WFP
World Food Programme
SAVING LIVES CHANGING LIVES

Geotargeting analysis

for seasonal assistance | CASE STUDY
Chad | June 2022

HIGHLIGHTS

- The WFP Chad Country Office, with the technical support of the regonal bureau (RBD), piloted the use of satellite products (climatic indicators, seasonal anomalies) to inform the geographical targeting of its seasonal assistance programme.
- This approach enabled WFP Chad Country Office to prioritize 2052 villages and to target 937,000 food insecure people for the 2022 lean season response.
- When subjected to validation by the local authorities, the objective data provided by satellite imagery allowed retention of between 60% and 95% of villages whose analyses indicated a high degree of vulnerability.
- In 71% percent of the villages retained during the geographic targeting step, results of the baseline assessment showed that more than half of the households had poor or borderline food consumption indicating a successful selection.
- The main limitation of the analysis was the lack of shapefiles for areas below admin2 level and the fact that there remain a number of villages in some provinces that are not georeferenced and could not be included in the analysis, introducing necessity for more input from local authorities.
- Further research on the methodology and potential automation could facilitate its operationalization and scale up in similar contexts

CONTEXT

Similar to most countries in Western Africa, Chad experiences a lean season during the period June-September during which food insecurity is at its peak owing to exhaustion of household food stocks. The humanitarian response to the lean season is typically informed by the Cadre Harmonisé (CH) analysis which provides a classification[1] of the level of food insecurity in a given administrative area e.g. province, department, etc. In Chad, food security assessments are representative at the admin2 (department)[2] level and the CH analysis is consequently conducted at this level, providing the first layer of geographic targeting.

However, this level of geographic targeting does not allow for accurate identification of the smallest geographic units (villages) with highest vulnerability, which in turn makes it difficult to identify the most vulnerable households. The identification of such villages with highest vulnerability would conventionally require the availability of representative household assessments data on food insecurity which is not feasible. Thus the process has historically been done through an non-standardized process that involved the use of a mix of data sources (local government reports, key informants, production data, etc) to identify the most affected villages within each department classified as phase 3+. Needless to say, this introduced a high risk of inclusion and exclusion errors.

This paper describes the methodology that was developed to address these gaps using remote sensing data, presents the results obtained using the methodology, and discusses the challenges in its utilisation.

APPROACH

The overall approach was premised on the documented relationship between climatic indicators such as rainfall, temperature, etc. and food security[3]. Such indicators could be obtained, through remote sensing, at the lowest geographic/administrative level (village) and used to project the level of vulnerability to food insecurity, thus refining the geographic targeting process.

Methodology

For the 2022 lean season, there were 24 departments pojected in severe food insecurity (CH Phase 3+)[4]. This analysis considers 15 of the 24 departments (in 5 provinces) that were initially prioritized for the WFP response: Batha West, Barh El Gazal North, Bahr El Gazal West, Bahr El Gazal South, Dagana, Fittri , Fouli, Kanem, Kaya, Kleta , Mamdi , Mangalme , Kanem North, Wadi Bissam and Wayi.

Prior to extraction of relevant remote sensing indicators, it was necessary to map all the villages in each of the departments prioritized. However, there is no shapefile available for Chad below admin level 2. In that context, two approaches were used to obtain point coordinates for the villages: i) Georeferenced data (latitute, longitude coordinates) of the villages was accessed via the national census (RGPH 2) database provided by the National Institute for Statistics, Economic and Demographic Studies (INSEED) conducted in 2009 and ii); complementary field GPS coordinates data collection in 2022, intended to fill the gaps identified with the RGPH2 data owing to the lapse of time between 2009 and present day sub-divisions.

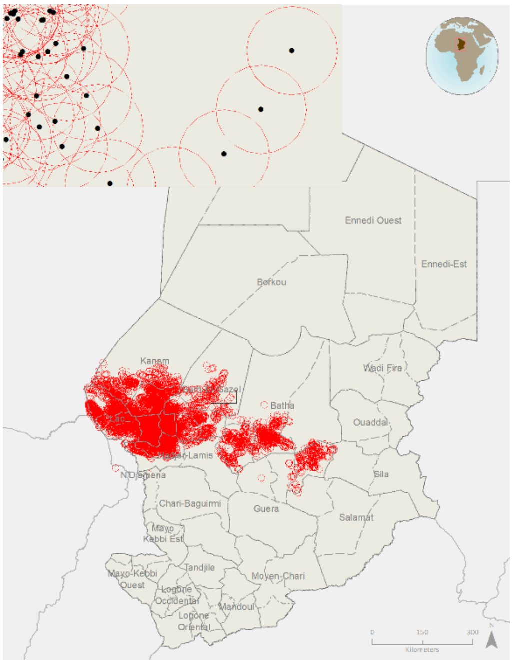

Figure 1. 10-km buffer zones around villages in the 15 departments identified for analysis

Over 7,500 villages were identified in the respective departments as an input list for this analysis. Due to the unavailability of shapefiles for the villages, and in order to enable the targeting , 10-km buffer zones were created around each village, from which aggregated values were derived from satellite-based seasonal indicators, and assigned to the vilage. An additional consideration here was that satellite-derived rainfall (and other) indicators are usually more accurate at an aggregated level, rather than at the pixel level.

[1] https://www.ipcinfo.org/ch
[2] Admin 1 – Province ; Admin 2 – Department ; Admin 3 – Sous-préfecture ; Admin 4 – Canton ; Admin 5 - village
[3] See for example, Climate change and food security: a framework document (https://www.fao.org/3/k2595e/k2595e00.pdf)
[4] https://fscluster.org/chad/document/ch-resultats-cadre-harmonise-mars-2022

Data

The satellite products considered for the analysis were derived from georeferenced images from a variety of sources, at a variety of spatial resolutions. Most of these products are processed internally by WFP. The indicators were: :

- Rainfall anomaly (percent of average) for the full growing season, approximated by [10 June-10 October] *(Source CHIRPS RFE (Rainfall Estimated) from Climate Hazards Group, UCSB and prepared by WFP RBD)* ;
- Rainfall anomaly (percent of average) for the beginning of the growing season, approximated by [1-31 July] *(Source: CHIRPS RFE (Rainfall Estimated) from Climate Hazards Group, UCSB and prepared by WFP RBD)* ;
- Rainfall anomaly (percent of average) for the middle of the growing season, approximated by [1-31 August] *(Source: CHIRPS RFE (Rainfall Estimated) from Climate Hazards Group, UCSB and prepared by WFP RBD)* ;
- Rainfall anomaly (percent of average) for the end of the growing season, approximated by [1-30 September] *(Source: CHIRPS RFE (Rainfall Estimated) from Climate Hazards Group, UCSB and prepared by WFP RBD)* ;
- Anomaly in the number of rainy days from May to October (difference from average) *(Source: CHIRPS RFE (Rainfall Estimated) from Climate Hazards Group, UCSB and prepared by WFP RBD)*;
- Anomaly of the date of the growing season onset (relative to average) at 31 August *(Source: CHIRPS RFE (Rainfall Estimated) from Climate Hazards Group, UCSB and prepared by WFP RBD*;
- NDVI anomaly (percent of average) for the period [20 August - 5 September], theoretically corresponding to the peak of vegetation *(Source: MODIS NDVI, EOSDIS-NASA and prepared by WFP RBD)*;
- Land surface temperature anomaly *(Source: MODIS Terra Aqua, EOSDIS-NASA and prepared by WFP RBD)*;
- Evapotranspiration anomaly *(Source : FEWSNET, 2021 and prepared by WFP RBD)*;
- SPI in the 3 months ending 20 September (Standardized Precipitation Index) *(Source: CHIRPS RFE (Rainfall Estimated) from Climate Hazards Group, UCSB and prepared by WFP RBD)*;
- WRSI (Water RequirementSatisfaction Index) *(Source: CHIRPS RFE (Rainfall Estimated) from Climate Hazards Group, UCSB/FWSNET 2021 and prepared by WFP RBD)*.

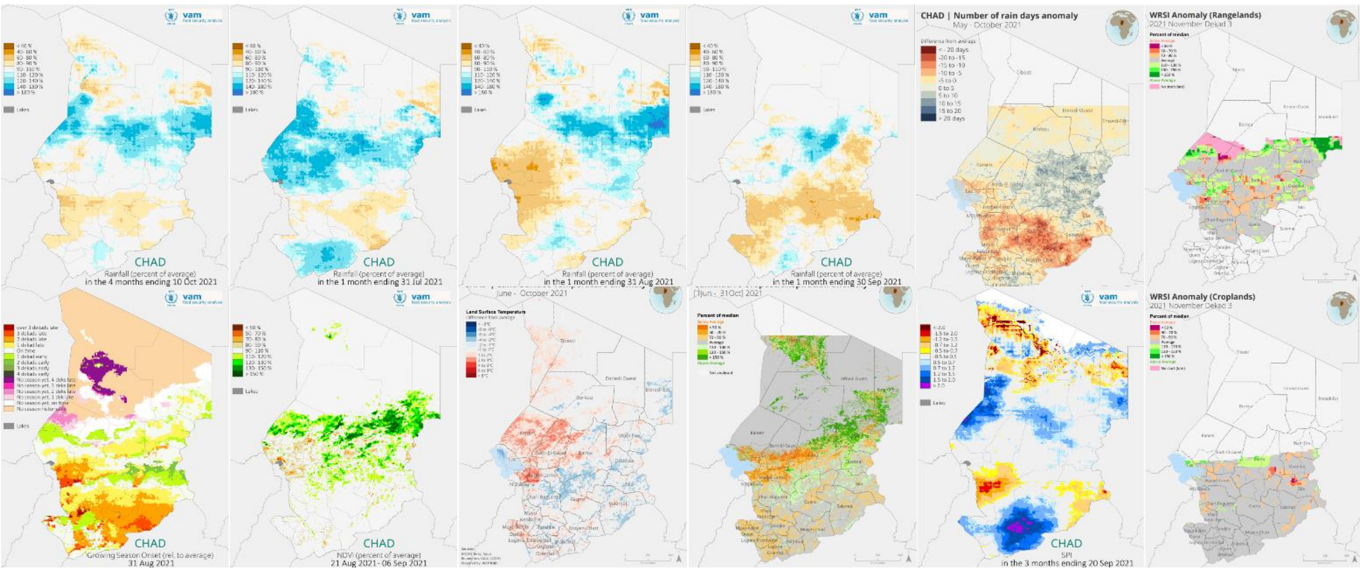

Figure 2. Maps of 12 seasonal indicators derived from a variety of satellite data sources for the 2021 growing season of Chad. From left to right (top, then bottom) : rainfall anomaly for the full season, for the beginning, the middle and the end of the growing season, number of rainy days anomaly, WRSI (rangeland), onset of growing season anomaly, NDVI anomaly, temperature anomaly, evapotranspiration anomaly, SPI, WRSI (cropland).

Processing steps

GIS operations

A GIS software (ArcGIS) was used to create 10-kilometre buffer zones around each locality. Then, an average value was calculated for each indicator — except for the growing season onset — within this buffer zone (using a *Zonal Statistics* tool) and added as a new column in the attribute table of the localities shapefile.

List production

The output from the previous step was a spreadsheet containing localities' names (admin 1-5), GPS coordinates, and aggregated values for each of the satellite-derived seasonal indicators.

Province	Département	Sous-Pré	Canton	Village	x coord	y coord	Anomalie pluv. Saison entière (%	Anomalie pluv. Début de saison (	Anomalie pluv. Milieu de saison (	Anomalie pluv. Fin de saison (%)	Anomalie nombre jours de pluie	Anomalie date de début saison des pousses	Anomalie NDVI (%)	Anomalie Température (°C)
Batha	Batha Ouest	Ati	Commune Ati	Abdiene	18.4014191	13.0666474	102.3	115.9	97.7	82.4	6.1	1 dekad late	101.1	0.68
Batha	Batha Ouest	Ati	Commune Ati	Abgache 1	18.4721728	13.0645314	102.1	116.1	98.5	81.5	5.1	On time	103.2	0.39
Batha	Batha Ouest	Ati	Commune Ati	Abgache 2	18.4850455	13.0628238	102.0	116.2	98.2	81.5	5.0	On time	103.3	0.33
Batha	Batha Ouest	Ati	Commune Ati	Abgadah	18.4512039	13.1327032	101.0	114.5	95.6	82.6	3.3	On time	108.5	0.55
Batha	Batha Ouest	Ati	Commune Ati	Abkissi	18.476715	13.2596102	98.6	105.7	95.7	81.4	4.3	On time	105.0	0.14
Batha	Batha Ouest	Ati	Commune Ati	Abniran	18.0767369	13.3985533	93.9	108.5	81.3	90.5	2.6	On time	110.7	0.49
Batha	Batha Ouest	Ati	Commune Ati	Abou achour	18.8242867	13.5897134	99.4	107.1	91.9	99.3	8.4	1 dekad late	88.3	0.38
Batha	Batha Ouest	Ati	Commune Ati	Abouhadjilidj	17.7924376	13.3826636	103.8	124.6	91.2	96.0	1.3	On time	110.9	1.56
Batha	Batha Ouest	Ati	Commune Ati	Aboutahir	18.7880386	13.570191	98.5	105.5	91.8	97.3	8.3	1 dekad late	84.7	0.18
Batha	Batha Ouest	Ati	Commune Ati	Abroki	18.392208	13.207744	100.0	111.7	93.9	82.6	3.5	On time	108.9	0.39
Batha	Batha Ouest	Ati	Commune Ati	Absabe	18.4709956	13.0007618	104.6	116.8	103.8	81.1	6.6	On time	101.9	0.23
Batha	Batha Ouest	Ati	Commune Ati	Absafarok	18.5806099	13.1126543	102.1	113.4	98.0	81.8	4.7	On time	103.9	0.07
Batha	Batha Ouest	Ati	Commune Ati	Abtandjak	18.9427215	13.5568589	100.4	108.3	95.4	94.9	6.2	2 dekads late	98.1	-0.24
Batha	Batha Ouest	Ati	Commune Ati	Abtchetchena	18.3788442	13.1467657	101.4	115.8	94.6	82.5	4.1	1 dekad late	105.8	0.58
Batha	Batha Ouest	Ati	Commune Ati	Abteta	18.5633428	13.0777048	102.2	114.6	98.5	81.1	5.0	On time	103.6	0.03
Batha	Batha Ouest	Ati	Commune Ati	Abtibini est	18.5605403	12.9753284	105.3	115.2	105.8	79.9	6.0	On time	106.9	-0.15
Batha	Batha Ouest	Ati	Commune Ati	Abtibini ouest	18.5600319	12.9731158	105.3	115.2	105.8	79.9	6.0	On time	106.9	-0.16
Batha	Batha Ouest	Ati	Commune Ati	Abyokho 1	18.478471	13.0227861	103.8	117.1	101.9	81.8	6.0	On time	100.9	0.25
Batha	Batha Ouest	Ati	Commune Ati	Abyokho 2	18.4460517	12.9940747	104.8	116.6	103.9	81.3	6.6	On time	100.7	0.32
Batha	Batha Ouest	Ati	Commune Ati	Al -hilele	18.3014923	13.2089932	100.1	114.7	90.8	85.3	2.8	On time	106.8	0.19
Batha	Batha Ouest	Ati	Commune Ati	Albeda	18.1011839	13.4767067	92.8	105.4	82.1	91.8	1.6	1 dekad late	117.5	0.74
Batha	Batha Ouest	Ati	Commune Ati	Albeda	18.7368036	13.457079	97.1	103.9	90.6	92.7	6.8	On time	91.7	-0.25
Batha	Batha Ouest	Ati	Commune Ati	Alboultal acheil	18.3449786	13.281221	97.3	106.8	91.0	84.4	4.0	On time	104.0	-0.14
Batha	Batha Ouest	Ati	Commune Ati	Alboutal darsal	18.3627498	13.2927846	97.3	105.8	91.6	83.6	4.2	On time	103.9	-0.15
Batha	Batha Ouest	Ati	Commune Ati	Aldjaloli	18.4592517	13.2771685	98.5	105.1	95.6	81.2	4.4	On time	103.3	0.06
Batha	Batha Ouest	Ati	Commune Ati	Al-ifenat	18.6327645	13.6711044	94.8	99.4	89.1	95.3	4.0	1 dekad late	80.6	1.13
Batha	Batha Ouest	Ati	Commune Ati	Al-ifene	18.4956014	13.3483023	96.9	103.8	92.6	83.3	5.1	On time	96.4	-0.18
Batha	Batha Ouest	Ati	Commune Ati	Alkaillani	18.5315653	13.4324549	94.9	104.2	88.6	82.9	5.4	On time	88.4	0.12

Figure 3. Table providing for each locality the aggregated values of satellite-derived seasonal indicators.

Logic and calculation of final vulnerability index

To remain consistent with the approach used by the CH to identify areas of high vulnerability, the geographic targeting analysis used several sources of information to determine the degree of vulnerability in these geographic entities. These include the ENSA[5] surveys which provide information on people's livelihoods (livestock ownership, agricultural production, commercial activities) and food security; the Second General Population and Housing Census (RGPH2), which provides information on population structure; and satellite imagery data, which provides important information for assessing the quality of the season and its possible impact on food security and livelihoods.

At the admin3 level, i.e., sub-prefecture, all this information was used and grouped into four dimensions: food security, FS (ENSA); human capital, CH (RGPH2, ENSA); economic capital, CE (ENSA); and quality of the season, AC (satellite imagery). Note that the ENSA survey is representative at admin2 level, thus analysis performed at admin3 level is indicative. To assess the degree of vulnerability of each sub-prefecture, thresholds and weights were assigned to the indicators and dimensions, respectively. These weights can be adjusted according to program objectives. In this case, a higher weighting (admittedly subjective) is given to food security because the response aims to address food insecurity. The table below shows how this calculation was done at the admin3 level. For the selection of the vulnerable cantons and villages (admin 4&5), only the seasonal/climatic indicators were analysed.

Scheme for the prioritization of sub-prefectures

Food Security (FS)	Human Capital (CH)	Economic capital (CE)	Climatic anomalies (AC)
Food Consumption Score (FS_A)	Household head gender (CH_A)	Household shocks (CE_A)	NDVI anomaly (AC_A)
Reduced Coping Strategy Index (FS_B)	Household head marital status (CH_B)	Production coverage of own needs (CE_B)	Number of rain days anomaly (AC_B)
Livelihood Coping Strategy Index (FS_C)	Presence of PLW (CH_C)	Available stocks (CE_C)	Mean WRSI (AC_C)
Prevalence of food insecurity (FS_D)	Presence of persons with disabilities (CH_D)	Livestock possession (CE_D)	Rainfall anomaly - entire season (AC_D)
	Presence of children 0-23 months (CH_E)		Rainfall anomaly - start of growing season (AC_E)

5 Enquête Nationale sur la Sécurité Alimentaire

	Mean household size (CH_F) Dependence ratio (CH_G)	Rainfall anomaly - mid growing season (AC_F)

Scoring FS = FS_A + FS_B + FS_C + FS_D

Scoring CH = CH_A + CH_B + CH_C + CH_D + CH_E + CH_F + CH_G

Scoring AC = AC_A + AC_B + AC_C + AC_D + AC-E + AC_F

Scoring CE = CE_A + CE_B + CE_C + CE_D

Scoring S-Pture = 35 * Scoring FS/12 + 15 * Scoring CH/21 + 20 * Scoring AC/18 + 20 * Scoring CE/12).

The approach used to provide quantified data on the degree of vulnerability of each administrative entity provides an opportunity for WFP Chad to address the issue of estimating the affected population by sub-prefecture and by canton. By calculating the relative degree of vulnerability from the overall vulnerability of all geographic entities, it was possible to use this data to disaggregate the populations in Phase 3+. This analysis was combined with the demographic weight of each entity considered so as to have a suitable estimate. Thus, at the end of the analysis, the number of people, households and villages per sub-prefecture and canton was obtained, under the assumption of an average number of 75 households per village[6] and a household size for assistance set at 6 people.

Admin level		Human Capital Score	Economic Capital Score	Food Security Score	Climatic Anomalies Score	Overoll Score	Relative Score	Population	Population weight	Cross Rate (G)*(I)	Relative Cross Rate	Beneficiaries Breakdown
Admin 2	Kédédina	2.67	2.00	1.8	1.29	56.29	0.26	35,977	0.17	0.04	0.18	11,024
	Mao	1.33	2.00	1.8	2.02	54.45	0.25	161,597	0.77	0.19	0.76	47,899
	Méléa	2.17	2.00	1.8	1.86	57.56	0.26	9,999	0.05	0.01	0.05	3,133
	Wadjigui	1.67	2.00	1.8	1.21	50.72	0.23	2,776	0.01	0.00	0.01	766
Admin3	**Kanem**	-	-	-	-	**219.02**	**1.00**	**210,349**	**1.00**	**0.25**	**1.00**	**62,823**
Admin2	Nokou	1.83	1.33	2.6	1.05	55.39	0.26	38,363	0.27	0.07	0.29	10,305
	Ntiona	1.83	2.67	1	1	45.25	0.21	46,790	0.33	0.07	0.29	10,268
	Ziguey	2.06	2.67	1.8	1.38	58.37	0.27	8,652	0.06	0.02	0.07	2,449
	Rig-Rig	2.42	1.67	2.2	1.15	56.51	0.26	46,892	0.33	0.09	0.36	12,851
Admin3	**Nord Kanem**	-	-	-	-	**215.52**	**1.00**	**140,697**	**1.00**	**0.24**	**1.00**	**35,873**
Admin2	Am-Doback	2.25	1.67	1.8	2.26	58.44	0.48	40,838	0.32	0.15	0.30	10,533
	Mondo	1.75	2.33	2.2	2.13	64.2	0.52	87,040	0.68	0.36	0.70	24,662
Admin3	**Sud Kanem (Wadi Bissam)**	-	-	-	-	**122.64**	**1.00**	**127,878**	**1.00**	**0.51**	**1.00**	**35,195**

Results

The primary output of the analysis in each department was the list of villages according to the overall vulnerability score. In each department, the list of villages was subjected to validation by the authorities before proceeding the community-based targeting step. In general, the list produced was validated by more than 90% by the authorities, who found the approach very innovative. Discussions often focused on villages that had the same degree of vulnerability and for which some had to be selected. The objective of this discussion was to use the knowledge of authorities from the field to prioritise the final number sought.

The map below provides a visual representation of the villages finally targeted and the level of food insecurity in the villages based on the baseline survey conducted post-targeting and pre-assistance. Out of 1594 villages that were analysed in the selected provinces, results showed that 53% had elevated level of food insecurity with more than 75% of households in those villages having poor or borderline food consumption, while another 18% had critical levels (50-75% having poor or borderline food consumption score). The analysis shows that the approach was efficient in selecting villages with high vulnerability.

[6] Lors du Deuxième Recensement Général de la Population et de l'Habitat (RGPH2), les données indiquaient une moyenne 71 ménage par village. Ce nombre a été majoré légèrement pour tenir compte de la croissance démographique mais aussi pour éviter une sous-estimation.

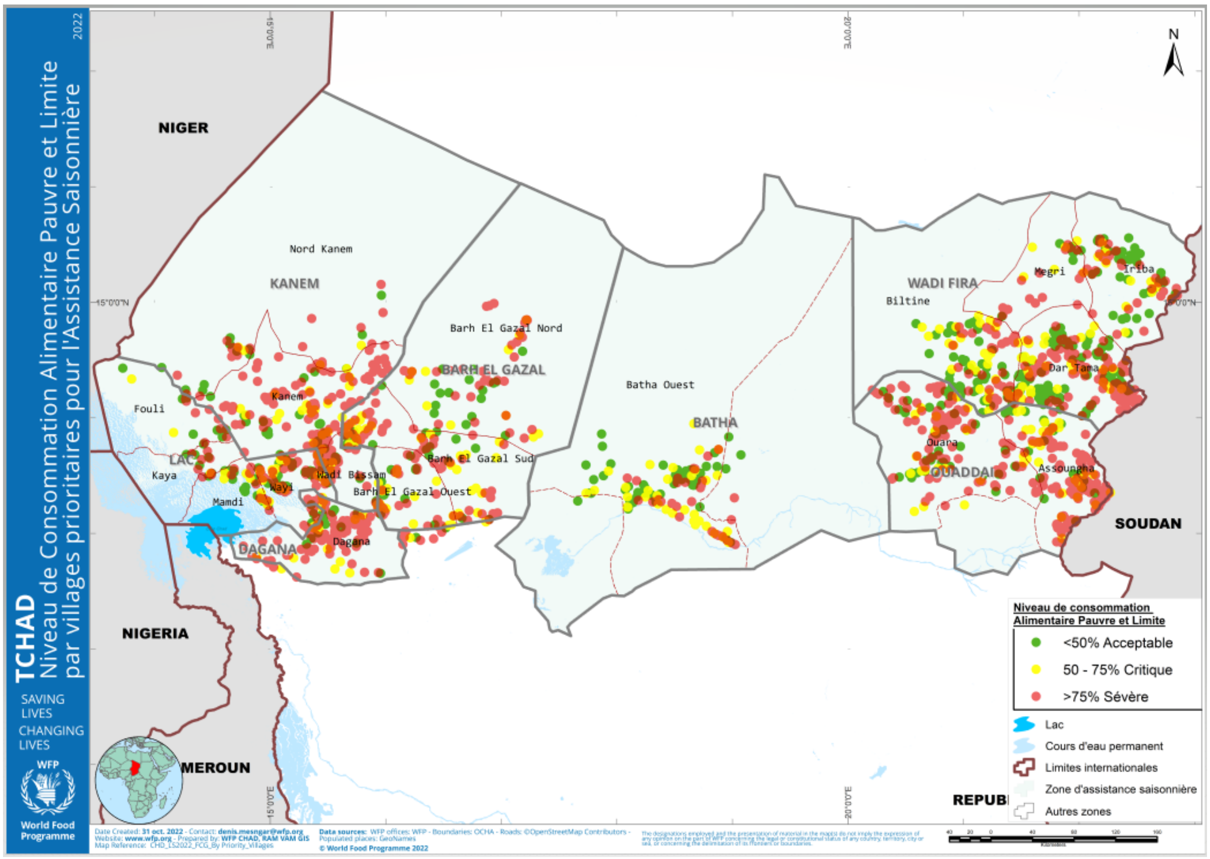

Figure 1: Map of food insecurity in the departments of interest (source: WFP, 2022)

The vulnerability analysis presented in this document also enabled to disaggregate the beneficiaries by sub-prefecture (administrative level 3) and canton (administrative level 4). This was well and consensually accepted by the working groups during the targeting exercise in June 2022, avoiding disagreements among authorities as it may have been the case previously, due to a lack of granular and objective data on which to base the prioritization process. The results derived from remote sensing indicators, together with the data from the general population census, made it possible to estimate the number of villages to be targeted to reach the planned beneficiaries.

DISCUSSION

The scope of the analysis and its acceptance during the geographic targeting workshops depends largely on the coverage of the department in terms of the number of villages analysed, but also on the composition of the participants.

Indeed, in areas where there was good coverage of GPS data such as Kanem and the Lake provinces, participants were more reassured because most villages had been analyzed and the results provided a ranking of entities according to their degree of vulnerability. This also prevented any subjectivity that some participants would have introduced in the absence of data. In these provinces, most of the analyses were validated by the audience. For example, in Kanem, the participants only gave their opinion when it came to selecting a certain number of villages from among several that had the same vulnerability scores. In future, this could be improved by adding more indicators to the analysis or a revison of the calculation approach depending on the context.

On the other hand, in areas where the number of geo-referenced villages was low, such as in Dagana and Wadi Fira (Megri), there was more room for subjective influence by the participants who evoked certain realities that could not be counter-verified. It is hoped that this part of the analysis will progressively improve as more villages are geo-referenced e.g., through ENSA surveys and other programme activities until they are all covered through the next national census.

Experience from the operationalization of this approach shows that for the geographic targeting workshops, it is important to have participants who know a given geographic area well enough to comment on the quality of the analysis during the process. However, it is important to ensure that these contributors understand and accept the principles of evidence- and vulnerability-based targeting. Also, the analysis is more objective when the participants/analysts are composed of technicians rather than political leaders of the areas in question. It is notable that in all targeting workshops where canton chiefs were invited to the workshops e.g. in Bahr El Gazal, there were more difficulties than solutions because of vested interests. In either case, introducing/reinforcing sessions on vulnerability and food insecurity prior to the workshop is recommended to ensure equal understanding of the guiding principles.

In all cases, the objective data provided by satellite imagery allowed us to retain between 60% and 95% of villages whose analyses indicate a high degree of vulnerability. It is in the departments of Dagana and Megri that a low validation rate was achieved due to the fact that few villages are geo-referenced.

CONCLUSIONS

Main findings

The use of remote sensing data in combination with census and survey data enabled the successful selection of lower-level geographic units (up to the village) with highest vulnerability.

The results were used by authorities and partners during the targeting exercise for the lean season 2022, conducted in June 2022. The results contributed to prioritization of 937,000 people considered as the most likely to be vulnerable during the lean season.

The unprecedented level of spatial precision provided by these results feeds into decision-making, as a tool to better target vulnerable communities at village-level. The list of localities that were identified as most affected by seasonal aspects helped WFP, the authorities, and other partners to better plan their seasonal response.

Lessons learnt

Remote sensing is a powerful and cost-effective tool to generate information about seasonal performance throughout the whole country. In particular, where there are limited options for detecting the effects of climate and seasonal patterns, the integration of satellite technology offers a solution to help cope with a lack of timely, long-term, homogeneous and reliable ground information.

To validate the results and ensure their acceptance by national agencies and other partners, a significant triangulation with official datasets and other data sources is essential.

Limitations

The hypothesis underlying the whole analysis is that the observed seasonal and climatic indicators, as sensed by satellite, have an impact on livelihoods on the ground, and so on food security of households living in the corresponding village. Not all aspects that should be taken into account to prioritize a response in terms of vulnerabilities can be monitored via remotely sensed data. Indeed, the interpretation of satellite data does not replace field surveys. Results should thus be further investigated with communities to evaluate the impacts of those changes.

The list of indicators can be completed and improved with other existing, relevant ones. It must be noted too that positive anomalies, especially for rainfall, if they are too extreme, should not be taken as a positive impact in the calculation of the final index, given that too much rainfall may negatively impact the area of interest (flooding, too much rain can prevent certain crops to grow, etc.).

The absence of shape files below admin2 level is a significant challenge which is made worse by the fact that in some departments, the percentage of villages that are geo-referenced is low. While an approach to resolve this was developed in the framework of the implementation e.g. through dedicated GPS coordinate data collection activities, it remains inadequate. There is need for systemic support and advocacy for the Government to resolve this issue.

Way forward / recommendations

1 > STRENGTHEN the technical capacity of government, national early warning systems and partners in using satellite-derived data, to ensure appropriation of the technology and its integration into existing national information systems and decision-making mechanisms.

2 > INVOLVE line ministries, technical services and all partners with a participatory approach upfront at key steps of the analysis and a broad validation afterwards, in order to ensure adequate appropriation of the satellite-derived results by all counterparts.

3 > REFINE the methodology with further research in collaboration with specialised institutions and to with the view to develop more rigorous analytic models and improve the accuracy in selection of villages

4 > EXPLORE how to automate this analysis step to make the process faster and better.

5 > EXPAND to other contexts by replicating a similar exercise in other countries where WFP is operating and run it over time to consistently feed humanitarian response with updated information.

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