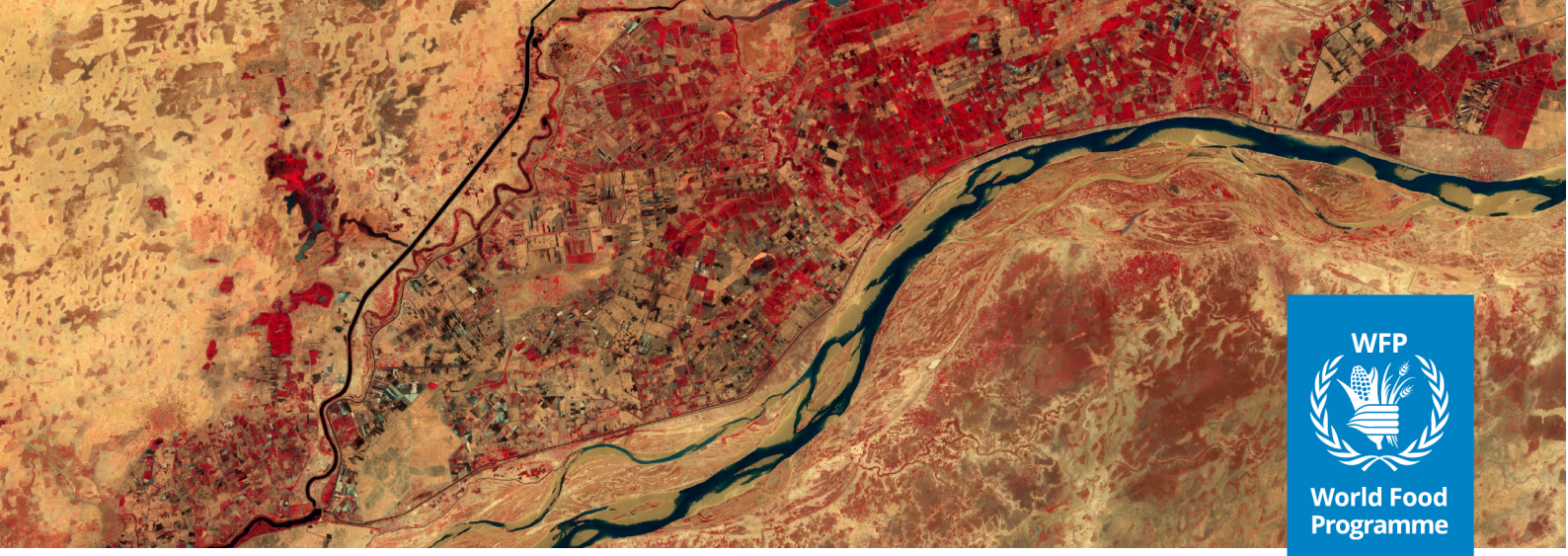


World Food Programme

SAVING LIVES
CHANGING LIVES

Mali

Satellite imagery analysis 2022

Cropland change detection analysis in hard-to-reach areas

Introduction

Mali has experienced a security crisis due to conflicts between armed groups and inter- and intra-community tensions in the northern parts of the country since 2012. Instability has spread to the central regions of the country since 2018 and gradually worsened, with conflict and insecurity impacting food security and livelihoods, as well as limiting access to affected areas.

To better understand the impact on food security and livelihoods in hard-to-reach areas, WFP has developed a methodology that relies on high-resolution satellite imagery to assess cropland change dynamics. This summary note presents the methodology and analysis results, including an estimate of population impacted by cropland losses.

Methodology

Satellite images, namely Sentinel-2 (ESA/Copernicus), were acquired for the main agricultural season (i.e. between 15th June and 15th October) for the current year, the previous year, and a reference year before the start of the conflict in the analysed areas. The cropland changes in the conflict zones are detected by measuring the degree of change between the current year and a reference year, as well as between the current year and the previous year.

The temporal (5 days) and spatial (10 meters) resolution of these images makes it possible to detect fields of any size and to extract results at the scale of localities.

For each year of the study, cultivated areas are detected by calculating the Normalized Difference Vegetation Index (NDVI), which is a vegetation index commonly used in remote sensing. NDVI values for cultivated field during the agricultural season (from the time of the end of land preparation and sowing until the shoots of the drops and start of harvest) differ from those of other types of landscape, including natural vegetation or abandoned fields.

Localities are classified into the following 7 classes in the final map, after comparing the current year with the reference or previous year.

- Severe decrease: >50% estimated area loss.
- Medium decrease: 25%-50% estimated area loss.
- Slight decrease: <25% estimated area loss.
- Slight increase: <25% estimated area gain.
- Medium increase: 25%-50% estimated area gain.
- Significant increase: >50% estimated area gain.

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

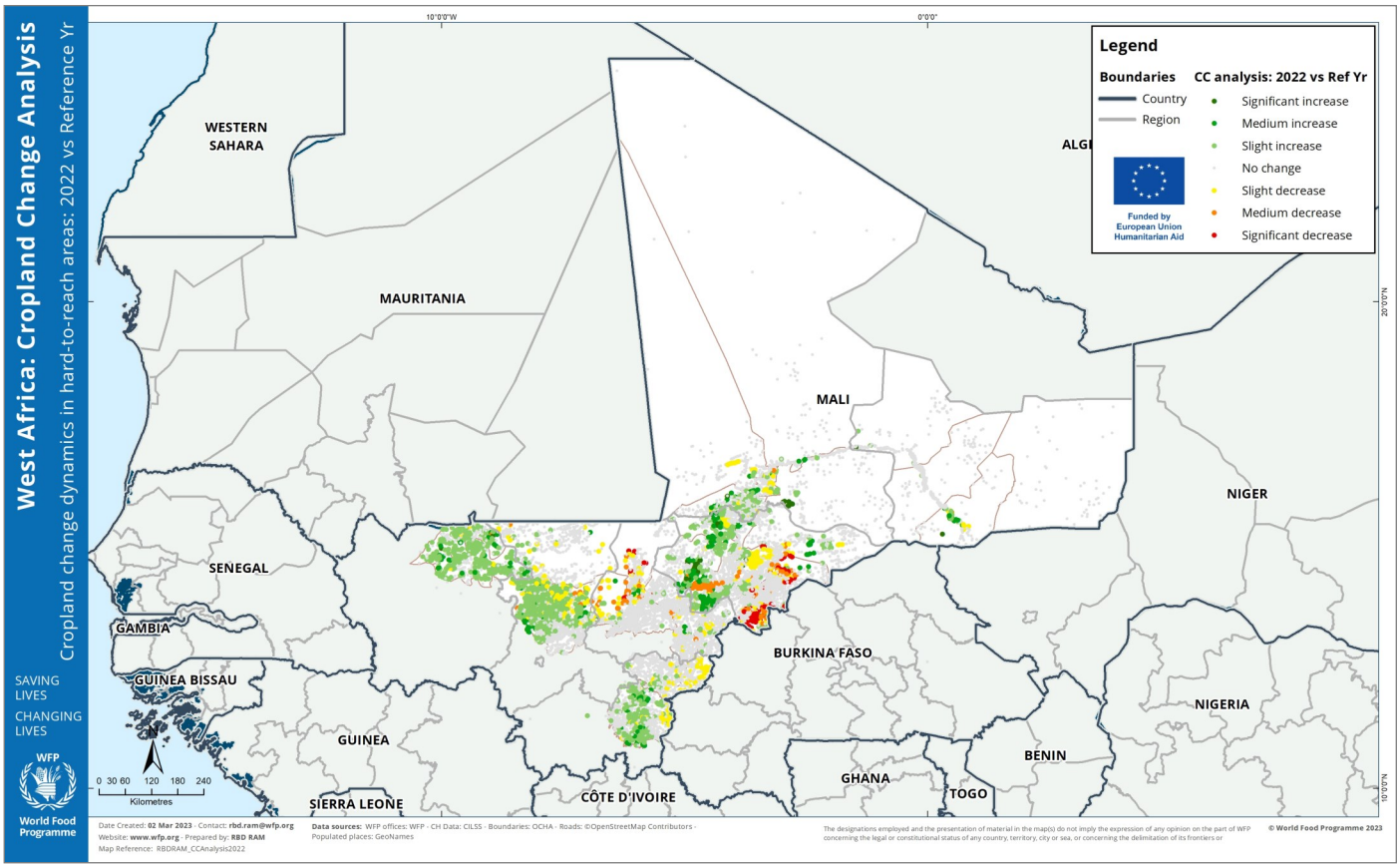
The advantage of this methodology is that it provides timely, cost-efficient, reliable and evidence-based assessment of conflict impacts on agriculture, in hard-to-reach areas where field data is limited. Moreover, the level of detail of the analysis can directly inform needs assessments and response planning at the locality level.

European Commission

Analysis results

I. Cropland change

- Overall, only minor changes in croplands were detected across all analysed regions compared to the pre-crisis situation (2016 or 2017, depending on the area). Nearly 94% of the analysed localities did not record any change or recorded only minor increases or decreases of agricultural surface areas.
- Only Mopti and Ségou regions recorded a slightly higher proportion of villages that experienced medium to significant decreases in cultivated areas, with 7% and 2.5% of the assessed localities respectively.
- Within Mopti region, the districts (cercles) most affected by medium to significant decreases are Bankass (with 24% of villages recording medium to significant decreases in croplands), Djenne (16%) and Koro (11%). In Ségou, medium to significant decreases were recorded in Niono district (for 9% of villages). It is important to note that the cropland losses observed in Djenne concern mostly the northern parts of the district, while cropland increases were recorded in the southern parts.
- In the northern regions of the country (Gao and Tomboctou), cropland increases are mainly located along the river and around other water bodies, which are the main cropping areas.
- Increases in croplands have been recorded in around 3% of localities covered by the analysis, particularly in parts of Mopti (7% of villages recording medium to significant increases in croplands) and Kayes (5%). In Mopti, increases in croplands were observed particularly in Tenenkou district (31% of villages), Djenne (19%) and Youwarou (12%). Ansongo district in Gao region also recorded a medium to significant increase in agricultural surface areas compared to the pre-crisis baseline for 12% of the assessed localities.
- Compared to last year (2021), no changes or only minor increases or decreases were observed for nearly all analysed villages (98%). In Bandiagara (Mopti region), a slightly higher proportion of villages recorded medium to significant decreases in croplands compared to 2021 (7%), with a slightly lower proportion of villages in Bankass (4%) and Djenne (3%). On the other hand, the situation improved slightly in Ansongo (Gao region), with 7% of villages recording medium to significant increases in croplands, as well as in Gourma-Rharous (Tomboctou region, 7%) and Diema (Kayes region, 6%).



Region	Localities analysed	Significant increase	Medium increase	Slight increase	No change	Slight decrease	Medium decrease	Significant decrease
Gao	577	0.35%	2.77%	3.47%	90.99%	2.08%	0.35%	0.00%
Kayes	547	0.37%	4.94%	54.48%	37.66%	2.38%	0.18%	0.00%
Koulikouro	1,808	0.00%	2.49%	31.25%	58.74%	6.91%	0.55%	0.06%
Mopti	3,150	1.84%	4.92%	12.38%	68.51%	5.33%	3.81%	3.21%
Segou	2,546	0.00%	0.35%	2.04%	91.99%	3.18%	1.69%	0.75%
Sikasso	1,423	0.00%	1.97%	15.39%	76.95%	5.69%	0.00%	0.00%
Tombouctou	943	1.06%	2.12%	8.59%	83.46%	4.67%	0.11%	0.00%
	10,994	**0.65%**	**2.73%**	**14.78%**	**74.36%**	**4.77%**	**1.61%**	**1.10%**

II. Estimated affected population in Mopti and Ségou

The analysis conducted in November 2022 for Mali also included an estimation of the population affected by cropland decrease in Mopti and Segou regions (note that other regions were not included due to the lack of disaggregated population data at the time of the analysis). The analysis, which takes into account the reliance on agricultural activities at the household level, suggests that the areas most affected by medium to significant cropland decreases in terms of population are Mopti region, especially Bankass (20% of the population affected), Koro (7%) and Djenne (2%). For Ségou region, the most affected districts are Niono (9%), and Macina (2%). In absolute terms, around 183,000 people representing 4% of the total population of Mopti and 3% of Ségou, are estimated to be impacted by medium to significant cropland loss in 2022. This represents a slight decrease compared to the results of the analysis conducted in November 2021, which concluded that nearly 254,000 people were impacted by medium to severe cropland losses in the two regions. The situation appears to have remained stable in some areas such as Bankass (Mopti region). An improvement compared to last year was observed in Djenne (11% to 2%) and Koro (18% to 7%) districts of Mopti region. However, a slight deterioration was noted in parts of Ségou, including Niono (3% to 9% of the population affected).

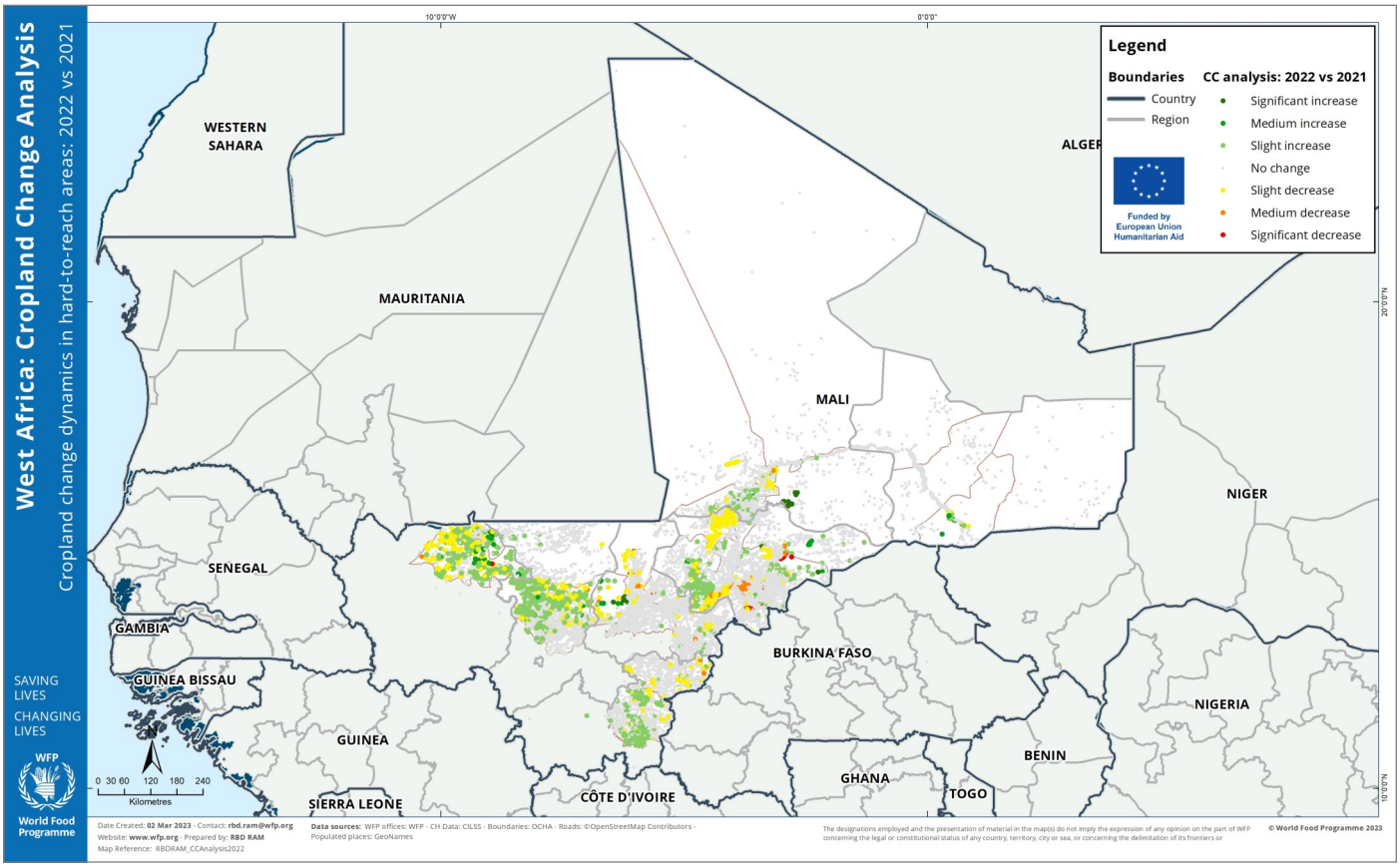
III. Overlay with security data

According to ACLED[1], the number of security incidents reported in the analysis area represents 20% of the total incidents and 28% of total fatalities reported in Mali. The most affected regions are Mopti, Gao, Ségou, and Tombouctou. The overlay of analysis results with ACLED data highlights the following patterns.

- The localities that are affected by medium and significant decreases are mainly located in areas where numerous security incidents with fatalities have been reported.
- Mopti region and north and east of Ségou region face high levels of conflict due to the presence of armed groups, inter-community violence and an overall very volatile security context.
- The regions of Gao (northern and western part), Timbuktu, Sikasso, Koulikoro and Kayes experienced violent events during this period.

Region	Locality	Population 2019	Estimated affected population in 2021		Estimated affected population in 2022	
			Number	%	Number	%
Mopti	Bandiagara	430,896	2,675	1	0	0
	Bankass	363,978	74,396	20	72,606	20
	Djenne	286,497	32,526	11	4,450	2
	Douentza	339,026	843	0	0	0
	Koro	498,435	90,834	18	35,191	7
	Mopti	507,120	3,485	1	4,214	1
	Tenenkou	223,965	4,430	2	478	0
	Youwarou	149,182	0	0	0	0
	Sub-total	**2,799,099**	**209,188**	**7**	**116,940**	**4**
Ségou	Macina	324,526	859	0	6,449	2
	Niono	501,574	15,075	3	46,211	9
	San	458,605	6,117	1	0	0
	Ségou	956,923	14,541	2	10,347	1
	Tominian	303,978	8 040	3	3,118	1
	Sub-total	**2,545,606**	**44,633**	**2**	**66,125**	**3**
Total		**5,344,705**	**253,821**	**5**	**183,065**	**3**

[1] *Armed Conflict Location and Event Data Project: https://acleddata.com/.*



Conclusion

The use of satellite images is an effective and innovative way to acquire data in areas with limited access. It makes it possible to overcome the lack of quality, credible and reliable information in hard-to-reach areas due to conflicts or disasters. Additionally, the results of the analysis being at the local level, allowed better targeting and decision-making support in the development of humanitarian assistance and resilience programs.

The main aim of this analysis is to support food security analysis and early warning (including the Cadre Harmonisé and national agricultural monitoring systems), as well as inform operational planning and targeting, including early response mechanisms. The satellite-based approach allows reducing the costs, time and risks associated with field data collection while increasing the accuracy, quality, credibility and reliability of analyses, thus contributing to the effectiveness of humanitarian interventions.

Overall, the analysis conducted for Mali for the 2022 season shows that cropland has been impacted differently in the analysed areas. Overall, no major changes compared to 2021 or the pre-crisis baseline (2016 or 2017) were detected, with the exception of some parts of Mopti and Ségou regions, where more pronounced cropland losses were observed. On the other hand, some areas in central and northern Mali recorded an increase in cropland. While a variety of factors impact cropland change dynamics, the analysis shows that insecurity remains a key factor that affects agricultural activities in Mali. The areas most affected by civil insecurity also have seen a decrease in cultivated areas; for instance Bankass, Koro and Djenne in Mopti, and Niono, Ségou and Tominian in Ségou region, where inter-community tensions and conflicts between armed groups have been reported since the end of 2022.

Confinement of some communities to their villages is an equally important form of vulnerability in terms of food insecurity, although it is often less visible. Populations living in those localities continue to have limited access to their farmlands. Although some localised improvements were detected (this is especially the case for the Bandiagara cliff where little cultivation is done, as well as in other parts of Mopti and Ségou regions), cropland decreases were visible. Also, this is the case in Djenne (Mopti region) and Niono (Ségou region), where the situation deteriorated in 2022 compared to 2021, which was an already difficult year in terms of cropland abandonment.

On the other hand, insecurity appears to have little impact on agricultural activities in other parts of Mali, including Kayes, Koulikoro and Sikasso in the centre, as well as in Tombouctou and Gao regions in the north of the country. In some of these areas, cropland increases were recorded in 2022.

Recommendations

The recommendations include the following.

1. Explore the availability of other primary or secondary data to overlay with cropland change analysis results to further assess the impact estimates and vulnerability assessment.
2. Continue building the technical capacities of partners and state services in handling earth observation tools and analysis products to improve the quality of the information available.
3. Use this analysis in decision-making and the definition of the most appropriate humanitarian responses especially to target communities, displaced people, and vulnerable population affected by significant reductions in cropland areas.

Recommendations for Cadre Harmonisé

It is recommended to use this analysis to inform the Cadre Harmonisé (CH) for November 2022, 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, 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 locality 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. The following thresholds were 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.

The following table presents the preliminary recommendations to be considered as indicative for Mopti and Segou region.

Region	Locality	Directly affected population, 2022		Recommandations for CH		Number of security incidents	Number of deaths
		Number	Percentage (%)	Availability dimension	Dangers & Vulnerability dimension		
Mopti	Bandiagara	0	0	Medium positive impact	Slight negative impact	166	464
	Bankass	72 606	20	Strong Negative impact	Strong Negative impact	100	648
	Djenne	4 450	2	Strong Positive impact	Medium negative impact	152	1014
	Douentza	45 565	13	Light positive impact	-	170	876
	Koro	35 191	7	Medium negative impact	Medium negative impact	51	92
	Mopti	4 214	1	Medium positive impact	-	109	132
	Tenenkou	478	0	Strong Positive impact	-	34	54
	Youwarou	0	0	Strong Positive impact	-	16	6
Segou	Macina	6 449	2	-	-	24	78
	Niono	46 211	9	Slight negative impact	Slight negative impact	139	454
	San	0	0	-	-	5	4
	Segou	10 347	1	-	-	34	102
	Tominian	3 118	1	-	-	24	90

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