Structural Vulnerability Map of Burkina Faso – February 2015

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The Purpose of the Map

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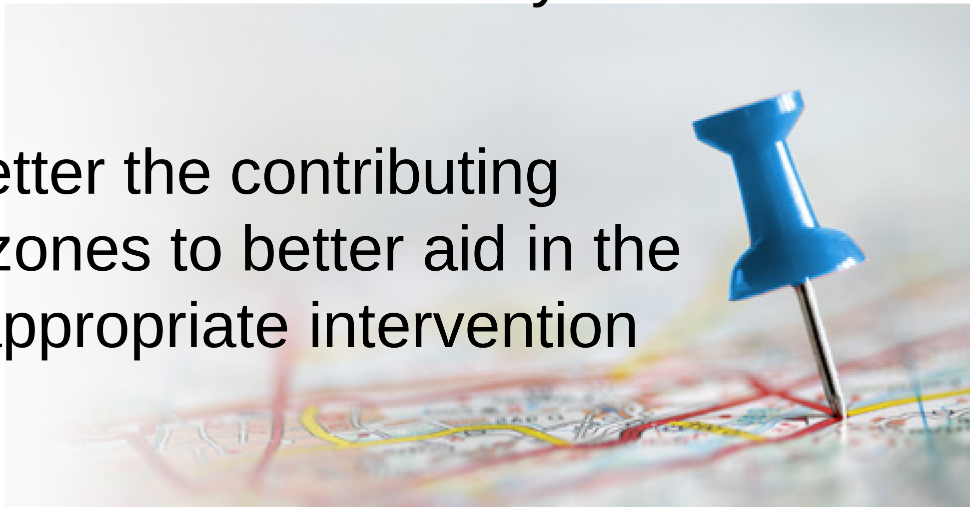
- To leverage evidence and data analytics to better geographically target zones in need of long term resilience investments
- Aid in prioritizing limited resources where they are actually needed the most
- Stimulate analysis and discussion on the dynamics and determinants of vulnerability in relation to available datasets
- A tool for understanding better the contributing factors behind vulnerable zones to better aid in the development of the most appropriate intervention package



What the map IS and what the map ISN’T

The map ISN’T:

- A food security map (ie. SAP, FEWSNET, Cadre Harmonise)
- A map showing vulnerability at a particular point in time (conjunctural)
- Perfect – mix of art & science (qualitative and quantitative)

The map IS:

- A hi-tech overlap map – “hotspot” map
- A map of *structural* vulnerability (historical datasets aggregated overtime to get at tendency)
- A decision-making tool for targeting longer term resilience investments (most vulnerable zones)
- A geographically referenced resilience measurement index (each pixel in map has a vulnerability/resilience score)

Definition of Structural Vulnerability

Structural vulnerability is a tendency to be in a state of high-risk to negative well-being outcomes(ie. undernutrition, anemia) on account of persistent exposure to various potential shocks (ie. climatic, price) in combination with a chronic resilience deficit (ie. lack of absorptive, adaptive and transformative capacities).

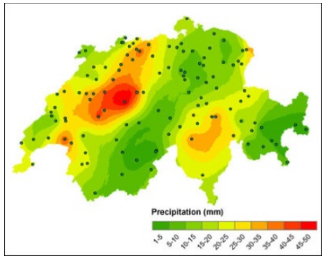
Methodology:

<u>Step 1 – Identify available data</u>

Identify most relevant sub-national indicators available for the analysis.

1. List ideal most relevant indicators desired
2. Look to what is *actually available* (both proxy and direct measurements)
3. Be sure the available data is disaggregated sub-nationally
4. Ensure the validity and reliability of the data

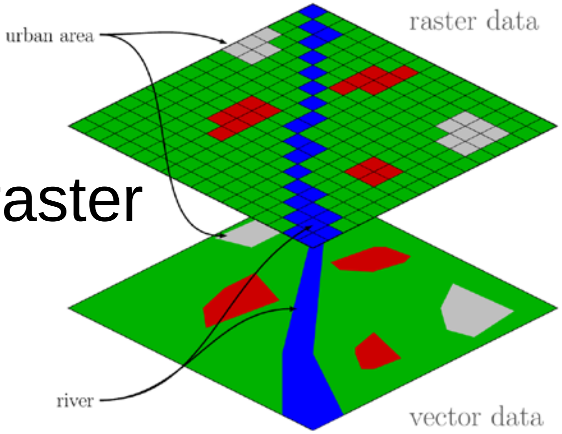
Methodology:



Step 2 – Convert to raster

Convert each geographic dataset to raster format. Use Kriging interpolation in the case of point data.

1. Data that is already in raster format (ie. remotely sensed imagery) will not need to be converted
2. Vector data at administrative levels (commune, region, etc.) can be converted directly into raster format
3. Point data can be used to create a raster surface using Kriging interpolation

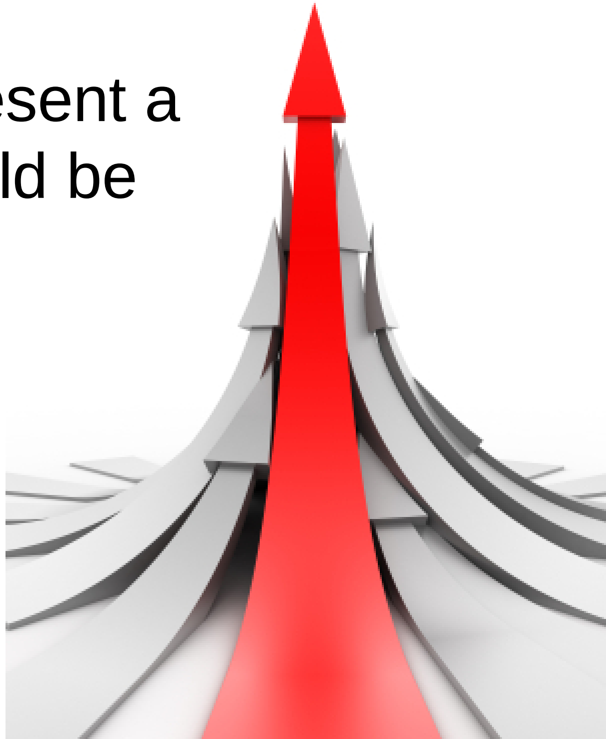


Methodology:

Step 2 – Same directionality

Be sure that all datasets have same directionality (i.e. higher values always indicate more vulnerability)

1. Data sets where higher values represent a positive thing (ie. precipitation) should be inverted in their ordering
2. Making all datasets have the same directionality allows for comparison



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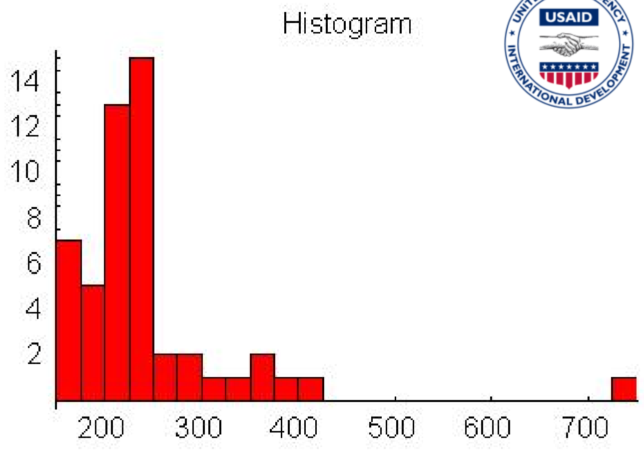
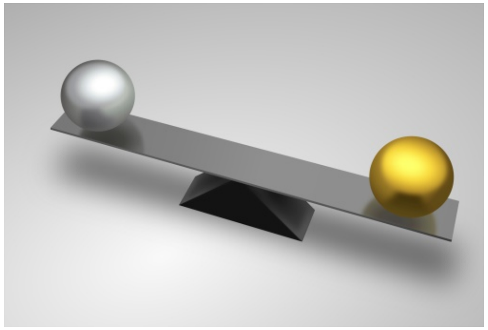


Step 4 - Winsorize

Winsorize data where appropriate based on histogram analysis. This prevents the data from being skewed by outlier data and amplifies geographic variation.

1. Histogram analysis allows for the identification of extreme outlier data within a data set
2. Outlier data should be adjusted so as to bring out geographic variation in majority of the data set

Methodology:



Step 5 - Rescale

Rescale all datasets to a common 0-100 scale so that they are comparable for averaging to create composites.

1. Subnational data will be at various scales (ie. 0-1, 10-26,000, etc.)
2. In order to enable comparability (averaging) all data sets must be at same scale
3. Stretch or shrink datasets proportionally so that the lowest value in the set becomes 0 and the highest becomes 100

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Methodology:

Step 6 – Weighted Averaging

Example:

Score		Weight		
65	×	1	=	65
60	×	1	=	60
80	×	2	=	160
95	×	3	=	285

wikiHow

Average datasets using weighting based on consensual subject matter expert judgment to create composites.

1. Related dataset should be grouped for aggregation into representative composites (ie. direct poverty measurements and proxies to poverty grouped into a poverty composite)
2. Relative weighting of each dataset contributing to the representative composite should be discussed in a consensual manner with the relevant subject matter experts
3. Sometimes composites created will aggregate again into higher level composites and weighting must be decided for these aggregations also

* Important to note here that refusing to weight datasets when averaging them into composites creates implicit weighting where all data becomes equally weighted, which is a kind of unintentional weighting by default. This doesn't reflect the reality of the variable contributions different datasets have in relation to vulnerability.

All datasets used for composites (datasets averaged based on weightings listed):

* datasets averaged based on weightings listed
* historical datasets used when available in order to map structural vulnerability vs. conjunctural
* all time series datasets have been averaged over entire period to map tendency (structural issues)

Title	Source	Date Range	Admin Level	Methodology notes	SubComposite Weight	SubComposite Title	Final Weight	Composite Title	Composite Weight	Top Index Composite	Final Weight
FEWSNET	FEWSNET food security outlook data	2008-2014	Province/ Livelihood zone	Averaged IPC score per zone over entire time period.	50%	Food Security	50%	Food Security/Ag. Productivity	31%	Resilience Capacity	49%
SAP	Système d'Alerte Précoce (SAP) vulnerable communes	2009-2014	Commune	Commune score generated by totalling number of times communes identified as vulnerable during time period.	50%						
% of non-self sufficient farm households	Ministry of Agriculture - Burkina Faso	2008-2009	Region	Averaged % per region over both years.	43%	Agricultural Productivity	50%				
Soil Organic Carbon Density	International Soil Reference and Information Centre - World Soil Information	2013	Raster	The soil organic carbon predicted mean for the 1st standard depth (0–5cm), 2nd standard depth (5–15cm) and 3rd standard depth (15–30cm) were summed for an approximation of the soil organic carbon in top soil, which is 0–20cm.	57%						
Educational Level	Annuaire Statistique de l'education nationale	2010-2013	Province	The passing rates for grades 1 thru 5 were averaged and then these averages were averaged over the 4 years.			40%	Literacy Rates	23%		
Literacy Rates	Census Data	2006	Commune	During the 2006 census, everyone over the age of 3 were asked whether or not the respondent could read and write in any language.			60%				
Poverty	Burkinabè Household Living Conditions Survey (ECBVM)	2003, 2009	Region	Averaged poverty rates per region to approximate general tendency.	67%	Poverty (adjusted)	25%	Poverty	31%		
Remittances	Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO)	2011	Region	A per capital amount was calculated for remittances per region.	33%						
Wealth Index	Demographic and Health Surveys (DHS)	2003, 2010	Cluster Points	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)			33%				
Lack of Access to Health Services on Account of Financial Constraints	Demographic and Health Surveys (DHS)	2003, 2010	Cluster Points	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)			8%				
Tropical Livestock Units	Ministry of Livestock - Burkina Faso	2012	Province	Projected Livestock figures converted to TLU			17%				
Immigration Rates	Census Data	2006	Commune	During the 2006 census, every family was asked if they had moved in the last year, and if so, from where to where. Immigration Rates were used as a proxy for vulnerability based on the assumption that generally zones that are less vulnerable are more attractive (offer more opportunities) and thus have higher rates of immigration.			17%				
Lack of Access to Health Services on Account of Distance	Demographic and Health Surveys (DHS)	2003, 2010	Cluster Points	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)	40%	Distance to Health Services	20%	Service Access	15%		
Distance to Health Center	Ministry of Health - Burkina Faso	2013	Province	Yearly report from the Ministry of Health that calculates how many people in each province are 10 km or more away from a health center	60%						
# of People per Unit Area	AFRIPOP	2014 estimate	Raster	Areas of lower population are considered as a proxy to lack of access to services (remoteness)			27%				
Access to Improved Sanitation	Demographic and Health Surveys (DHS)	2003, 2010	Cluster Points	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)			20%				
Access to Improved Drinking Water Source	Demographic and Health Surveys (DHS)	2003, 2010	Cluster Points	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)			13%				
> 30 minutes walk to nearest drinking water source	Demographic and Health Surveys (DHS)	2003, 2010	Cluster Points	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)			20%				

Table continues on next slide...

Average Rainfall Variability	CHIRPS dataset, C. Funk et al.	Jan. 1981 - Sept. 2014	Raster	Coefficient of Variation of rainfall data was calculated across entire time period for the month of May (planting time) and the month of October (harvest). The variation in rainfall during these two months is considered critical. The two rasters were then averaged to highlight the most vulnerable zones in regards to rainfall variability and its affect on ag. production.			29%	Recurrent Climate Shock	44%	Exposure (Shocks & Stresses)	21%
Average Temperature during Rainy Season	University of East Anglia's Climatic Research Unit (UEA/CRU)	2000-2011 (JJAS- rainy season)	Raster	Average temperature during each rainy season (JJAS) over entire time period was averaged to get a general rainy season average temperature. Hotter average temperature during rainy season can be considered a proxy to plant stress at higher temperatures.			14%				
Average Length of Rainy Season	Famine Early Warning Systems Network (FEWSNET)	2001-2010	Raster	Zones with shorter rainy seasons are considered more vulnerable.			29%				
Average Total Annual Precipitation	CHIRPS dataset, C. Funk et al.	Jan. 1981 - Sept. 2014	Raster	Calculated over entire time period. Zones of lower average total precipitation are considered more vulnerable.			29%				
Historical Conflict	Armed Conflict Location & Event Data (ACLED) database	1/1/1997 to 7/16/2014	Point Data	# of incidents per location plus number of fatalities multipied by two was used to generate a "conflict score" per point location. All types of conflict from database were included (ie. protests, armed groups, police, ethnic milities, etc.).			67%	Historic Sites of Conflict	11%		
Refugees	World Food Programme (WFP)	2014	Point Data	Total refugee count was used per location as a proxy to conflict because of population and resource pressures created by refugee presence.			33%				
Malaria Prevalence	Demographic and Health Surveys (DHS)	2010	Point Data	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)			100%	Health Shock	11%		
Average millet price during lean season	SIM/SONAGESS	2004-2014	Point Data	Point data represents all markets surveyed monthly for prices. Average market prices were calculated for all markets overtime during lean season. Lean season is when high prices have the biggest negative impact on household food security. Point data was interpolated to Raster using Kriging Method (both rasters for each year averaged). Relative weighting for each commodity was calculated proportionally to each commodities production level.			27%	Recurrent Price Shocks	33%		
Average yellow corn price during lean season	SIM/SONAGESS	2004-2014	Point Data	SAME METHODOLOGY NOTES FOR ALL PRICE DATA IN COMPOSITE (SEE NOTES FOR MILLET PRICES)	50%	Corn Prices	29%				
Average white corn price during lean season	SIM/SONAGESS	2004-2014	Point Data	SAME METHODOLOGY NOTES FOR ALL PRICE DATA IN COMPOSITE (SEE NOTES FOR MILLET PRICES)	50%						
Average white sorghum price during lean season	SIM/SONAGESS	2004-2014	Point Data	SAME METHODOLOGY NOTES FOR ALL PRICE DATA IN COMPOSITE (SEE NOTES FOR MILLET PRICES)			33%				
Average red sorghum price during lean season	SIM/SONAGESS	2004-2014	Point Data	SAME METHODOLOGY NOTES FOR ALL PRICE DATA IN COMPOSITE (SEE NOTES FOR MILLET PRICES)			11%				

Prevalence < 5 Severe Anemia	Demographic and Health Surveys (DHS)	2003, 2010	Cluster Points	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)			67%	Anemia Prevalence	20%	Well-Being Outcome	30%
Anemia Prevalence (Women)	Demographic and Health Surveys (DHS)	2003, 2010	Cluster Points	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)			33%				
Average GAM Rates (SMART)	Standardized Monitoring and Assessment of Relief and Transitions (SMART)	2009-2013	Region	Each region was polled by SMART every other year, all information was averaged together	50%	Average GAM Rates	67%	Undernutrition	80%		
Average GAM Rates (DHS)	Demographic and Health Surveys (DHS)	2003, 2010	Cluster Points	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)	50%						
Average Stunting Rates (SMART)	Standardized Monitoring and Assessment of Relief and Transitions (SMART)	2009-2013	Region	Each region was polled every other year, all information was averaged together	50%	Average Stunting Rates	33%				
Average Stunting Rates (DHS)	Demographic and Health Surveys (DHS)	2003, 2010	Cluster Points	Points interpolated to Raster using Kriging Method (both rasters for each year averaged)	50%						

Structural Vulnerability Map of Burkina Faso - Feb. 2015

Definition of Structural Vulnerability:

Structural vulnerability is a tendency to be in a state of high-risk to negative well-being outcomes(ie. undernutrition, anemia) on account of persistent exposure to various potential shocks (ie. climatic, price) in combination with a chronic resilience deficit (ie. lack of absorptive, adaptive and transformative capacities).

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Vulnerability Estimate (left) gets "corrected" here by averaging it with real well-being outcome measurements through the well-being composite above. The result of this correction is the Final Vulnerability Map to the right.

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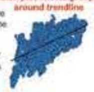
Linear Regression Analysis:
A linear regression was run to determine how well the Vulnerability Estimate composite model predicts (correlates to) the Well-Being Outcome composite. The assumption is that if Resilience Capacities and Exposure to Shocks and Stresses are combined to form a Vulnerability Estimate, the vulnerable zones identified therein should correlate to geographic zones of negative well-being outcomes (ie. undernutrition). Modeled grid cell values from both geographic models were used for the regression analysis.

R-Squared = 0.39



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Absorptive, Adaptive, & Transformative Capacities

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Purpose of Map:

The purpose of the final vulnerability map is to better identify "hotspots" of structural vulnerability in order to better geographically target longer term resilience investments (development adapted to vulnerable contexts) where the need is greatest. Improved geographic targetting of the most vulnerable is critical to decision making regarding strategic investments for resilience and redressal of social justice related grievances which may lead to conflict.

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Basic Methodology:

Big data analytics were leveraged to identify structurally vulnerable zones. These zones of development need were calculated by averaging together all relevant and available sub-national development indicators across a broad spectrum. In all, 36 datasets, many of which were historical, were aggregated into composites, which were then aggregated into higher level composites. Geographic areas where most development indicators were negative are more red and areas where indicators were relatively better are more blue.

Basic data processing steps are listed below:

1) Identify most relevant sub-national indicators available for the analysis.
2) Convert each geographic dataset to raster format. Use Kriging interpolation in the case of point data.
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4) Rescale all datasets to a common 0-100 scale so that they are comparable for averaging to create composites.
5) Average datasets using weighting based on consensual subject matter expert judgement to create composites.

Final Vulnerability Map

Legend:

how to read this infographic

1) Red Zones on all maps are most vulnerable and the blue zones represent least vulnerable relatively.

2) Boxes with blue border contain composite index maps. The + sign between composite maps signifies that they are averaged together to form yet another composite map. Follow the arrow symbol with = sign to see which composite they create when averaged together.

3) Boxes with brown border contain sub-composite index maps. All subcomposite maps in brown bordered boxes are averaged together to form the composite maps they feed into (see the tip of brown box with = sign in it). It should be noted here that subcomposite maps in this infographic are based on other component maps not visualized on this infographic. The table at right gives the specifics about datasets used and the nature of the components maps that were aggregated using a weighted average to produce the subcomposite maps you see in this infographic.

6) Numbers in red circles represent relative weighting of each composite or subcomposite as it contributes to the average. Weightings are represented as a percentage out of 100%. The reason that some of the weightings are odd numbers is because they were derived from an initial intuitive weighting based on double-weighting, half-weighting, one and a half weighting etc., based on a group consensus of subject matter experts. These informal weightings were then converted to a percentage of 100 to calculating weighted averages to form composites.

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Top 50 Most Vulnerable Communes

[illegible]

All datasets used for composites (datasets averaged based on weightings listed):

[illegible]

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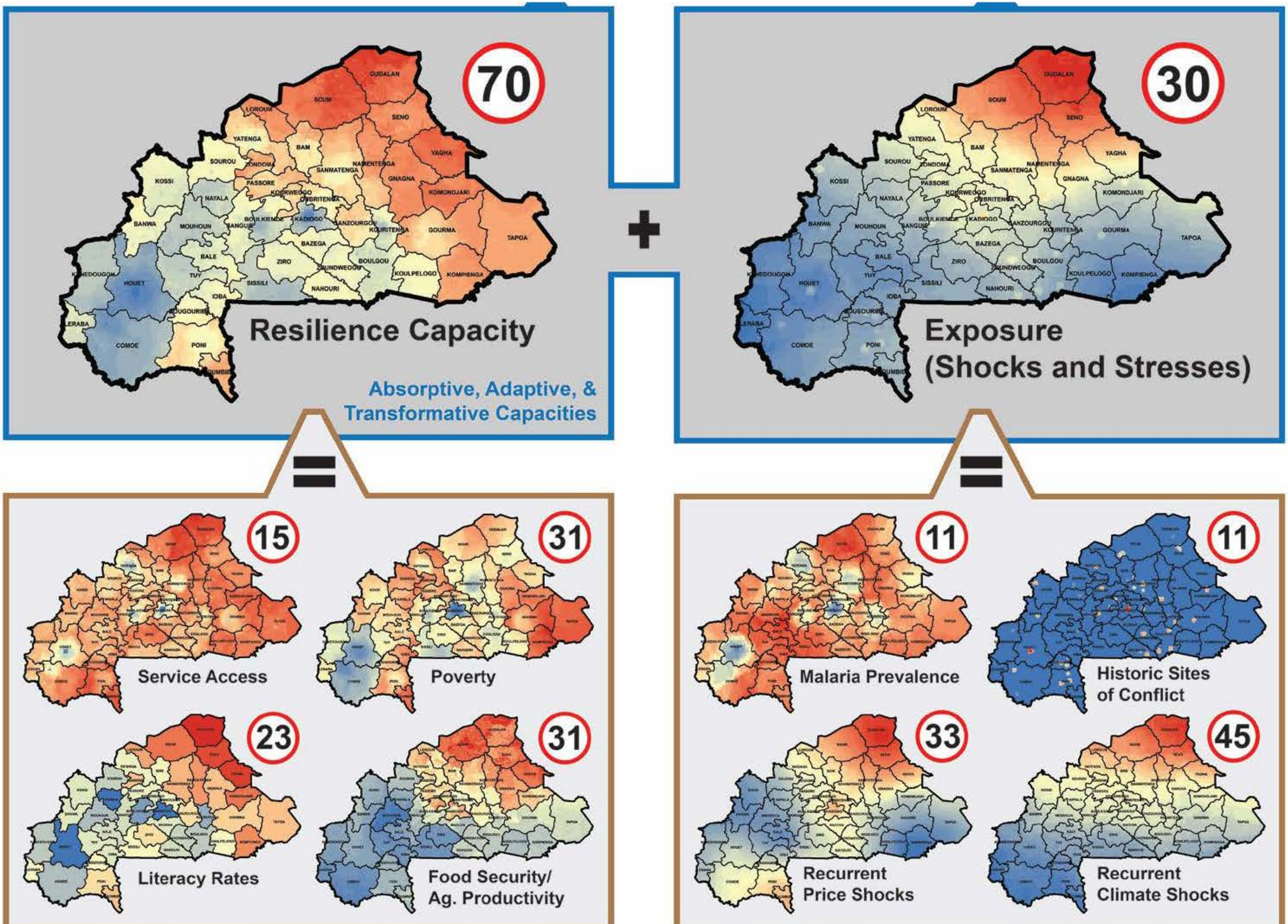
70
Resilience Capacity
Absorptive, Adaptive, & Transformative Capacities
+
30
Exposure
(Shocks and Stresses)
=
15
Service Access
31
Poverty
23
Literacy Rates
31
Food Security/
Ag. Productivity
=
11
Malaria Prevalence
11
Historic Sites
of Conflict
33
Recurrent
Price Shocks
45
Recurrent
Climate Shocks

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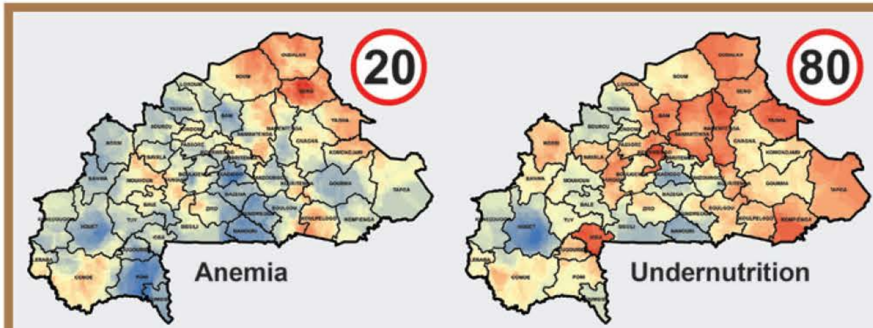

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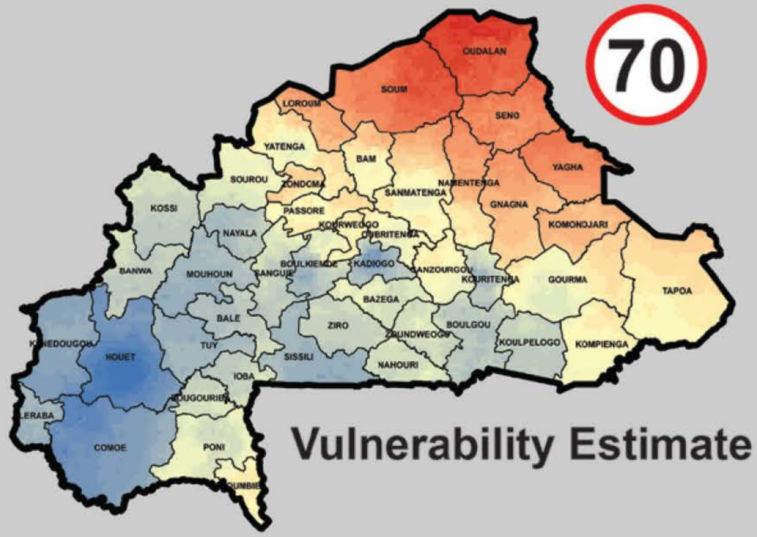

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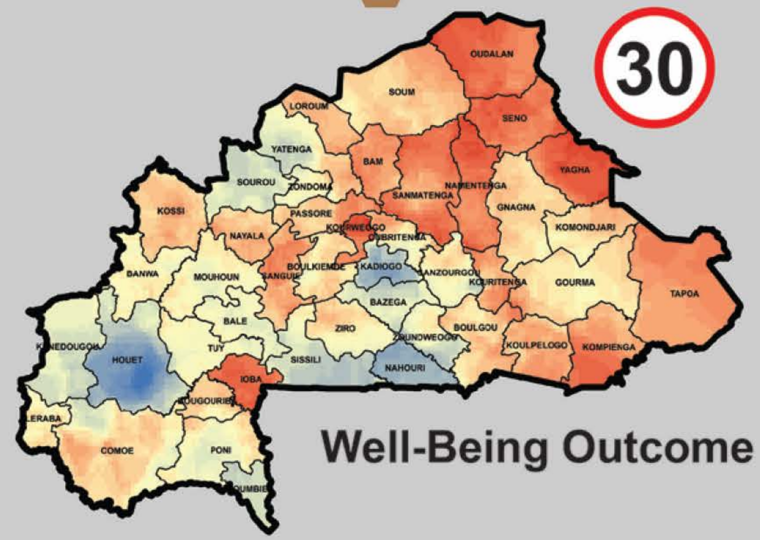

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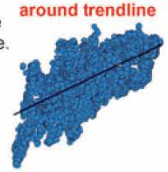
R-Squared = 0.39

Scatterplot shows grouping around trendline



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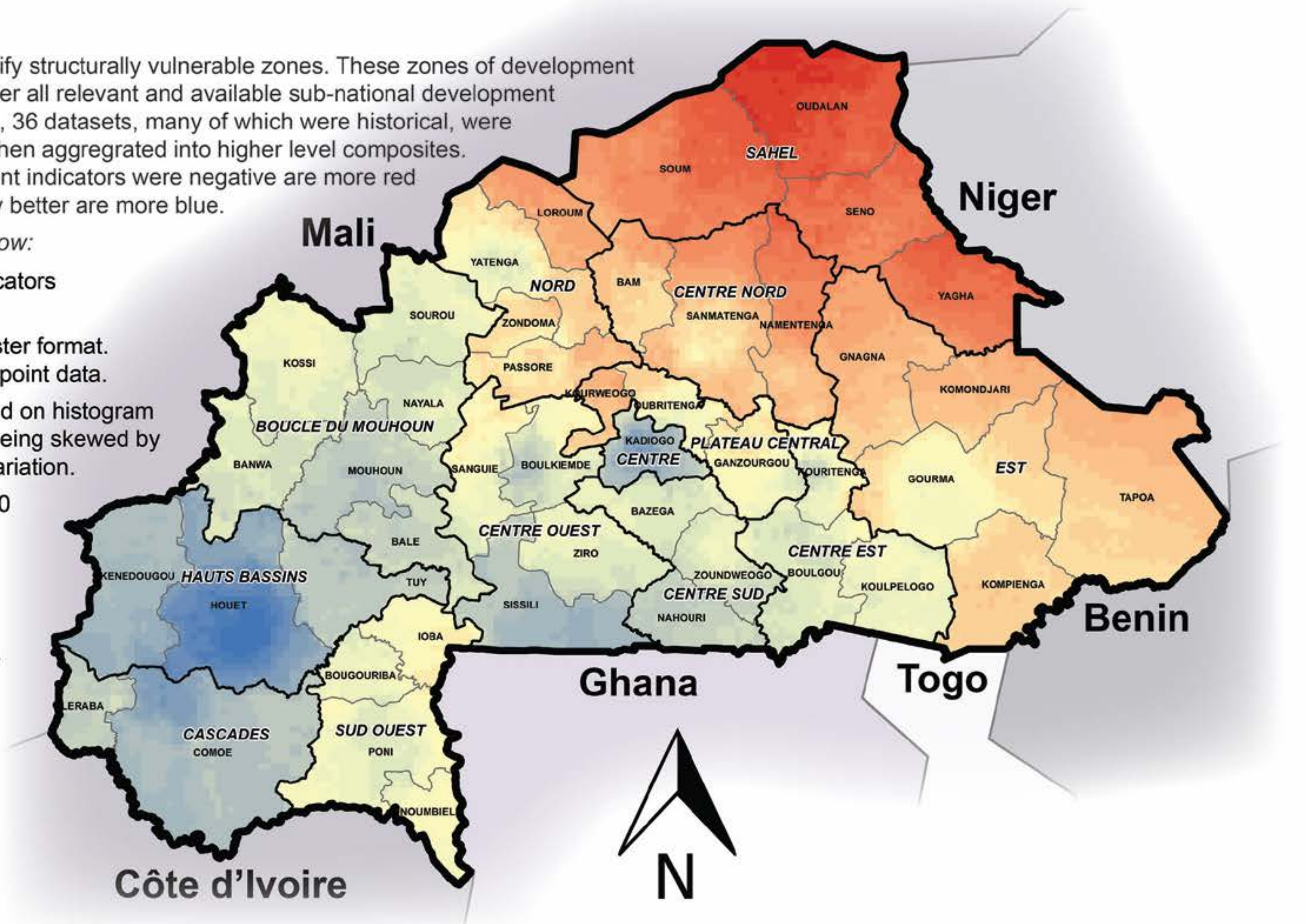

Final Vulnerability Map

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Top 50 most structurally vulnerable communes

Rang	Departement	Province	Region	Score de vulnerabilité	POP (2006 Census)
1	TIN-AKOFF	Oudalan	SAHEL	96.3	21,013
2	DEOU	Oudalan	SAHEL	95.5	25,321
3	OURSI	Oudalan	SAHEL	91.9	15,806
4	GOROM-GOROM	Oudalan	SAHEL	88.8	106,346
5	MARKOYE	Oudalan	SAHEL	88.5	27,478
6	KOUTOUGOU	Soum	SAHEL	88.4	18,655
7	TITABE	Yagha	SAHEL	87.5	20,639
8	FALAGOUNTOU	Seno	SAHEL	85.5	18,180
9	TANKOUGOUNADIE	Yagha	SAHEL	85.2	16,453
10	ARBINDA	Soum	SAHEL	84.5	91,020
11	SEBBA	Yagha	SAHEL	84.1	32,374
12	BOUNDORE	Yagha	SAHEL	83.9	22,773
13	GORGADJI	Seno	SAHEL	83.7	29,913
14	DORI	Seno	SAHEL	82.6	106,808
15	SEYTENGA	Seno	SAHEL	82.2	31,585
16	BOUROUM	Namentenga	CENTRE NORD	81.6	46,232
17	SOLHAN	Yagha	SAHEL	81.1	25,108
18	NAGBINGOU	Namentenga	CENTRE NORD	80.9	16,004
19	SAMPELGA	Seno	SAHEL	80.6	19,227
20	TONGOMAYEL	Soum	SAHEL	80.2	70,372
21	NASSOUMBOU	Soum	SAHEL	80.1	20,165
22	BANI	Seno	SAHEL	79.6	59,278
23	YALGO	Namentenga	CENTRE NORD	78.7	31,641
24	KELBO	Soum	SAHEL	78.3	24,157
25	MANSILA	Yagha	SAHEL	78.2	42,805
26	PENSA	Sanmatenga	CENTRE NORD	77.3	36,158
27	DJIBO	Soum	SAHEL	76.3	60,042
28	DABLO	Sanmatenga	CENTRE NORD	76.2	20,707
29	DIGUEL	Soum	SAHEL	75.0	8,989
30	TOUGOURI	Namentenga	CENTRE NORD	74.4	76,824
31	SOLLE	Loroum	NORD	72.8	17,526
32	BARABOULE	Soum	SAHEL	72.0	29,883
33	BANH	Loroum	NORD	70.8	30,332
34	COALLA	Gnagna	EST	70.8	42,652
35	MANI	Gnagna	EST	70.7	68,448
36	BOURZANGA	Bam	CENTRE NORD	69.8	47,751
37	BARSALOGHO	Sanmatenga	CENTRE NORD	69.7	78,919
38	OUINDIGUI	Loroum	NORD	69.4	28,278
39	POBE-MENGAO	Soum	SAHEL	69.3	24,052
40	TITAO	Loroum	NORD	69.2	66,717
41	NAMISSIGUIMA	Sanmatenga	CENTRE NORD	69.0	9,752
42	THION	Gnagna	EST	68.3	23,025
43	BOTOU	Tapoa	EST	68.0	46,959
44	FOUTOURI	Komandjari	EST	67.7	14,683
45	BARTIEBOUGOU	Komandjari	EST	67.5	16,067
46	TOEGHIN	Kourweogo	PLATEAU CENTRAL	67.4	16,500
47	BOGANDE	Gnagna	EST	66.7	84,838
48	LIPTOUGOU	Gnagna	EST	66.5	41,823
49	NIOU	Kourweogo	PLATEAU CENTRAL	66.2	26,998
50	ZEGUEDEGUIN	Namentenga	CENTRE NORD	66.0	21,904

Limitations:

- Secondary data was used. Ideally, a large scale household survey collecting most relevant vulnerability related indicators would be best (ex. World Bank LSMS).
- Many datasets were not available at a low level of disaggregation (ie. sometimes only regional data whereas commune level would be best)
- Weighting based on consensual process with subject matter experts can always be improved.
- Data was difficult to collect on account of the limited availability of some data “gate-keepers”

Next Steps:

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- Map should be used to better geographically target long term resilience investments. Government of Burkina should take the lead.
- Component maps (36) and composite maps (20) can be analyzed to understand the dynamics and relative contributions of the different factors in relation to vulnerability in the different geographies
- After understanding the different factors contributing to the vulnerability of a zone, appropriate interventions can be operationalized
- Joint assessments may be useful to ground truth findings from map. Three of the most vulnerable communes can be compared to three of the least vulnerable to better understand the dynamics of vulnerability and glean insights.

Next Steps:

- Since the map measures structural vulnerability based on averaging historical datasets, change in tendency will likely take **at least five years**. Thus the map can be considered valid for five years. Every five years, all new data over last five years can be aggregated to create an updated map of structural vulnerability to see if the tendencies are changing.

- Synergies with other tools for vulnerability analysis should be explored (ie. HEA, SAP, FEWSNET, Cadre harmonisé)

- Interesting to note *relationship between zones of structural vulnerability and conflict/stability issues*.

Thank you.