2021 in hard-to-reach LGAs of Sokoto and northern Zamfara, analysis ahead of Nov 2021 CH (© 2021 WFP)

the observed majority: one is 50-Kebbe (in the southwest of the Sokoto State), where the percentage of No change is the lowest (17%) and has higher values in agriculture increase and decrease. We see for this AOI that there were several cropland areas that were initiated and almost the same amount of cropland areas that were abandoned; the other LGA is 53-Gwer West, in the west of the Benue State, where the No change is 28%, with a slight increase trend when comparing the values of cropland increase against decrease.

Last year compared to current season: 2020 / 2021

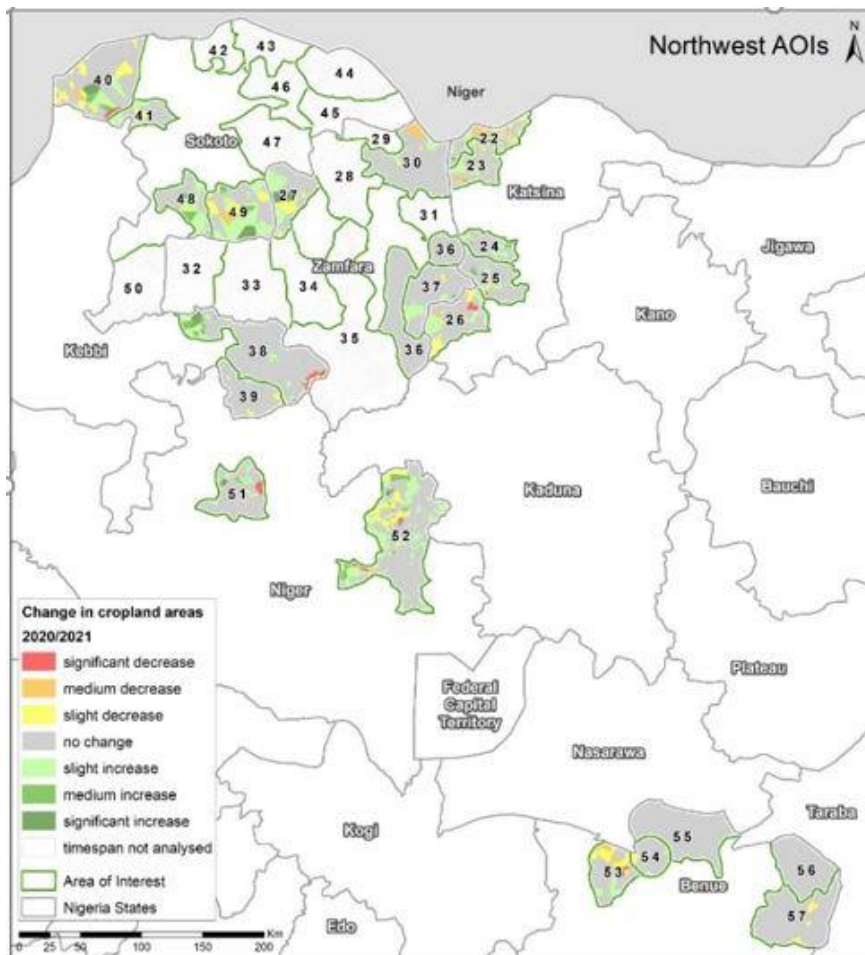
Regarding the 2020-2021 comparison, the majority of the LGAs have a No change trend. There LGAs present cropland loss: 22-Jibia in the north of Katsina State, 40-Gudu at the north of Sokoto - these two are close to the border between Nigeria and Niger - and 53-Gwer West in the East of Benue State.

Results from the analysis conducted for the 2021 agricultural season are presented in Map 10 with red, orange, yellow indicating cropland abandonment by decreasing severity and green dots (lighter to darker shades) indicating cropland gain (slight to important). It shows that most agricultural lands in previously affected areas have remained abandoned in 2021. In localised parts of Sabon Birni (south), Isa (west), Goronyo (southeast) and Birnin Magaji (south-east), additional cropland losses were observed in 2021. On the other hand, a few

localities that were already affected by cropland abandonment in 2020 have witnessed a slight recovery of agricultural land in 2021, more specifically in Maradun.

Significant cropland losses were observed in localised areas that were not affected previously, particularly in Rabah. Finally, green dots corresponding to agricultural gains in Sabon Birni (Zamfara) and to a lesser extent in Gada and Goronyo (Sokoto), are visible along the river; this is due to floods that occurred in 2020, which had led to significant crop loss that year while agricultural activities could be conducted “normally” in 2021. Most localities impacted by severe cropland loss are situated far from urbanized areas and more specifically concentrated close to forests, which are reportedly used by armed groups as camps. In addition to cropland losses, important settlement damage was detected by satellite imagery, most of which occurred between 2019 and 2020 agricultural seasons, but additional ones could also be observed between 2020 and 2021.

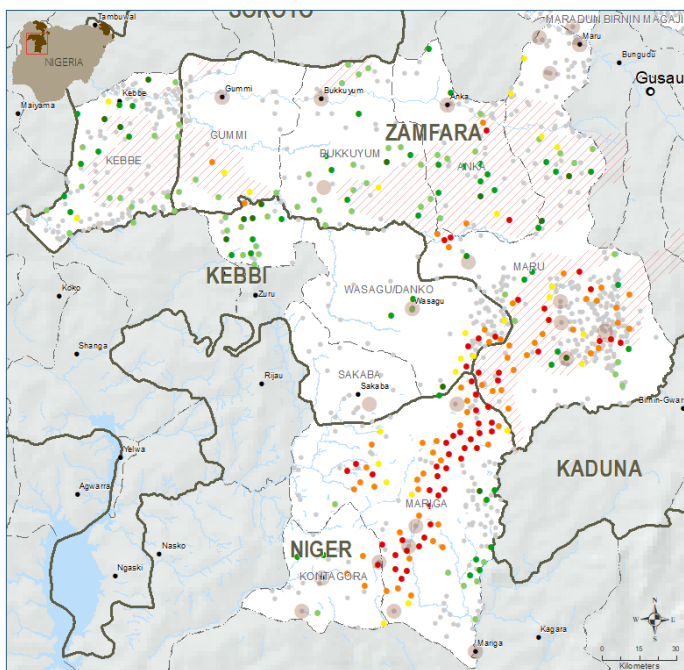
Map 10 focuses on southern LGAs of Sokoto and Zamfara states, as well as LGAs identified as hard-to-reach in Niger and Kebbi states. Large areas in the LGAs of Sokoto and Zamfara were heavily affected by cropland loss in 2020. While agricultural recovery could be observed for some localities in the LGAs of Kebbe (Sokoto), Bukkuyum, Anka, northern Maru (Zamfara) and western Wasagudanko (Kebbi), additional severe cropland losses occurred in the course of



Map 9. Sokoto, Katsina, Kebbi, Zamfara, Niger and Benue state analysis for 2020-2021 [EMSN113 Technical Report V1] (Copernicus EMS © 2022 EU)

2021, more specifically in the south of Maru (Zamfara), where several violent incidents involving communal militias were recorded (source: ACLED).

Violence seems to have spread south to Niger state, where significant cropland losses impacted many localities in 2021, notably in Mariga, and to a lesser extent in west of Wasagu/Danko in the state of Kebbi. More than 10% of the population of Mariga is estimated to be affected by such cropland abandonment. On the other hand, a few localities located east of Mariga show gains in agricultural land, which may be the consequence of population displacement to this area, or a better or improved security situation in that area.



Map 10. Cropland change 2020/2021 in hard-to-reach LGAs of Niger, Kebbi, southern Zamfara and Sokoto, analysis ahead of Nov 2021 CH (© 2021 WFP)

Using the results to inform WFP and government emergency responses

Geographic targeting of WFP and government response

The unprecedented level of spatial precision provided by these results can inform humanitarian response mechanisms, including strategic decision-making related to programming in hard-to-reach areas. Specifically, this analysis can help identify villages and communities for seasonal and livelihood programming, which had previously been unable to conduct normal farming activities during the agricultural season due to insecurity and hampered access to land.

The list of localities identified by satellite analysis as being most affected by agricultural decline is with the WFP Nigeria Country Office. This list is intended to help WFP and other partners of the Food Security Sector to plan their emergency response ahead of upcoming the lean season, as well as support identifying localities targeted under the Rapid Response Mechanism (RRM) for the hard-to-reach areas

Food security analysis: Cadre Harmonisé (CH)

The result presented above can be used to inform the analysis of the contributing factors for both the November 2021 and March 2022 Cadre Harmonise analysis, specifically for the following two components:

- **Availability:** As the analysis of crop dynamics is an analysis of vegetation indices, the data produced can inform the analysis of contributing factors under the availability component, in accordance with the provisions of the Cadre Harmonise Manual. If the share of the population affected by a decrease (resp. by an increase) of the area cultivated is larger than 20%, it is likely that the area aggregated food availability is impacted accordingly.
- **Hazards & Vulnerability:** Where a decrease in cultivated area is associated with total abandonment of villages and cultivated fields and/or violent events (based on ACLED data), the information generated can also inform the analysis of contributing factors under the Hazards & Vulnerability component.

As a first step, the proportion of villages/localities that fall into each category of cropland change (no change, slight decrease, medium decrease etc.) is identified. Then, this is translated into proportion of affected population for each LGA, based on the estimated population by locality. This ensures that changes are not biased, e.g. if the most affected localities are the least populated. The proportion of population by cropland change class is what is used to inform the CH recommendations.

To facilitate the interpretation of the results of the analysis, thresholding is proposed. It is important to note that consultations on the thresholding of the crop dynamics analysis are still ongoing at the level of the CH Technical Committee. The recommendations below are therefore to be considered as preliminary and indicative.

For the **Availability** component, the overall positive or negative change (pre-crisis versus present) at LGA level is used, determined from the difference between medium-significant increases and decreases ratios, both in terms of localities and populations:

- If one of the absolute positive/negative changes is between 5 and 10%: **slight** positive/negative impact.
- If one of the absolute positive/negative changes is between 10 and 20%: **medium** positive/negative impact.
- If one of the absolute positive/negative changes is greater than 20%: **strong** positive/negative impact.

For the **Hazards & Vulnerability** component, thresholding takes into account only negative changes observed over the past year. For both NE and NW Nigeria, the following thresholds are applied:

- If the negative change is between 5 and 10%: **slight negative** impact.
- If the negative change is between 10 and 20%: **medium negative** impact.
- If the negative change is greater than 20%: **strong negative** impact.

Please refer to tables 1A and 1B in the following pages for proposed contributing factors analysis for the March 2022 CH cycle.

		Change 2020-2021		Change ref year-2021			
Adm1	Adm2	% of population		% of population		Contributing Factors	
		Medium and significant decrease	Medium and severe increase	Medium and significant decrease	Medium and severe increase	Availability	Hazards and Vulnerability
Katsina	22-Jibia	30.1%	0.5%	22.7%	23.0%		Strong negative
	23-Batsari	2.1%	0.6%	2.7%	21.7%	Medium positive	
	24-Dan Musa	0.2%	2.4%	0.0%	12.6%	Medium positive	
	25-Kankara	1.5%	0.5%	1.4%	6.2%		
	26-Faskari	2.8%	0.0%	10.8%	10.2%		
Zamfara	27-Bakura	0.4%	5.7%	1.4%	12.4%	Medium positive	
	28-Maradun	2.0%	-2.0%	23.6%	1.6%	Strong negative	
	29-Shinkafi	2.1%	-2.1%	12.6%	1.7%	Medium negative	
	30-Zurmi	1.6%	0.1%	2.7%	2.3%		
	31-Birnin Magaji	2.5%	-2.5%	1.7%	0.0%		
	32-Gummi	1.9%	-1.9%	11.6%	21.9%	Medium positive	
	33-Bukkuyum	6.2%	-5.8%	0.0%	32.3%	Strong positive	Slight negative
	34-Anka	3.5%	-3.5%	27.8%	32.5%		
	35-Maru	3.8%	-3.5%	6.3%	19.0%	Medium positive	
	36-Gusau	0.0%	0.0%	0.2%	0.2%		
37-Tsafe	0.0%	0.3%	0.0%	7.3%	Slight positive		
Kebbi	38-Wasagu-Danko	1.1%	2.3%	1.2%	13.1%	Medium positive	
	39-Sakaba	0.0%	0.0%	0.4%	6.9%	Slight positive	
Sokoto	40-Gudu	1.8%	2.9%	4.4%	15.4%	Medium positive	
	41-Binji	0.0%	0.2%	7.8%	4.5%		
	42-Illela	0.0%	0.0%	1.7%	10.4%	Slight positive	
	43-Gada	1.8%	-1.8%	1.2%	27.1%	Strong positive	
	44-Sabon Birni	6.2%	-4.8%	15.1%	5.3%	Slight negative	Slight negative
	45-Isa	1.9%	-1.9%	19.3%	6.0%	Medium negative	
	46-Goronyo	8.1%	-8.1%	22.0%	19.0%		Slight negative
	47-Rabah	2.4%	-2.4%	45.2%	15.6%	Strong negative	
	48-Shagari	0.0%	4.6%	1.0%	15.6%	Medium positive	
	49-Tureta	2.1%	5.6%	11.3%	18.8%	Slight positive	
50-Kebbe	5.2%	-4.3%	25.4%	38.3%	Medium positive	Slight negative	
Niger	51-Kontagora	0.7%	1.1%	1.1%	10.9%	Slight positive	
	52-Shiroro	2.5%	3.6%	3.8%	33.3%	Strong positive	
Benue	53-Gwer West	7.1%	0.0%	17.6%	33.5%	Medium positive	Slight negative
	54-Makurdi	0.0%	0.0%	1.6%	8.5%	Slight positive	
	55-Guma	0.0%	0.0%	0.0%	3.4%		
	56-Ukum	0.0%	0.0%	0.0%	11.8%	Medium positive	
	57-Katsina-Ala	0.0%	0.0%	0.0%	7.7%	Slight positive	
Total		2.2%	1%	7.8%	14%		

Table 1A. Proposed indicators and contributing factors for use at the Nigeria Cadre Harmonisé (CH) in March 2022, northwest Nigeria.

		Change 2020-2021		Change ref year-2021		Contributing Factors	
Adm1	Adm2	% of population		% of population		Availability	Hazards and Vulnerability
		Medium and significant decrease	Medium and severe increase	Medium and significant decrease	Medium and severe increase		
Borno	1-Abadam	5.4%	5.4%	60.1%	10.0%	Strong negative	Slight negative
	2-Guzamala	10.6%	9.1%	26.7%	9.3%	Medium negative	Medium negative
	3-Kukawa	0.6%	3.8%	64.3%	14.0%	Strong negative	
	4-Marte	1.0%	7.4%	91.8%	0.3%	Strong negative	
	5-Kala-Balge	n/a	n/a	93.2%	2.4%	Strong negative	
	6-Mobbar	0.3%	3.4%	8.8%	45.4%	Strong positive	
	7-Nganzai	0.1%	24.5%	30.6%	16.5%	Medium negative	
	8-Monguno	0.0%	24.2%	45.4%	16.3%	Strong negative	
	9-Magumeri	9.1%	2.1%	21.5%	23.1%		Slight negative
	10-Mafa	0.1%	18.5%	43.4%	19.5%	Strong negative	
	11-Kaga	2.1%	7.8%	14.3%	53.0%	Strong positive	
	12-Konduga	7.8%	18.2%	60.1%	11.8%	Strong negative	Slight negative
Adamawa	13-Madagali	18.5%	18.5%	11.5%	4.8%	Slight negative	Medium negative
	14-Michika	0.0%	3.5%	3.8%	5.1%		
Yobe	15-Yusufari	0.0%	1.5%	2.5%	79.6%	Strong positive	
	16-Yunusari	0.9%	8.1%	0.2%	31.6%	Strong positive	
	17-Bursari	6.5%	9.9%	2.4%	84.0%	Strong positive	Slight negative
	18-Geidam	3.4%	1.6%	2.5%	34.5%	Strong positive	
	19-Tarmua	2.9%	14.3%	0.6%	61.6%	Strong positive	
	20-Gujba	2.3%	7.3%	13.6%	38.0%	Strong positive	
	21-Gulani	0.0%	1.4%	4.0%	48.8%	Strong positive	
Total		3%	9%	30%	26%		

Table 1B. Proposed indicators and contributing factors for use at the Nigeria Cadre Harmonisé (CH) in March 2022, northeast Nigeria.

Conclusion

The assessment of the dynamics of cultivated areas in restricted access zones helps to inform the impacts of conflict on farming and food security in conflict-prone zones in Nigeria. The post-harvest analysis of the 2021 agricultural season revealed favourable changes in areas in parts of northern Borno, however still these gains were relatively small when compared to the pre-crisis period. On the other hand, negative changes were observed in areas that have experienced recurrent, recent attacks (northwestern Nigeria, more specifically LGAs of Mariga and Maru) in the last couple of years. A more in-depth study should determine the links between the dynamics observed and the local security conditions.

Given access constraints, it is difficult to triangulate this data with field validation. Future analysis may consider possibilities to correlate these findings with insecurity and access related secondary data, to the extent that datasets on security incidents remain robust and available for such analysis.

In 2022, WFP will organize a capacity strengthening workshop to train government technical structures on this analysis, so that it can be fully appropriated and implemented by state actors and used systematically for the Cadre Harmonisé and the identification of priority areas for emergency response during the lean season in Nigeria.

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[[EMSN113 Technical Report V1](#)] : EMSN-113, Crop change detection in conflict-affected areas of Nigeria, agricultural season 2021. Technical report.

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