

**HUMANITARIAN
AND DEVELOPMENT
PROGRAMME**

**A QUANTITATIVE STUDY OF FUTURE HOTSPOTS OF
VULNERABILITY IN WEST AND CENTRAL AFRICA BY 2020**

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HUMANITARIAN FORESIGHT THINK TANK

This project analyses variables of change based on quantitative information extracted from selected indicators to outline the potential of vulnerability of West and Central Africa countries at a subnational level. Variables are grouped in three components: inherent fragility, risk and exposure and lack of preparedness. These components are forecasted and aggregated and then combined with official population projections to obtain a map of hotspots of vulnerability by 2020.

INTRODUCTION

This project main objective is to help visualizing the early future situation of the West and Central Africa region by means of a series of maps displaying information on vulnerability and risks. To this aim, a quantitative measure for vulnerability has been defined and computed. To complement the information on vulnerability provided by this index, the maps also display population projections for 2020¹. By doing so, not only the future state of subnational vulnerability can be assessed, but also the total population that will be affected.

A specific interpretation to the otherwise complex concept of 'human vulnerability' is given here. It has been tailored by the particular needs of humanitarian organizations operating in this area².

The list of countries covered by the project is: Mauritania, Mali, Senegal, Guinea, Sierra Leone, Liberia, Ivory Coast, Burkina Faso, Nigeria, Cameroon, Niger, Chad, Central African Republic, and Democratic Republic of Congo. To make it as informative as possible, the unit for analysis has been chosen to be the subnational regions inside each country.

QUANTIFYING VULNERABILITY

The measure used to assess the vulnerability situation in West and Central Africa has been defined as a combination of multiple variables that provide insight and conform an adequate quantitative indicator of different aspects of this multifaceted phenomenon³. As mentioned above, a particular vision of vulnerability is targeted in this project, and so the variables included have been suggested according to the humanitarian organization's needs and in the basis of data availability at the subnational level. As an exception, in the absence of data at the subnational level for highly informative variables, national level values have been used instead⁴.

For the sake of interpretability of the vulnerability measure and to allow the visualization of different aspects of it separately, all the variables included in the analysis have been thematically grouped into three categories or components: inherent fragility, risk and exposure, and lack of preparedness. Inside each component, each variable has been given a relative weight according

¹ See Table 2 for details.

² ACF has been consulted for this study.

³ Full list in Table 1.

⁴ See Table 1 for details.

to its importance, as defined by the requesters of the project. The weighted average inside each component and an aggregation of the three components together are finally computed to get the vulnerability measure.

DATA ACQUISITION

The data used for the different variables was available at different geographical resolutions among which: country level, subnational official divisions at different levels (such as regions, provinces...), survey regions level⁵, geographical location⁶ and spatial grids of different resolutions⁷.

In this context, the use of GIS technology was required to combine together the different sources of information, and to produce a final quantitative measure of vulnerability for 205 subnational regions⁸.

DATA ANALYSIS

The first step of the analysis consisted on obtaining all variable values at the 205 subnational regions considered by aggregating, joining or extracting the original data (depending on the geographical format of each variable).

In order to be able to produce forecasts for 2020, annual historical data (from 1991 to 2016, or the available time range within this period) have been gathered for each variable.

Previous to the combination of multiple variables together, all variable values have been standardized, transformed to avoid heavy asymmetries, and scaled from 0 to 10 (0 representing the lowest risk or best situation and 10 representing the highest risk or worst situation)⁹. Then, for each year and each component of the vulnerability measure, a weighted average of all variable values was computed for each one of the 205 regions, with the weights given in Table 1¹⁰.

This procedure generated a time series for each country and each component of the index from 1991 to 2016 (with possible missing values in between). A weighted¹¹ simple regression model of each component of the index versus time was then used to forecast 2020 values of each component for each region. Note that the forecasts obtained with this kind of model rely on the

⁵ Regions defined for survey design purposes (DHS, MICS...) that do not necessary correspond to current official divisions within a country.

⁶ As for fatalities in armed conflicts where the exact coordinates of the event is recorded.

⁷ See Table 2 for the full list of sources and data types.

⁸ First order subnational administrative divisions, except for Sierra Leone in which 2nd order divisions were considered.

⁹ For the variables expressed in terms of number of persons, the logarithm has been applied. Otherwise, minimum and maximum values have been determined for all variables for scaling purposes. They have been obtained as the min and max values for which skewness is lower than 2 and kurtosis is lower than 3.5 in each variable.

¹⁰ In the case of missing data for some variable at a given year and region, the weighted average was computed by distributing that variable weight to the rest of variables. Only when the total weight of variables with missing data was higher than 25% for a given year and region, the corresponding value for the component was not computed.

¹¹ Observations were weighted proportionally to their recentness, with more recent observations getting heavier weights.

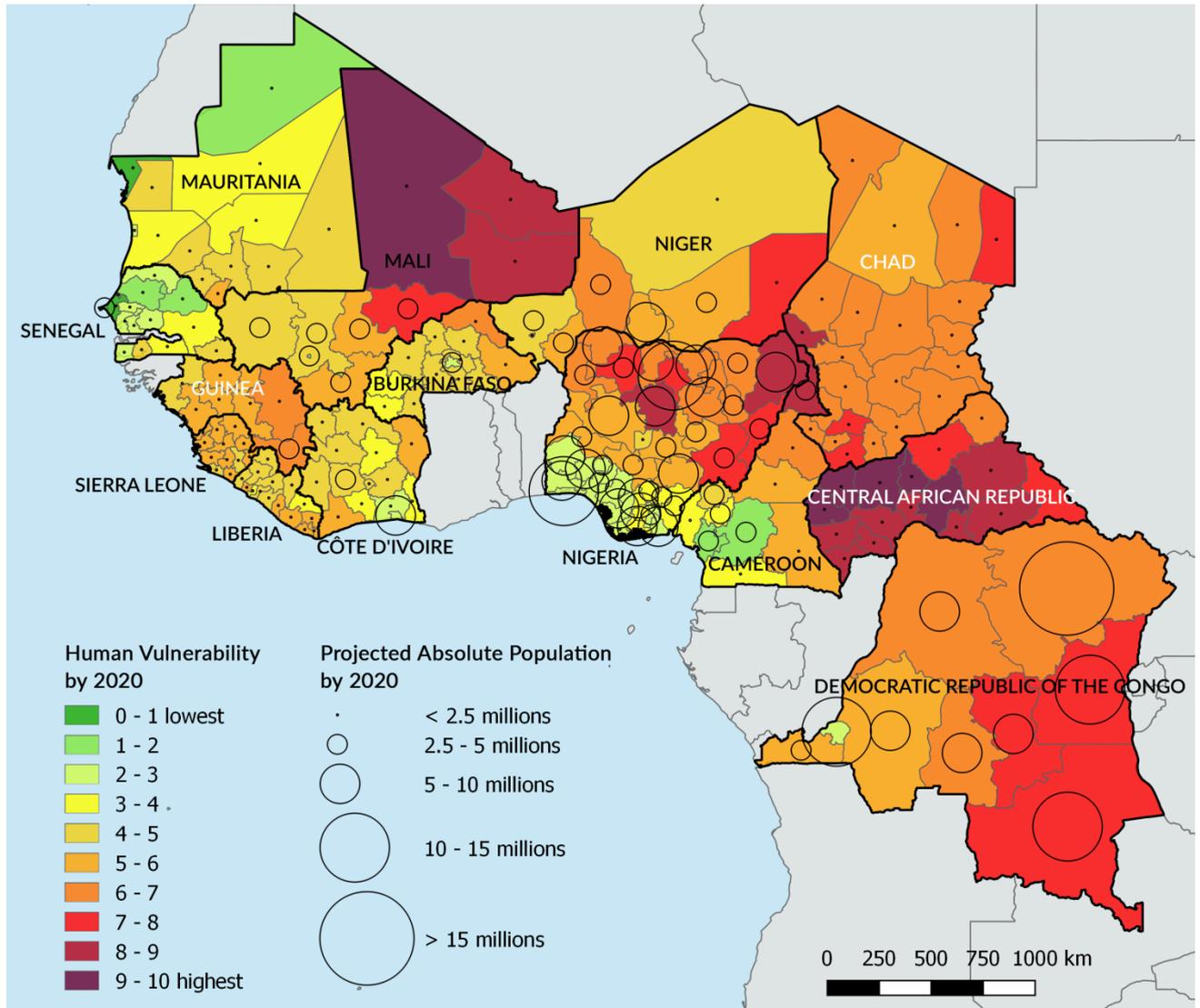
strong assumption that the general trend of each component in each region will remain unchanged on the future years. However, let us stress that forecasting has been done only on the final components (inherent fragility, risk and exposure and lack of preparedness), which are an aggregation of multiple variables, and not on the original variables. While the three components could experiment trend changes in the future, these changes should be smoother than the ones experienced by the variables themselves.

Finally, the vulnerability measure was obtained by averaging the three component values¹². In order to get values that facilitate the interpretation, both after the aggregation inside each component, and after the aggregation of the three components together, obtained values have been rescaled between 0 and 10 (0 representing the lowest risk or best situation and 10 representing the highest risk or worst situation). Let us stress that, as an effect of the scaling procedure, final values in each one of the three components and on the aggregated vulnerability measure represent relative situations. That is, a 0 value in the vulnerability measure does not mean that the corresponding region is completely vulnerability free, but rather that it is the least vulnerable among the 205 subnational regions that conform the geographic scope of this project. The same applies to any of the three components of vulnerability. Inversely, a value of 10, in the aggregated measure or in any of the components, represents the worst situation relative to the 205 subnational regions.

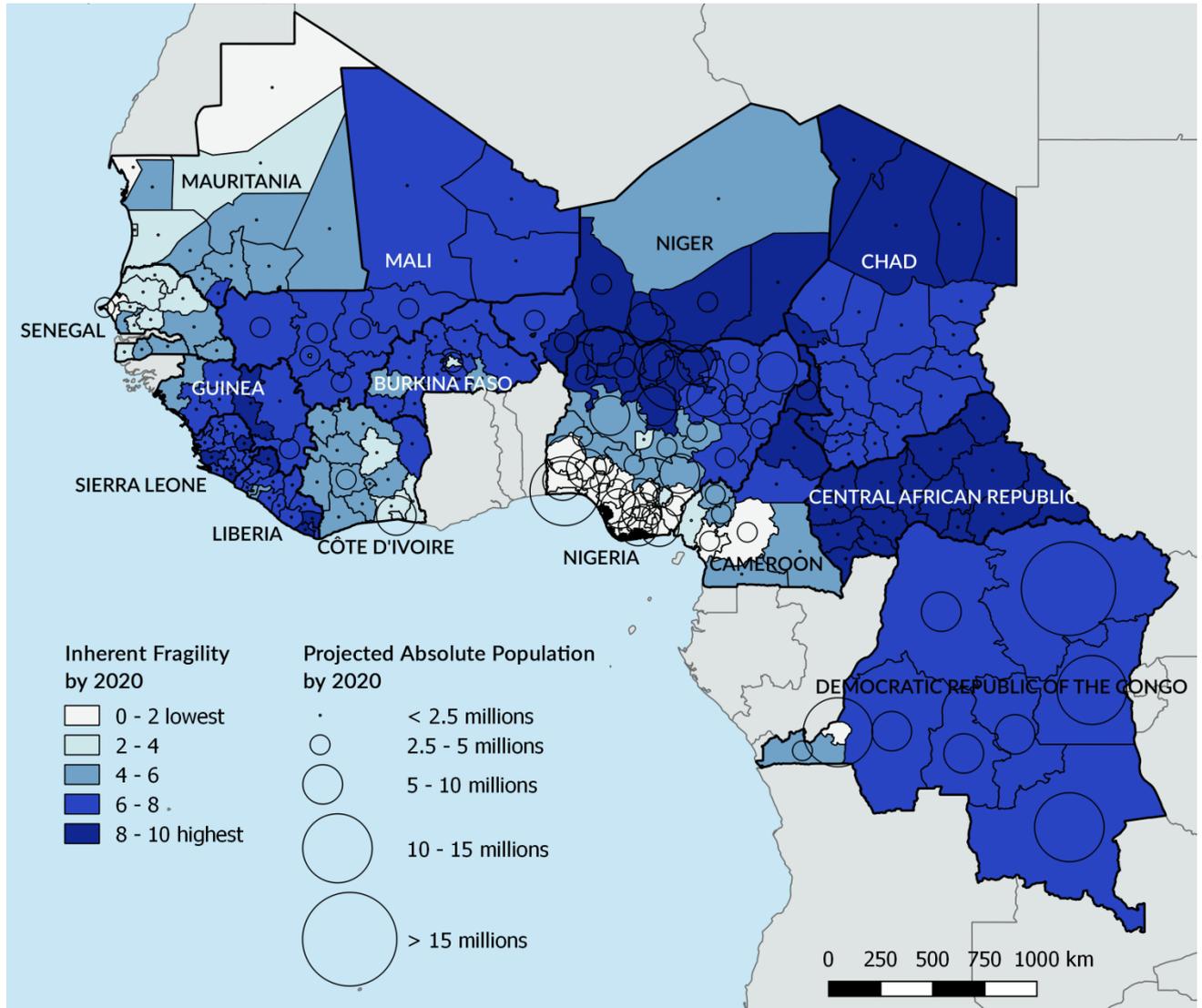
¹² A geometric average has been used to combine the three components together as $1 + (\text{Fragility} - 1)^{1/3} (\text{Risk} - 1)^{1/3} (\text{LackPrep.} - 1)^{1/3}$.

HOTSPOTS MAPS OF HUMAN VULNERABILITY AND ITS THREE COMPONENTS

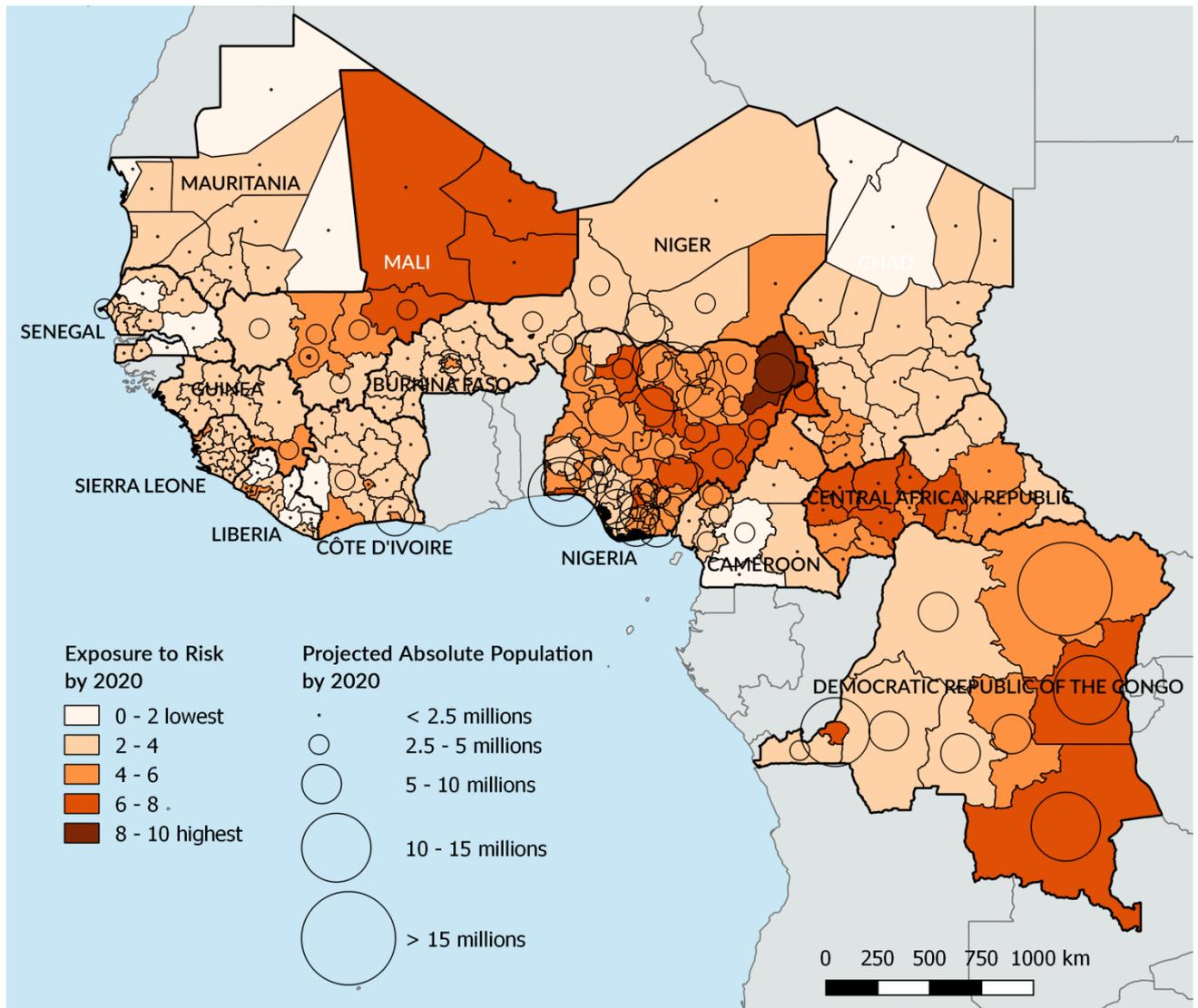
HUMAN VULNERABILITY BY 2020 IN WEST AND CENTRAL AFRICA



INHERENT FRAGILITY BY 2020 IN WEST AND CENTRAL AFRICA



RISK AND EXPOSURE BY 2020 IN WEST AND CENTRAL AFRICA



LACK OF PREPAREDNESS BY 2020 IN WEST AND CENTRAL AFRICA

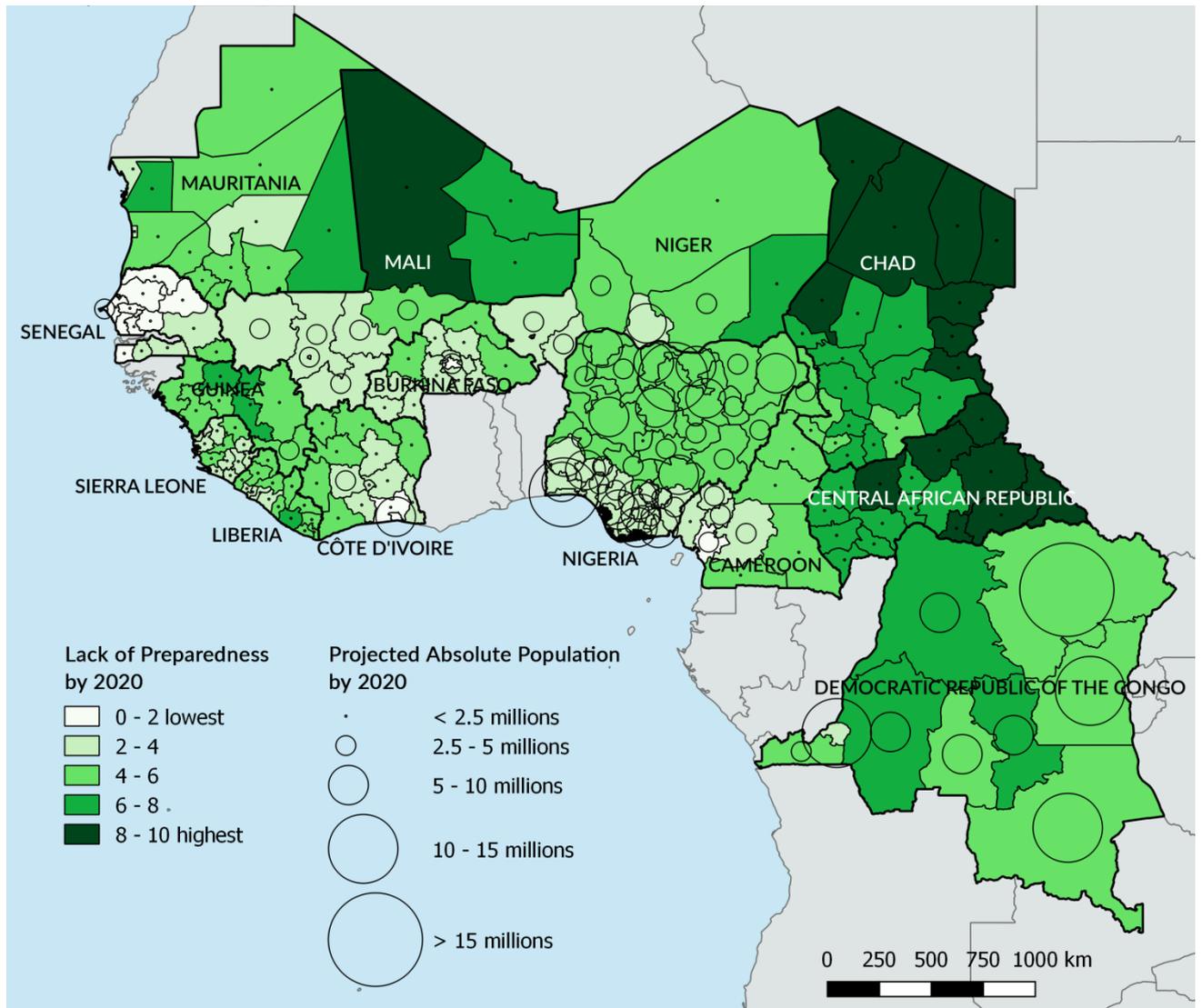


Table 1: Variables selected for each component¹³

Component 1: Inherent Fragility			Component 2: Risk and Exposure			Component 3: Lack of Preparedness		
Group	Variable	Relative weight of variable	Group	Variable	Relative weight of variable	Group	Variable	Relative weight of variable
Young population	Population under 15 (% of total)	10/100		Land degradation index	15/100	Water and sanitation	Households without any toilet facility (% of total)	10/100
	Households with refrigerator (% of total)	2.5/100		Mortality risk associated to droughts	6.25/100		Households without an improved source of water (% of total)	10/100
Standard of living/Poverty	Households with phone (% of total)	2.5/100	Natural and climatic risk	Physical exposure to drought - average annual population exposed (% of total)	6.25/100	Physical connectivity	Accessibility (connectivity and concentration of economic activity)	20/100
	Mean International Wealth index (IWI)	7.5/100		Mortality risk associated to floods	6.25/100		Communications	Mean years of education of adults aged 20+
	Households with IWI < 50 (% of total)	7.5/100		Physical exposure to flood - average annual population exposed (% of total)	6.25/100	Households with electricity (% of total)		4/100

¹³ Variables with data only available at national level appear in shaded boxes.

Component 1: Inherent Fragility			Component 2: Risk and Exposure			Component 3: Lack of Preparedness		
Group	Variable	Relative weight of variable	Group	Variable	Relative weight of variable	Group	Variable	Relative weight of variable
	GINI index	5/100	Armed conflicts	Fatalities in armed conflict events	30/100		Households with a cellphone (% of total)	4/100
Family structure	Average household size	5/100		Length of past-conflicts	10/100		Households with television (% of total)	4/100
Gender	Mean years of education difference between men and women aged 20+	4.5/100		Ethnic tensions	Ethnic fractionalization index	2/100		Households with radio (% of total)
	Mean age difference between partners (husband - wife)	4.5/100	Linguistic fractionalization index		1.5/100	Access to health care	Children aged 1 with measles vaccination (% of total)	20/100
	Mean age at first birth of women aged 20-50	6/100	Religious fractionalization index		1.5/100	Governance	Corruption Perception Index	10/100
Dependence on external aid	Net ODA received (% of GNI)	10/100	Population displacement	Refugees by country of asylum	2/100		Government effectiveness	10/100
Health and undernutrition	Wasting prevalence (in children < 5)	7.5/100		Political instability	Refugees by country of origin	4/100		
	Stunting prevalence (in children < 5)	7.5/100	Internally Displaced Persons		4/100			
	Underweight prevalence (in children < 5)	2.5/100	Freedom House Political Rights index	5/100				
	Under 5 mortality rate	7.5/100						
	Malaria incidence	5/100						
Food insecurity	Main staples prices (volatility in prices)	5/100						

Table 2: Data sources and types

Variable	Source	Characteristics
Population projections	Worldpop Africa Continental Population Datasets (2000 - 2020)	Spatial grid 1 km – 2000-2020 every 5 years

Variable	Source	Characteristics
Component 1: Inherent Fragility		
Population under 15 (% of total)	Worldpop Africa Continental age/sex structure Population Datasets 2000/05/10/15/20	Spatial grid 1 km – 2000-2020 every 5 years
Households with refrigerator (% of total)	Global Data Lab Area Database (compilation of DHS and MICS surveys original data)	Subnational data at the survey regions (admin 1, admin 2 or groups of those) – 1 to 4 surveys available from 1991 to 2016 depending on countries.
Households with phone (% of total)		
Mean International Wealth index (IWI)		
Households with IWI < 50 (% of total)		
GINI index	World Bank Data	National data – 2 to 6 values available from 1991 to 2016 depending on countries
Average household size	Global Data Lab Area Database (see details above)	See details for Global Data Lab Area Database above
Mean years of education		
difference between men and women aged 20+		
Mean age difference between partners (husband – wife)		
Mean age at first birth of women aged 20-50	World Bank Data	National data – annual
Net ODA received (% of GNI)		
Wasting prevalence (in children < 5)	Global Data Lab Area Database (see details above)	See details for Global Data Lab Area Database above
Stunting prevalence (in children < 5)		
Underweight prevalence (in children < 5)		
Under 5 mortality rate	The Malaria Atlas Project	Spatial grid 5 km - 2000-2015 annual
Malaria incidence (pixel-level mean rate of clinical Plasmodium falciparum malaria cases per person per year observed)		
Main staples prices (volatility in prices)	Own elaboration from the World Food Program VAM data on market prices	Subnational data at specific markets (no nationwide coverage) – 1992-2017 annual
Component 2: Risk and Exposure		
Land degradation index	Global land degradation information system GLADIS, FAO/ISRIC/LADA/IIASA/IFPRI	Spatial grid 1 km – Single time point
Mortality risk associated to droughts	Global Drought Mortality Risks and Distribution dataset, v1 (2000), NASA Socioeconomic Data and Applications Center (SEDAC)	Spatial grid 5 km – Single time point (2000) from historical data (1981 to 2000)
Physical exposure to drought - average annual population exposed (% of total)	Global Risk Data Platform	Spatial grid 5 km – Single time point

Variable	Source	Characteristics
Mortality risk associated to floods	Global Flood Mortality Risks and Distribution dataset, v1 (2000), NASA Socioeconomic Data and Applications Center (SEDAC) -	Spatial grid 5 km – One single data point (2000) from historical data (1981 to 2000)
Physical exposure to flood - average annual population exposed (% of total)	Global Risk Data Platform	Spatial grid 5 km – Single time point
Fatalities in armed conflict events	ACLED Version 7 (1997 – 2016) dataset, Armed Conflict Location & Event Data Project	Georeferenced events – from 1997 to 2016
Length of past-conflicts	Own elaboration from the UCDP Conflict Termination dataset version 2-2015, Uppsala Conflict Data Program	Information on conflicts processed to get subnational data at the admin 1 level – from 1991 to 2016
Ethnic fractionalization index	Alesina, A., A. Devleeschauwer, W. Easterly, S. Kurlat, and R. Wacziarg, 2003. "Fractionalization." <i>Journal of Economic Growth</i> , 8: 155-94.	National data – single time point
Linguistic fractionalization index		
Religious fractionalization index		
Refugees by country of asylum	World Bank Data	National data – annual
Refugees by country of origin	World Bank Data	National data – annual
Internally Displaced Persons	Global Internal Displacement Database, Internal Displacement Monitoring Center	National data – 2008-2016 annual
Freedom House Political Rights index	Freedom House - https://freedomhouse.org/report-types/freedom-world	National data – 1991-2016 annual
Component 3: Lack of Preparedness		
Households without any toilet facility (% of total)	The Demographic and Health Surveys Program (DHS)	Subnational data at the survey regions (admin 1, admin 2 or groups of those) – 1 to 4 surveys available from 1991 to 2016 depending on countries
Households without an improved source of water (% of total)		
Accessibility (connectivity and concentration of economic activity)	Global land degradation information system GLADIS, FAO/ISRIC/LADA/IIASA/IFPRI	Spatial grid 1 km – Single time point
Mean years of education of adults aged 20+	Global Data Lab Area Database (see details above)	See details for Global Data Lab Area Database above
Households with electricity (% of total)		
Households with a cellphone (% of total)		
Households with television (% of total)		
Households with radio (% of total)		
Households with radio (% of total)	The Demographic and Health Surveys Program (DHS)	See details for DHS above
Children aged 1 with measles vaccination (% of total)	Global Data Lab Area Database (see details above) , MICS surveys for Central African Republic (2006 and 2010), Guinea (1999) and DHS surveys for Mauritania (2007)	Subnational data at the survey regions (admin 1, admin 2 or groups of those) – 1 to 4

Variable	Source	Characteristics
Corruption Perception Index	<u>Transparency International</u>	surveys available from 1991 to 2016 depending on countries National data - 2001-2016 annual
Government effectiveness	<u>Worldwide Governance Indicators, The World Bank</u>	National data - 1996-98-2000 and annual from 2002

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Humanitarian Foresight Think Tank

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