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Integrated and Enhanced Datasets on Food Security and Household Coping Strategies in the G5 Sahel Countries (2018-2023)

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Abstract

This report describes the methodology and output behind the integration and enhancement of nationally representative household surveys on food security and coping strategies implemented in the G5 Sahel countries between 2018 and 2023. Whereas the data integration process involves the harmonization of variables across multiple cross-sectional surveys, the enhancement procedure focuses on adding shock data on multiple dimensions of political violence, food price anomalies, and climate- and weather-related events. Despite shortcomings in data quality and exhaustivity, the resulting datasets represent a unique playground to study the interaction between shocks and stressors on the one hand and household coping strategies and their impact on food security on the other hand.

Keywords: G5 Sahel, food security, coping strategies, shocks, Mali, Burkina Faso, Niger, Chad

Introduction

Following the 2023 Humanitarian Needs and Requirements Overview of UNOCHA, more than 30% of people in the Sahel region are in need of humanitarian assistance and protection (UNOCHA 2023). This staggering figure is the outcome of a complex and mutually reinforcing set of drivers, involving increased conflict and political instability, climate variability and increased pressure on natural resources, hunger and food insecurity, and migration and forced displacement. Indeed, multiple sources indicate that the number of conflict incidents have steadily increased since 2015 and have spread to coastal West African countries, that food security is likely to further deteriorate in 2024 while at the same time remaining a recurrent issue, that changing temperature and rainfall patterns impose considerable challenges to people's rural livelihoods, and that the number of displaced people in the Sahel region has reached an all-time high (UNOCHA 2023; WFP & FAO 2023; Nsaibia 2022; CILSS 2023; Yobom 2020; Gangneron et al. 2022).

Despite the intuition behind the co-movement of observed trends, it is often difficult to neatly assign attribution or control for endogeneity within this complex web of intertwined factors. In addition, the exact impact on people's livelihoods, in the short and longer term, depends on the coping strategies adopted by households, which is contingent upon their coping capacity, as well as on past and future shocks expected at any given time and location. To gain more insight into the coping strategies of Sahelian households when confronted with shocks and stressors of different kinds, this metadata report presents the methodology and resulting output contained in the integrated and enhanced datasets on food security and household coping strategies of Mali, Burkina Faso, Niger, and Chad between 2018 and 2023.[1]

To achieve this, the next section describes the integration and harmonization of data collected through a series of household food security surveys conducted in each of the four countries between 2018 and 2023. These surveys, implemented by national institutes of statistics and technically supported by WFP, are generally representative at the second-tier administrative level and cover data on the household's socio-demographical status, its food security situation and the coping strategies adopted. A subsequent section presents the methodology to derive detailed shock profiles of conflict and political violence, food price anomalies, and climate and weather variability. These profiles are added to the above integrated household datasets based on the location and timing of shocks, whereby the former refers to the second-level administrative areas in the G5 Sahel region and the latter to the precise inter-survey periods. The final section discusses key reflections and points of attention when using these integrated and enhanced datasets for the study of household coping behavior in multi-shock environments.

[1] While Mauritania is part of the so-called G5 Sahel, the country's data architecture did not allow for the compilation of an integrated and enhanced dataset on food security and household coping strategies.

Integration of cross-sectional data on food security and household coping

General approach

To inform the *Cadre Harmonisé* (CH) process in each of the countries, large-scale national household surveys are implemented (typically) twice a year to capture information on the household's socio-demographical status (especially of the household head), its food security situation (using a variety of indicators) and the several consumption- and livelihoods-based strategies adopted by the household to cope with food insecurity. These surveys typically take place around February-March (half-way the lean season) and September-October (at the end or after the harvesting period), and they are generally representative at the second-tier administrative level. Despite their different naming (that is, ENISAN in Burkina Faso, ENSA in Chad, ENSAN in Mali, and EVIAM in Niger) and the methodological changes introduced over the years, these surveys have a large common set of variables that can be pooled together to analyze trends or conduct comparative studies on food security. The general approach adopted to integrate the several cross-sections involves the selection and standardization of modalities of all common variables found in the survey waves between 2018 and 2023.[2]

Overview of variables

Table 1 presents an overview of key common variables across all waves in the four Sahel countries.[3]

The first subset of variables involves data related to identification (hhid), timing (year-wave), location (admin0Pcod-area), and sampling weights (weight). While most of these variables are straightforward, the following observations are important. First, household IDs could not be retrieved for two waves of Mali ("sep-oct 2022" and "feb-mar 2023"), three waves of Niger ("sep-oct 2018", "sep-oct 2021" and "sep-oct 2022") and all waves in Burkina Faso (except for "feb-mar 2019"). The underlying reason for these missing household IDs in part stems from the tight controls imposed by national governments regarding the collection and sharing of household data, as well as from legitimate privacy concerns leading to the removal of many socio-economic variables (including household IDs). This said, it has been assured that all households are unique observations in each wave. Second, for the location variables, we used the geographic datasets and administrative coding system of UNOCHA, which is the main reference used by most humanitarian and development partners in the Western Sahel.[4] This dataset consists of 232 second-level administrative areas, covering 45 provinces in Burkina Faso, 70 departments in Chad, 50 cercles in Mali, and 67 departments in Niger. While several countries introduced changes to their official administrative boundaries between 2018 and 2023, we mapped all households to this administrative delimitation. Third, the integrated datasets of Chad and Niger contain no information on the area type (urban/rural) where households are living, while the same information is very incomplete for Burkina Faso. Fourth, the sampling weights assigned to enumeration areas are based on the sampling frames and corresponding demographic data maintained at WFP country offices in collaboration with national public partners. While representativeness at the second-tier administrative level is pursued in each country, this objective is not always guaranteed given the lack of reliable and recent demographic information. For

[2] This data integration process was largely conducted by a team of WFP in the Regional Bureau of Dakar (Senegal), and technically supported by the authors of this report. Lacking a dedicated data architecture (especially for the 2018 and 2019 waves), this process required a reconsolidation and reprocessing of the initial raw data files. Given methodological revisions over time and to assure consistency across the waves, a substantial part of this work involved recomputing key coping strategy and food security indicators. Consequently, it is important to highlight that results obtained from these integrated datasets do not necessarily correspond with those presented in the original survey reports.

[3] While a brief explanation is provided below, we refer the interested reader to WFP's VAM Resource Centre for more documentation on the exact methodologies behind the construction of key coping strategies and food security indicators (see: https://resources.vam.wfp.org).

[4] UNOCHA geographic datasets are published on HDX, see https://data.humdata.org/dataset/sahel-administrative-boundaries.

example, it is important to highlight that the sampling weights linked to the "feb-mar 2020" wave in Chad are on average around six to nine times smaller compared to the preceding and subsequent waves; yet with proportions across administrative areas remaining roughly constant. The same applies to the sampling weights assigned to the “sep-oct 2023” wave in Burkina Faso, which are almost three times higher than the preceding waves.

The second subset of variables concerns information about the household head, in terms of gender, marital status and education level (sex_head-education_head). To align data across the waves, several modalities on education level have been reclassified in broader groups. Despite being basic information, the data on marital status and education level of the household head could not be retrieved for two entire waves in Burkina Faso (that is, the “sep-oct 2019” and “feb-mar 2020” waves), and are also often missing in the “sep-oct 2022” wave of Niger.

The third subset of variables involves data on livelihood- and consumption-based coping strategies (Lcs_stress_DomAsset-rCSI). Regarding livelihood-based coping, the integrated datasets cover a series of individual household strategies to cope with food insecurity. These strategies are categorized according to their severity level in three classes (that is, stress, crisis, and emergency), and households can respond whether they resorted to each of these strategies in the past 30 days or whether these strategies were already depleted in the past 12 months. The Livelihood Coping Strategies index (LCS) then reflects the most severe strategy adopted within a list of ten strategies, among which four stress, three crisis and three emergency strategies.[5] Consumption-based coping is measured through a classification of the reduced Coping Strategy Index (rCSI) into three categories (that is, an index ranging from 0-3, 4-18, or ≥19). The rCSI itself is the result of a weighted sum of frequency scores based on five individual consumption strategies adopted in the past seven days, such as eating less preferred food items and reducing portion sizes.

The fourth and final subset concerns a series of food security indicators (FCS-CARI). The Food Consumption Score (FCS) is a measure of food group (8) consumption frequency over the past seven days with assigned weights reflecting nutritional density, and ranges from 0-112. Based on thresholds defined by WFP country offices, the FCS is classified into poor, borderline and acceptable food consumption, which is the variable retained in the integrated datasets. The Household Dietary Diversity Score (HDDS) is based on 24-hour recall of food consumption within 12 food groups. The variable retained again concerns a classification of HDDS into five frequency groups (that is, 0-1 groups, 2 groups, 3 groups, 4 groups, and ≥5 groups). The Household Hunger Scale (HHS) is a household food deprivation measure based on three questions pertaining to the past 30 days (that is, lacking food in house, going to sleep hungry, and going a full day without eating) and several frequency modalities (rarely, sometimes, and often), resulting in a scale from 0-6. This scale is reduced to five categories within the integrated datasets (that is, 0, 1, 2-3, 4, and 5-6).[6] Finally, the Consolidated Approach for Reporting Indicators (CARI) is a summary indicator of food insecurity, which is based on four key indicators: that is, FCS and rCSI to proxy current food insecurity status, and a measure of economic vulnerability combined with LCS to proxy the coping capacity of households. These indicators are converted into a 4-point CARI scale, before they are averaged and rounded to the nearest integer to yield the final outcome, labelled as food secure, marginally food secure, moderately food insecure, and severely food insecure.

[5] The list of individual livelihood-based coping strategies in the integrated datasets is often longer than ten items, which relates to the flexibility given to WFP country offices to either adjust the list of ten strategies depending on the precise context at every new survey wave, or to add other individual strategies beyond the ten selected for the Livelihood Coping Strategies index.

[6] HHS has not been surveyed in the “sep-oct 2018” and “feb-mar 2019” waves of Chad.

Table 1: Variable overview of the integrated household datasets, G5 Sahel (2018-2023)

Subset	Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
Identification	hhid	Household ID	Identifiant Unique
Timing	year	Year	Année
	wave	Wave	Vague
Location	admin0Pcod	ADMIN0PCOD	ADMIN0PCOD
	admin0name	ADMIN0NAME	ADMIN0NAME
	admin1Pcod	ADMIN1PCOD	ADMIN1PCOD
	admin1name	ADMIN1NAME	ADMIN1NAME
	admin2Pcod	ADMIN2PCOD	ADMIN2PCOD
	admin2name	ADMIN2NAME	ADMIN2NAME
	area	Area type	Milieu de Résidence
Weight	weight	Weight	Poids/Pondération
Household head	sex_head	Gender of household head	Sexe du chef de ménage
	marital_head	Marital status of household head	Situation matrimoniale du chef de ménage
	education_head	Education level of household head	Niveau d'éducation du chef de ménage
Coping strategies	Lcs_stress_DomAsset	Selling household assets or goods (radio, furniture, television, jewelry)	Vente d'actifs ou de biens du ménage (radio, meubles, télévision, bijoux)
	Lcs_stress_Saving	Spending savings	Dépense de l'épargne
	Lcs_stress_EatOut	Sending household members to eat elsewhere	Envoi des membres du ménage pour manger ailleurs
	Lcs_stress_BorrowCash	Borrowing money to cover food needs	Prêt d'argent pour couvrir les besoins alimentaires
	Lcs_stress_BorrowFood	Buying food on credit	Achat de la nourriture à crédit
	Lcs_stress_MoreLabour	Resorting to casual labor more than usual	Recours au travail occasionnel plus que d'habitude
	Lcs_stress_Animals	Selling animals more than usual	Vente d'animaux plus que d'habitude
	Lcs_crisis_ProdAssets	Selling productive assets or means of transport (wheelbarrow, bicycle)	Vente d'actifs productifs ou de moyens de transport (brouette, vélo)
	Lcs_crisis_Edu_Health	Reducing essential non-food expenditures (education/health)	Réduction des dépenses non alimentaires essentielles (éducation/santé)
	Lcs_crisis_HHSeparation	Sending one or more household members to live elsewhere	Envoi d'un ou plusieurs membres du ménage à vivre ailleurs
	Lcs_crisis_ChildWork	Child labor (<15 years) to contribute to household income	Travail des enfants (< 15 ans) pour contribuer au revenu du ménage
	Lcs_crisis_OutSchool	Withdrawing children from school	Retrait des enfants de l'école
	Lcs_crisis_Health	Reducing health expenditures (including drugs)	Réduction des dépenses de santé (y compris les médicaments)
	Lcs_crisis_EatCrops	Harvesting and consumption of immature crops	Récolte et consommation des cultures immatures
	Lcs_crisis_AgriCare	Reducing expenditures on fertilizers, pesticides or fodder	Réduction des dépenses en engrais, pesticides ou fourrage
	Lcs_crisis_Seed	Consuming seed stocks reserved for the next season	Consommation des stocks de semences réservés pour la saison suivante
	Lcs_em_Migration	Migrating one or more household members informally/irregularly	Migration d'un ou plusieurs membres du ménage de manière informelle/irrégulière
	Lcs_em_ResAsset	Mortgaging/selling the house/land where the household was permanently living	Hypothèque/vente de la maison/terrain où vivait le ménage en permanence
	Lcs_em_Begged	Begging or asking strangers for money/food	Mendicité ou demande de l'argent/nourriture à des étrangers
	Lcs_em_IllegalAct	Engagement in socially degrading, high-risk or exploitative jobs	Engagement dans des emplois socialement dégradants, à haut risque ou exploitants
	Lcs_em_FemAnimal	Selling of last female animals	Vente des derniers animaux femelles
	LCS	Livelihood Coping Strategies (LCS) index - Category	Indicateur des Stratégies d'Adaptation des Moyens de subsistance (LCS) - Catégorie
	rCSI	Reduced Coping Strategies Index (rCSI) - Category	Indice des Stratégies d'Adaptation réduit (rCSI) - Catégorie
Food security	FCS	Food Consumption Score (FCS) - Category	Score de Consommation Alimentaire (SCA) - Catégorie
	HDDS	Household Dietary Diversity Score (HDDS) - Category	Score de Diversité Alimentaire des Ménages (SDAM) - Catégorie
	HHS	Household Hunger Scale (HHS) - Category	Indice Domestique de la Faim (HHS) - Catégorie
	CARI	Consolidated Approach for Reporting Indicators (CARI) - Category	Approche Consolidée pour le Compte-rendu des Indicateurs (CARI) – Catégorie

Notes: The integrated and enhanced datasets retain the English variable name, the French variable label, and (if applicable) the English modalities.
Source: Compilation based on common variables in ENISAN, ENSA, ENSAN, and EVIAM surveys.

Integrated dataset samples by country

The following tables present the final samples of the four countries covering the number of households surveyed in each wave and second-level administrative area.

Table 2 presents the integrated dataset sample of Mali based on the ENSAN surveys implemented in 50 cercles across 11 waves. In total, 123,382 households were surveyed between 2018 and 2023. Due to budget constraints, the ENSAN surveys of early 2019 and early 2021 could not be implemented or were less comprehensive in Bamako and several cercles in Kayes, Koulikoro, Segou, and Sikasso. In addition, the entire “feb-mar 2022” wave had to be skipped.

Table 3 presents the integrated dataset sample of Chad based on the ENSA surveys implemented in 69 departments across 11 waves.[7] In total, 145,381 households were surveyed between 2018 and 2023. No survey, however, was implemented in the first half of 2018.

Table 4 presents the integrated dataset sample of Niger based on the EVIAM surveys implemented in 67 departments across 7 waves. In total, 90,074 households were surveyed between 2018 and 2023. Due to financial constraints, no surveys were implemented in February-March 2018, 2019, 2022 and 2023, as well as in September-October 2019. In addition, the “feb-mar 2021” wave was much less comprehensive due to high levels of insecurity in several locations. In those cases, face-to-face interviews were replaced by phone surveys following the mVAM protocol developed by WFP. Given their distinct methodological design, the mVAM data are not integrated in this dataset.

Table 5 presents the integrated dataset sample of Burkina Faso based on the ENISAN surveys implemented in 45 provinces across 9 waves. In total, 65,345 households were surveyed between 2018 and 2023. Again, budget constraints explain why no surveys were implemented in February-March 2018 and in September-October 2018 and 2020.

[7] The capital region of N'Djamena was not covered by the ENSA surveys.

Table 2: Sample overview of integrated household dataset, Mali (2018-2023)

Region Cercle	feb-mar 2018	sep-oct 2018	feb-mar 2019	sep-oct 2019	feb-mar 2020	sep-oct 2020	feb-mar 2021	sep-oct 2021	sep-oct 2022	feb-mar 2023	sep-oct 2023	TOTAL
Bamako												
Bamako	1,202	1,200		1,526	1,527	1,963	901	1,959	1,810	815	2,145	15,048
Gao												
Ansongo	127	150	130	441	437	554	150	568	197	150	517	3,421
Bourem	150	150	150	322	322	413	149	387	365	150	365	2,923
Gao	160	160	160	469	476	612	150	612	583	138	552	4,072
Menaka	150	150	150	306	280	396	150	396	394	168	848	3,388
Kayes												
Bafoulabe	140	130		175	183	234		235	229	134	257	1,717
Diema	150	150		343	203	261	150	261	224	90	249	2,081
Kayes	260	250		182	182	234	150	234	226	138	250	2,106
Kenieba	150	130		175	175	225		224	212	132	244	1,667
Kita	220	217		196	202	252		242	260	135	251	1,975
Nioro	200	200		182	182	232	150	219	232	150	259	2,006
Yelimane	150	150		175	174	225	150	225	225	129	250	1,853
Kidal												
Abeibara	150	148	150	154	149	199	151	198	154	187	100	1,740
Kidal	150	143	150	317	307	396	153	406	390	100	503	3,015
Tessalit	150	151	150	307	291	396	150	392	223	177	380	2,767
Tin-Essako	150	155	150	155	168	207	148	216	215	98	18	1,680
Koulikoro												
Banamba	150	150		252	210	270		270	260	135	259	1,956
Dioila	270	270		196	196	252		252	252	135	243	2,066
Kangaba	150	150		175	175	224		225	201	121	250	1,671
Kati	299	299		174	211	271		271	263	135	250	2,173
Kolokani	149	150		217	203	261		252	250	133	250	1,865
Koulikoro	151	150		184	182	234		234	224	134	258	1,751
Nara	148	150		182	182	234	140	201	188	135	214	1,774
Mopti												
Bandiagara	261	260	220	126	161	216	150	233	146	146	260	2,179
Bankass	190	190	190	175	175	225	150	221	157	136	260	2,069
Djenne	150	139	140	154	197	234	150	240	162	135	296	1,997
Douentza	160	160	161	147	147	198	150	140	147	24	259	1,693
Koro	229	220	219	140	140	208	150	234	144	150	260	2,094
Mopti	220	229	239	231	232	336	150	342	199	146	383	2,707
Tenenkou	151	90	100	167	175	295	148	307	193	140	337	2,103
Youwarou	150	150	150	259	165	288	150	361	251	143	342	2,409
Segou												
Baroueli	150	150		196	195	252		251	250	134	278	1,856
Bla	180	180		182	181	234		234	234	121	253	1,799
Macina	140	130		319	175	225	150	228	225	133	247	1,972
Niono	170	230		175	175	242	150	197	243	91	341	2,014
San	230	230		210	209	270		270	246	132	294	2,091
Segou	246	230		211	226	288		288	288	131	328	2,236
Tominian	150	160		196	196	252	150	252	250	135	280	2,021
Sikasso												
Bougouni	250	250		182	217	279		279	280	133	243	2,113
Kadiolo	150	150		175	175	224		224	221	135	249	1,703
Kolondieba	140	150		196	196	252		252	251	135	276	1,848
Koutiala	239	240		189	189	243		242	184	134	249	1,909
Sikasso	240	239		217	222	288		288	287	120	316	2,217
Yanfolila	150	149		175	175	216		224	173	134	250	1,646
Yorosso	150	150		175	196	252	150	252	251	126	245	1,947
Tombouctou												
Dire	150	150	149	231	224	288	150	288	181	102	288	2,201
Goundam	140	140	150	297	350	454	150	450	379	81	485	3,076
Gourma-Rharous	140	140	129	294	384	501	150	603	584	150	672	3,747
Niafunke	140	140	140	176	280	387	150	403		88	447	2,351
Tombouctou	140	140	140	189	217	279	268	432	173	100	591	2,669
TOTAL	**9,782**	**9,739**	**3,317**	**12,189**	**12,191**	**15,971**	**5,508**	**16,214**	**13,676**	**7,154**	**17,641**	**123,382**

Source: Compilation based on ENSAN surveys.

Table 3: Sample overview of integrated household dataset, Chad (2018-2023)

Region Department	sep-oct 2018	feb-mar 2019	sep-oct 2019	feb-mar 2020	sep-oct 2020	feb-mar 2021	sep-oct 2021	feb-mar 2022	sep-oct 2022	feb-mar 2023	sep-oct 2023	TOTAL
Barh-El-Gazel												
Barh-El-Gazel Nord	145	309	136	416	201	168	228	206	230	240	228	2,507
Barh-El-Gazel Ouest	104		133	399	218	165	228	220	229	192	226	2,114
Barh-El-Gazel Sud	149	159	152	413	205	169	228	236	230	265	230	2,436
Batha												
Batha Est	144	145	172	214	202	168	225	228	229	170	228	2,125
Batha Ouest	153	149	146	206	216	157	227	225	256	240	230	2,205
Fittri	144	147	144	208	216	178	226	231	198	241	227	2,160
Borkou												
Borkou	127	179	139	189	119	120	164	160	131	241	198	1,767
Borkou Yala	163	257	117	168	133	148	232	234	135	228	204	2,019
Chari-Baguirmi												
Baguirmi	146	145	144	209	207	174	226	222	220	252	182	2,127
Chari	143	154	144	204	204	170	204	228	228	248	224	2,151
Loug Chari	151	146	144	206	204	168	203	229	229	245	230	2,155
Ennedi Ouest												
Fada	127	121	143	189	199	165	181	168	193	227	231	1,944
Mourtcha	119	144	132	216	189	160	146	204	252	251	228	2,041
Ennedi-Est												
Am-Djarass	112	157	75	192	154	184	192	240	203	243	209	1,961
Wadi Hawar	147	156	75	193	191	182	170	146	216	253	212	1,941
Guera												
Abtouyour	149	150	145	205	210	168	228	207	231	257	192	2,142
Barh Signaka	142	144	144	198	208	168	227	225	230	238	224	2,148
Guera	138	142	132	205	204	167	229	223	234	245	210	2,129
Mangalme	142	149	148	215	216	164	241	217	150	255	214	2,111
Hadjer-Lamis												
Dababa	148	150	186	210	210	175	228	228	228	252	228	2,243
Dagana	144	150	150	210	210	167	228	228	228	252	228	2,195
Haraze Al Biar	155	153	144	209	204	170	228	223	227	252	218	2,183
Kanem												
Kanem	168	179	144	485	204	168	228	230	240	225	191	2,462
Nord Kanem	108	180	144	487	204	168	228	229	228	193	217	2,386
Wadi Bissam	96	178	137	508	207	170	206	225	228	192	231	2,378
Lac												
Fouli	144	137	141	210	204	171	226	225	232	252	215	2,157
Kaya	145	146	146	204	195	168	227	244	219	254	228	2,176
Mamdi	148	146	133	192	204	168	203	231	227	248	219	2,119
Wayi	143	145	140	216	204	168	229	223	215	252	213	2,148
Logone Occidental												
Dodje	143	149	113	197	202	178	186	229	206	251	229	2,083
Gueni	142	132	108	204	202	165	205	213	232	252	230	2,085
Lac Wey	150	127	148	203	204	150	212	229	224	254	216	2,117
Ngourkosso	146	118	144	203	205	162	211	222	227	257	228	2,123
Logone Oriental												
Kouh Est	141	153	154	191	203	182	219	230	239	254	201	2,167
Kouh Ouest	139	153	146	190	207	178	224	232	231	252	198	2,150
La Nya Pende	144	145	145	200	208	116	230	229	228	272	224	2,141
La Pende	143	145	140	204	171	154	228	226	228	234	217	2,090
La nya	143	144	136	212	202	180	225	239	223	230	229	2,163
Monts de Lam	144	140	143	205	199	212	226	232	228	260	217	2,206
Mandoul												
Barh Sara	145	143	136	202	206	166	204	226	226	213	202	2,069
Mandoul Occidental	146	156	145	203	184	169	240	229	245	230	221	2,168
Mandoul Oriental	147	156	141	214	203	171	228	230	223	254	230	2,197
Mayo Kebbi Est												
La Kabbia	146	143	143	207	198	173	224	227	217	253	225	2,156
Mayo Boneye	146	140	152	213	213	169	229	229	157	248	237	2,133
Mayo Lemye	144	152	151	222	187	167	228	228	139	255	228	2,101
Mont Illi	121	145	144	205	153	168	207	228	224	252	219	2,066
Mayo-Kebbi Ouest												
Lac Lere	144	142	144	211	189	154	227	230	230	252	226	2,149
Mayo Dallah	138	144	143	203	201	168	228	228	228	253	186	2,120
Mayo-Binder	130	148	152	212	192	143	198	232	228	253	174	2,062
Moyen-Chari												
Bahr Koh	145	143	153	203	203	167	227	228	218	228	206	2,121
Grande Sido	147	147	141	210	174	169	229	230	229	205	233	2,114
Lac Iro	143	141	151	204	186	168	226	227	204	238	210	2,098
Ouaddai												
Abdi	147	146	278	209	204	168	228	238	229	253	230	2,330

Assoungha	145	148	145	210	206	171	226	228	234	242	232	2,187
Ouara	144	153	145	212	204	165	228	228	228	240	228	2,175
Salamat												
Aboudeia	144	166	146	207	215	178	214	189	226	252	215	2,152
Bahr Azoum	146	138	149	207	182	178	256	205	223	250	222	2,156
Haraze Mangueigne				219		181		214		252		866
Sila												
Djourf Al Ahmar	144	163		206	212	168	232	230	228	208	228	2,019
Kimiti	133	154	155	212	198	168	230	225	233	252	228	2,188
Tandjile												
Tandjile Centre	132	145	149	203	178	170	228	219	228	259	231	2,142
Tandjile Est	143	275	151	204	193	175	229	232	228	252	232	2,314
Tandjile Ouest	148	264	140	207	197	165	204	225	222	252	231	2,255
Tibesti												
Tibesti Est	84		55	138	82	168	118	137	217	149	245	1,393
Tibesti Ouest	30		89	105	88	126	133	175	159	202	123	1,230
Wadi Fira												
Biltine	141	157	135	213	197	169	228	228	215	243	214	2,140
Dar Tama	152	146	147	215	206	161	225	228	228	258	228	2,194
Iriba	148	155	156	204	204	173	226	169	228	239	228	2,130
Megri	141	122	140	190	204	168	228	228	215	207	158	2,001
TOTAL	**9,443**	**10,155**	**9,483**	**15,455**	**13,204**	**11,517**	**14,730**	**15,186**	**14,871**	**16,563**	**14,774**	**145,381**

Source: Compilation based on ENSA surveys.

Table 4: Sample overview of integrated household dataset, Niger (2018-2023)

Region Department	sep-oct 2018	feb-mar 2020	sep-oct 2020	feb-mar 2021	sep-oct 2021	sep-oct 2022	sep-oct 2023	TOTAL
Agadez								
Aderbissinat	185	396	200		240	200	195	1,416
Arlit	199	595	200		240	198	195	1,627
Bilma	350	550	199		240	172	195	1,706
Iferouane	180	558	198		240	192	194	1,562
Ingall	198	551	200		240	200	195	1,584
Tchirozerine	236	589	200		239	376	192	1,832
Diffa								
Bosso						130		130
Diffa	877	288				285	157	1,607
Goudoumaria	320	375	200	259	240	200	195	1,789
Maïné Soroa	916	280	200	260	240	263	195	2,354
N'Gourti	291	200	200	260	231	193	195	1,570
N'Guigmi	640	215				137		992
Dosso								
Boboye	418	195	200		233	197	195	1,438
Dioundiou	317	200	199		239	199	195	1,349
Dogondoutchi	378	99	200	254	240	324	196	1,691
Dosso	253		200		239	400	195	1,287
Falmey	534	226	180		240	197	195	1,572
Gaya	416	218	180		240	198	195	1,447
Loga	199	200	201		239	200	194	1,233
Tibiri	198	224	200		240	200	194	1,256
Maradi								
Aguié	199	201	200		239	199	196	1,234
Bermo	261	321	184		239	200	188	1,393
Dakoro	300	200	200		239	200	195	1,334
Gazaoua	260	461	199		240	200	194	1,554
Guidan Roumdji	382	178	200	259	240	380	195	1,834
Madarounfa	338	142	200	258	225	265		1,428
Mayahi	311	198	199		236	199	195	1,338
Tessaoua	265	319	200		240	199	193	1,416
Ville de Maradi						198	195	393
Niamey								
Ville de Niamey	455	214	201		240	200	195	1,505
Tahoua								
Abalak	220	201	196	260	240	200	194	1,511
Bagaroua	608	499	199	260	240	195	195	2,196
Birni N'Konni	317	396	200		240	192	194	1,539
Bouza	363	430	199		237	200	195	1,624
Illéla	336	300	200		240	198	194	1,468
Keita	596	420	200	259	240	200	193	2,108
Madaoua	275	197	200		240	200	194	1,306
Malbaza	377	195	197		238	200	195	1,402
Tahoua	509		200		233	322	195	1,459
Tassara	361				239	60		660
Tchintabaraden	435	259	200	246	212	200	195	1,747
Tillia	314					80		394
Ville de Tahoua		197				183	195	575
Tillabéri								
Abala	242					137		379
Ayerou	200		200			148		548
Balleyara	533	493		260	240	197	190	1,913
Banibangou	327					90		417
Bankilaré	260					82		342
Filingué	198	250	199	242	240	162		1,291
Gothèye	435	240	154	260	238	92		1,419
Kollo	326	199	198	259	237	200	194	1,613
Ouallam	311	376	99	260	229	330	194	1,799
Say	559	240	160	240	239	337	195	1,970
Tillabéri	277	216	199	260	235	518	195	1,900
Torodi	322					102		424
Téra	221	145	170	171	232	198		1,137
Zinder								
Belbedji	197	396	200		235	196	194	1,418
Damagaram Takaya	293	198	199		239	194	194	1,317
Dungass	536	392	200		240	200	195	1,763
Gouré	375	198	200		239	193	195	1,400
Kantché	270	200	200		240	200	195	1,305
Magaria	281	234	200		238	198	195	1,346

Mirriah	197	196	200		238	199	194	1,224
Takeita	224	336	200		240	200	195	1,395
Tanout	198	196	200		240	200	195	1,229
Tesker	190	255	199		240	194	195	1,273
Ville de Zinder						197	195	392
TOTAL	**21,559**	**16,047**	**10,508**	**4,527**	**13,076**	**13,895**	**10,462**	**90,074**

Source: Compilation based on EVIAM surveys.

Table 5: Sample overview of integrated household dataset, Burkina Faso (2018-2023)

Region Province	feb-mar 2019	sep-oct 2019	feb-mar 2020	feb-mar 2021	sep-oct 2021	feb-mar 2022	sep-oct 2022	feb-mar 2023	sep-oct 2023	TOTAL
Boucle du Mouhoun										
Bale	61	88	263	150	141	120	130	120	120	1,193
Banwa	43	95	240	150	115	120	120	110	120	1,113
Kossi	66	241	240	150	239	242	205	231	298	1,912
Mouhoun	55	153	252	150	121	120	120	120	120	1,211
Nayala	62	93	264	150	100	111	120	120	300	1,320
Sourou	86	77	220	147	137	192	287	188	300	1,634
Cascades										
Comoe	43	128	264	151	120	120	121	120	219	1,286
Leraba	60	84	264	150	120	120	121	120	21	1,060
Centre										
Kadiogo	76	116	175	150	110	130	238	300	120	1,415
Centre-Est										
Boulgou	78	85	252	151	115	129	120	132	123	1,185
Koulpelogo	66	109	251	150	152	140	110	120	303	1,401
Kouritenga	90	92	252	150	196	241	261	330	243	1,855
Centre-Nord										
Bam	99	83	201	151	300	289	260	245	300	1,928
Namentenga	96	88	252	201	258	200	272	245	286	1,898
Sanmatenga	108	110	239	150	312	248	288	304	301	2,060
Centre-Ouest										
Boulkiemde	122	94	240	151	120	120	121	130	120	1,218
Sanguie	110	75	252	150	110	150	120	160	119	1,246
Sissili	42	86	240	150	120	120	120	120	122	1,120
Ziro	44	94	252	150	120	120	120	126	120	1,146
Centre-Sud										
Bazega	90	89	252	150	124	130	120	150	153	1,258
Nahouri	120	237	264	150	121	130	120	130	120	1,392
Zoundweogo	96	115	264	150	120	120	121	130	120	1,236
Est										
Gnagna	109	179	261	150	238	258	290	271	327	2,083
Gourma	72	83	250	206	194	241	251	270	300	1,867
Komonjdjari	116	77	144	199	91	105	217	263	300	1,512
Kompienga	84	67	145	147	275	134	120	216	300	1,488
Tapoa	121	216	227	150	175	108	302	261	291	1,851
Hauts-Bassins										
Houet	36	87	276	150	120	120	239	240	122	1,390
Kenedougou	78	221	264	150	120	120	120	120	120	1,313
Tuy	36	112	252	150	120	120	120	120	120	1,150
Nord										
Loroum	108	83	241	181	201	72	140	291	307	1,624
Passore	90	95	252	150	151	130	130	130	120	1,248
Yatenga	108	112	249	150	267	265	295	291	260	1,997
Zondoma	72	96	168	151	134	120	119	123	300	1,283
Plateau Central										
Ganzourgou	36	87	264	143	125	120	120	120	120	1,135
Kourweogo	54	80	252	160	149	130	164	150	120	1,259
Oubritenga	90	89	252	150	120	120	119	150	120	1,210
Sahel										
Oudalan	120	75		150	229	166	256	228	323	1,547
Seno	122	105	200	150	259	198	331	258	312	1,935
Soum	120	199	216	151	236	6	227	255	300	1,710
Yagha	121	93	190	150	179	131	360	250	250	1,724
Sud-Ouest										
Bougouriba	96	85	264	150	123	130	120	120	120	1,208
Ioba	86	165	252	150	120	121	117	140	120	1,271
Noumbiel	119	71	252	150	155	121	120	140	120	1,248
Poni	72	87	264	150	133	130	131	120	118	1,205
TOTAL	**3,779**	**4,996**	**10,528**	**6,940**	**7,285**	**6,578**	**8,023**	**8,278**	**8,938**	**65,345**

Source: Compilation based on ENISAN surveys.

Enhancement of integrated household datasets with shock information

General approach

To examine the relationship between covariate shocks and corresponding household coping strategies, the following sections detail how various shock indicators are computed and used to enhance the integrated datasets of Mali, Burkina Faso, Niger, and Chad. Conform the current challenges in the Sahel, these methodologies focus on conflict and political violence (by relying on ACLED's conflict index), economic shocks (as approached by food price anomalies), and several climate-based and weather variability shocks (using remote sensing data). To go beyond a mere counting and to better reflect the complex and multifaceted nature of shocks, the methods adopted aim to capture several dimensions, such as geographical dispersion or rebel group fragmentation in the case of political violence; mean intensity level or maximum duration for price hikes; average performance of the rainy season; and maximum spell of extreme weather events. These indicators are derived for all second-level administrative areas and for sequential periods of five and seven months, which roughly align with the inter-survey intervals of the integrated household datasets. While some deviations make perfect sense (see further below), the general assumption of the time assignment of the shock data is that households engage in particular coping strategies depending on the shock profile experienced in the *preceding* period.

Methodology on conflict and political violence

To capture shock information on conflict and political violence, we make use of the data and conflict index methodology developed by the Armed Conflict Location & Event Data project (ACLED).[8]

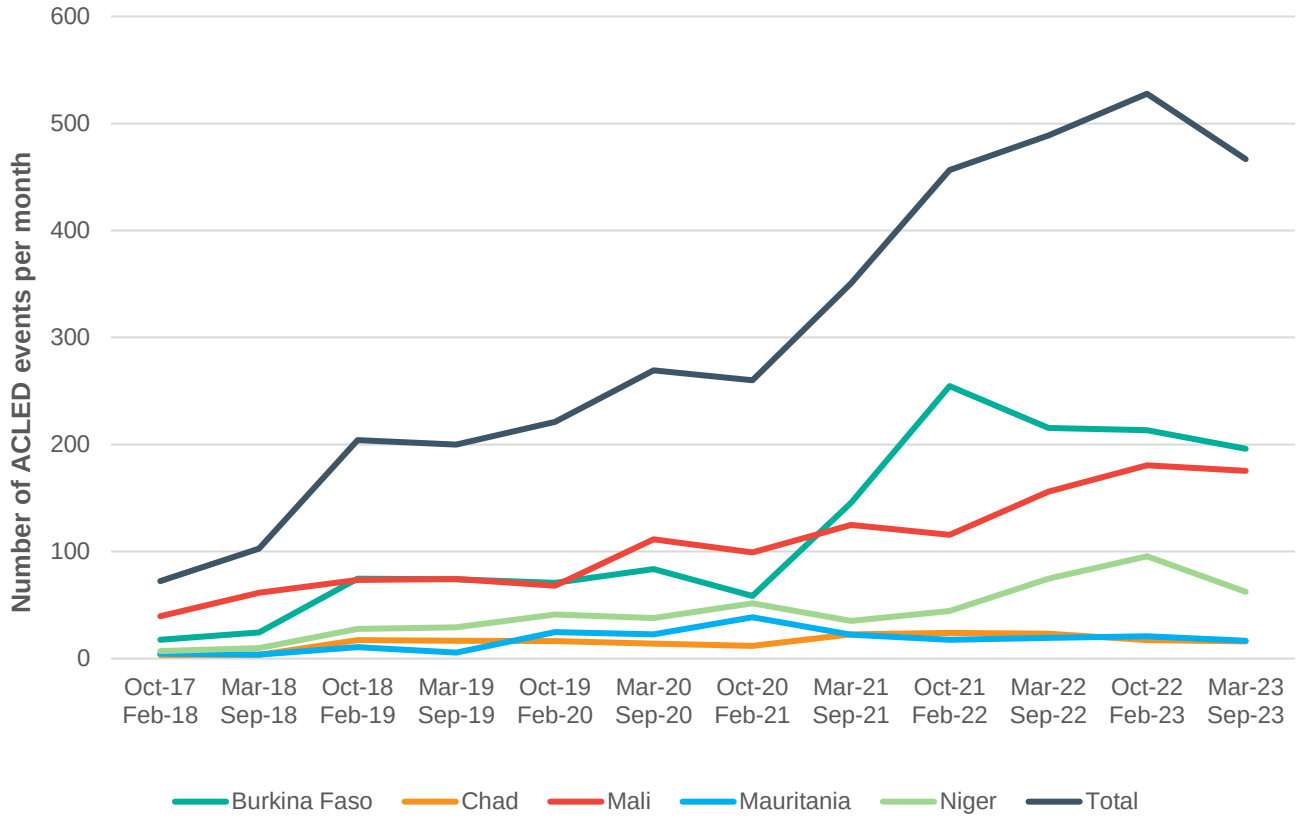
Based on tailor-made sourcing strategies per country and region, ACLED extracts key attributes from occurring political violence and demonstration events and makes the corresponding data and codebooks publicly accessible on its website.[9] The information gathered essentially involves dates, actors, locations, fatalities, and event types. The data used to enhance the integrated household datasets with information on conflict and political violence are extracted from the curated dataset for Africa published by ACLED on 15 March 2024.

Figure 1 displays the evolution of the number of ACLED events that are on average recorded per month in each of the G5 Sahel countries across the twelve inter-survey waves between October 2017 and September 2023. In total, we count 21,857 events, most of which have occurred in Burkina Faso (8,624) and Mali (7,807), followed by Niger (3,083), and finally Mauritania (1,220) and Chad (1,123). Compared to the initial waves, all countries have experienced an increase in the number of ACLED events in subsequent periods. Most salient in this respect are Burkina Faso, Mali, and Niger, while the evolution in the number of ACLED events in Mauritania and Chad was much less dramatic or has even plateaued in recent periods.

[8] For a temporally and spatially refined conflict profile on political violence in the G5 Sahel countries (2018-2023) or for more methodological detail regarding ACLED's conflict index methodology, we refer to Marivoet et al. (2024).

[9] Armed Conflict Location & Event Data project (ACLED): https://acleddata.com.

Figure 1: ACLED events, G5 Sahel (2017-2023)



Source: Based on ACLED's curated dataset for Africa (15 March 2024).

The ACLED conflict index is a ranking-based composite measure based on four underlying dimensions or indicators, which are deadliness, danger, diffusion, and fragmentation – with higher values each time pointing to worse or more difficult-to-resolve conflicts. For the purpose of this analysis, we compute the four constituent indicators for each second-level administrative area and for each 5- or 7-month inter-survey period between October 2017 and September 2023. While ACLED in total distinguishes six event types, 25 sub-event types, and three overarching disorder types, the focus of the ACLED conflict index is exclusively on political violence, which covers the "battle", "explosions/remote violence", and "violence against civilians" event types as well as the "excessive force against protesters" and "mob violence" sub-event types. This subset of events amounts to 14,375 observations, thus roughly representing two thirds of all recorded ACLED events over the same period.

Table 6 presents an overview of the four indicators used to construct the ACLED conflict index.[10]

The first dimension of the conflict index concerns **deadliness**, or the total number of fatalities reported from events classified as political violence within each second-level administrative area and each wave between October 2017 and September 2023. Given that the most conservative fatality rate is retained in case of conflicting reports, this dimension provides a lower-bound estimate of conflict intensity. The second indicator is **danger**, or the total number of events within the same administrative unit and inter-survey period that have targeted civilians, either as their main or exclusive target. This dimension not only has

[10] Given its ranking-based nature, the conflict index itself is not computed because the exact time or location reference depends on the purpose of the analysis. For example, fatalities may be ranked across all waves in one country or across one wave in all countries.

a direct impact on people and their immediate feelings of insecurity, but it may also provide an indication on the likelihood that these events continue or even proliferate as armed groups do not experience much resistance from civilians.

Table 6: Overview of ACLED's conflict index dimensions

Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
deadliness	Fatalities of political violence (number)	Décès dus à la violence politique (nombre)
danger	Civilian-targeting events (number)	Événements visant des citoyens (nombre)
diffusion	Geographical spread of political violence (%)	Répartition géographique de la violence politique (%)
fragmentation	Rebel groups and militias (number)	Groupes rebelles et milices (nombre)

Notes: The integrated and enhanced datasets retain the English variable name and the French variable label.
Source: Compilation based on the ACLED conflict index methodology.

The third dimension is **diffusion**, which is obtained using the geocoordinates of each political violence event combined with population data from WorldPop.[11] The construction of this indicator involves the following three steps. First, we overlay a 10x10km grid on all G5 Sahel countries. Second, to avoid scarcely populated areas having an unduly effect on the final diffusion indicator, we exclude all grid cells with less than 50 inhabitants, as estimated by the WorldPop datasets. Third, for each second-level administration area, we compute the proportion of eligible grid cells with three or more conflict events per wave.[12] As such, this indicator aims to capture the geographical spread of political violence within each administrative unit – with higher percentages pointing to more dispersed conditions of high-violence and assumably higher costs to resolve or reduce conflict (and vice versa). The fourth indicator measures **fragmentation**, approached by the number of distinct rebel groups and militias, either as main or associate actor, which are active in each second-level administrative area and during each wave. Similar to ACLED's methodology, this counting of groups excludes unidentified armed groups, includes pro-government militias, and limits the number of identity militias to a maximum of one group per third-level administrative unit.[13]

Methodology on food price shocks

To identify food price shocks for enhancing the integrated datasets, we make use of the data export tool of WFP to obtain food price information of retail markets in Mali, Burkina Faso, Niger, and Chad for the period from January 2012 to June 2024.[14] The price datasets downloaded for each country have been compiled from raw data collected by WFP, the countries' national institutes and other partners, such as SIM/SONAGESS in Burkina Faso, FEWSNET in Chad, OMA in Mali, and SIMA in Niger. While the exact survey procedure may slightly differ across the four countries, a common feature involves the dispatching of survey teams to selected urban and rural markets to collect food prices and measure corresponding weights on a monthly basis.[15]

Our methodology to capture food price anomalies and shocks consists of the following three steps.

[11] More specifically, this analysis relies on the "constrained individual countries 2020 UN adjusted (100-meter resolution)" datasets for Mali, Burkina Faso, Niger, and Chad (see: www.worldpop.org). Given the midpoint reference of 2020, it is assumed that any demographic change between 2018 and 2023 will have only a minor effect on the estimated diffusion indicator.

[12] Compared to ACLED's methodology and to capture more spatial variation, we decided to lower the eligibility threshold from 100 to 50 inhabitants and the identification threshold from 10 to 3 events.

[13] With this focus on third-tier administrative units, we in fact mimic ACLED's global country analysis, where first-level units are used to cap the number of identity militias.

[14] The final dataset used for this analysis was downloaded from https://dataviz.vam.wfp.org/economic/export-data/prices on June 5, 2024.

[15] Despite most measurements being in metric weights, livestock, leavy vegetables, and eggs are captured in heads, piles, and units, respectively.

The first step computes for each month and for a selected number of key commodities the average price level observed across all markets located in the same second-level administrative area.[16] The exact list of food items is obtained by combining information from three minimum expenditure baskets (MEB) as defined by authorities and technical partners in Burkina Faso, Chad, and Mali, while disregarding the individual items for which no price monitoring took place across the four countries.

Table 7 provides an overview of the number of price records compiled between 2012 and 2024 for the 15 food items thus identified at the second-tier administrative level. As can be noted, most attention has been devoted to the price monitoring of cereals and pulses.

Table 7: Overview of price records for selected food items (2012-2024)

	Burkina Faso	Chad	Mali[1]	Niger
Cereals				
Maize	5,146	2,413	3,784	5,846
Millet	5,487	3,920	4,682	6,248
Rice	3,634	2,344	4,668	6,163
Semolina	.	.	295	.
Sorghum	5,321	3,602	4,199	5,934
Pulses				
Cowpea	4,966	1,043	3,538	909
Peanut	1,576	1,497	3,372	.
Other food groups				
Potato	.	.	273	.
Onions	.	.	575	.
Oranges	.	.	290	.
Beef	.	.	611	.
Milk (powder)	.	.	606	.
Vegetable oil	.	.	624	.
Sugar	.	.	608	.
Salt	.	.	623	.

Note: [1] For Mali, red potatoes are assumed as they are the only type of potato occurring in the dataset. Further, given the imprecise MEB descriptions, beef meat and vegetable oil are assumed for the food groups of animal protein and oils as they generally have lower prices and/or more observations compared to goat/sheep meat and palm oil, respectively.
Source: Based on minimum expenditure baskets (MEB) defined for Burkina Faso, Chad, and Mali and on WFP's price datasets downloaded on June 5, 2024 (https://dataviz.vam.wfp.org/economic/export-data/prices).

The second step involves the determination of price anomalies for each of the selected food items within the country's second-level administrative areas. To achieve this, z-scores are computed, which indicate the number of standard deviations σ, that each price level p of a given year y and month m differs from its long-term average μ, defined as the average price level observed for the same month over the preceding five years. As such, these anomalies also account for the degree of observed past price volatility. Equation (1) provides a mathematical expression of the price anomalies used in this analysis.

$$z_m^y = \frac{\left[p_m^y - \mu_m^{y-1,y-5}\right]}{\sigma_m^{y-1,y-5}} \quad (1)$$

[16] While this aggregation may dissolve important price differences between urban and rural areas, the price data however do not allow to neatly distinguish between urban and rural markets. Furthermore, the observed price differences between both types of areas are assumed to be more limited at the relatively disaggregated admin2 levels, which follows from "economic arbitrage", in that urban households will try to acquire food in proximate rural markets if price opportunities exist (and vice versa), thus contributing to price convergence.

These z-scores closely resemble the Alert for Price Spikes (ALPS) indicator developed by WFP (2014), except for the fact that the long-term reference in ALPS is based on a fitted model as opposed to the average computed for the preceding five years. As summarized in Table 8, this analysis however applies the same thresholds as used in the ALPS methodology to label food price conditions as “normal”, “stress”, “alert” or “crisis”.

Table 8: Food price anomaly types, thresholds and corresponding color codes

Type	Thresholds	Color code
Normal	$(p - \mu)/\sigma < 0.25$	
Stress	$0.25 \leq (p - \mu)/\sigma < 1.00$	
Alert	$1.00 \leq (p - \mu)/\sigma < 2.00$	
Crisis	$2.00 \leq (p - \mu)/\sigma$	

Source: Based on the ALPS methodology (WFP 2014).

As an illustration, Figure 2 presents the evolution of millet prices in the department of Djenne in Niger between 2017 and 2023. While the solid and dashed lines respectively display the actual prices and the month-specific long-term averages, the bar chart presents the corresponding z-scores as derived using Equation (1). After an initial period with higher-than-normal prices, the period from halfway 2019 to September 2021 is roughly characterized by millet prices being slightly lower than their long-term average. Since October 2021, millet prices sharply went up and roughly stayed (much) higher than their long-term average until September 2023, when they returned to their expected value.

The third step concerns the aggregation of the above food price anomaly data for each second-level administrative area and each 5- or 7-month inter-survey interval between October 2017 and September 2023. For this time aggregation, three distinct shock dimensions are considered and summarized in Table 9.

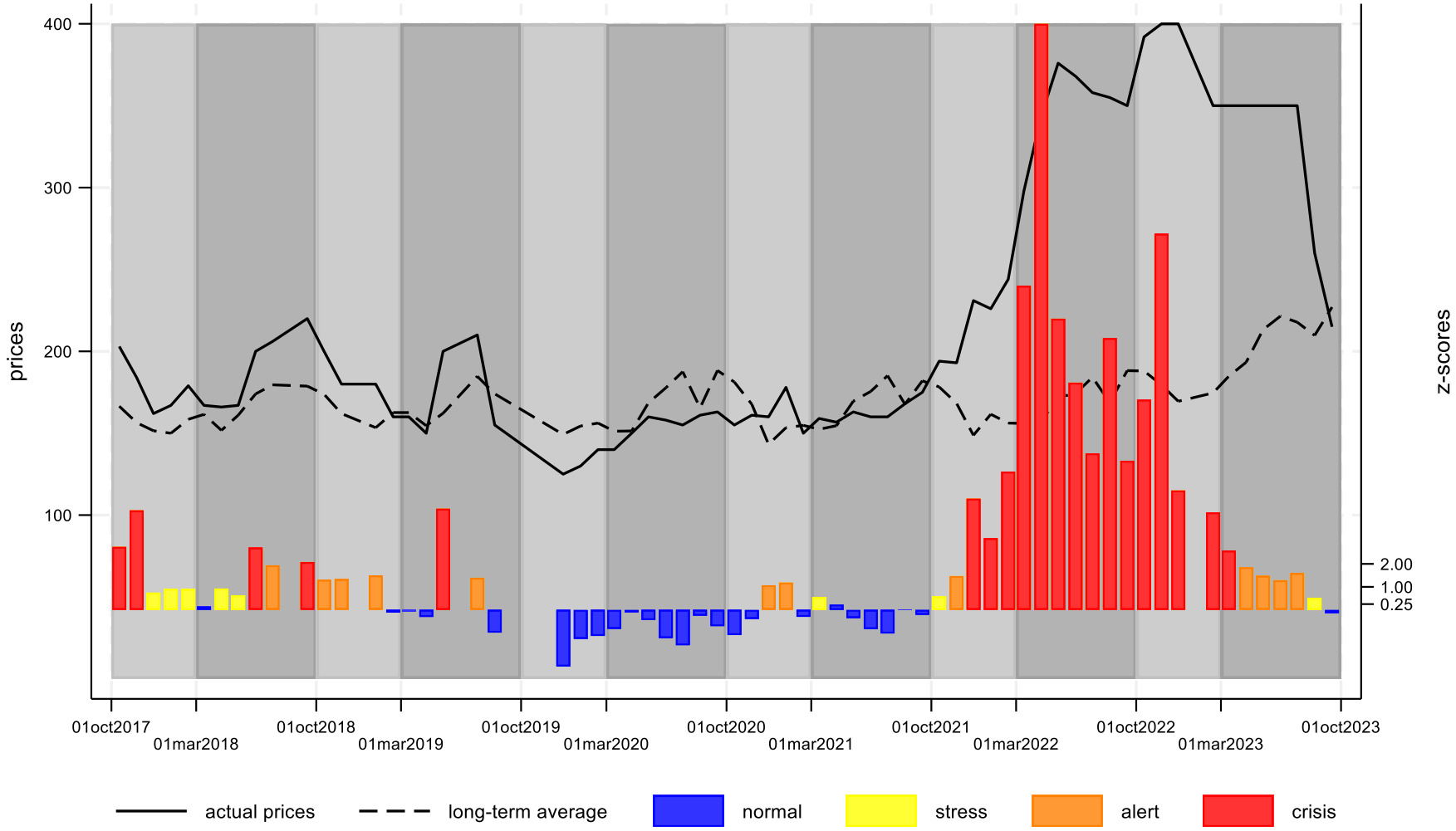
Table 9: Overview of food price shock dimensions

Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
zs_item_inte	*Item*_intensity: Average price anomaly, with *item* = {maize, millet, rice, semolina, sorghum, cowpea, peanut, potato, onion, orange, beef, milk powder, vegetable oil, sugar, salt}	*Produit*_intensité: Anomalie de prix moyen, dont *produit* = {maïs, mil, riz, semoule, sorgho, niébé, arachide, pomme de terre, oignon, orange, bœuf, lait en poudre, huile végétale, sucre, sel}
zs_item_freq	*Item*_frequency: Percentage of months with alert/crisis price levels, with *item* = {maize, millet, rice, semolina, sorghum, cowpea, peanut, potato, onion, orange, beef, milk powder, vegetable oil, sugar, salt}	*Produit*_fréquence: Pourcentage des mois avec prix d'alerte/crise, dont *produit* = {maïs, mil, riz, semoule, sorgho, niébé, arachide, pomme de terre, oignon, orange, bœuf, lait en poudre, huile végétale, sucre, sel}
zs_item_spell	*Item*_maxspell: Longest duration in months with alert/crisis price levels with *item* = {maize, millet, rice, semolina, sorghum, cowpea, peanut, potato, onion, orange, beef, milk powder, vegetable oil, sugar, salt}	*Produit*_périodemax: Durée maximale en mois avec prix d'alerte/crise, dont *produit* = {maïs, mil, riz, semoule, sorgho, niébé, arachide, pomme de terre, oignon, orange, bœuf, lait en poudre, huile végétale, sucre, sel}

Notes: The integrated and enhanced datasets retain the English variable name and the French variable label.
Source: Authors' own compilation.

The first dimension is **shock intensity**, defined as the average z-score observed over an entire inter-survey wave. The second dimension is **shock frequency**, defined as the percentage of total months with z-scores equal to or higher than 1, which corresponds to “alert” and “crisis” price conditions. The third dimension is **maximum spell**, defined as the highest number of consecutive months with z-scores again equal to or higher than 1. Regarding the latter dimension, it is important to highlight that the maximum duration can follow from high price anomalies accumulated in previous waves.

Figure 2: Evolution in millet prices (FCFA) in the department of Djenne, Niger (2017-2023)



Shock dimension	Wave1	Wave2	Wave3	Wave4	Wave5	Wave6	Wave7	Wave8	Wave9	Wave10	Wave11	Wave12
Intensity	1.930	1.407	1.007	0.883	-1.621	-0.731	0.092	-0.235	3.205	12.463	8.733	1.312
Frequency	40.0%	50.0%	75.0%	40.0%	0.0%	0.0%	40.0%	0.0%	80.0%	100.0%	100.0%	71.4%
Maximum spell	4	3	6	2	0	0	2	0	4	11	15	20

Source: Authors' own representation.

Returning to Figure 2, the subsequent waves are highlighted by light and dark grey background colors with their corresponding shock dimensions summarized in the table below the chart. The first three waves are characterized by price shock intensity levels above 1, shock frequency levels between 40% and 75%, and maximum spells ranging from 3 to 6 months. Interestingly, Wave 3, which has the lowest intensity (1.007) of the first three waves, also has the highest frequency (75%) and longest uninterrupted duration (6 months) of episodes with alert and crisis price conditions. Similarly, within the last four waves (i.e., Wave 9-12), Wave 12 has the lowest intensity (1.312) and lowest frequency level (71.4%) but also the longest price shock length (20 months).

Despite evident correlations, the different ranking of the twelve waves according to each shock dimension clearly indicates that important nuances exist and could potentially trigger different household responses. Using the same example above: if certain coping strategies are only triggered by intensity levels, then households are expected to react in the same way to the millet price conditions of Wave 2 and Wave 12, despite important differences in terms of shock frequency and maximum spell. In contrast, if the latter two shock dimensions are key in triggering certain coping mechanisms, then households are expected to react in the same way during Wave 4 and Wave 7, despite very different intensity levels.

Methodology on climate-related and weather variability shocks

To enhance the integrated household datasets with information on climate- and weather-related shocks, we make use of several types of remote sensing data and related products. The selected or constructed indicators focus on three different time horizons: (i) long-term trends in climate change and related risks; (ii) annual performances of the rainy season; and (iii) monthly extreme weather events.

For the long-term trends of climate change and related risks, the selected indicators are based on the work of Craparo et al. (forthcoming), who derive and classify normalized values for three individual climate hazards (that is, drought, flooding and heat) as well as for their composite index. This exercise is run on a global raster layer at a resolution of 0.7° and for two distinct periods pooled together: the 1981-2010 period, based on historical observations, and the 2020-2040 period, based on extractions from the phase 6 Coupled Model Intercomparison Project (CMIP6). Table 10 provides an overview of the underlying data and methodology adopted to derive **drought, flooding, heat**, and composite climate hazard indices for the historical (1981-2010) and projected (2020-2040) periods. By pooling the data of both periods together, the methodology ensures that all climate hazards can be safely compared across time and space.

Table 10: Data and methodology of long-term climate hazards

Indicator	Data	Methodology	Value range
Drought hazard index (historical; projected)	Standardized Precipitation Evapotranspiration Index (SPEI)	1. Normalization of pixel values between 0 and 1, based on min/max values observed in both periods 2. Shift of distribution to align severe thresholds to 0.6, with "severe" defined as 10% of driest years with SPEI<-1 (for drought), SDII value 10 (for flooding), and 30 days/year with a HI ≥ 41°C (for heat) 3. Truncation of values to [0,1] 4. Aggregation of pixel-level to second-level administrative data	0-1 (0 = least dry, flood-prone, hot; 1= most dry, flood-prone, hot)
Flooding hazard index (historical; projected)	Simple Daily precipitation Intensity Index (SDII)		
Heat hazard index (historical; projected)	Heat Index (HI)		
Composite climate hazard index (historical; projected)	Based on the datasets above	Same method as above, except for the application of a negative inverse transformation on the truncated pixel values of the three hazard types (after step 3), followed by a normalization of the resulting values based on min/max values observed in both periods	

Source: Based on Craparo et al. (forthcoming).

To obtain an indication of the degree by which climate hazards are expected to change in the longer term, Equation (1) defines anomalies as the ratio (*R*) between the projected (*proj*) and historical (*hist*) index values (*index*) for each hazard type (*ht*), both aggregated at the second-tier administrative level (*adm*).

$$R\_ht_{adm} = index\_ht_{adm}^{proj} / index\_ht_{adm}^{hist} \, x \, 100 \quad (1)$$

With *ht* = {drought hazard, flooding hazard, heat hazard, composite hazard}

A ratio close to 100% refers to minimal changes in climate conditions, while higher ratios point to drier, more flood-prone, and hotter climate conditions (and vice versa) depending on the hazard type considered. Table 11 provides a summary of the four climate hazard anomalies derived and added to the integrated datasets of Mali, Burkina Faso, Niger, and Chad (2018-2023).

Table 11: Overview of indicators of long-term climate hazard trends

Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
R_drought	Ratio of projected and historical drought index values	Ratio des valeurs projetées et historiques de l'indice de sécheresse
R_flood	Ratio of projected and historical flood index values	Ratio des valeurs projetées et historiques de l'indice d'inondation
R_heat	Ratio of projected and historical heat index values	Ratio des valeurs projetées et historiques de l'indice de chaleur
R_composite	Ratio of projected and historical composite index values	Ratio des valeurs projetées et historiques de l'indice composite

Notes: The integrated and enhanced datasets retain the English variable name and the French variable label.
Source: Authors' own compilation.

To capture the overall performance of the rainy season, we make use of the Combined Drought Index (CDI) and its constituent components, developed by WFP's Humanitarian Data Cube. The three components are **water input** (rainfall), **water storage** (soil moisture) and **water demand** (potential evapotranspiration). Table 12 summarizes the data and methodology adopted to obtain seasonal values per second-level administrative area, ranging from 0 (most dry) to 100 (most wet) for each of the three constituent dimensions as well as for the CDI.

Table 12: Data and methodology of seasonal performance indicators[1]

Indicator	Data	Methodology	Value range
Seasonal rainfall (input)	CHIRPS	1. Aggregation of daily to monthly time steps 2. Derivation of monthly anomalies expressed as percentiles within long-term distribution 3. Aggregation of monthly percentiles to seasonal percentiles, using (i) a logit conversion, (ii) an application of monthly weights based on the long-term relative contribution of each month to total seasonal rainfall, and (iii) an inverse logit conversion 4. Aggregation of pixel-level to second-level administrative data	0-100% (0 = most dry; 100 = most wet)
Seasonal soil moisture (storage)	ERA5[2]		
Seasonal potential evapotranspiration (demand)	FAO WAPOR[3]		
Combined Drought Index	Based on the datasets above	Same method as above, except for the application of importance weights after step 2 to combine the three components in one index. This again involves: (i) a logit conversion, (ii) an application of the following weights: 0.4 (rainfall), 0.3 (evapotranspiration), 0.3 (soil moisture); and (iii) an inverse logit conversion	

Notes: [1] The rainy season considered in this analysis runs from June to September. [2] This indicator involves a reanalysis of ERA5 data focusing on root zone soil moisture using a depth weighted average of the top three individual soil layer moisture values. [3] Penman Monteith formulation using AgERA datasets obtained from ERA5 with corrections for bias and with improved resolution.
Source: Based on data and methodology developed by WFP's Humanitarian Data Cube.

Table 13 presents an overview of the four selected indicators added to the integrated household datasets to assess the performance of the rainy season.

Table 13: Overview of indicators of seasonal performance

Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
cdi_rainfall	Seasonal rainfall performance (input %)	Performance saisonnière des précipitations (input %)
cdi_soilmoisture	Seasonal soil moisture performance (storage %)	Performance saisonnière de l'humidité du sol (stockage %)
cdi_evapotranspiration	Seasonal evapotranspiration performance (demand %)	Performance saisonnière de l'évapotranspiration (demande %)
cdi_combined	Combined Drought Index (%)	Indice Combiné de Sécheresse (%)

Notes: The integrated and enhanced datasets retain the English variable name and the French variable label.
Source: Authors' own compilation.

Using absolute thresholds, the final set of indicators focuses on extreme weather events in terms of rainfall (**dry and heavy rainfall days**) and temperature (**hot and cold days**) by capturing monthly information on both frequencies and spells. Table 14 presents the underlying data and methodology used to compute each of the indicators. Dry, heavy rainfall, hot, and cold days are respectively identified by rainfall below 2 mm and above 20 mm and by average daily temperatures above 33 °C and below 22 °C. The rainfall cut-offs are in line with Bliefernicht et al. (2022) and common practice by WFP's Humanitarian Data Cube.[17] The temperature thresholds for hot and cold days are computed from FAO's ECOCROP database as the average of the optimal maximum and minimum temperature requirements of six common crops (that is, rice, millet, sorghum, maize, cowpea, and peanut) in West Africa.[18]

Table 14: Data and methodology to construct indicators on extreme weather events

Indicator	Data	Methodology	Value range
Dry days - Frequency - Spell **Heavy rainfall days** - Frequency - Spell	CHIRPS	1. Aggregation of pixel-level to second-level administrative data 2. Identification of dry (< 2mm), heavy rainfall (> 20mm), hot (> 33°C) and cold days (< 22°C) 3. Frequencies defined as the number of dry, heavy rainfall, hot and cold days per month 4. Spells defined as the longest number of consecutive dry, heavy rainfall, hot and cold days per month	Frequency (0-100%) Spell (# days)
Hot days - Frequency - Spell **Cold days** - Frequency - Spell	MODIS temperature data (with cloud-filter & gap-filler techniques)		

Source: Based on data obtained from WFP's Humanitarian Data Cube, Bliefernicht et al. (2022), and FAO ECOCROP.

Table 15 presents an overview of the constructed indicators added to the integrated household datasets covering information on extreme weather events related to rainfall and temperature.

[17] See: https://prism.dakar.wfp.org.

[18] See: https://gaez.fao.org/pages/ecocrop.

Table 15: Overview of indicators of monthly extreme weather events

Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
dry_freq_month	Frequency of dry days in *month* (%), with *month* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}	Fréquence des jours secs en *mois* (%), dont *mois* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}
dry_spell_month	Longest duration of consecutive dry days in *month* (d), with *month* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}	Durée la plus longue de jours secs consécutifs en *mois* (j), dont *mois* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}
heavy_freq_month	Frequency of heavy rainfall days in *month* (%), with *month* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}	Fréquence des jours de fortes pluies en *mois* (%), dont *mois* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}
heavy_spell_month	Longest duration of consecutive heavy rainfall days in *month* (d), with *month* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}	Durée la plus longue de jours de fortes pluies consécutifs en *mois* (j), dont *mois* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}
hot_freq_month	Frequency of hot days in *month* (%), with *month* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}	Fréquence des jours chauds en *mois* (%), dont *mois* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}
hot_spell_month	Longest duration of consecutive hot days in *month* (d), with *month* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}	Durée la plus longue de jours chauds consécutifs en *mois* (j), dont *mois* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}
cold_freq_month	Frequency of cold days in *month* (%), with *month* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}	Fréquence des jours froids en *mois* (%), dont *mois* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}
cold_spell_month	Longest duration of consecutive cold days in *month* (d), with *month* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}	Durée la plus longue de jours froids consécutifs en *mois* (j), dont *mois* = {oct, nov, dec, jan, feb, mar, apr, may, jun, jul, aug, sep}

Notes: The integrated and enhanced datasets retain the English variable name and the French variable label.
Source: Authors' own compilation.

Assignment of spatial shock profiles to inter-survey waves

The assignment of the above information to the integrated household food security and coping datasets is based on the timing and location of shocks.

Regarding location, the matching key are the 232 second-level administrative areas of the four Sahel countries. As mentioned above, this delimitation is based on UNOCHA's geographic datasets and cover 45 provinces in Burkina Faso, 70 departments in Chad, 50 cercles in Mali, and 67 departments in Niger. On average, this geographic delimitation has a land surface area of 6,075 km^2 in Burkina Faso, 18,073 km^2 in Chad, 25,037 km^2 in Mali, and 17,668 km^2 in Niger.

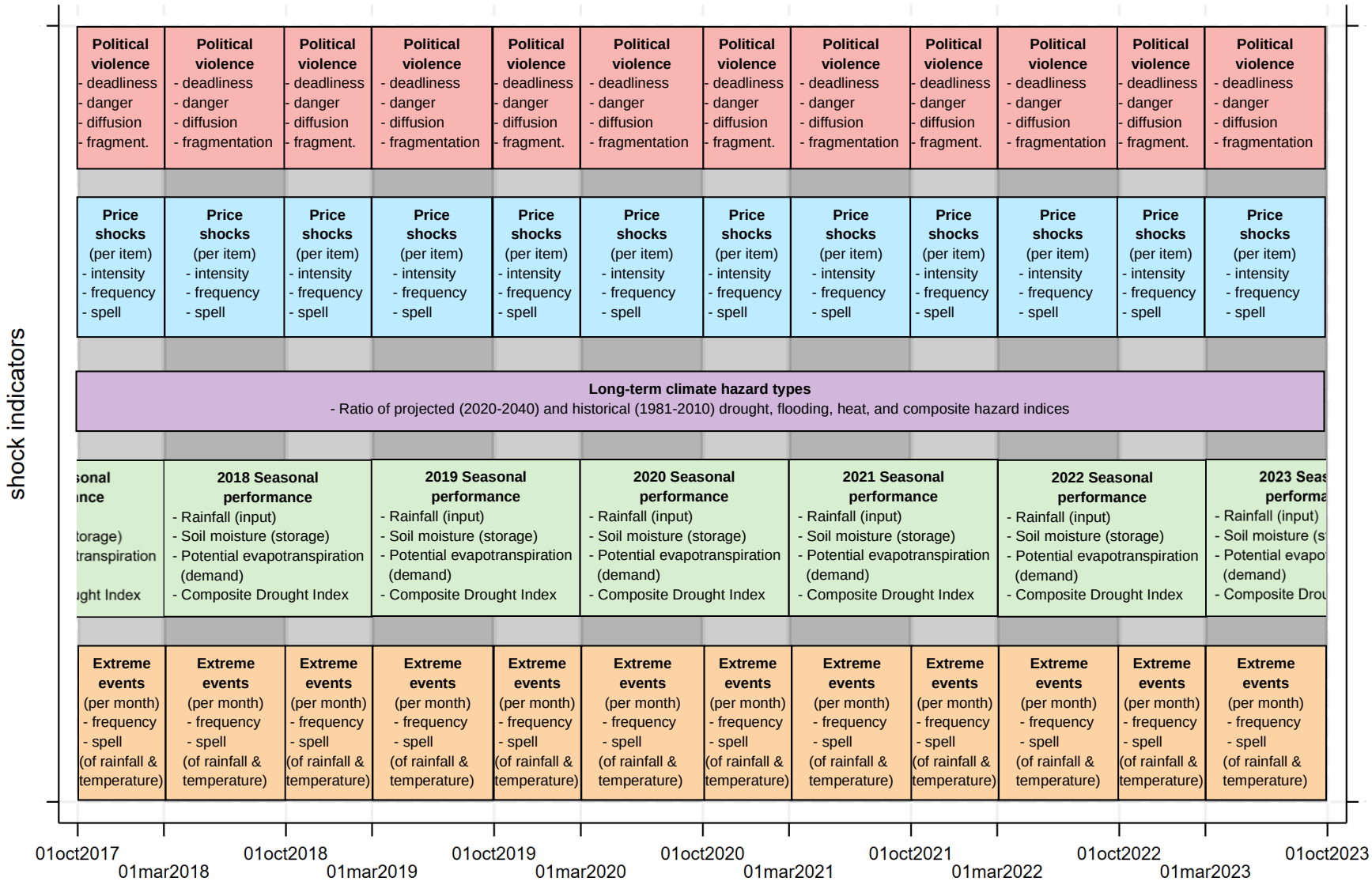
Regarding timing, the constructed shock indicators generally pertain to the immediate period preceding the implementation of the household food security and coping surveys. As such, it is assumed that coping strategies pursued by households are mainly triggered by the shock profile of the preceding inter-survey periods between 2018 and 2023, running each time from October till February (5-month wave) and from March to September (7-month wave). This is the case for the indicators of political violence, price shocks, and extreme weather events. It is however important to highlight that the time aggregation for extreme weather events is slightly different than the one used for political violence and price shocks, in that the latter two are aggregated for the entire wavelength whereas the extreme weather shocks are aggregated for each month within its corresponding wave. The underlying logic here relates to the general indifference of households with respect to the exact timing of political violence or price shocks (that is, they are always unwelcome), as opposed to extreme weather events which are more critical during certain months of the year.

In contrast, the long-term hazard indices are assigned to all waves between 2018 and 2023 as they reflect the degree in which climate and related risks are changing. Another exception to the strict inter-survey wave assignment are the indicators measuring the overall performance of the rainy season. These indicators are assigned to both the 7-month period in which the rainy season takes place as well as to

the subsequent 5-month wave. The reasoning here is that a failed crop season may have lasting consequences and may possibly trigger certain coping strategies beyond the harvesting period.

Figure 3 presents a schematic overview of the assignment of all shock indicators to the 12-wave period shaped by the approximate timing of the household food security and coping surveys implemented in the four countries between 2018 and 2023.

Figure 3: Mapping of shock indicators to 12-wave period between 2018 and 2023



Source: Authors' own representation.

Reflections on the use of the integrated and enhanced datasets

While providing a unique opportunity to study household coping strategies and food security in event of shocks different in nature, intensity, frequency and duration, the integrated and enhanced datasets generated for the G5 Sahel countries do not follow from a dedicated research design to serve this objective. As a matter of fact, all coping strategies listed relate to the multiple ways in which households try to deal with food insecurity *without specifying its precise origins*. By enhancing the integrated datasets with shock information, it is basically assumed that people pursue certain coping mechanisms following the occurrence of shocks – yet without being sure about the precise impact of these shocks on food security or about people's awareness and perceptions of these shocks.

Apart from this conceptual limitation, there are several operational constraints to highlight as well. First, as the exact date of each household visit could not be retrieved, the time assignment of the shock data to their inter-survey period may be inaccurate. Indeed, most households have not been surveyed exactly on March 1st or October 1st but on a day around these generic dates. Second, the recall periods used to capture information on people's coping and food security status range from 24 hours for HDDS, 7 days for FCS and rCSI, to 30 days for HHS and the several livelihood-based coping strategies, and to even 12 months in case the same coping mechanisms have been depleted over time. As such, the periods referred to in the household survey questions and those used to aggregate the shock information only partially overlap. Despite both these inaccuracies in terms of time alignment, it is basically assumed that the survey data on coping and food security are representative for the (often) longer preceding shock period, or alternatively, that shocks which occurred before the household recall period continue to affect and challenge people's food security status within the recall period. Third, given the arbitrary delimitation of administrative areas, the geographic alignment between shocks and household responses might also be imperfect. For example, households may react to certain shocks occurring in very nearby locations, yet which may be part of another administrative area. In a similar vein, shock-intense locations might be located very far from the surveyed households despite sharing the same administrative unit – an issue which might be particularly relevant for the bigger administrative areas in the northern parts of Niger and Mali.

The three operational shortcomings in fact relate to the limitations inherent in the integrated datasets, in that they do not allow for a more accurate alignment in terms of time and place between shocks and coping strategies. This said, even if a perfect alignment would be technically feasible, there are no clear guidelines on what an appropriate reference period or reference space would be for triggering certain household responses. For example, it is unclear what a reasonable delay would be for any given shock to culminate in a situation requiring a particular action – knowing that people need time to assess new situations, digest additional information, and discuss possible options with peers. In a similar vein, certain shocks, distant in geographical terms, might be experienced as very near in psychological terms, such as the impact of a coup d'état on the functioning and power balances in remote villages. These aspects of time and location elasticity essentially point to deeper conceptual issues related to the measurement of impact, vulnerability and resilience.

Annex: Overview of variables in the integrated and enhanced household datasets, G5 Sahel (2018-2023)

Subset	Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
Identification	hhid	Household ID	Identifiant Unique
Timing	year	Year	Année
	wave	Wave	Vague
Location	admin0Pcod	ADMIN0PCOD	ADMIN0PCOD
	admin0name	ADMIN0NAME	ADMIN0NAME
	admin1Pcod	ADMIN1PCOD	ADMIN1PCOD
	admin1name	ADMIN1NAME	ADMIN1NAME
	admin2Pcod	ADMIN2PCOD	ADMIN2PCOD
	admin2name	ADMIN2NAME	ADMIN2NAME
	area	Area	Milieu de Résidence
Weight	weight	Weight	Poids/Pondération
Household head	sex_head	Gender of household head	Sexe du chef de ménage
	marital_head	Marital status of household head	Situation matrimoniale du chef de ménage
	education_head	Education level of household head	Niveau d'éducation du chef de ménage
Coping strategies	Lcs_stress_DomAsset	Selling household assets or goods (radio, furniture, television, jewelry)	Vente d'actifs ou de biens du ménage (radio, meubles, télévision, bijoux)
	Lcs_stress_Saving	Spending savings	Dépense de l'épargne
	Lcs_stress_EatOut	Sending household members to eat elsewhere	Envoi des membres du ménage pour manger ailleurs
	Lcs_stress_BorrowCash	Borrowing money to cover food needs	Prêt d'argent pour couvrir les besoins alimentaires
	Lcs_stress_BorrowFood	Buying food on credit	Achat de la nourriture à crédit
	Lcs_stress_MoreLabour	Resorting to casual labor more than usual	Recours au travail occasionnel plus que d'habitude
	Lcs_stress_Animals	Selling animals more than usual	Vente d'animaux plus que d'habitude
	Lcs_crisis_ProdAssets	Selling productive assets or means of transport (wheelbarrow, bicycle)	Vente d'actifs productifs ou de moyens de transport (brouette, vélo)
	Lcs_crisis_Edu_Health	Reducing essential non-food expenditures (education/health)	Réduction des dépenses non alimentaires essentielles (éducation/santé)
	Lcs_crisis_HHSeparation	Sending one or more household members to live elsewhere	Envoi d'un ou plusieurs membres du ménage à vivre ailleurs
	Lcs_crisis_ChildWork	Child labor (<15 years) to contribute to household income	Travail des enfants (< 15 ans) pour contribuer au revenu du ménage
	Lcs_crisis_OutSchool	Withdrawing children from school	Retrait des enfants de l'école
	Lcs_crisis_Health	Reducing health expenditures (including drugs)	Réduction des dépenses de santé (y compris les médicaments)
	Lcs_crisis_EatCrops	Harvesting and consumption of immature crops	Récolte et consommation des cultures immatures
	Lcs_crisis_AgriCare	Reducing expenditures on fertilizers, pesticides or fodder	Réduction des dépenses en engrais, pesticides ou fourrage
	Lcs_crisis_Seed	Consuming seed stocks reserved for the next season	Consommation des stocks de semences réservés pour la saison suivante
	Lcs_em_Migration	Migrating one or more household members informally/irregularly	Migration d'un ou plusieurs membres du ménage de manière informelle/irrégulière
	Lcs_em_ResAsset	Mortgaging/selling the house/land where the household was permanently living	Hypothèque/vente de la maison/terrain où vivait le ménage en permanence
	Lcs_em_Begged	Begging or asking strangers for money/food	Mendicité ou demande de l'argent/nourriture à des étrangers
	Lcs_em_IllegalAct	Engagement in socially degrading, high-risk or exploitative jobs	Engagement dans des emplois socialement dégradants, à haut risque ou exploitants
	Lcs_em_FemAnimal	Selling of last female animals	Vente des derniers animaux femelles
	LCS	Livelihood Coping Strategies (LCS) index - Category	Indicateur des Stratégies d'Adaptation des Moyens de subsistance (LCS) - Catégorie
	rCSI	Reduced Coping Strategies Index (rCSI) - Category	Indice des Stratégies d'Adaptation réduit (rCSI) - Catégorie
Food security	FCS	Food Consumption Score (FCS) - Category	Score de Consommation Alimentaire (SCA) - Catégorie
	HDDS	Household Dietary Diversity Score (HDDS) - Category	Score de Diversité Alimentaire des Ménages (SDAM) - Catégorie
	HHS	Household Hunger Scale (HHS) - Category	Indice Domestique de la Faim (HHS) - Catégorie
	CARI	Consolidated Approach for Reporting Indicators (CARI) - Category	Approche Consolidée pour le Compte-rendu des Indicateurs (CARI) – Catégorie

Annex: Continued

Subset	Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
Conflict and political violence	deadliness	Fatalities of political violence (number)	Décès dus à la violence politique (nombre)
	danger	Civilian-targeting events (number)	Événements visant des citoyens (nombre)
	diffusion	Geographical spread of political violence (%)	Répartition géographique de la violence politique (%)
	fragmentation	Rebel groups and militias (number)	Groupes rebelles et milices (nombre)
Food price shocks	zs_maize_inte	maize_intensity: Average price anomaly	maïs_intensité: Anomalie de prix moyen
	zs_maize_freq	maize_frequency: Percentage of months with alert/crisis price levels	maïs_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_maize_spell	maize_maxspell: Longest duration in months with alert/crisis price levels	maïs_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_millet_inte	millet_intensity: Average price anomaly	mil_intensité: Anomalie de prix moyen
	zs_millet_freq	millet_frequency: Percentage of months with alert/crisis price levels	mil_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_millet_spell	millet maxspell: Longest duration in months with alert/crisis price levels	mil_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_rice_inte	rice_intensity: Average price anomaly	riz_intensité: Anomalie de prix moyen
	zs_rice_freq	rice_frequency: Percentage of months with alert/crisis price levels	riz_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_rice_spell	rice_maxspell: Longest duration in months with alert/crisis price levels	riz_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_semolina_inte	semolina_intensity: Average price anomaly	semoule_intensité: Anomalie de prix moyen
	zs_semolina_freq	semolina_frequency: Percentage of months with alert/crisis price levels	semoule_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_semolina_spell	semolina_maxspell: Longest duration in months with alert/crisis price levels	semoule_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_sorghum_inte	sorghum_intensity: Average price anomaly	sorgho_intensité: Anomalie de prix moyen
	zs_sorghum_freq	sorghum_frequency: Percentage of months with alert/crisis price levels	sorgho_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_sorghum_spell	sorghum_maxspell: Longest duration in months with alert/crisis price levels	sorgho_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_cowpea_inte	cowpea_intensity: Average price anomaly	niébé_intensité: Anomalie de prix moyen
	zs_cowpea_freq	cowpea_frequency: Percentage of months with alert/crisis price levels	niébé_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_cowpea_spell	cowpea_maxspell: Longest duration in months with alert/crisis price levels	niébé_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_peanut_inte	peanut_intensity: Average price anomaly	arachide_intensité: Anomalie de prix moyen
	zs_peanut_freq	peanut_frequency: Percentage of months with alert/crisis price levels	arachide_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_peanut_spell	peanut_maxspell: Longest duration in months with alert/crisis price levels	arachide_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_potato_inte	potato_intensity: Average price anomaly	pommedeterre_intensité: Anomalie de prix moyen
	zs_potato_freq	potato_frequency: Percentage of months with alert/crisis price levels	pommedeterre_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_potato_spell	potato_maxspell: Longest duration in months with alert/crisis price levels	pommedeterre_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_onion_inte	onion_intensity: Average price anomaly	oignon_intensité: Anomalie de prix moyen
	zs_onion_freq	onion_frequency: Percentage of months with alert/crisis price levels	oignon_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_onion_spell	onion_maxspell: Longest duration in months with alert/crisis price levels	oignon_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_orange_inte	orange_intensity: Average price anomaly	orange_intensité: Anomalie de prix moyen
	zs_orange_freq	orange_frequency: Percentage of months with alert/crisis price levels	orange_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_orange_spell	orange_maxspell: Longest duration in months with alert/crisis price levels	orange_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_beef_inte	beef_intensity: Average price anomaly	bœuf_intensité: Anomalie de prix moyen
	zs_beef_freq	beef_frequency: Percentage of months with alert/crisis price levels	bœuf_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_beef_spell	beef_maxspell: Longest duration in months with alert/crisis price levels	bœuf_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_milkpowder_inte	milkpowder_intensity: Average price anomaly	laitenpoudre_intensité: Anomalie de prix moyen
	zs_milkpowder_freq	milkpowder_frequency: Percentage of months with alert/crisis price levels	laitenpoudre_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_milkpowder_spell	milkpowder_maxspell: Longest duration in months with alert/crisis price levels	laitenpoudre_périodemax: Durée maximale en mois avec prix d'alerte/crise

Annex: Continued

Subset	Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
Food price shocks	zs_vegoil_inte	vegetableoil_intensity: Average price anomaly	huilevégétale_intensité: Anomalie de prix moyen
	zs_vegoil_freq	vegetableoil_frequency: Percentage of months with alert/crisis price levels	huilevégétale_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_vegoil_spell	vegetableoil_maxspell: Longest duration in months with alert/crisis price levels	huilevégétale_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_sugar_inte	sugar_intensity: Average price anomaly	sucre_intensité: Anomalie de prix moyen
	zs_sugar_freq	sugar_frequency: Percentage of months with alert/crisis price levels	sucre_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_sugar_spell	sugar_maxspell: Longest duration in months with alert/crisis price levels	sucre_périodemax: Durée maximale en mois avec prix d'alerte/crise
	zs_salt_inte	salt_intensity: Average price anomaly	sel_intensité: Anomalie de prix moyen
	zs_salt_freq	salt_frequency: Percentage of months with alert/crisis price levels	sel_fréquence: Pourcentage des mois avec prix d'alerte/crise
	zs_salt_spell	salt_maxspell: Longest duration in months with alert/crisis price levels	sel_périodemax: Durée maximale en mois avec prix d'alerte/crise
Long-term climate hazards	R_drought	Ratio of projected and historical drought index values	Ratio des valeurs projetées et historiques de l'indice de sécheresse
	R_flood	Ratio of projected and historical flood index values	Ratio des valeurs projetées et historiques de l'indice d'inondation
	R_heat	Ratio of projected and historical heat index values	Ratio des valeurs projetées et historiques de l'indice de chaleur
	R_composite	Ratio of projected and historical composite index values	Ratio des valeurs projetées et historiques de l'indice composite
Seasonal performance	cdi_rainfall	Seasonal rainfall performance (input %)	Performance saisonnière des précipitations (input %)
	cdi_soilmoisture	Seasonal soil moisture performance (storage %)	Performance saisonnière de l'humidité du sol (stockage %)
	cdi_evapotranspiration	Seasonal evapotranspiration performance (demand %)	Performance saisonnière de l'évapotranspiration (demande %)
	cdi_combined	Combined Drought Index (%)	Indice Combiné de Sécheresse (%)
Extreme weather events	dry_freq_oct	Frequency of dry days in oct (%)	Fréquence des jours secs en oct (%)
	dry_spell_oct	Longest duration of consecutive dry days in oct (d)	Durée la plus longue de jours secs consécutifs en oct (j)
	heavy_freq_oct	Frequency of heavy rainfall days in oct (%)	Fréquence des jours de fortes pluies en oct (%)
	heavy_spell_oct	Longest duration of consecutive heavy rainfall days in oct (d)	Durée la plus longue de jours de fortes pluies consécutifs en oct (j)
	hot_freq_oct	Frequency of hot days in oct (%)	Fréquence des jours chauds en oct (%)
	hot_spell_oct	Longest duration of consecutive hot days in oct (d)	Durée la plus longue de jours chauds consécutifs en oct (j)
	cold_freq_oct	Frequency of cold days in oct (%)	Fréquence des jours froids en oct (%)
	cold_spell_oct	Longest duration of consecutive cold days in oct (d)	Durée la plus longue de jours froids consécutifs en oct (j)
	dry_freq_nov	Frequency of dry days in nov (%)	Fréquence des jours secs en nov (%)
	dry_spell_nov	Longest duration of consecutive dry days in nov (d)	Durée la plus longue de jours secs consécutifs en nov (j)
	heavy_freq_nov	Frequency of heavy rainfall days in nov (%)	Fréquence des jours de fortes pluies en nov (%)
	heavy_spell_nov	Longest duration of consecutive heavy rainfall days in nov (d)	Durée la plus longue de jours de fortes pluies consécutifs en nov (j)
	hot_freq_nov	Frequency of hot days in nov (%)	Fréquence des jours chauds en nov (%)
	hot_spell_nov	Longest duration of consecutive hot days in nov (d)	Durée la plus longue de jours chauds consécutifs en nov (j)
	cold_freq_nov	Frequency of cold days in nov (%)	Fréquence des jours froids en nov (%)
	cold_spell_nov	Longest duration of consecutive cold days in nov (d)	Durée la plus longue de jours froids consécutifs en nov (j)
	dry_freq_dec	Frequency of dry days in dec (%)	Fréquence des jours secs en dec (%)
	dry_spell_dec	Longest duration of consecutive dry days in dec (d)	Durée la plus longue de jours secs consécutifs en dec (j)
	heavy_freq_dec	Frequency of heavy rainfall days in dec (%)	Fréquence des jours de fortes pluies en dec (%)
	heavy_spell_dec	Longest duration of consecutive heavy rainfall days in dec (d)	Durée la plus longue de jours de fortes pluies consécutifs en dec (j)
	hot_freq_dec	Frequency of hot days in dec (%)	Fréquence des jours chauds en dec (%)
	hot_spell_dec	Longest duration of consecutive hot days in dec (d)	Durée la plus longue de jours chauds consécutifs en dec (j)
	cold_freq_dec	Frequency of cold days in dec (%)	Fréquence des jours froids en dec (%)
	cold_spell_dec	Longest duration of consecutive cold days in dec (d)	Durée la plus longue de jours froids consécutifs en dec (j)

Annex: Continued

Subset	Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
Extreme weather events	dry_freq_jan	Frequency of dry days in jan (%)	Fréquence des jours secs en jan (%)
	dry_spell_jan	Longest duration of consecutive dry days in jan (d)	Durée la plus longue de jours secs consécutifs en jan (j)
	heavy_freq_jan	Frequency of heavy rainfall days in jan (%)	Fréquence des jours de fortes pluies en jan (%)
	heavy_spell_jan	Longest duration of consecutive heavy rainfall days in jan (d)	Durée la plus longue de jours de fortes pluies consécutifs en jan (j)
	hot_freq_jan	Frequency of hot days in jan (%)	Fréquence des jours chauds en jan (%)
	hot_spell_jan	Longest duration of consecutive hot days in jan (d)	Durée la plus longue de jours chauds consécutifs en jan (j)
	cold_freq_jan	Frequency of cold days in jan (%)	Fréquence des jours froids en jan (%)
	cold_spell_jan	Longest duration of consecutive cold days in jan (d)	Durée la plus longue de jours froids consécutifs en jan (j)
	dry_freq_feb	Frequency of dry days in feb (%)	Fréquence des jours secs en feb (%)
	dry_spell_feb	Longest duration of consecutive dry days in feb (d)	Durée la plus longue de jours secs consécutifs en feb (j)
	heavy_freq_feb	Frequency of heavy rainfall days in feb (%)	Fréquence des jours de fortes pluies en feb (%)
	heavy_spell_feb	Longest duration of consecutive heavy rainfall days in feb (d)	Durée la plus longue de jours de fortes pluies consécutifs en feb (j)
	hot_freq_feb	Frequency of hot days in feb (%)	Fréquence des jours chauds en feb (%)
	hot_spell_feb	Longest duration of consecutive hot days in feb (d)	Durée la plus longue de jours chauds consécutifs en feb (j)
	cold_freq_feb	Frequency of cold days in feb (%)	Fréquence des jours froids en feb (%)
	cold_spell_feb	Longest duration of consecutive cold days in feb (d)	Durée la plus longue de jours froids consécutifs en feb (j)
	dry_freq_mar	Frequency of dry days in mar (%)	Fréquence des jours secs en mar (%)
	dry_spell_mar	Longest duration of consecutive dry days in mar (d)	Durée la plus longue de jours secs consécutifs en mar (j)
	heavy_freq_mar	Frequency of heavy rainfall days in mar (%)	Fréquence des jours de fortes pluies en mar (%)
	heavy_spell_mar	Longest duration of consecutive heavy rainfall days in mar (d)	Durée la plus longue de jours de fortes pluies consécutifs en mar (j)
	hot_freq_mar	Frequency of hot days in mar (%)	Fréquence des jours chauds en mar (%)
	hot_spell_mar	Longest duration of consecutive hot days in mar (d)	Durée la plus longue de jours chauds consécutifs en mar (j)
	cold_freq_mar	Frequency of cold days in mar (%)	Fréquence des jours froids en mar (%)
	cold_spell_mar	Longest duration of consecutive cold days in mar (d)	Durée la plus longue de jours froids consécutifs en mar (j)
	dry_freq_apr	Frequency of dry days in apr (%)	Fréquence des jours secs en apr (%)
	dry_spell_apr	Longest duration of consecutive dry days in apr (d)	Durée la plus longue de jours secs consécutifs en apr (j)
	heavy_freq_apr	Frequency of heavy rainfall days in apr (%)	Fréquence des jours de fortes pluies en apr (%)
	heavy_spell_apr	Longest duration of consecutive heavy rainfall days in apr (d)	Durée la plus longue de jours de fortes pluies consécutifs en apr (j)
	hot_freq_apr	Frequency of hot days in apr (%)	Fréquence des jours chauds en apr (%)
	hot_spell_apr	Longest duration of consecutive hot days in apr (d)	Durée la plus longue de jours chauds consécutifs en apr (j)
	cold_freq_apr	Frequency of cold days in apr (%)	Fréquence des jours froids en apr (%)
	cold_spell_apr	Longest duration of consecutive cold days in apr (d)	Durée la plus longue de jours froids consécutifs en apr (j)
	dry_freq_may	Frequency of dry days in may (%)	Fréquence des jours secs en may (%)
	dry_spell_may	Longest duration of consecutive dry days in may (d)	Durée la plus longue de jours secs consécutifs en may (j)
	heavy_freq_may	Frequency of heavy rainfall days in may (%)	Fréquence des jours de fortes pluies en may (%)
	heavy_spell_may	Longest duration of consecutive heavy rainfall days in may (d)	Durée la plus longue de jours de fortes pluies consécutifs en may (j)
	hot_freq_may	Frequency of hot days in may (%)	Fréquence des jours chauds en may (%)
	hot_spell_may	Longest duration of consecutive hot days in may (d)	Durée la plus longue de jours chauds consécutifs en may (j)
	cold_freq_may	Frequency of cold days in may (%)	Fréquence des jours froids en may (%)
	cold_spell_may	Longest duration of consecutive cold days in may (d)	Durée la plus longue de jours froids consécutifs en may (j)

Annex: Continued

Subset	Variable Name (EN)	Variable Label (EN)	Variable Label (FR)
Extreme weather events	dry_freq_jun	Frequency of dry days in jun (%)	Fréquence des jours secs en jun (%)
	dry_spell_jun	Longest duration of consecutive dry days in jun (d)	Durée la plus longue de jours secs consécutifs en jun (j)
	heavy_freq_jun	Frequency of heavy rainfall days in jun (%)	Fréquence des jours de fortes pluies en jun (%)
	heavy_spell_jun	Longest duration of consecutive heavy rainfall days in jun (d)	Durée la plus longue de jours de fortes pluies consécutifs en jun (j)
	hot_freq_jun	Frequency of hot days in jun (%)	Fréquence des jours chauds en jun (%)
	hot_spell_jun	Longest duration of consecutive hot days in jun (d)	Durée la plus longue de jours chauds consécutifs en jun (j)
	cold_freq_jun	Frequency of cold days in jun (%)	Fréquence des jours froids en jun (%)
	cold_spell_jun	Longest duration of consecutive cold days in jun (d)	Durée la plus longue de jours froids consécutifs en jun (j)
	dry_freq_jul	Frequency of dry days in jul (%)	Fréquence des jours secs en jul (%)
	dry_spell_jul	Longest duration of consecutive dry days in jul (d)	Durée la plus longue de jours secs consécutifs en jul (j)
	heavy_freq_jul	Frequency of heavy rainfall days in jul (%)	Fréquence des jours de fortes pluies en jul (%)
	heavy_spell_jul	Longest duration of consecutive heavy rainfall days in jul (d)	Durée la plus longue de jours de fortes pluies consécutifs en jul (j)
	hot_freq_jul	Frequency of hot days in jul (%)	Fréquence des jours chauds en jul (%)
	hot_spell_jul	Longest duration of consecutive hot days in jul (d)	Durée la plus longue de jours chauds consécutifs en jul (j)
	cold_freq_jul	Frequency of cold days in jul (%)	Fréquence des jours froids en jul (%)
	cold_spell_jul	Longest duration of consecutive cold days in jul (d)	Durée la plus longue de jours froids consécutifs en jul (j)
	dry_freq_aug	Frequency of dry days in aug (%)	Fréquence des jours secs en aug (%)
	dry_spell_aug	Longest duration of consecutive dry days in aug (d)	Durée la plus longue de jours secs consécutifs en aug (j)
	heavy_freq_aug	Frequency of heavy rainfall days in aug (%)	Fréquence des jours de fortes pluies en aug (%)
	heavy_spell_aug	Longest duration of consecutive heavy rainfall days in aug (d)	Durée la plus longue de jours de fortes pluies consécutifs en aug (j)
	hot_freq_aug	Frequency of hot days in aug (%)	Fréquence des jours chauds en aug (%)
	hot_spell_aug	Longest duration of consecutive hot days in aug (d)	Durée la plus longue de jours chauds consécutifs en aug (j)
	cold_freq_aug	Frequency of cold days in aug (%)	Fréquence des jours froids en aug (%)
	cold_spell_aug	Longest duration of consecutive cold days in aug (d)	Durée la plus longue de jours froids consécutifs en aug (j)
	dry_freq_sep	Frequency of dry days in sep (%)	Fréquence des jours secs en sep (%)
	dry_spell_sep	Longest duration of consecutive dry days in sep (d)	Durée la plus longue de jours secs consécutifs en sep (j)
	heavy_freq_sep	Frequency of heavy rainfall days in sep (%)	Fréquence des jours de fortes pluies en sep (%)
	heavy_spell_sep	Longest duration of consecutive heavy rainfall days in sep (d)	Durée la plus longue de jours de fortes pluies consécutifs en sep (j)
	hot_freq_sep	Frequency of hot days in sep (%)	Fréquence des jours chauds en sep (%)
	hot_spell_sep	Longest duration of consecutive hot days in sep (d)	Durée la plus longue de jours chauds consécutifs en sep (j)
	cold_freq_sep	Frequency of cold days in sep (%)	Fréquence des jours froids en sep (%)
	cold_spell_sep	Longest duration of consecutive cold days in sep (d)	Durée la plus longue de jours froids consécutifs en sep (j)

Notes: The integrated and enhanced datasets retain the English variable name and the French variable label.
Source: Authors' own compilation.

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