Climate and Conflict

Group 1

Alexandra DeKinder, Ameya Karnad,
Kulkanya Lekhyananda and Nitasha Nair

Outline

- Introduction
- Research Questions
- Methodology
- Data
- Analysis
- Challenges
- Policy Application and Challenges

Introduction & Background Information

West Africa


NORWAY
RUSSIA
CANADA
UNITED KINGDOM
GERMANY
UKRAINE
KAZAKHSTAN
MONGOLIA
FRANCE
UNITED STATES OF AMERICA
TURKEY
CHINA
SOUTH KOREA
JAPAN
TUNISIA
MOROCCO
IRAQ
IRAN
ALGERIA
LIBYA
PAKISTAN
SAUDI-ARABIA
INDIA
MEXICO
MYANMAR
MALI
NIGER
CHAD
OMAN
SENEGAL
YEMEN
PHILIPPINES
VENEZUELA
NIGERIA
IVORY COAST
ETHIOPIA
COLOMBIA
SOMALIA
KENYA
ECUADOR
OF THE CONGO
TANZANIA
INDONESIA
BRAZIL
PERU
ANGOLA
BOLIVIA
MOZAMBIQUE
NAMIBIA
PARAGUAY
BOTSWANA
MADAGASCAR
AUSTRALIA
SOUTH AFRICA
URUGUAY
ARGENTINA
CHILE
NEW ZEALAND

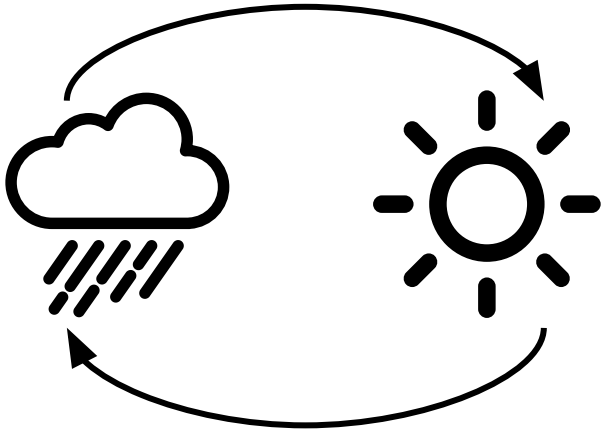
Conflicts in West Africa

- For decades, many countries in West Africa have experienced violent conflicts and civil strife.
- Recently, there has been an alarming signal that the number of conflicts is surging in this region.
- General conflict factors include:
  - Poverty and food insecurity
  - Growing population
  - Migration
  - Increasing desertification
- These conflicts have resulted in destruction of lives and property, internal displacement of people, a region-wide refugee crisis, poverty, and disease, as well as others.

Climate Pattern in the West Africa Region

Wet Season
(Apr - Oct)

Rainfall on average less than 2,000 mm per year



Dry Season
(Nov - Apr)

January is the coldest month with temperature 21-33c.

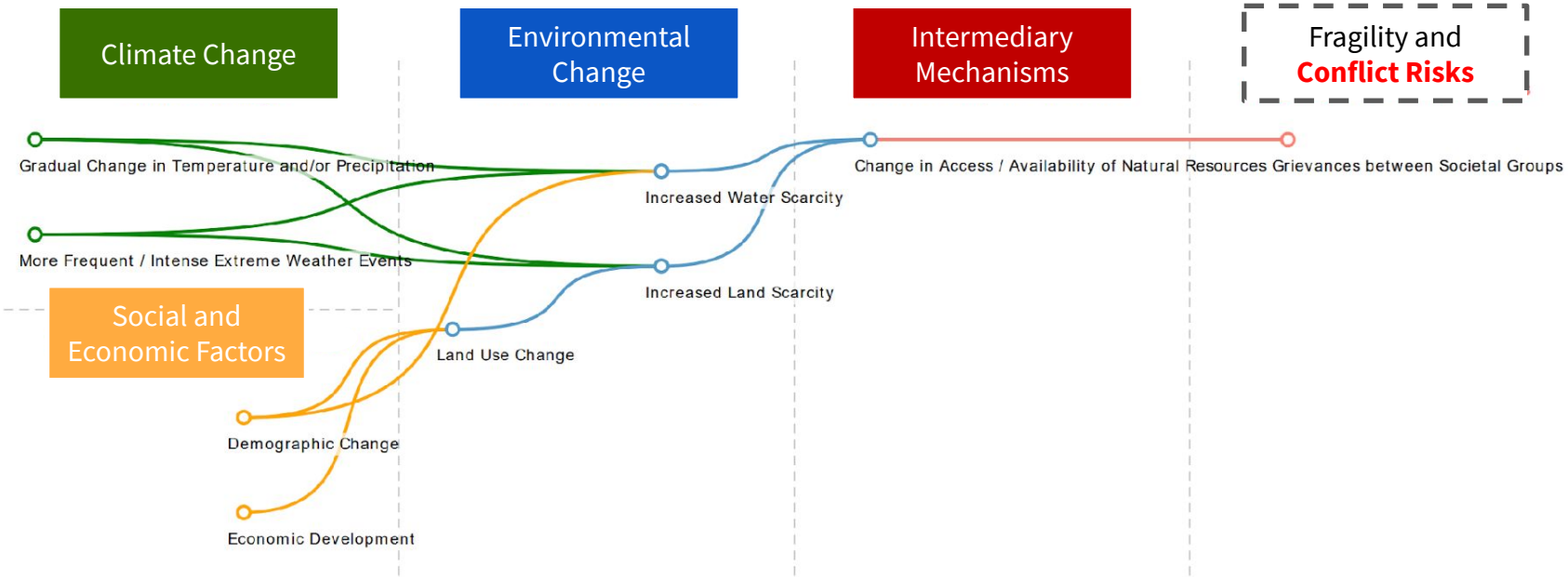
The temperature can reach the high of 40c.

- The change in sea-surface temperature causes the variability of rainfall in the region. The region experiences flood when the normal monsoon season associated with the periodic warming of the pacific ocean.
- The region also experiences series of drought, dating back to at least the 17th century.

Research Question

“How does climate change and natural resource shortage correlate with conflicts within a country?”

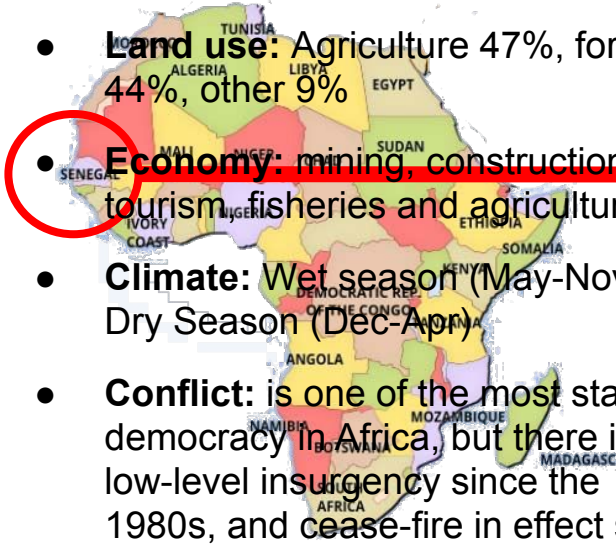
Conflict Drivers



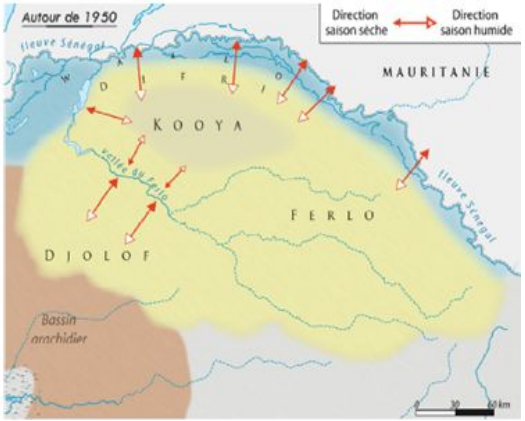
Source: ECC Platform

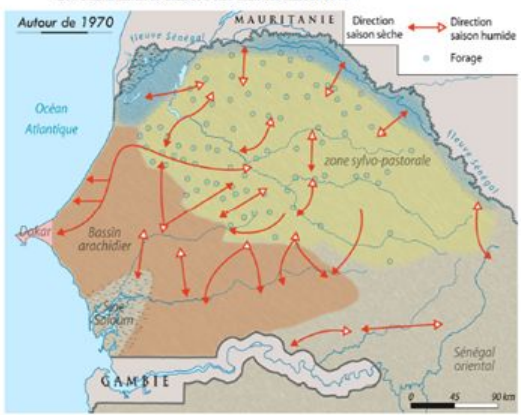
Senegal

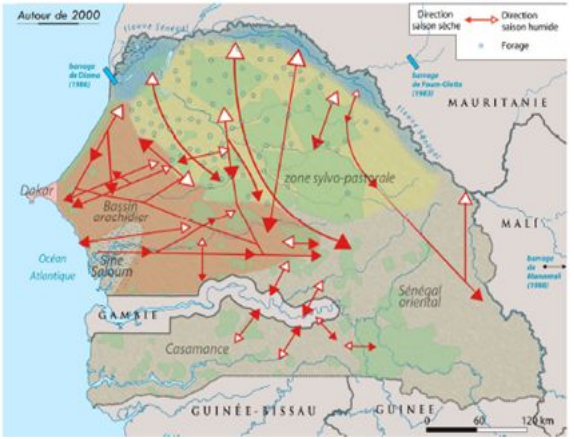
- **Capital:** Dakar
- **Population:** 15 million
- 14 **Regions** and 45 **Departments**
- **Land use:** Agriculture 47%, forest 44%, other 9%
- **Economy:** mining, construction, tourism, fisheries and agriculture
- **Climate:** Wet season (May-Nov), Dry Season (Dec-Apr)
- **Conflict:** is one of the most stable democracy in Africa, but there is low-level insurgency since the 1980s, and cease-fire in effect since 2012



Migration - Patterns of movement

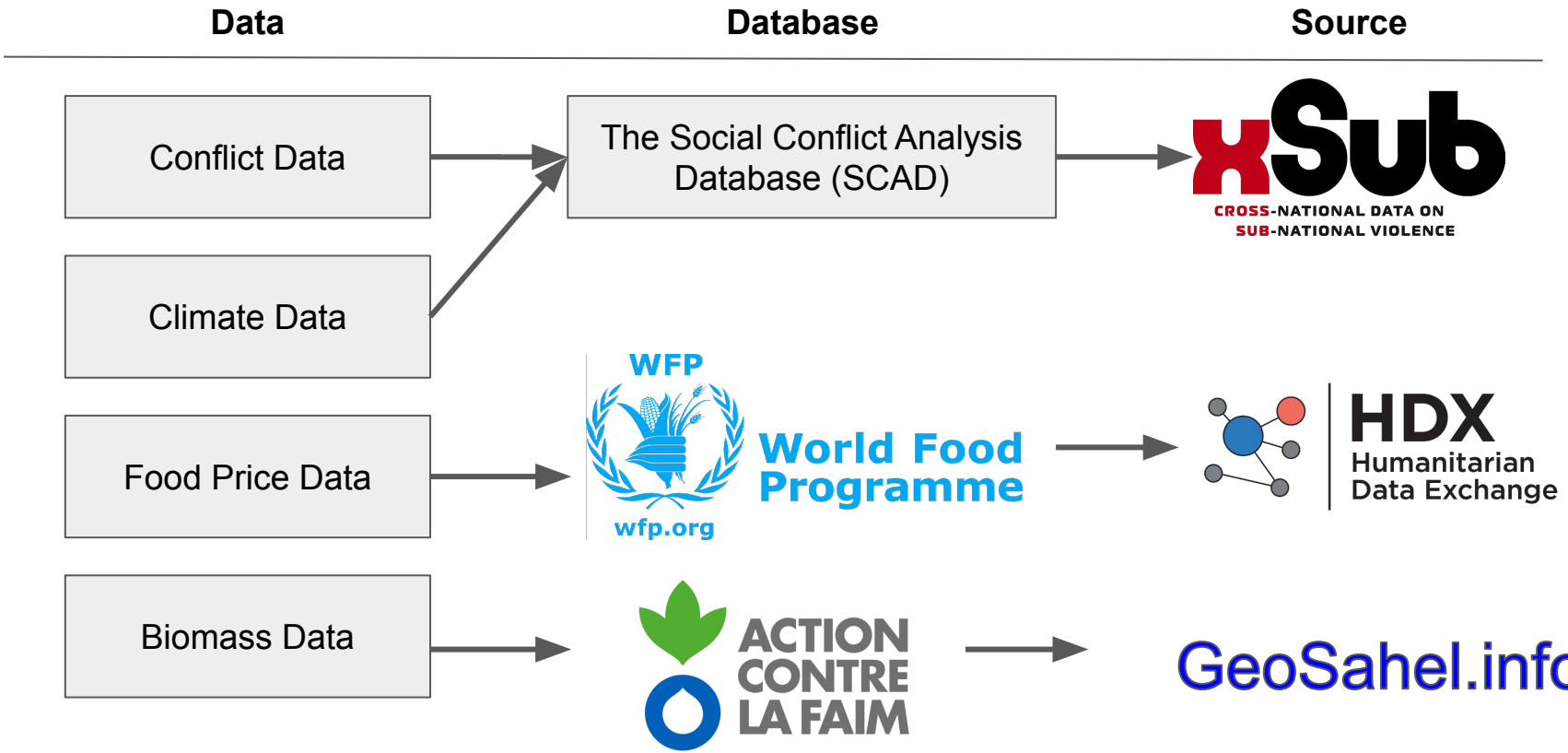






Data

Datasets


Data
Database
Source
Conflict Data
Climate Data
Food Price Data
Biomass Data
The Social Conflict Analysis Database (SCAD)
xSub
CROSS-NATIONAL DATA ON SUB-NATIONAL VIOLENCE
WFP
World Food Programme
wfp.org
HDX
Humanitarian Data Exchange
ACTION CONTRE LA FAIM
GeoSahel.info

Data Cleaning and preprocessing

- Confirmed Data Science “80/20 rule”
- Names of Departments were recorded differently (English/ French, Hyphen). Had to be manually cleaned

Thiès → Thies

- Other common issues related to Dates
- Merging of the datasets

Conflict Data

- Decided to go with **monthly department wise** dataset as other datasets were aggregated monthly
- The dataset consisted of various attributes like year_month, temperature, rainfall, population, landmass, wetland, farmland, location, number of conflicts etc.
- Selected **year_month, location, temperature and rainfall** as others are mostly static.

Food Price

Make sure the food price data can be merged with the conflict data → Market names did not correspond with department in other datasets → Manually look up in Google map → Match with an established department

date	cmname	unit	category	price	currency	country	admname	adm1id	mktname	mktid	cmid	ptid	umid	catid	sn	default
#date	#item+name	#item+unit	#item+type	#value	#currency	#country+na	#adm1+nam	#adm1+code	#name+mar	ket	#item+code			#item+type+	#meta+id	
1/15/07	Maize (local)	KG	cereals and t	160	XOF	Senegal	Kedougou	1374	Kedougou	419	56	15	5	1	419_56_15_5	
3/15/07	Maize (local)	KG	cereals and t	100	XOF	Senegal	Kedougou	1374	Kedougou	419	56	15	5	1	419_56_15_5	
4/15/07	Maize (local)	KG	cereals and t	200	XOF	Senegal	Kedougou	1374	Kedougou	419	56	15	5	1	419_56_15_5	
5/15/07	Maize (local)	KG	cereals and t	200	XOF	Senegal	Kedougou	1374	Kedougou	419	56	15	5	1	419_56_15_5	
7/15/07	Maize (local)	KG	cereals and t	190	XOF	Senegal	Kedougou	1374	Kedougou	419	56	15	5	1	419_56_15_5	
8/15/07	Maize (local)	KG	cereals and t	190	XOF	Senegal	Kedougou	1374	Kedougou	419	56	15	5	1	419_56_15_5	
9/15/07	Maize (local)	KG	cereals and t	190	XOF	Senegal	Kedougou	1374	Kedougou	419	56	15	5	1	419_56_15_5	
10/15/07	Maize (local)	KG	cereals and t	200	XOF	Senegal	Kedougou	1374	Kedougou	419	56	15	5	1	419_56_15_5	
11/15/07	Maize (local)	KG	cereals and t	187.5	XOF	Senegal	Kedougou	1374	Kedougou	419	56	15	5	1	419_56_15_5	
2/15/08	Maize (local)	KG	cereals and t	150	XOF	Senegal	Kedougou	1374	Kedougou	419	56	15	5	1	419_56_15_5	

Biomass

- Biomass dataset was quite clean
- Had to be converted from a wide format to a long format.
- The data was year wise, so when we merge, the biomass for the same months of the year was kept common.

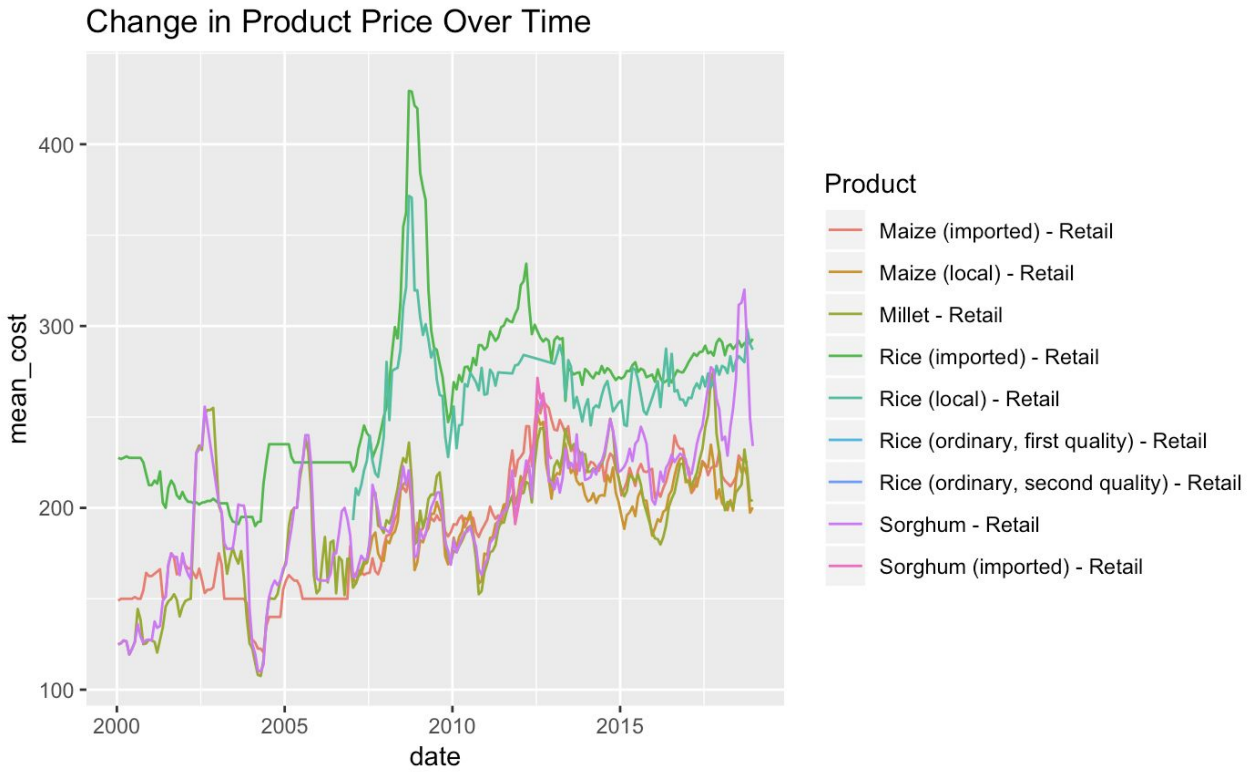
admin2Name	BIO_1998	BIO_1999	BIO_2000	BIO_2001	BIO_2002	BIO_2003	BIO_2004
Oussouye	1560110.411	1537335.461	1678915.448	1641250.351	1632475.367	1598316.585	1745985.031
Ziguinchor	2047302.224	2164199.305	2345175.103	2206426.726	2174319.678	2171063.176	2447281.339
Salemata	2711501.431	3426710.539	3252310.003	2935459.507	2779032.272	2909580.662	3223825.118
Goudomp	2725832.555	3018910.845	3212206.774	2903187.344	2626439.074	3095079.772	3273260.325
Sedhiou	3855458.39	4468341.549	4871179.531	4276381.514	3751757.607	4514758.171	4844117.534
Kolda	4523293.226	5502726.317	5454629.943	4886279.731	4287356.801	5403445.868	5701885.777
Bignona	8292660.923	9071224.15	9737392.451	9048874.617	8786806.887	9180807.412	9771370.737
Kedougou	9130150.613	11700951.07	10839437.55	10015334.42	8936085.363	9802141.101	10585849.99
Bounkiling	3729713.363	4653547.892	5035496.464	4420309.379	3904959.971	4532977.947	4762889.511
Saraya	10246374.9	12887300.68	11863191.46	10633061.44	9660624.748	10493965.14	10994788.67
Velingara	6261183.603	8015979.693	7954182.678	6975711.557	6150418.87	7497826.086	7968692.629
Medina Yoro Foulah	5530036.46	6960701.104	6824073.447	5964148.041	5351490.462	6588611.974	7089380.537

Final Dataset

- Month wise data for all cities including variables like Temperature (in C), Rainfall (in mm), Prices of Millet, Maize, Rice and Sorghum (in franc CFA per KG), biomass and number of conflicts.

YEAR	NAME_	YRMO	ID_1	ID_2	NAME_	TEMP	RAIN	ACTION	Maize	Millet	Rice	Sorghur	biomas
2007	Bakel	200701	12	36	Tambacou	26.95	0.028333	0	212.5	200	225	195	5317881
2007	Bakel	200708	12	36	Tambacou	27.98333	29.83833	0	200	200	250	190	5317881
2007	Bakel	200702	12	36	Tambacou	28.86667	0.101667	0	200	200	225	190	5317881
2007	Bakel	200710	12	36	Tambacou	30.35	3.056667	0	NA	200	250	190	5317881
2007	Bakel	200709	12	36	Tambacou	28.26667	8.158333	0	200	200	250	187.5	5317881
2007	Bakel	200705	12	36	Tambacou	35.95	1.118333	0	225	200	225	175	5317881
2007	Bakel	200707	12	36	Tambacou	29.8	18.31167	0	200	200	250	193.3333	5317881
2007	Bakel	200706	12	36	Tambacou	33.58333	5.721667	0	200	200	250	200	5317881
2007	Bakel	200711	12	36	Tambacou	28.66667	1.573333	0	200	200	250	190	5317881

Summary Statistics of the Food price data



Analysis

Models

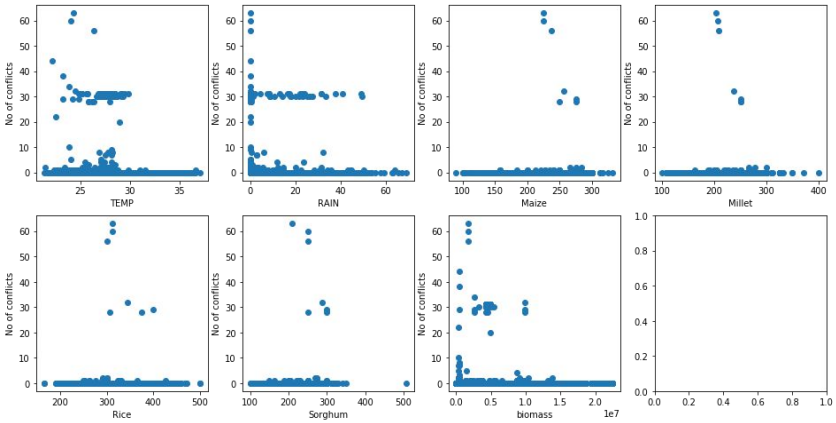
- Regression
- Classification
- Historical Data based Classification
- Incident case study

Linear Regression Model

- Linear model to predict number of conflicts - Prone to Failure

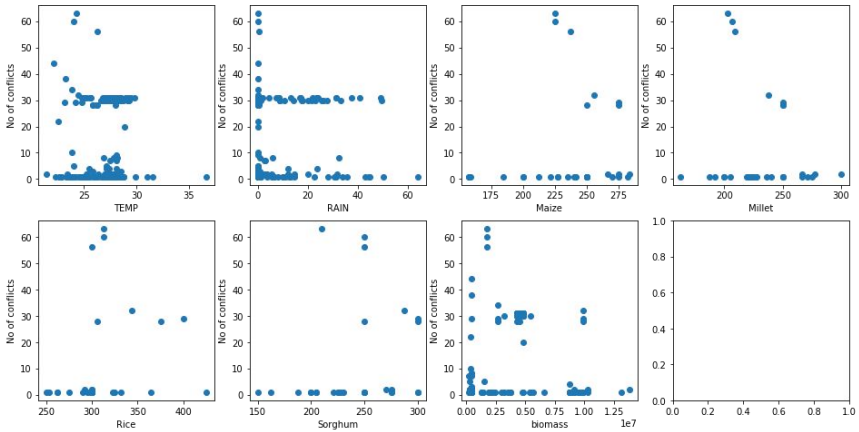
$$Y = b_0 + b_1 Temp + b_2 Rainfall + b_3 Pr\_Maize + b_4 Pr\_Rice + b_5 Pr\_Sorghum + b_6 Pr\_Millet + b_7 Biomass$$

For all cases



$R^2 = 0.053$

For months with conflict



$R^2 = 0.03$

Classification Model

- Converted number of incidents to as Yes / No case
- Used logistic regression - Accuracy = 98.2 %
- Too good to be True?? - you are right!

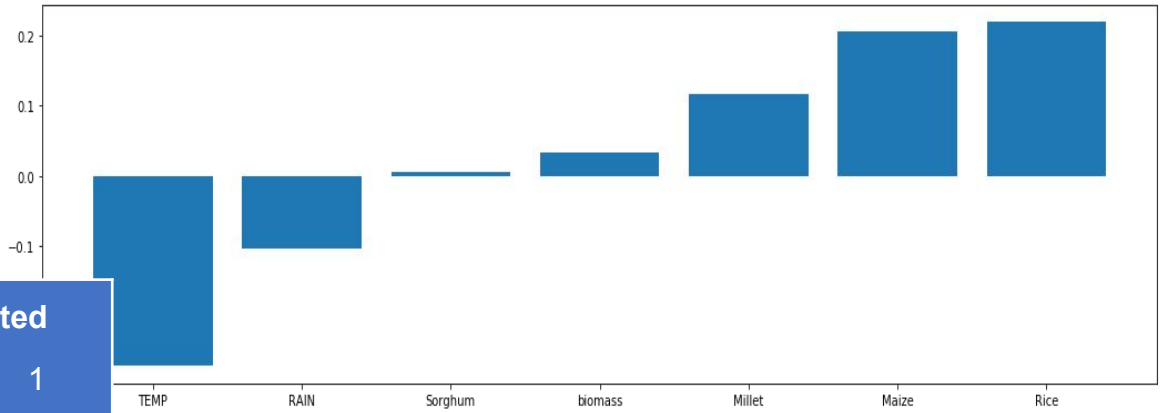
	Predicted	
Actual	0	1
0	504	0
1	9	0

- Need to tackle Class imbalance issue

Classification Model - Logistic regression

$$P = \frac{e^{a+bX}}{1+e^{a+bX}}$$

- Undersampled the no conflict data
- Accuracy = 67.64% , TPR = 100%



Actual	Predicted 0	Predicted 1
0	317	187
1	0	**9**

- Able to predict 1s correctly, but **lots** of False Positives.

Classification Model - Other models

- Same case with other classification models.

SVM - Accuracy = 74.85%
TPR = 100%

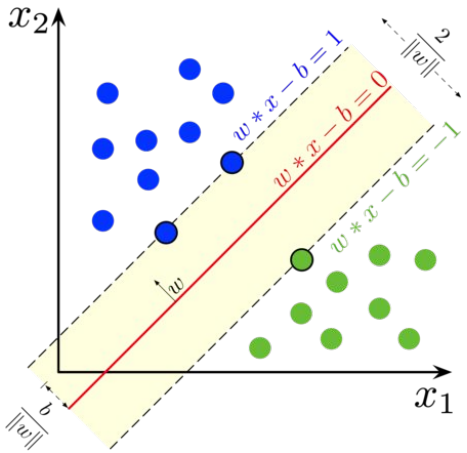
Actual	Predicted 0	Predicted 1
0	375	129
1	0	9

Decision Tree- Accuracy = 77.78%
TPR = 88.88%

Actual	Predicted 0	Predicted 1
0	391	113
1	1	8

Classification Model - Support Vector Machines

- SVM constructs hyperplane in high-dimensional space for classification
- Accuracy = 74.85%
- TPR = 100%

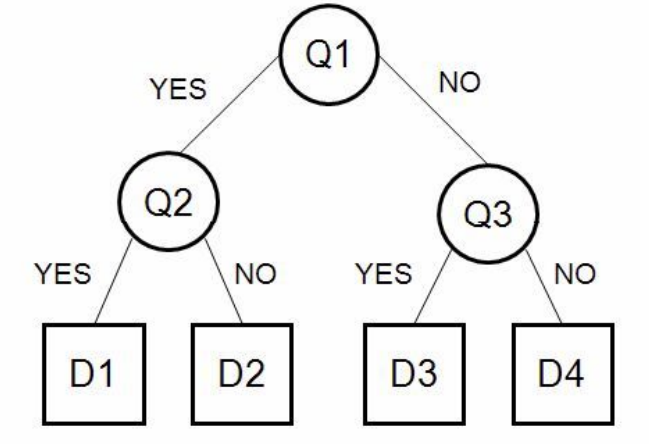


Actual	Predicted 0	Predicted 1
0	375	129
1	0	9

Image Source: Wikipedia

Classification Model - Decision Tree

- Decision trees use a tree-like model for decisions
- Decision Tree- Accuracy = 77.78%
- TPR = 88.88%



Actual	Predicted 0	Predicted 1
0	391	113
1	1	8

Historical data based Model

- Conflicts mainly happen due to long term effects.
- Not enough data for a Time series Classification model (LSTM)
- We tried to model data for Bignona (The only region with enough conflict data)
- Used a logistic regression based model to predict using attributes of upto 3 months prior (Oversampled in this case)
- Accuracy - 0.82 %

	Predicted	
Actual	0	1
0	16	3
1	1	3

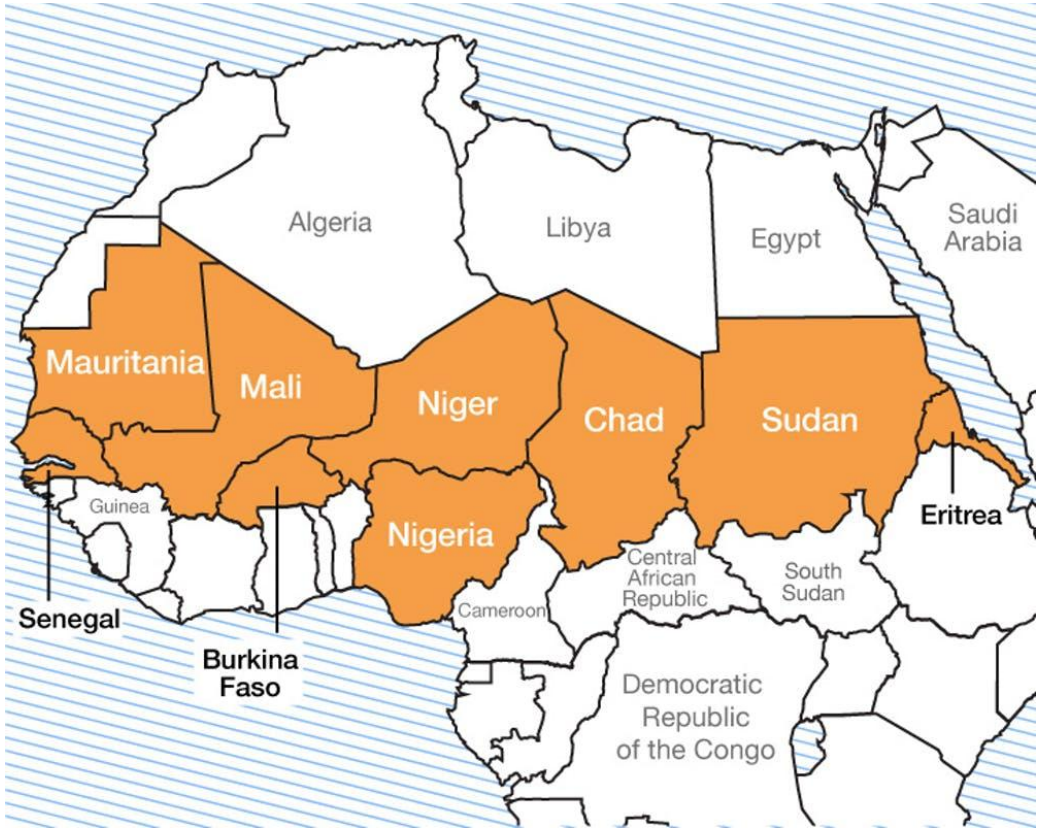
- Data highly Inadequate for the model to be used for real time classification

The 2010 Sahel Drought
A Case Study

Sahel Region

Sahara Desert

African Rainforest areas



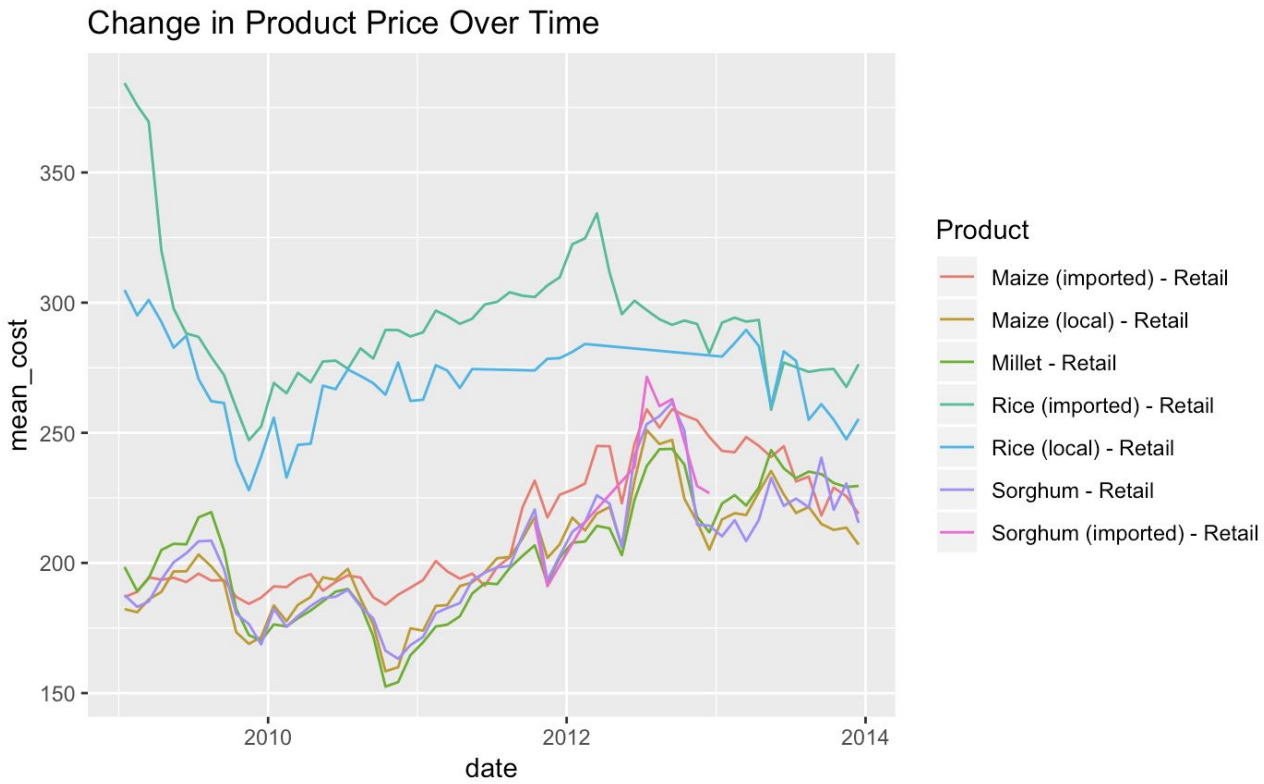
Drought in the Sahel

- The previous drought
  - First record: in 1680s
  - The 1740s - 1750s
  - The 1830s
  - The 1980s
- Possible causes of the drought
  - The tropical convection
  - The change in the temperature in the surrounding ocean
  - The West African Monsoon
  - El Niño
  - Deforestation
- Consequences
  - Less vegetation or greenery
  - Drying up of water resources in an already arid region

The Most Recent Drought

- Believed to have begun in 2010 after the onset of El Nino
- Rainfall was reported to be at the all-time low in February 2010
- Situation was most severe in 2012 when the region is reported to be in drought and famine (extreme scarcity of food)
- There has been no formal evidence of the end of this drought period
- Some sources say the situation recovered in 2017

Senegal Food Prices During Drought



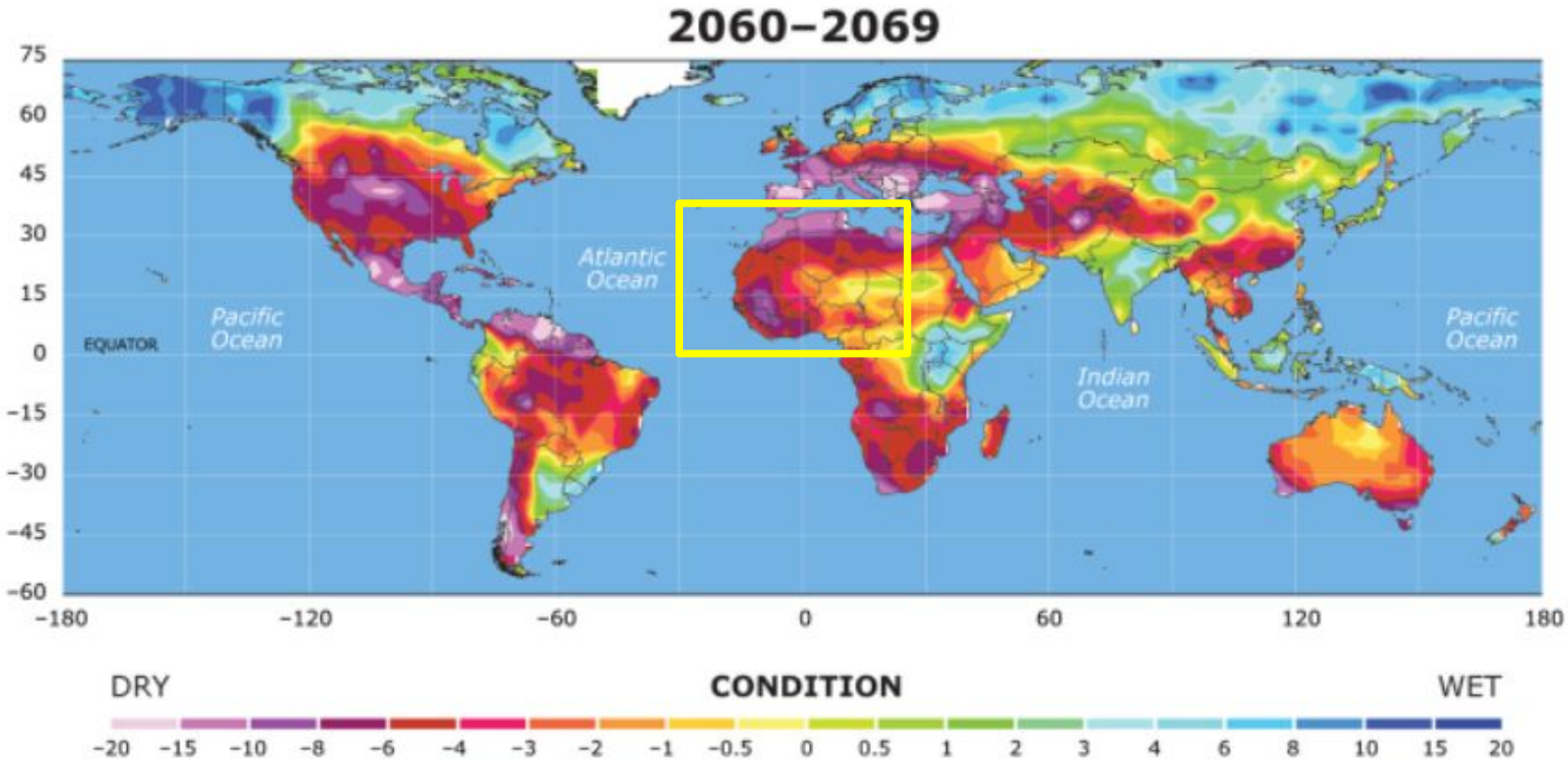
Conflict Dashboard

Challenges in Modeling Social Behavior and Conflicts

- Complicated
- Conflict is a complex topic, there are numerous factors which are difficult to measure and capture in the model
- Data collection is not always consistent over long periods of time or between regions, which result in data gaps and issues comparing across space.
- Rare event cases.

Policy Recommendation and Application

Projected temperature rise in the region

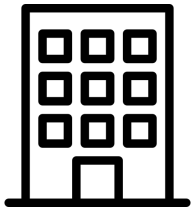


Projected drought and dry regions in 2060-2069

Relevant Stakeholders

Government agencies such as:

- Disaster Management
- Civil Protection Department



Private sector

- Insurance firms
- Health service providers

International Organisations

- Humanitarian Aid
- Multilateral Organizations like the UN

Communities

- Pastoralists, Farmers and civilians

Short- Medium Term

- Regulating Food Prices
- Macroeconomic policies to control inflation
- Early Warning System for Conflict Prevention

Long Term

- Resource management
- Extension services
- Climate change resilience building

Policy Challenges

- Decision makers often don’t have a comprehensive information and lack understanding of how different factors interact with each other
- Causation vs Correlation
- Migration across countries
- Implementing consistent data collection methods across the region is expensive
- Resources are managed nationally or subnationaly despite being a shared resource
- Results should used in conjunction with other information

Future Research

- Implication of climate change on spread of diseases
- Integrating migratory patterns
- Supplementing conflict incidents with social media sentiment analysis
- Satellite imaging as another source of data
- Expanding model to other countries

Thank You

Questions?