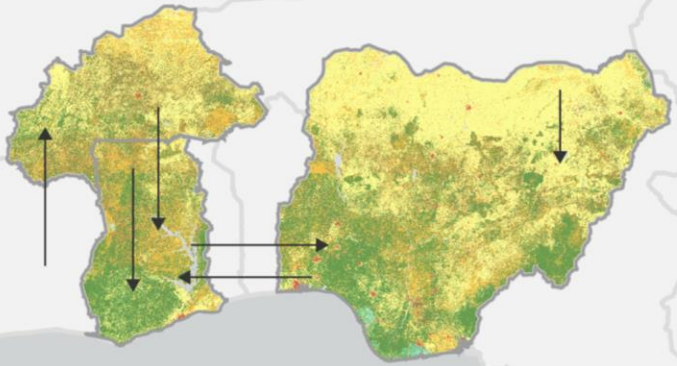
Analyzing land surface dynamics and weather extremes combined with qualitative field research to disentangle the food-climate-migration nexus in West Africa

Alina Schürmann, Janina Kleemann, Mike Teucher,
Christine Fürst, Christopher Conrad



AK Fernerkundung 06. - 07.October, Halle (Saale)

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Food-Climate-Migration Nexus

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KÜSTENEROSION

Klimawandel: Wenn das Meer an Afrikas Küsten nagt

Erosionen und Sturmfluten bedrohen das Leben an Westafrikas Küsten, viele Menschen müssen bereits ins Landesinnere fliehen - sie verlieren ihre Lebensgrundlage.

Westafrikas Strände - hier bei Cape Coast, Ghana - sind von Erosion und steigenden Meeresspiegeln betroffen

22 July 2022

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KLIMAWANDEL

Nach der Dürre kommt die Flut: Hochwasserschutz in Afrika

Afrikas Flüsse sind die Lebensadern des Kontinents. Doch der Wechsel von extremen Wetterereignissen macht das Leben mit dem Wasser immer schwerer. So im Nigerbecken, wo Frühwarnsysteme bisweilen versagen.

Überschwemmungen im Senegal

22 September 2022

ALJAZEERA News Ukraine war Features Economy Opinion

News | Humanitarian Crises

Oxfam, others: West Africa facing worst food crisis in a decade

About 27 million people already suffer from hunger. That could rise to 38 million by June unless urgent action is taken.

West Africa is hit by its worst food crisis in a decade, with 27 million people going hungry [File: Finbarr O'Reilly/Reuters]

5 Apr 2022

05 April 2022

Migration can be a strategy to adapt unfavorable conditions

ALJAZEERA News Ukraine war Features Economy Opinion Video

Floods, food shortages threaten to push Nigeria into food crisis

Floods and maize shortages follow coronavirus disrupti… disrupted spring planting.

People stand outside after their houses were destroyed following heavy rains in Kebbi state, Nigeria [File: Reuters]

04 September 2020

SAVING LIVES CHANGING LIVES

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Hunger in West Africa reaches record high in a decade as the region faces an unprecedented crisis exacerbated by Russia-Ukraine conflic…

TOPICS

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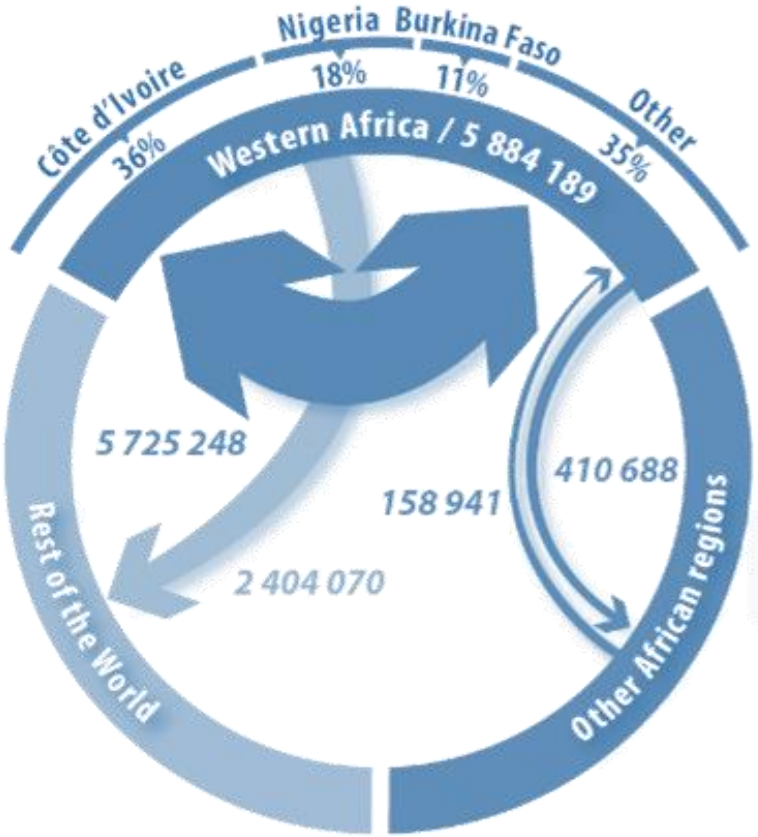
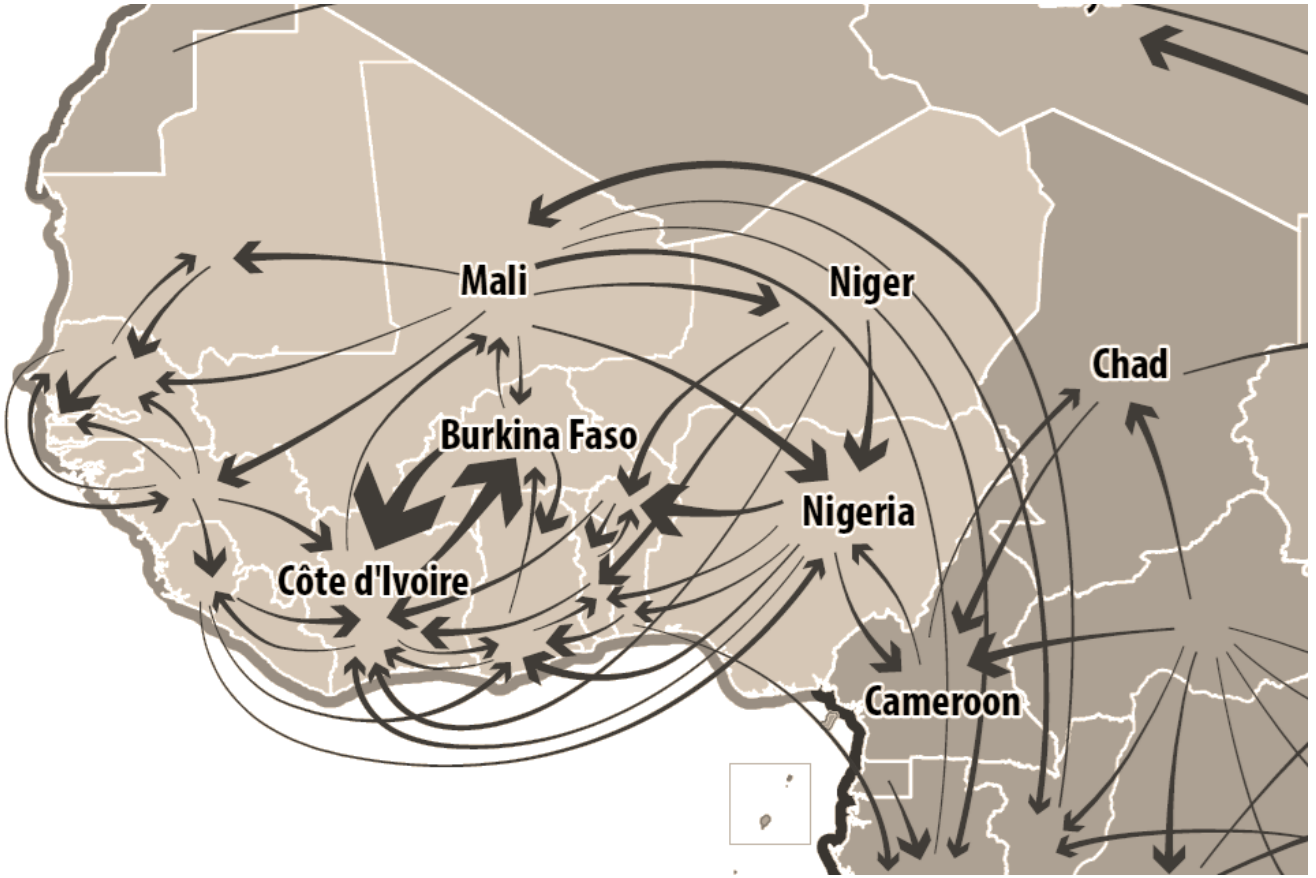
08 April 2022

Migration patterns in West Africa





Intra-Africa and overseas international migration (Mercandalli & Losch 2015)

"Migration is part of the system"

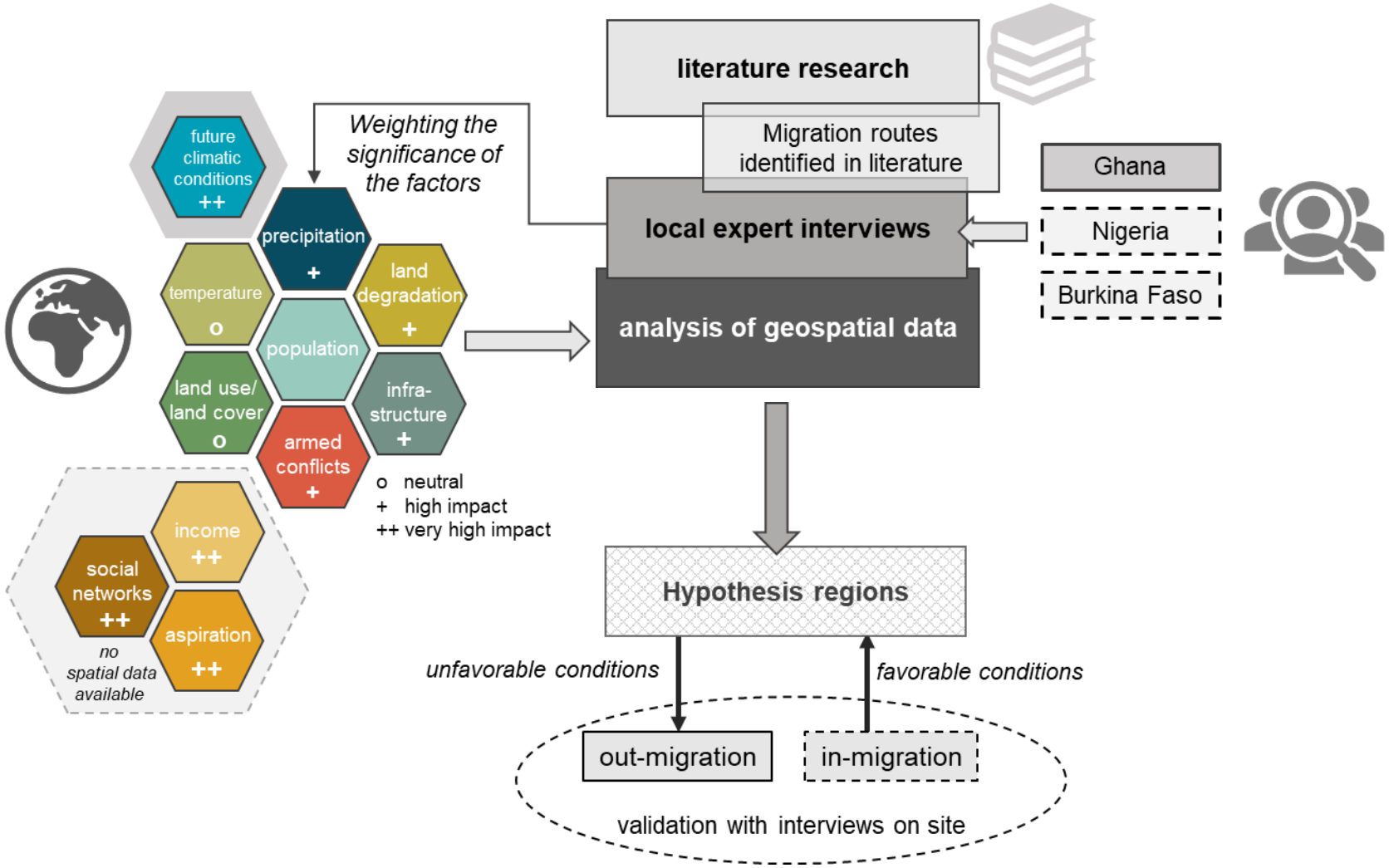
Aim of this study

Identify areas where the possibility of migration is high (or low) in order to:

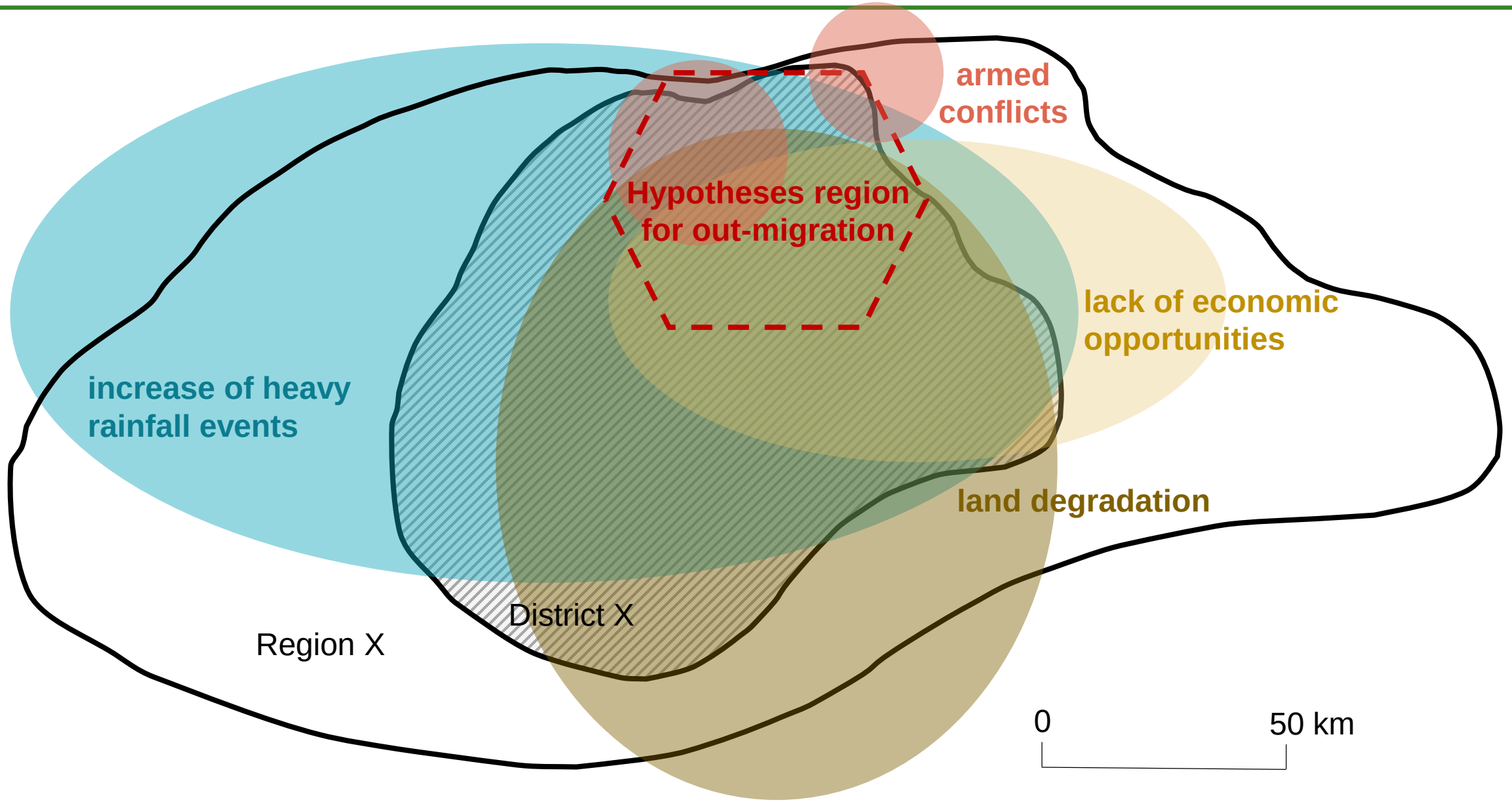
- target policy recommendations
- support climate change adaptations

→ (How) can RS and spatial data be used to identify starting areas of migration?

Framework Hypotheses Regions



Framework Hypotheses Regions



Expert interviews

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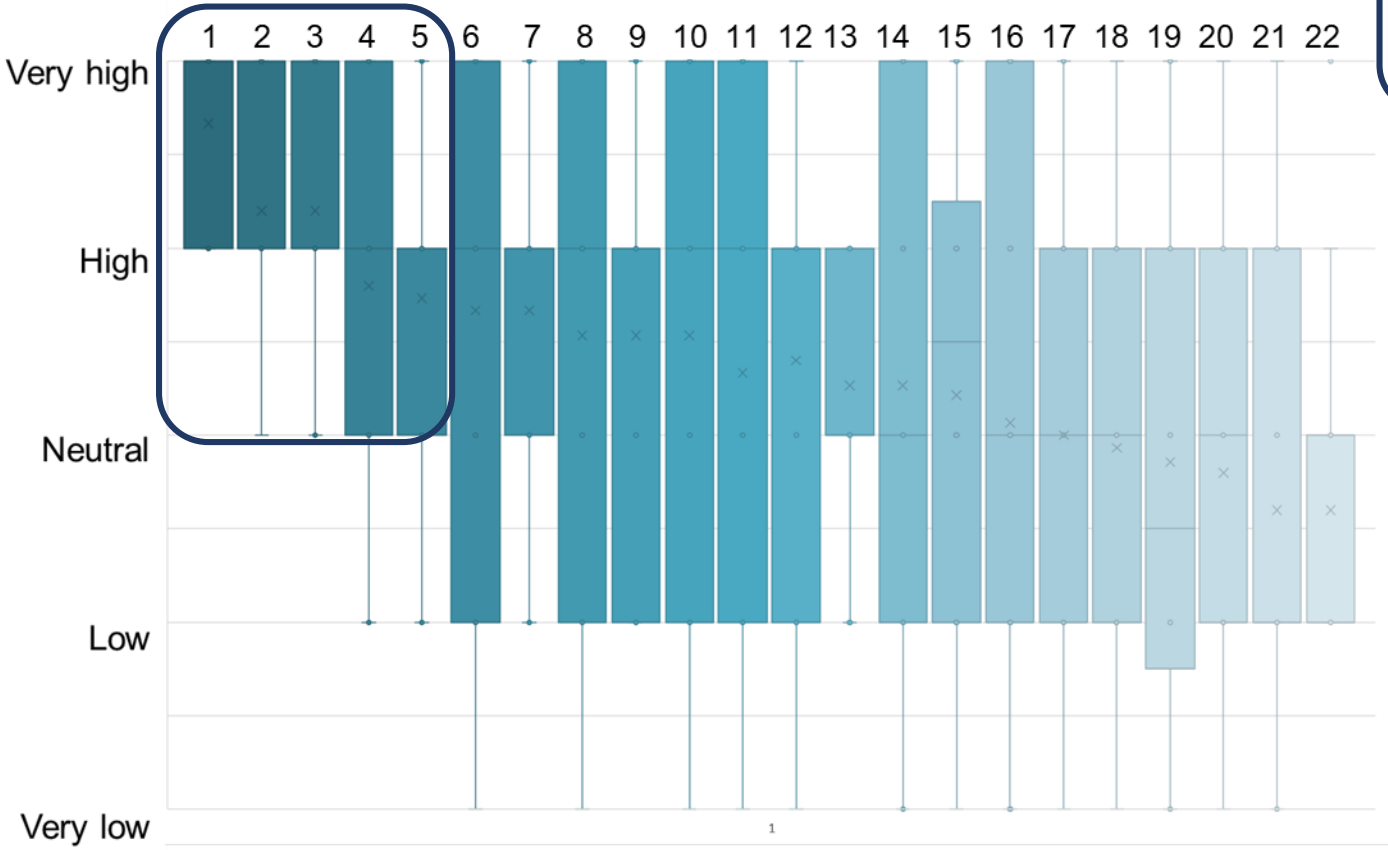

- 1 job opportunities
- 2 opportunity for trading
- 3 social contacts / network
- 4 consecutive dry days in the rainy season
- 5 environmental conditions for agriculture
- 6 fertile soils
- 7 permanent degradation of land/soils
- 8 food security
- 9 agricultural production
- 10 persistent droughts
- 11 access to education
- 12 poor infrastructure development
- 13 social conflicts (e.g. problems at home)
- 14 access to water
- 15 extreme rainfall events / flooding in the rainy season
- 16 regular armed conflicts
- 17 safety
- 18 access to farmland
- 19 rapidly occurring extreme events outside cropping season
- 20 land scarcity due to population pressure
- 21 occasional armed conflicts
- 22 the rise of sea levels

Based on own survey conducted in Ghana, March 2022

Available geospatial data

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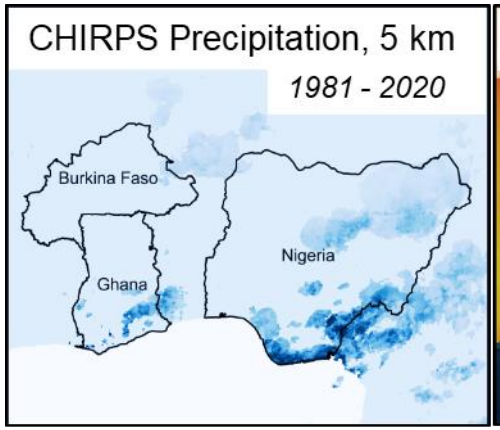
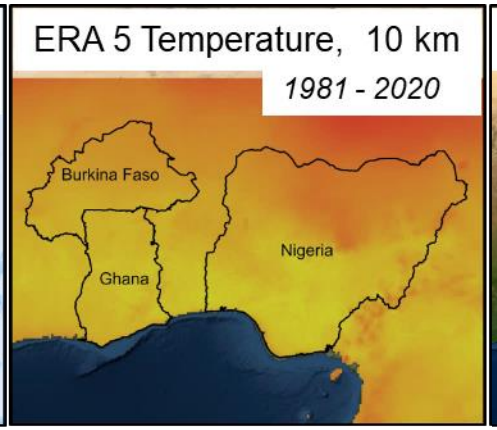
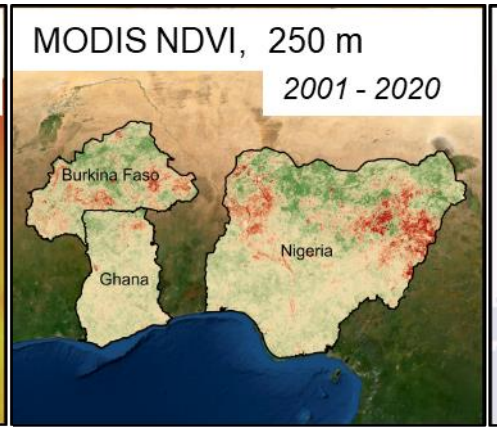


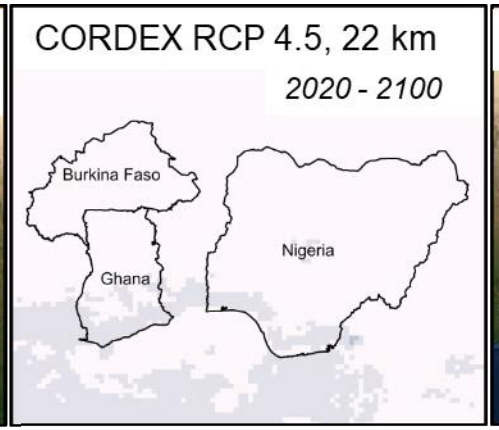
Funk et al., 2015



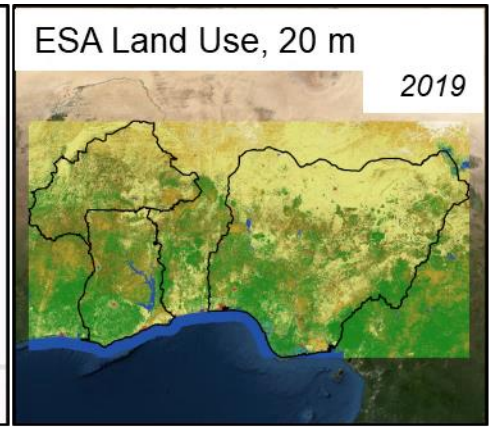
Copernicus Climate Change Service



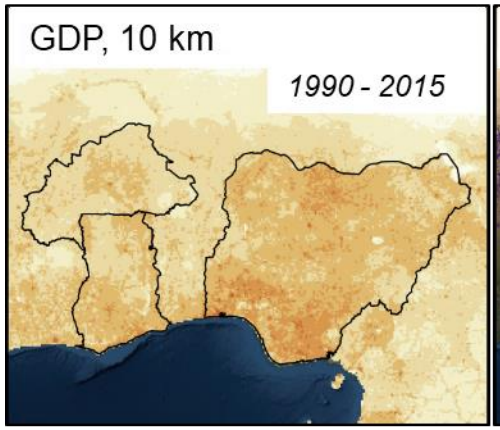
MODIS MOD13Q1
MODIS MYD13Q1



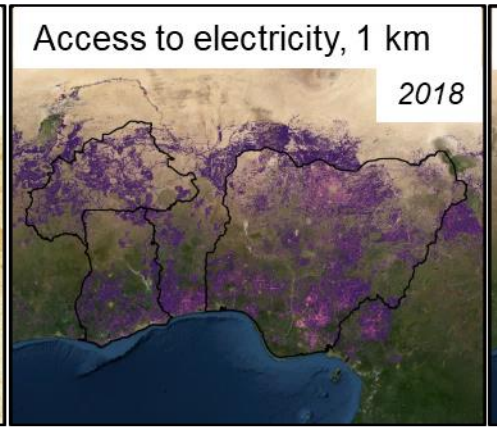
World Climate Research Programme (WCRP)



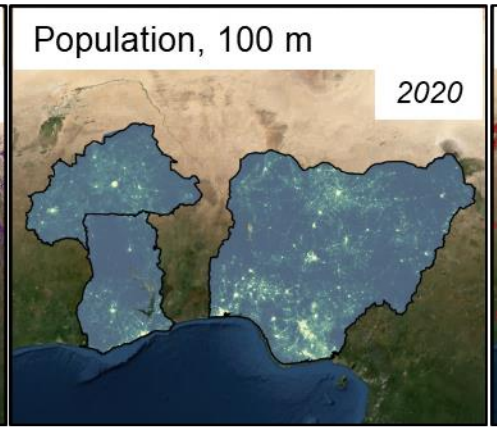
ESA CCI Land Cover project



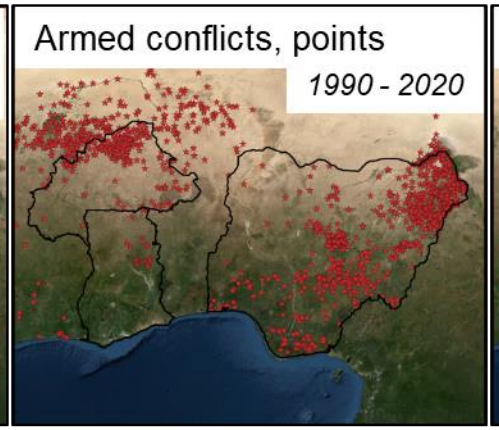
Kummu et al., 2019



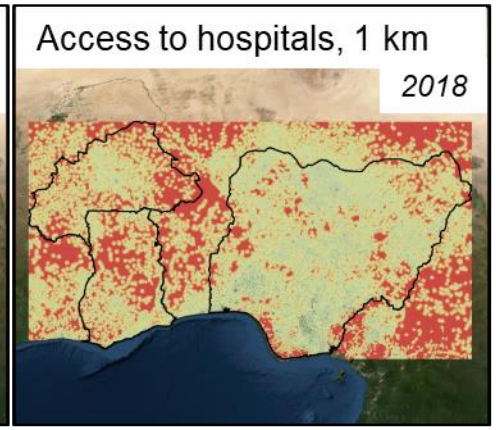
Falchetta et al., 2019



Bondarenko et al., 2020



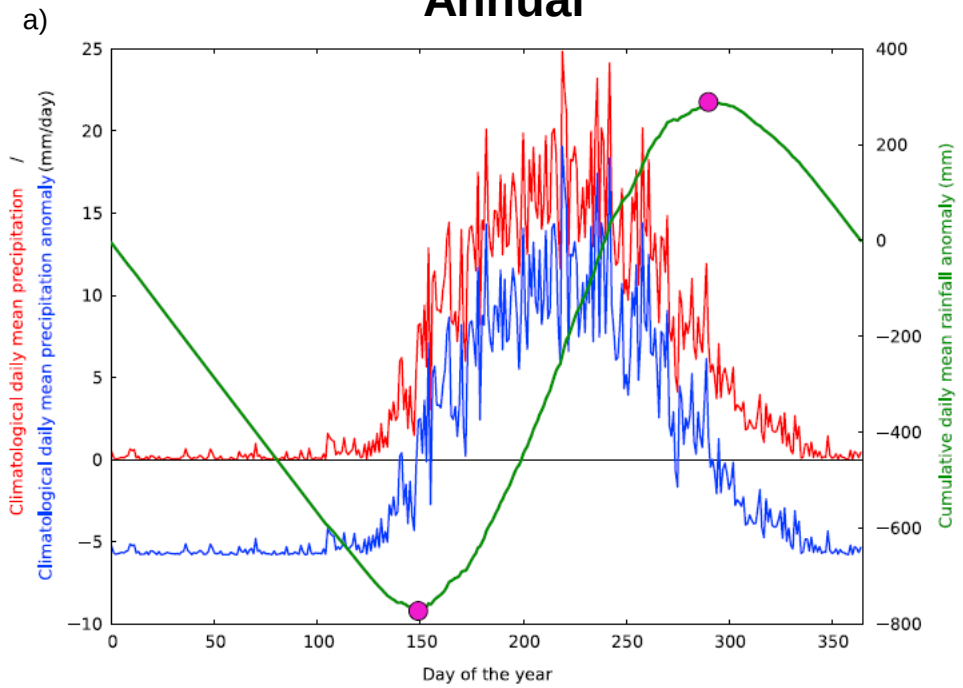
Pettersson et al., 2021



Maina et al., 2019

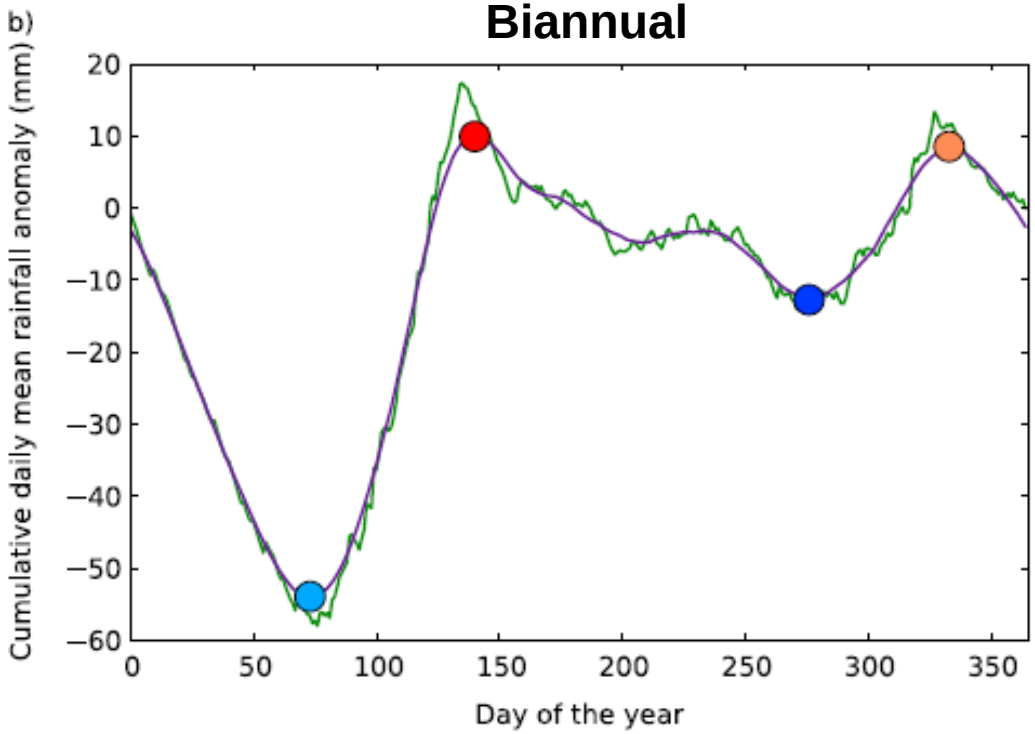
Annual and Biannual rainy season calculation (Dunning et al. 2016)

Annual



Climatological daily mean rainfall for each day of the year (red), climatological daily mean rainfall anomaly (blue), and **climatological cumulative daily mean rainfall anomaly** (green). The magenta dots mark the extent of the climatological water season.

Biannual



Climatological cumulative daily mean rainfall anomaly (green) and climatological cumulative daily mean rainfall anomaly smoothed using a 30 day running mean (purple). minima and maxima that mark the beginning and end of the climatological water seasons

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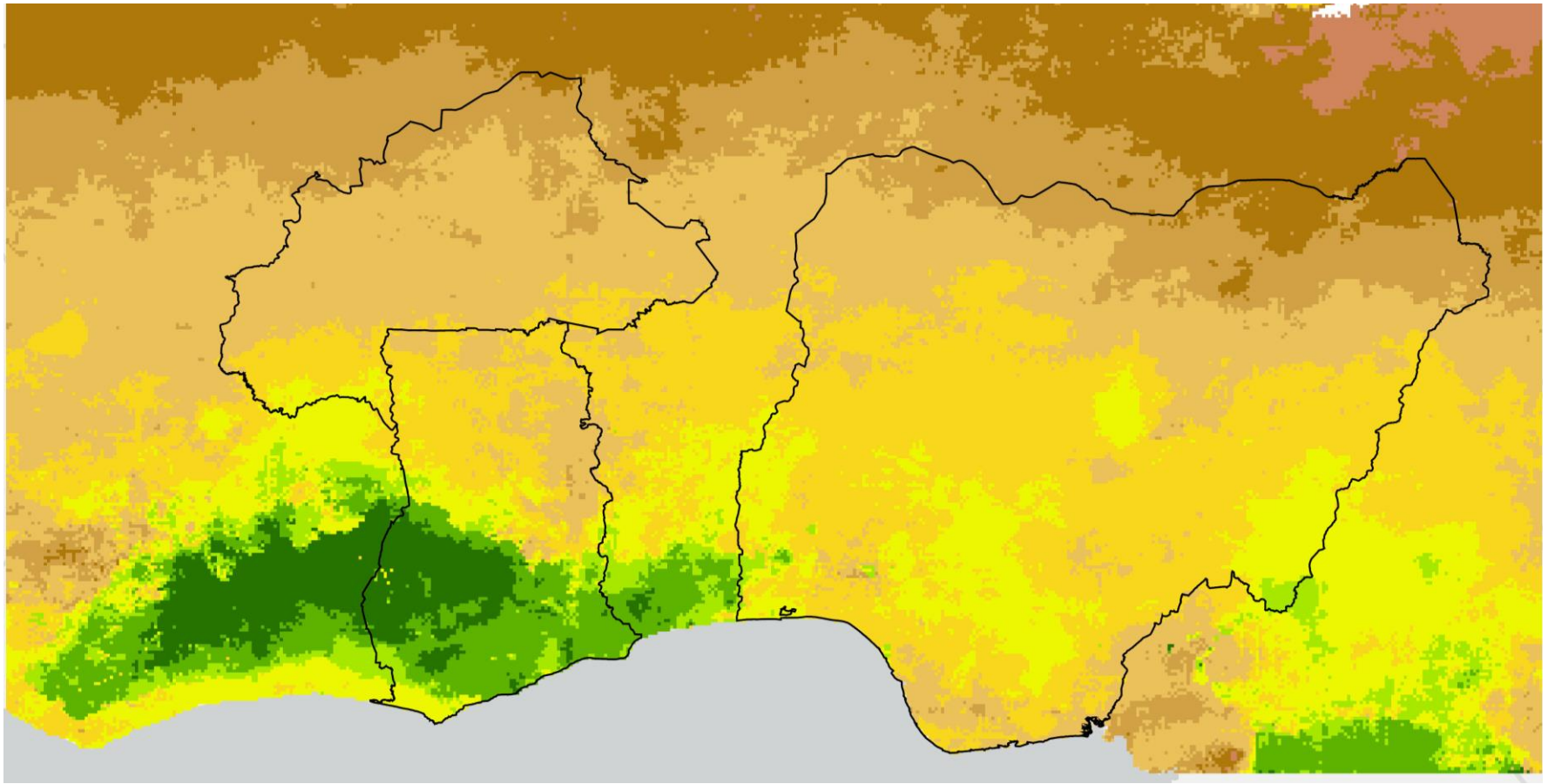
Annual and Biannual rainy season calculation (Dunning et al. 2016)



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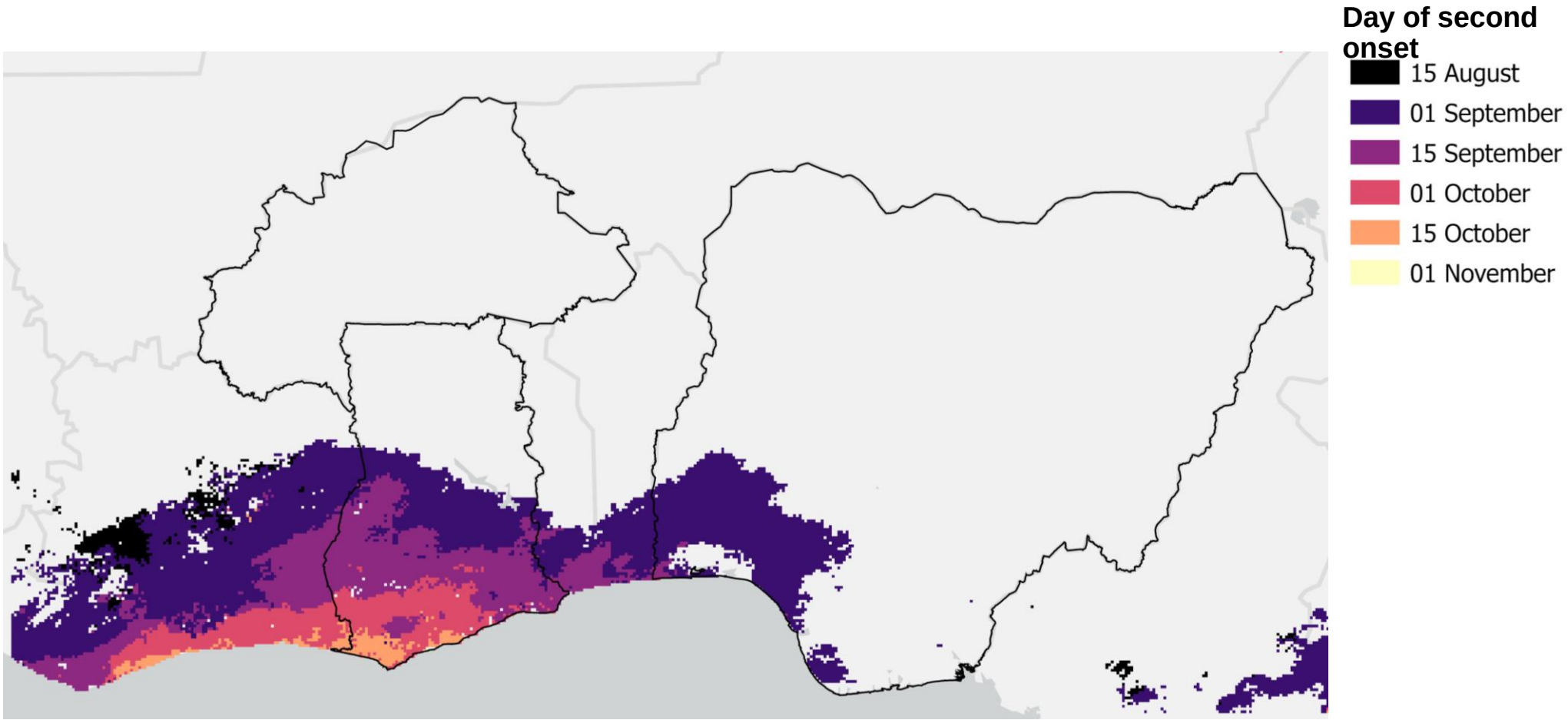
Annual and Biannual rainy season calculation (Dunning et al. 2016)



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rainfall indices per pixel

2011

	p_1	p_2	$p_{120.536}$
d_1	10	5	15
d_2	12	1	2
d_{365}	2	12	2

2012

11	10	0
10	0	0
2	18	2

⋮

2020

1	0	0
15	0	10
2	1	5

Rainy season

onset + offset

Dunning et al. 2016

Rainfall indices

RTOT
Rd
Dd
SDII
R10mm
R30mm
CDD
CWD
RX1day

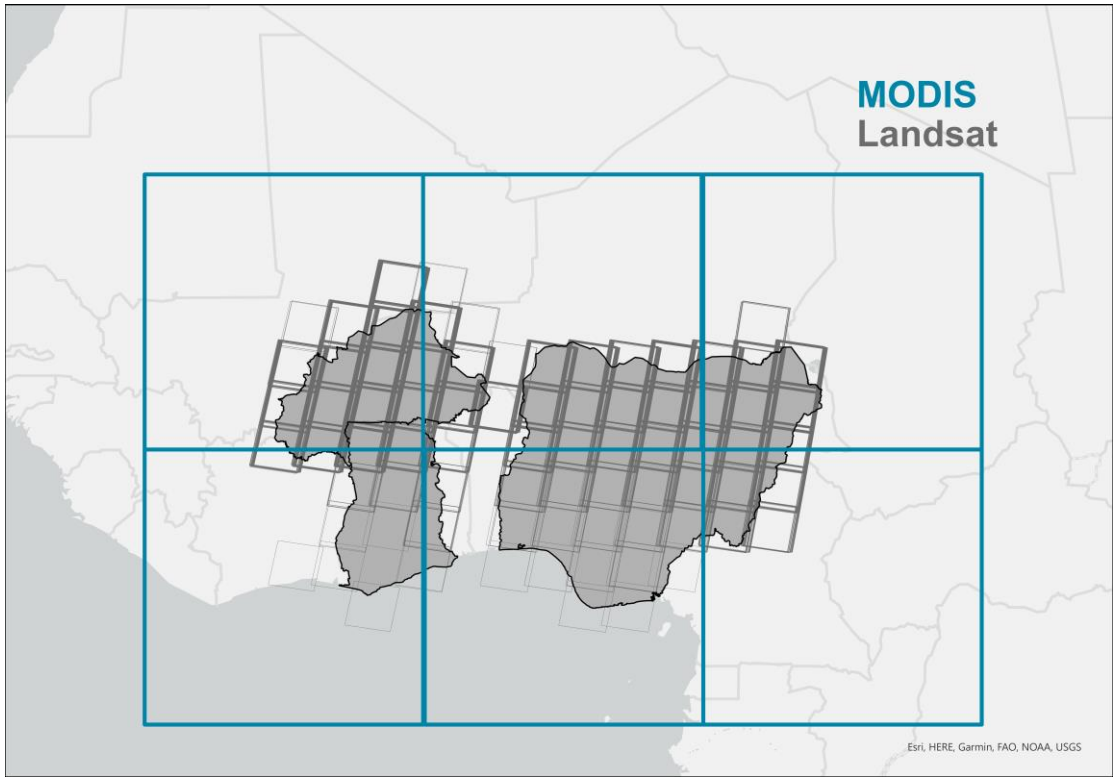
e.g. De Longville et al. 2020

trend detection

Mann-Kendall Test,
Sens Slope estimator

0,1	0,3	0
0,7	0	0
2	1,1	1,4

MODIS NDVI



Combination of MODIS Terra & Aqua
= 46 images per year (2011 – 2020)

MODIS NDVI

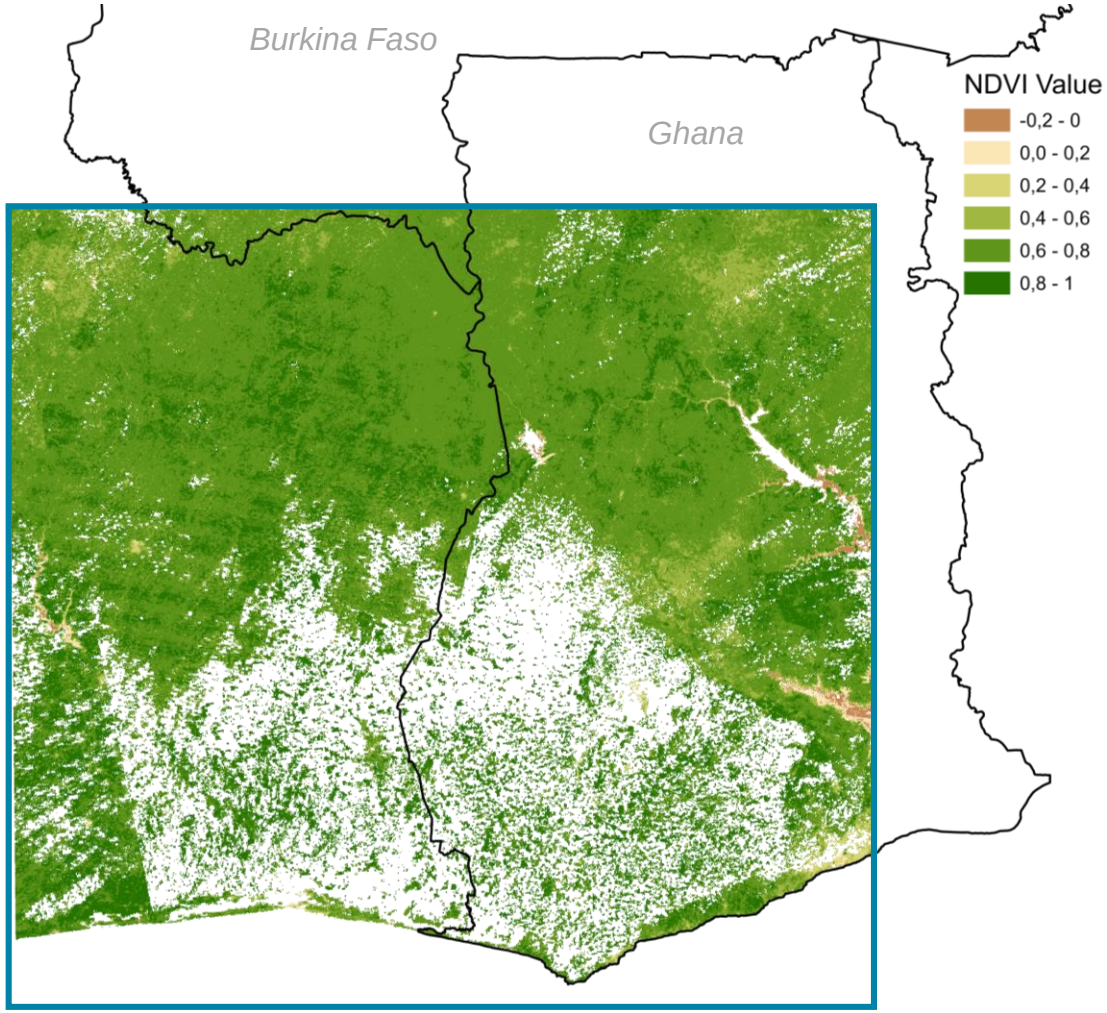
Problem: unreliable pixel values

Table 1: Product MOD13A1: 16-day 250/500-m VI.

Science Data Set	Units	Data type	Valid Range	Scale factor
250/500m 16 days NDVI	NDVI	int16	-2000, 10000	0.0001
250/500m 16 days EVI	EVI	int16	-2000, 10000	0.0001
250/500m 16 days VI Quality detailed QA	Bits	uint16	0, 65534	NA
250/500m 16 days red reflectance (Band 1)	Reflectance	int16	0, 10000	0.0001
250/500m 16 days NIR reflectance (Band 2)	Reflectance	int16	0, 10000	0.0001
250/500m 16 days blue reflectance (Band 3)	Reflectance	int16	0, 10000	0.0001
250/500m 16 days MIR reflectance (Band 7)	Reflectance	int16	0, 10000	0.0001
250/500m 16 days view zenith angle	Degree	int16	-9000, 9000	0.01
250/500m 16 days sun zenith angle	Degree	int16	-9000, 9000	0.01
250/500m 16 days relative azimuth angle	Degree	int16	-18000, 18000	0.01
250/500m 16 days composite day of the year	Day of year	int16	1, 366	NA
250/500m 16 days pixel reliability summary QA	Rank	int8	0, 3	NA

Table 4: MOD13Q1/A1 Pixel Reliability.

Rank Key	Summary QA	Description
-1	Fill/No Data	Not Processed
0	Good Data	Use with confidence
1	Marginal data	Useful, but look at other QA information
2	Snow/Ice	Target covered with snow/ice
3	Cloudy	Target not visible, covered with cloud



MODIS Terra NDVI, including only good and marginal data (Day 217, 2020, scene H18v07)

MODIS NDVI - Interpolation of missing values

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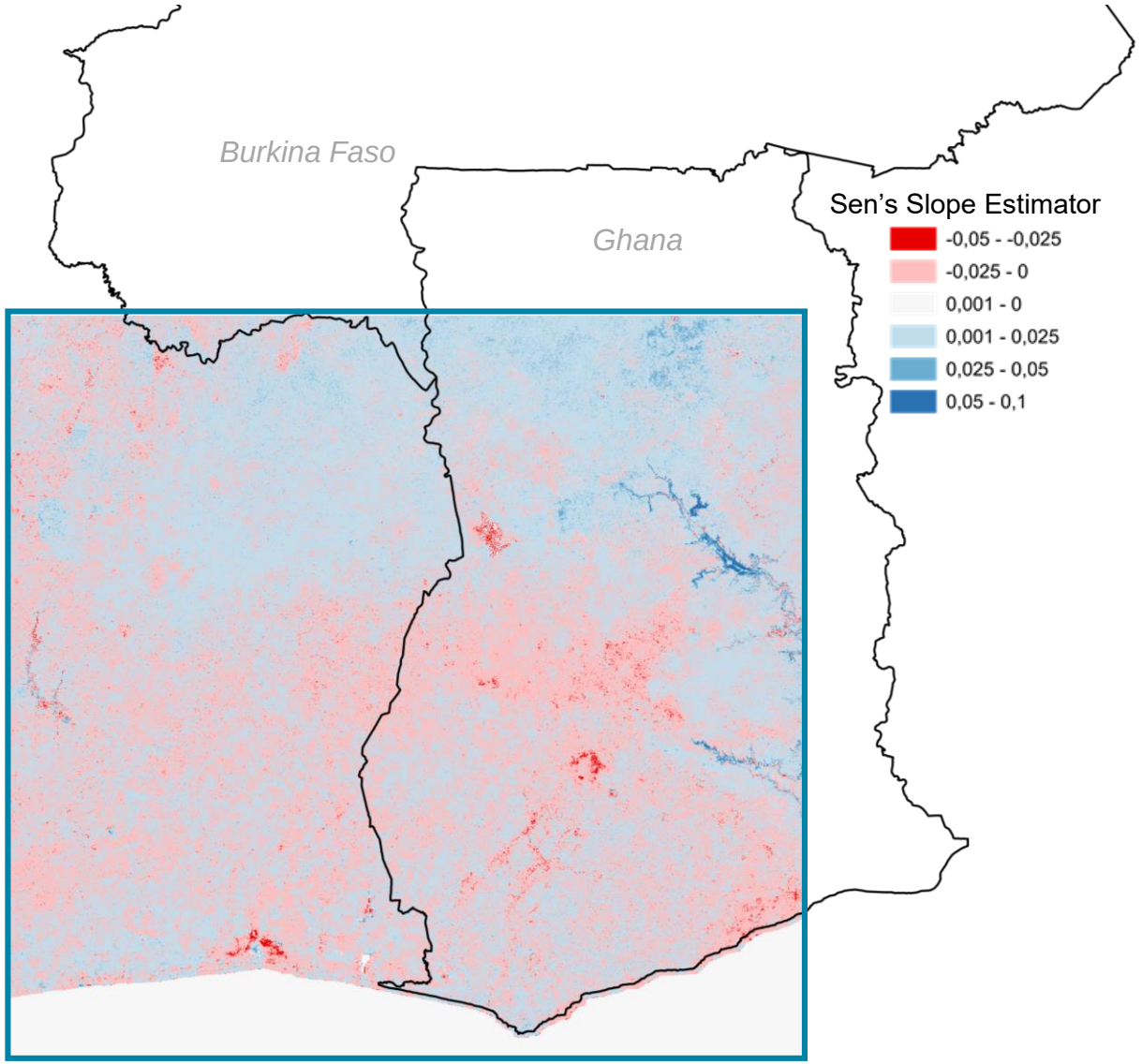
Interpolation of missing data (approxNA, focal)

→ Mean value of the month August

→ Mann Kendall-Test and Sen's Slope Estimator



Weighted overlay - Areas affected by multiple factors

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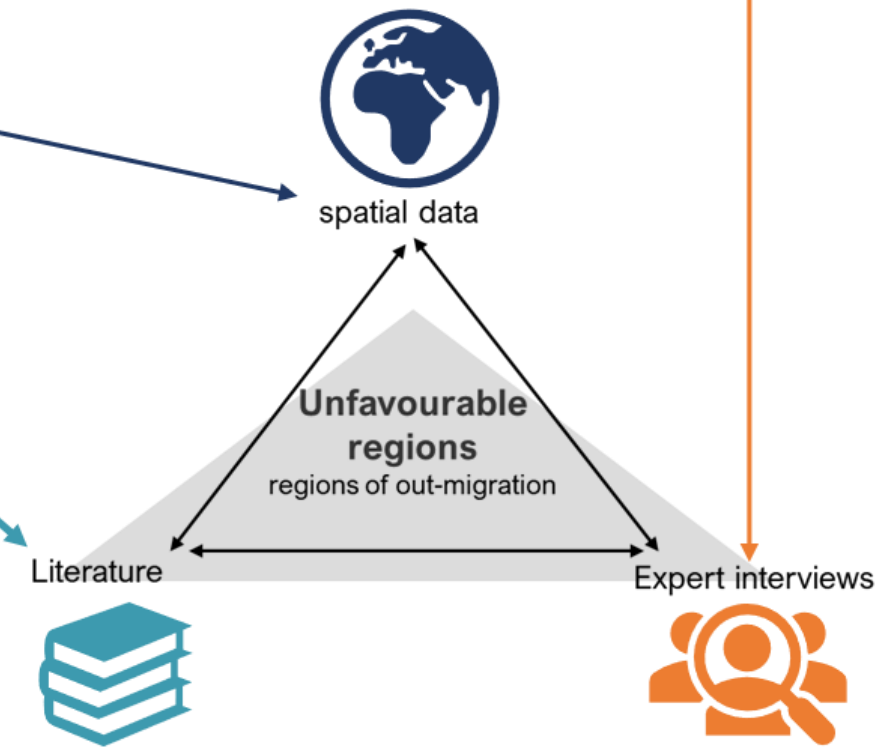
No	Parameter	Feature class	Scale weight	% of influence
1	Population density	0-75	2	30
		75-125	8	
		>125	10	
2	Decreasing NDVI	-1- -0,5	10	10
		-0,5 - -0,25	9	
		-0,25 – 0	8	
		0 – 0,25	1	
		0,25 – 0,5	1	
		0,5 - 1	1	
3	Average Precipitation	<500 – 600	10	10
		600 – 700	8	
		700 – 800	6	
		>800	1	
4	Increasing Dry Days in Rainy Season	-10 - -5	1	5
		-5 - -2,5	1	
		-2,5 - 0	1	
		0 – 2,5	2	
		2,5 - 5	4	
		5 - 10	6	
		10 - 15	8	
		15 - 20	10	
5	Travel time to cities (access to market)	0 - 60	1	10
		60 – 120	2	
		120 – 180	4	
		180 – 240	6	
		240 - 300	8	
		> 300	10	
6	Heavy Rainfall events (>30 mm)	0 - 5	2	5
		5 – 10	4	
		10 – 15	6	
		15 – 20	8	
		20 - 40	10	



Areas affected by multiple factors

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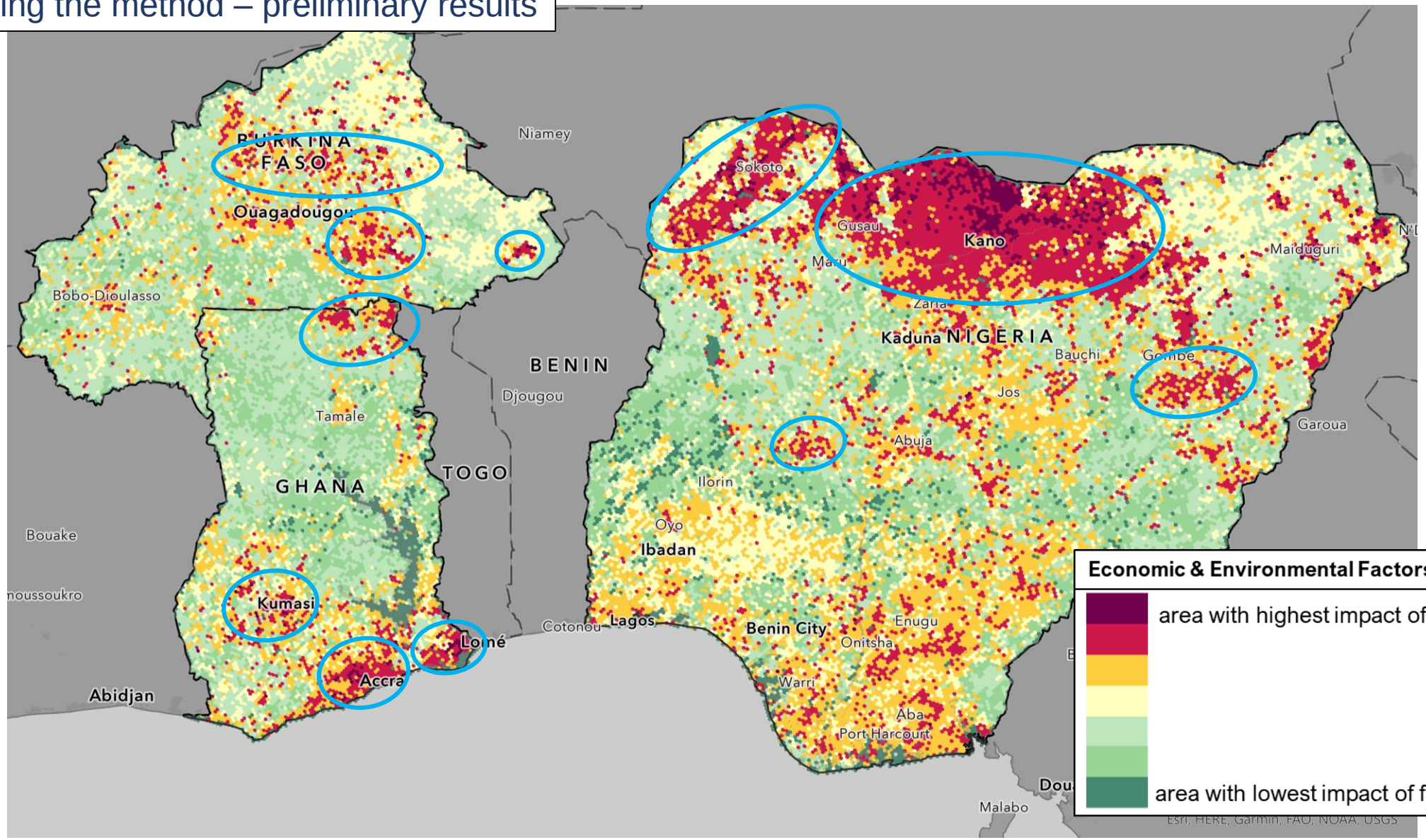
Testing the method – preliminary results



Further Research & Conclusion

- Different weighted overlay scenarios
  e.g for ecological and/or economic reasons only, different migration types…
- Validation of hypotheses regions using interviews with (potential) migrations
- RS and spatial data can be used to detect unfavourable regions
- The hypotheses regions can be a starting point for further research on migration decisions

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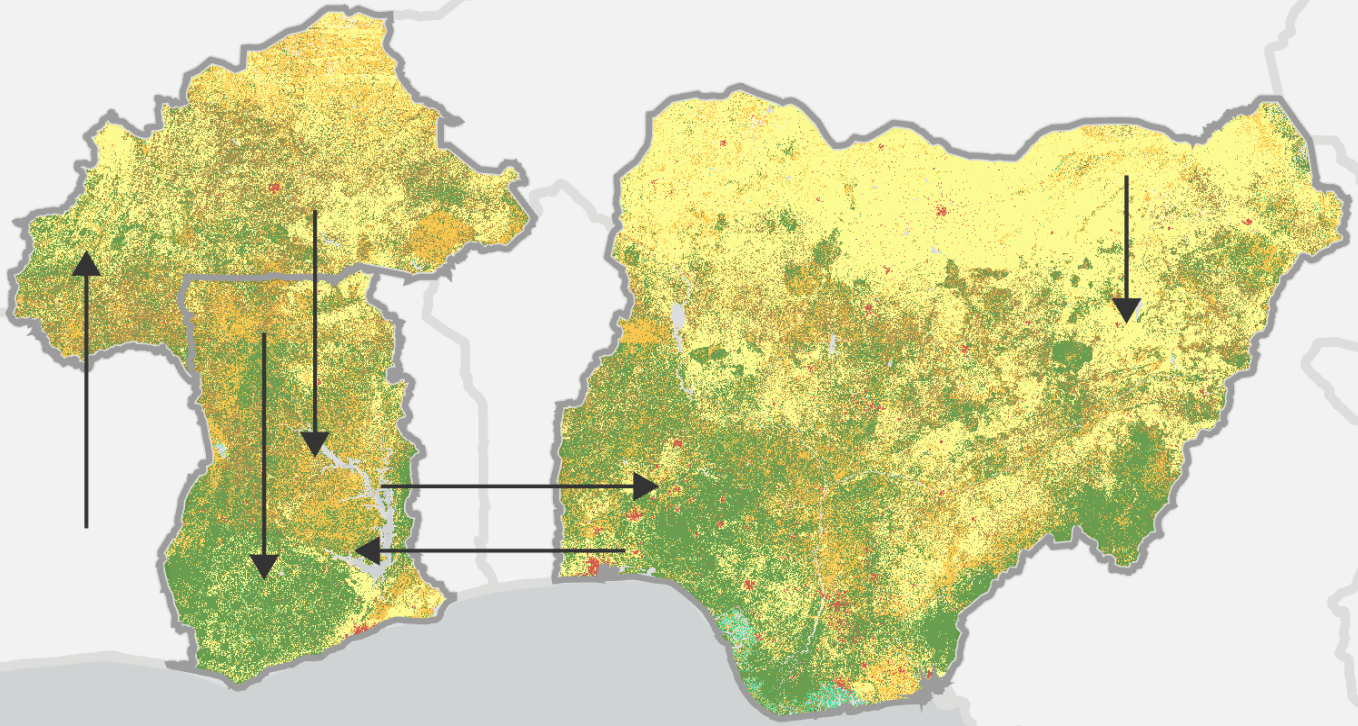
Thank you very much for your attention



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