COMPOUND RISK FRAMEWORK

Approach overview

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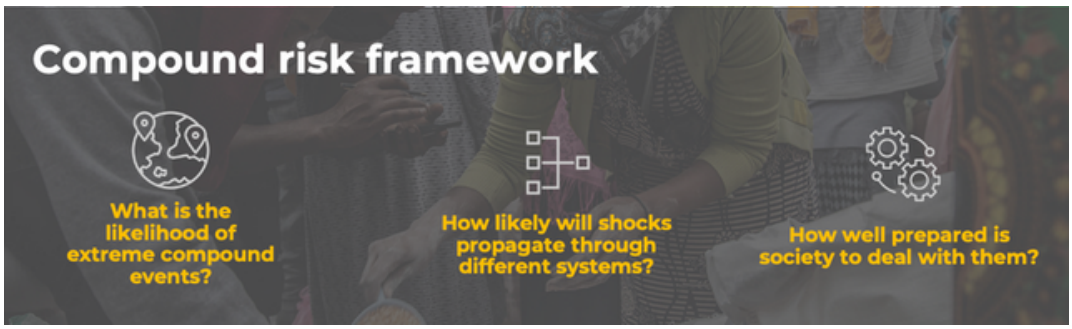
Compound Risk Framework (CRF)

Climate variability is widely impacting natural and human systems. We are increasingly exposed to compound and interrelated environmental, socioeconomic, and political crises. However, our approaches to these issues are often siloed and fragmented, rendering them inadequate. One of the many compound impacts is the escalating threat to food security. Here we propose a quantitative approach for developing a compound risk framework that can be used to compliment the monitoring of instability and fragility in countries of interest.



CRF

Country and regional fragility metric

Assess the overall fragility of each country and region

Drivers

Understand the underlying drivers of food insecurity or conflict events

Pathways

Move beyond direct/linear relationships and assess pathways between drivers

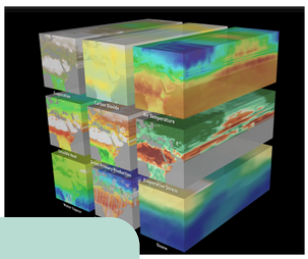
Buffers/mitigating and exacerbating factors

Identify the most influential factors for shock propogation/containment

Scenario simulation

Test how the system responds given new scenarios

Approach, model and major use



DATA CUBES

BAYESIAN NETWORKS

Bayesian Networks are able to give us a powerful measure of **causal interactions** as well as **dependence and independence** between all data dimensions

CAUSAL INTERACTIONS

SYSTEM FRAGILITY

System fragility is measured by Fractal dimension. The fractal dimension can be represented by **a single number** which could be used by **decision makers** to understand the country or sub-national **fragility** compared to other countries

REAL-WORLD USE CASES

The fractal dimension has been used to measure the vulnerability of airline operations as well as how to curb the spread of diseases

CONNECTIVITY AND CASCADING FAILURES

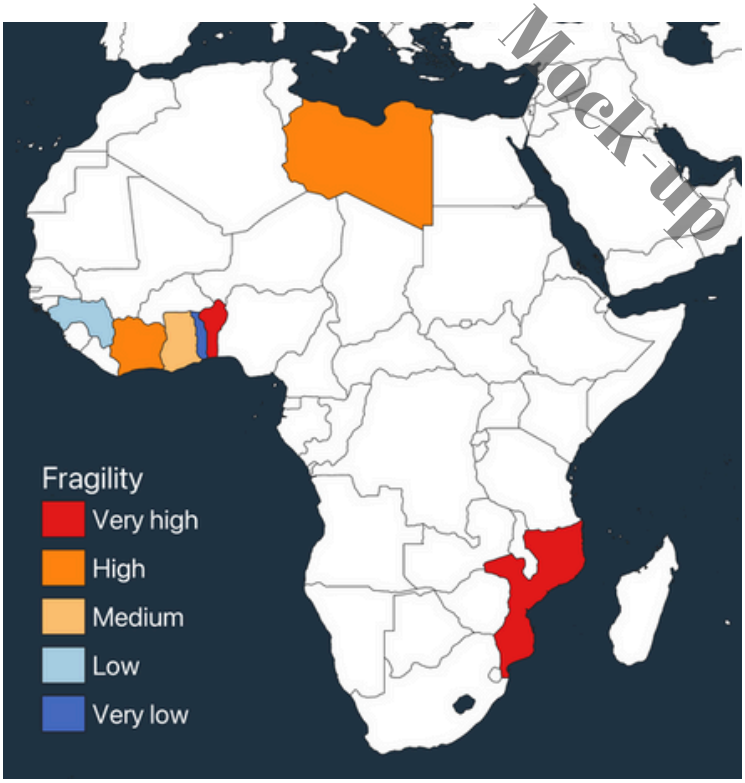
SCENARIO SIMULATION

Potential of reaching IPC>4 in a country? The model can be used to simulate the state of IPC (or any other variable of interest) based on its probability distribution given the known values of the other variables. IE. with simulated extremely high drought and conflict thresholds

Fragility

Fragility is a measure indicating how vulnerable a country or region is to different shocks, such as extreme weather or conflict

USE: Example output for higher level decision making - Fragility of GFA countries



Fragility can be represented by any output metric of interest; whether that's food security, economic fragility or conflict sensitivity

Simulated fragility metrics

19	Togo fragility
28	Guinea fragility
85	Benin fragility
53	Ghana fragility
70	Côte d'Ivoire fragility
83	Mozambique fragility
50	Libya fragility

Technical notes: ***Fragility calculation*** - We measure fragility by the fractal dimension of the exceedance probability of a system failure following a shock. The higher the value, the more fragile the system. Further reading: Approach and methodology document

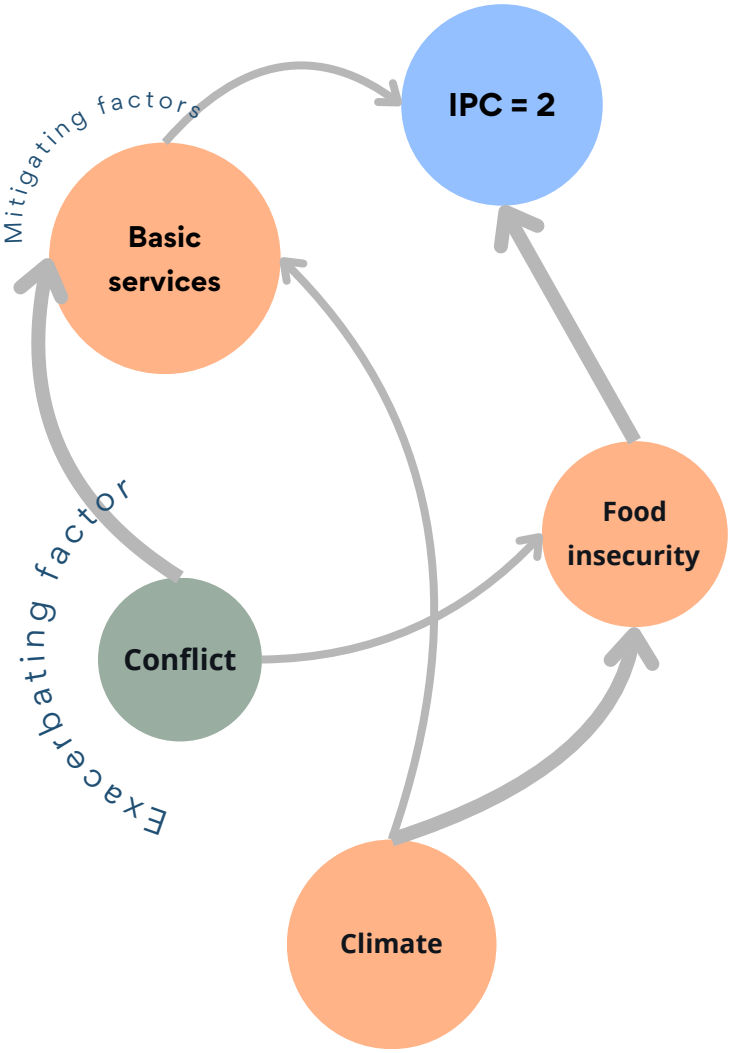
Drivers

The main drivers of food insecurity or conflict events are defined as the most probable factors which impact them, given the model outputs between the different system dimensions. For example we may find in a country that the primary drivers of food insecurity are drought events, poor governance system and conflict (see overview of data layers and sources below)

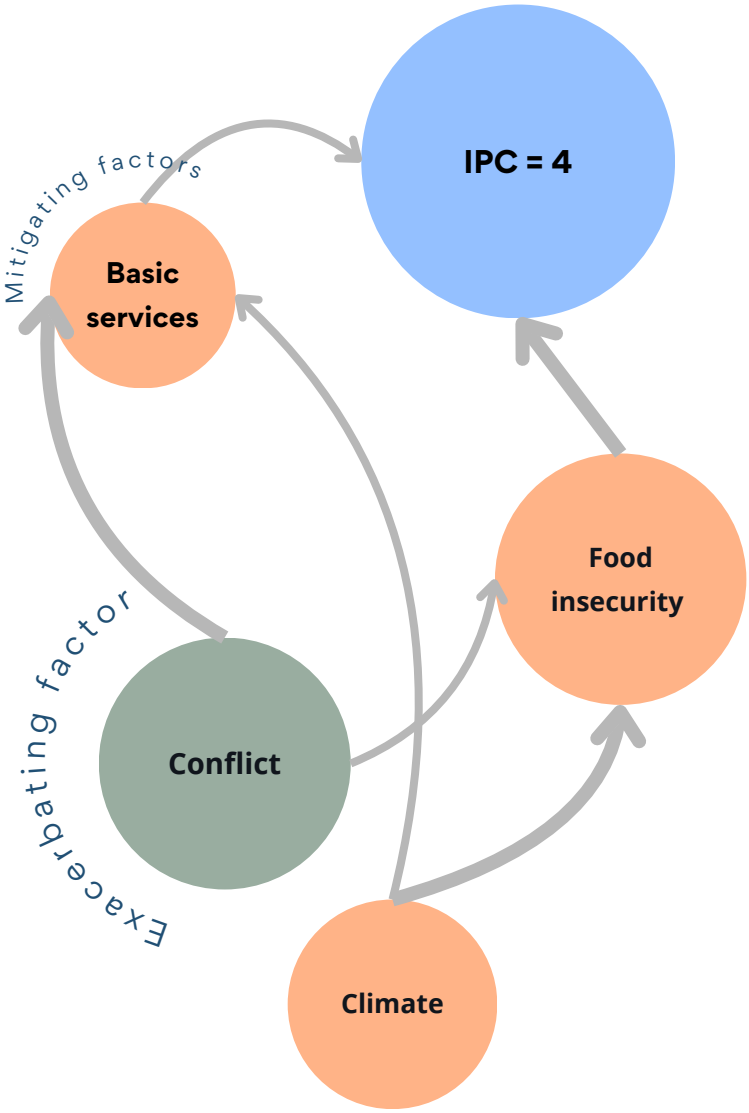
Technical notes: We identify these main drivers based on a Bayesian network model of conditional probabilities inferred from comprehensive spatiotemporal data. Further reading: Approach and methodology document

Pathways, buffers, exacerbating factors and scenario simulation

SIMPLIFIED MODEL
The following diagram represents a hypothetical situation of a country



SCENARIO SIMULATION?
What if conflict severity is increased? What will happen to the system, would the IPC classification shift?



Pathways to fragility are identified based on the most probable relationships between direct fragility drivers and secondary /tertiary drivers.

Buffers/mitigating or exacerbating factors
To identify the most influential factors for shock propagation/containment in the system, we use node centrality indices measured on the conditional probabilities of the Bayesian network.

Technical notes scenario simulation: To test how some components of the system respond to new scenarios (e.g. investigating on the most likely IPC level given failed governance and a high risk of conflict happening), we simulate under the probabilistic model, the state of the variable of interest based on the distribution of its conditional probability given simulated thresholds of the other variables.

Technical notes buffers/mitigating or exacerbating factors: Centrality indices are based on the extent to which that dimension is interrelated to other dimensions by impacting or being impacted by the other dimensions in the presence of a shock. Further reading: Approach and methodology document

Overview of data layers and sources

Data layer	***Source***
IPC classification	https://fews.net/data/acute-food-insecurity
Imports	https://comtradeplus.un.org
Exports	https://comtradeplus.un.org
Fatalities	ACLED and UCDP (merged)
Event number	ACLED and UCDP (merged)
Crop warning	https://agricultural-production-hotspots.ec.europa.eu/download.php
Rangeland warning	https://agricultural-production-hotspots.ec.europa.eu/download.php
Food insecurity prevalence	Phase 1 FEWSnet Report Classification
Heat index	https://cds.climate.copernicus.eu/cdsapp#!/dataset/sis-extreme-indices-cmip6?tab=overview
Flood index	https://data.chc.ucsb.edu/products/CHIRPS-2.0/global_daily/tifs/p05/
Drought index	https://spei.csic.es/database.html
Cyclone occurence	https://www.ncei.noaa.gov/products/international-best-track-archive
ENSO events	https://www.cpc.ncep.noaa.gov/data/indices/sstoi.indices
Economy index	https://bti-project.org/en/
GDP	https://data.worldbank.org/indicator/
Governance	https://bti-project.org/en/index/governance
Healthcare	https://www.who.int/data/gho/data/indicators/indicator-details/GHO/number-of-neonatal-deaths
Basic services	https://www.who.int/data/gho/data/indicators/indicator-details/GHO/population-using-at-least-basic-drinking-water-services-(-)
Gender Inequality Index	https://hdr.undp.org/data-center/thematic-composite-indices/gender-inequality-index#/indicies/GII
Unemployment	https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS