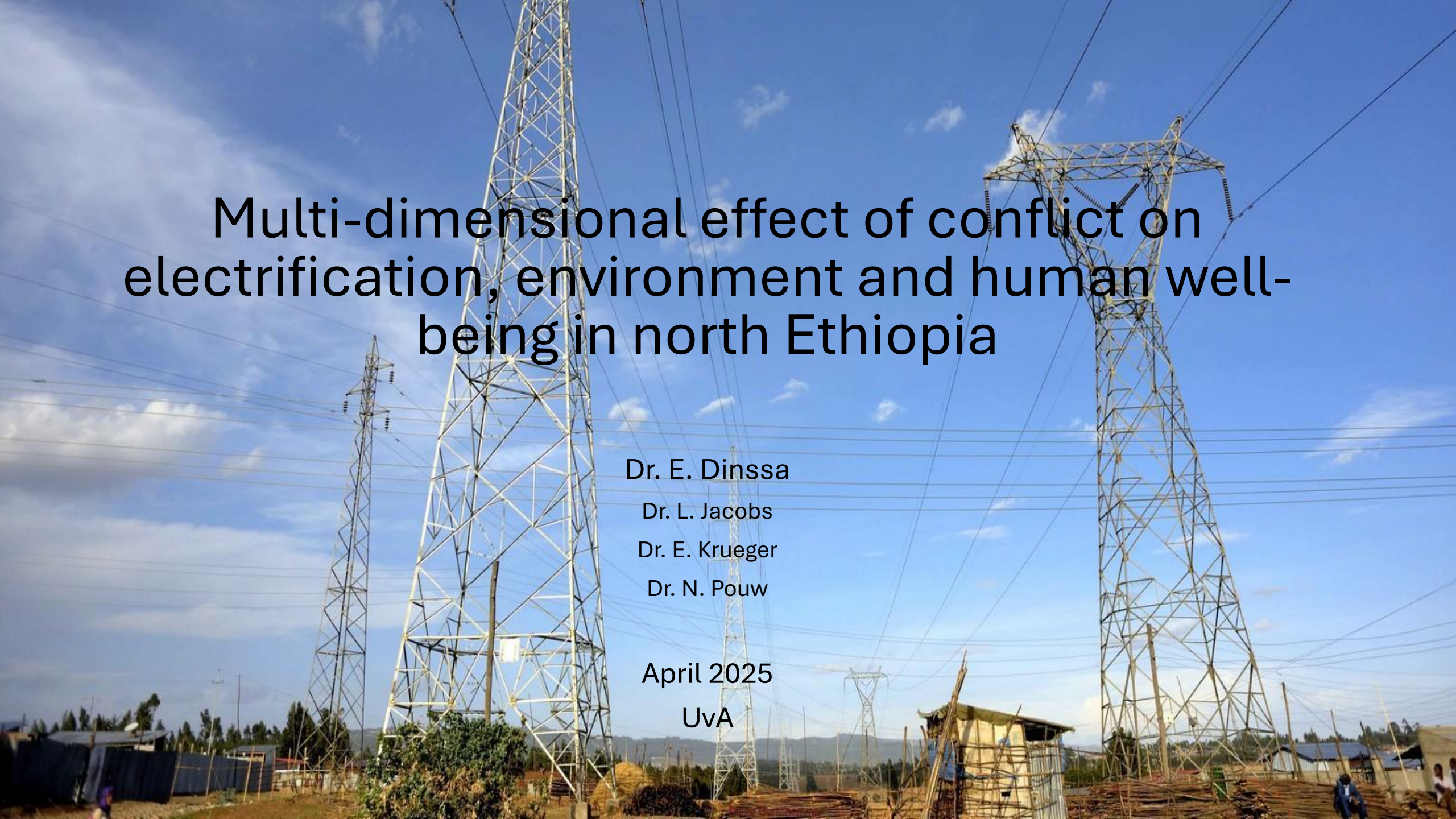


Multi-dimensional effect of conflict on electrification, environment and human well-being in north Ethiopia

Dr. E. Dinssa

Dr. L. Jacobs

Dr. E. Krueger

Dr. N. Pouw

April 2025

UvA

My journey to UvA

- Ethiopia
- Now live in Belgium as a refugee
- Education:
  - PhD: Ghent University, Belgium
  - MSc and Bachelor: Hawassa university, Ethiopia
- Work experience
  - Academic and applied research
    - EU funded project, ILVO, Flanders
    - Assistant professor, Mekelle University
- How at UvA?
  - ENLENS fund to UvA and IIE-SRF
- My research interest: Env studies

Links

https://orcid.org/0000-0002-9633-9038

https://www.linkedin.com/feed/



Outline

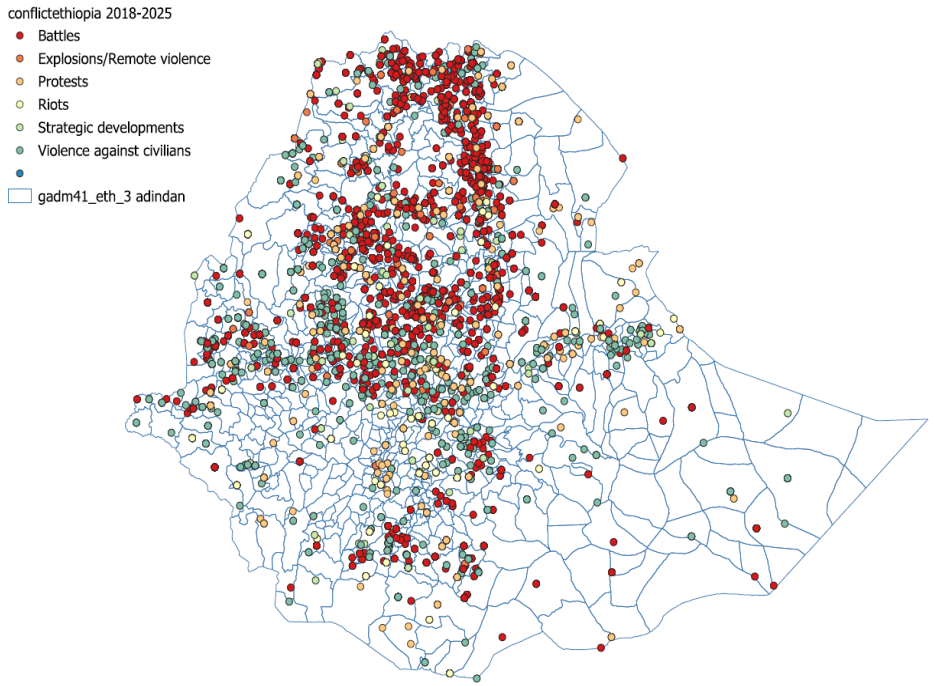
- ❑ Introduction
  - Background (evolution of this research project)
  - Problem statement
  - Research question
- ❑ Methodology
  - Data sources
  - Role of the open datasets at country level
  - Analysis
- ❑ Results and discussion
  - Conflict – Electrification and Environment
  - Triangulation with WorldBank data:
    - ✓ Main source of light and cooking fuel
    - ✓ Displacement due to conflict
- ❑ Lessons learned
- ❑ Other activities enabled through ENLENS

Background

- Ethiopia was peaceful and stable country
- 2018 on ward - Armed conflict in Ethiopia
- Tigray war (2020 - 2022)







- Caused widespread disruption
- Sets back decades of progress
- Electricity infrastructure damaged
- Energy insecurity?

➔This research emerges





Research gaps:

- ❑ Many researches exist on conflict impact
- ➢ Most of recent literature are limited in scopes
  - ✓ Cultivation/farmers, socio-political
- Limited sites of intervention- few sites
- Narrow in time spans
  - ✓ Confined to conflict period
  - ✓ No continues, monthly time-series data
- Descriptive, Nonspatial (ma NDVI)

Science of Remote Sensing
Volume 9, June 2024, 100133

Eyes in the sky on Tigray, Ethiopia - Monitoring the impact of armed conflict on cultivated highlands using satellite imagery

Home › Human Ecology › Article

Effects of War and Siege on Farmers' Livelihoods in Tigray, Ethiopia: Lessons for Conflict-Vulnerable Areas

Published: 09 September 2024
Volume 52, pages 877–890, (2024) Cite this article

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Access provided by University of Amsterdam

Research Article

Crop Cultivation at Wartime – Plight and Resilience of Tigray's Agrarian Society (North Ethiopia)

Jan Nyssen, Emnet Negash, Bert Van Schaeybroeck, Kiara Haegeman & Sofie Annys

Pages 618-645 | Received 27 Jul 2021, Accepted 12 Apr 2022, Published online: 01 May 2022

Political Geography
Volume 118, April 2025, 103298

Full Length Article

Tigray war: Modern geographies of mass violence and the invisibilization of populations

Teklehaymanot G. Weldemichel

International Soil and Water Conservation Research
Volume 12, Issue 3, September 2024, Pages 635-649

Original Research Article

The impacts of armed conflict on vegetation cover degradation in Tigray, northern Ethiopia

Solomon Hishe [a], Eskinder Gidey [b f], Amanuel Zenebe [b c], Woldeamlak Bewket [d], James Lyimo [e], Jasper Knight [f], Tsegay Gebretekle [g]

ARTICLE IN PRESS
International Soil and Water Conservation Research xxx (xxxx) xxx
Contents lists available at ScienceDirect
International Soil and Water Conservation Research
journal homepage: www.elsevier.com/locate/iswcr

Original Research Article

The effects of armed conflict on natural resources and conservation measures in Tigray, Northern Ethiopia

Hailemariam Meaza [a, *], Tesfaalem Ghebreyohannes [a], Zbelo Tesfamariam [a], Girmay Gebresamuel [b], Biadgilgn Demissie [a, c], Dawit Gebregziabher [d], Jan Nyssen [e]

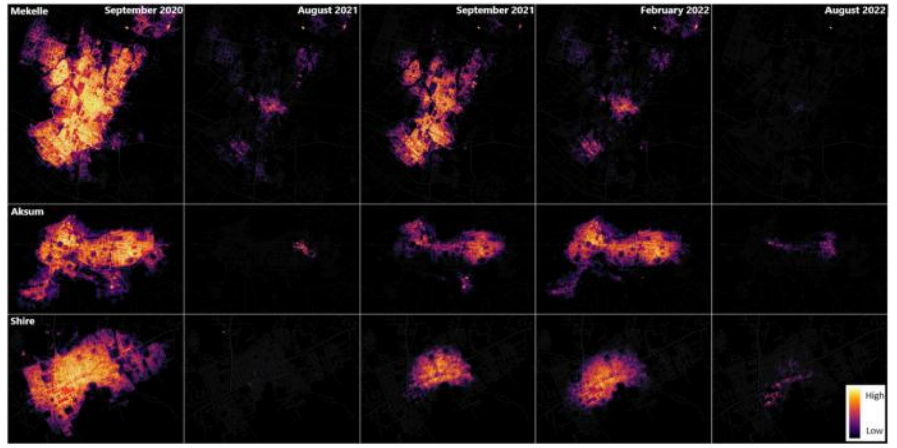
Research gap

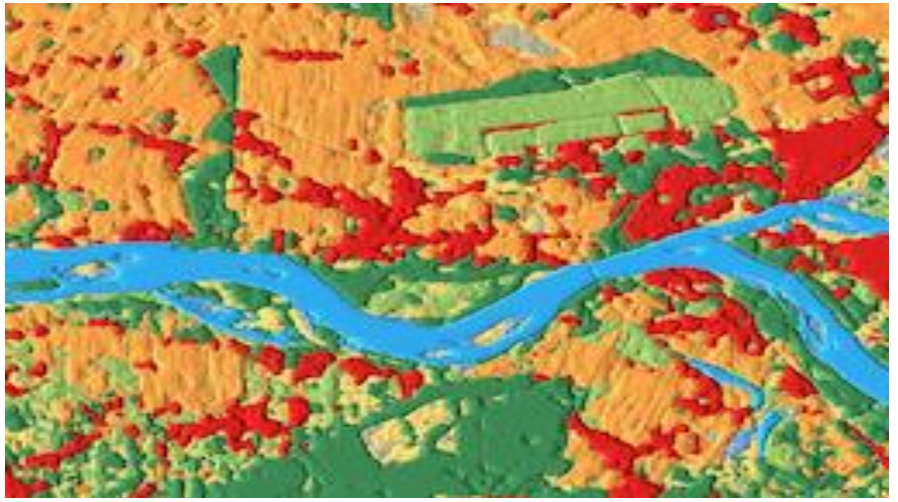
- Few studies on conflict-electrification
  - ✓ Lack of quantification of conflict intensity
  - ✓ Use of openly available datasets
  - ✓ Easily accessible through platforms such as Google Earth Engine

- Motivation of this research
- Understand effect across time and space
- Quantification using high spatiotemporal data- is critical to:
  - ✓ Draw lessons on effects of conflict accurately and
  - ✓ Provide nuanced analysis for future recovery planning.

Remote sensing reveals how armed conflict regressed woody vegetation cover and ecosystem restoration efforts in Tigray (Ethiopia)

Emnet Negash [a b], Emiru Birhane [b c d], Aster Gebrekirstos [e], Mewcha Amha Gebremedhin [f g], Sofie Annys [a], Meley Mekonen Rannestad [d], Daniel Hagos Berhe [h], Amare Sisay [h], Tewodros Alemayehu [i], Tsegai Berhane [j], Belay Manjur Gebru [k], Negasi Solomon [k], Jan Nyssen [a]





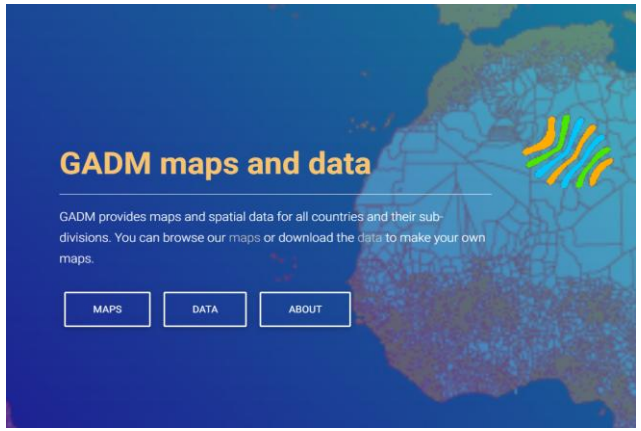
1. Research objectives

Analyze the spatio-temporal effects of armed conflict on electrification, environment and human well-being

2. Questions:

- Which spatial patterns occur in terms of landcover, electrification, and conflict in Tigray?
- Which influence does conflict have on electrification trajectories in Tigray?
- Can conflict be directly or indirectly be linked to deforestation and cropland abandonment?
- What are the consequences in terms of energy/food (in)security and IDPs?

Methods and Methodological objectives







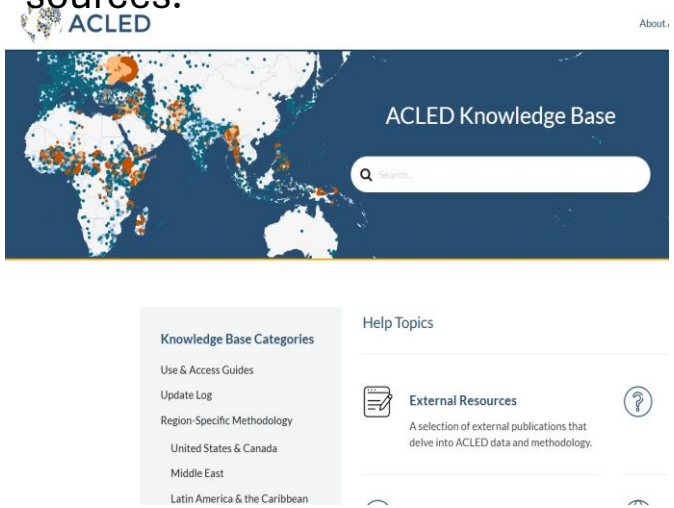
Tigray map with 53,000 km2, 7 mill. population, 35 Weredas/ Districts

- This research is built on **openly available RS and large-scale** survey – scalable, replicable.
- Three key time periods – capture short & long-term dynamics
- Spatial and temporal scale
- What is change? When and where?

Methods and Methodological objectives

- Main data sources: open
  - ✓Remote sensing
  - ✓Survey

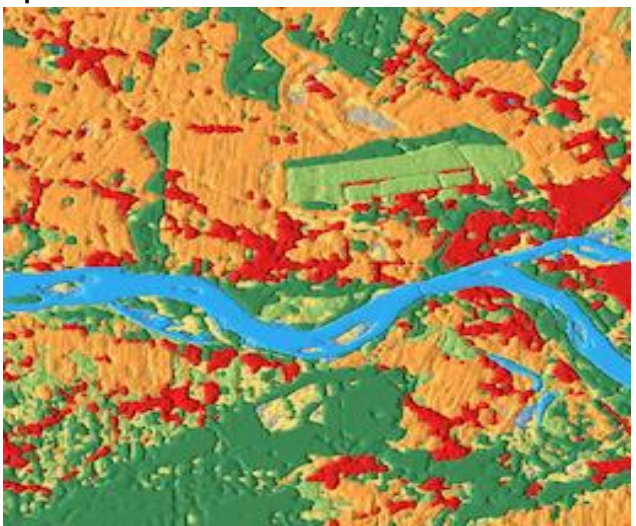
Armed Conflict Location & Event Data. 1997 – present, **conflict events**. Location, date, different sources.



VIIRS **Nighttime Light** image with high temporal resolution and 500 m per pixel.
Available from 2012 - present

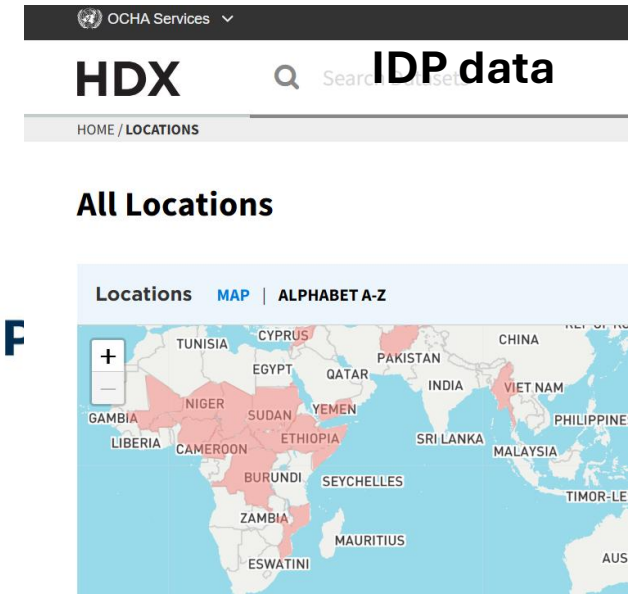


DynamicWorld (ESA) for **landcover** data, 10 m ressolution. Every 2-5 days, Since 2015. Provide pixel-wise probablities for each class.

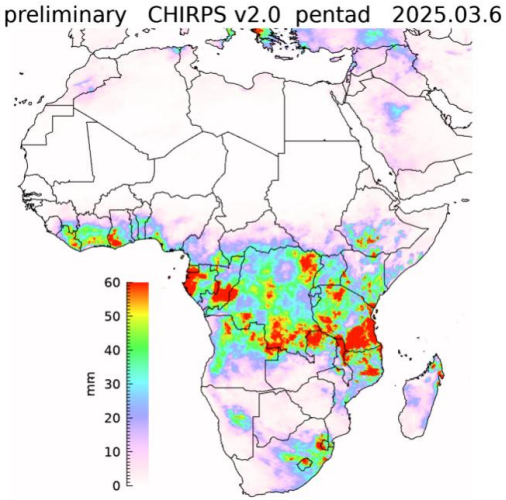


World Bank Group Household survey: **Light sources, food security, electricity infrastructure**

WORLD BANK GROUP

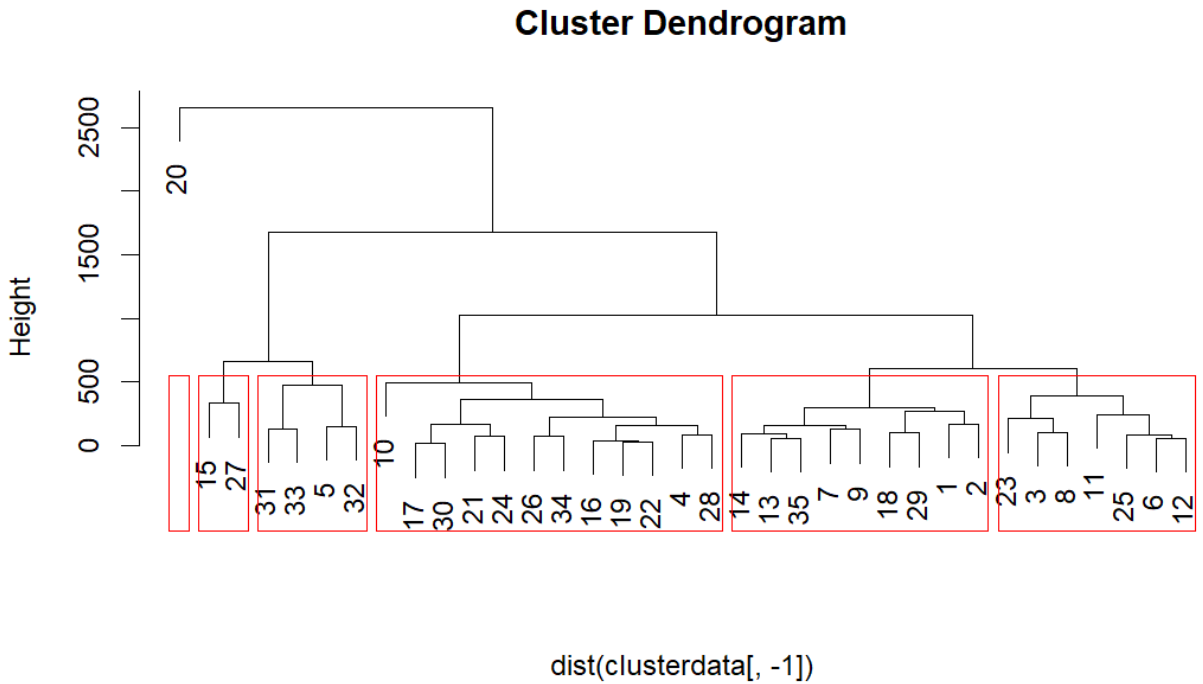


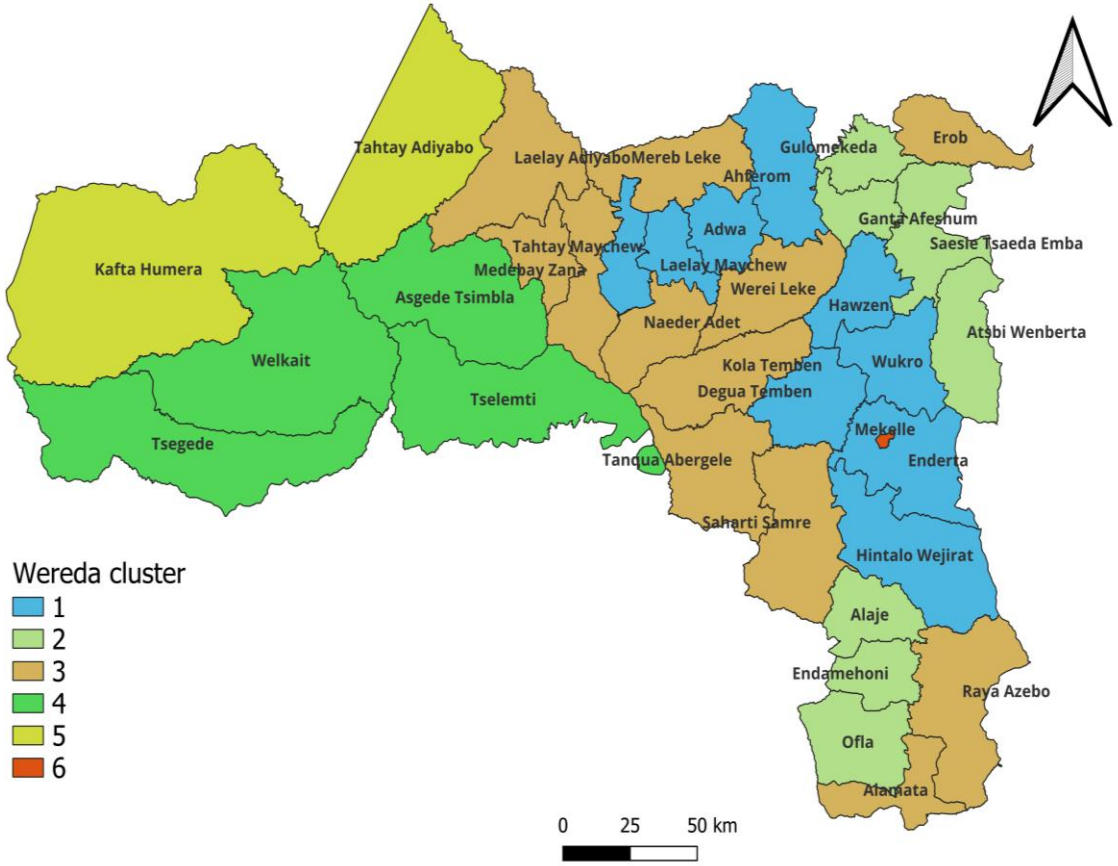
Rainfall data

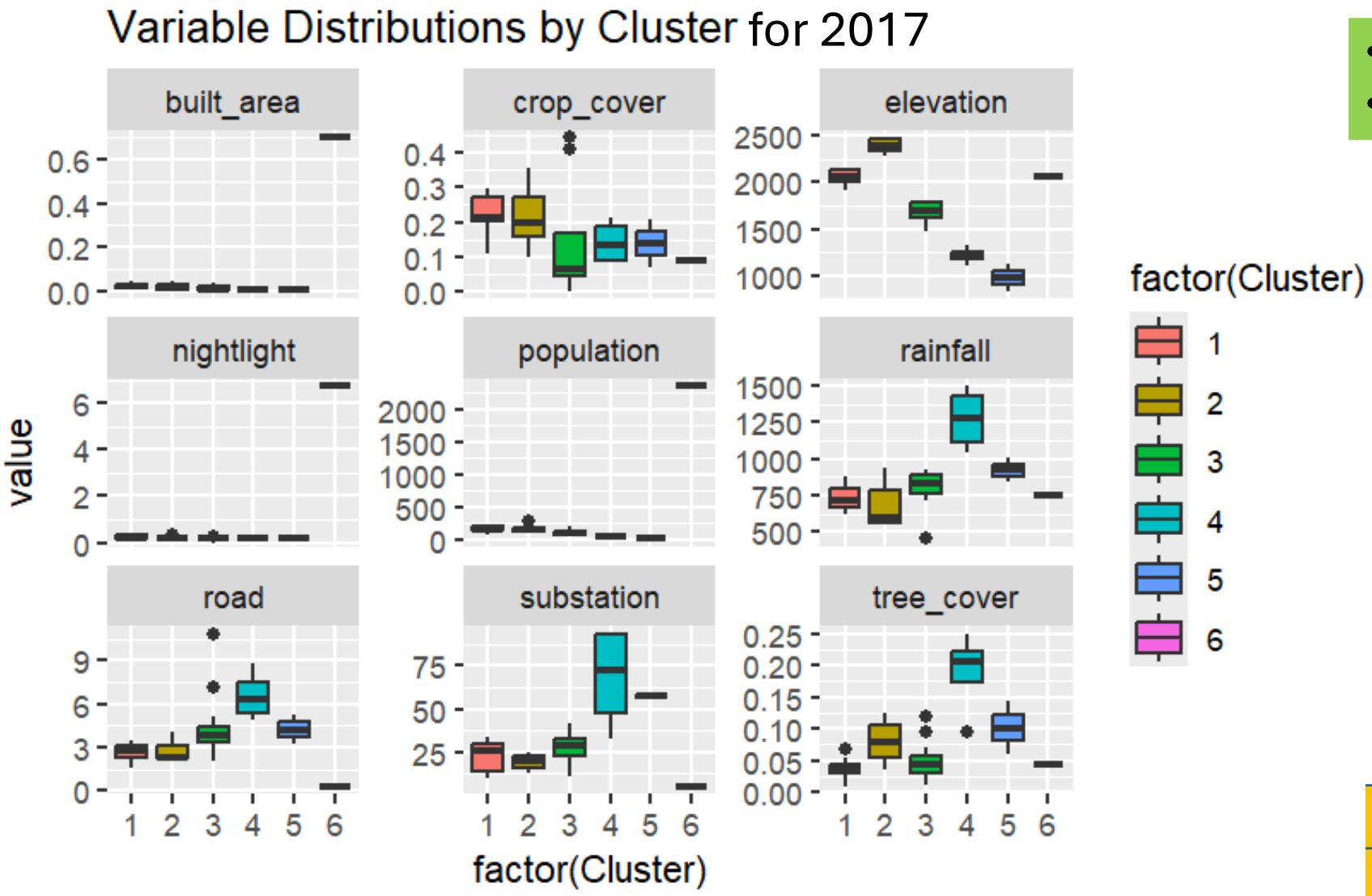


Analytical step 1:

- Cluster (hierarchical) the wereda administrative units for the 2017 baseline
  - Population density
  - Nighttime light
  - Land cover characteristics
  - Rainfall
  - Electricity infrastructure
  - Elevation



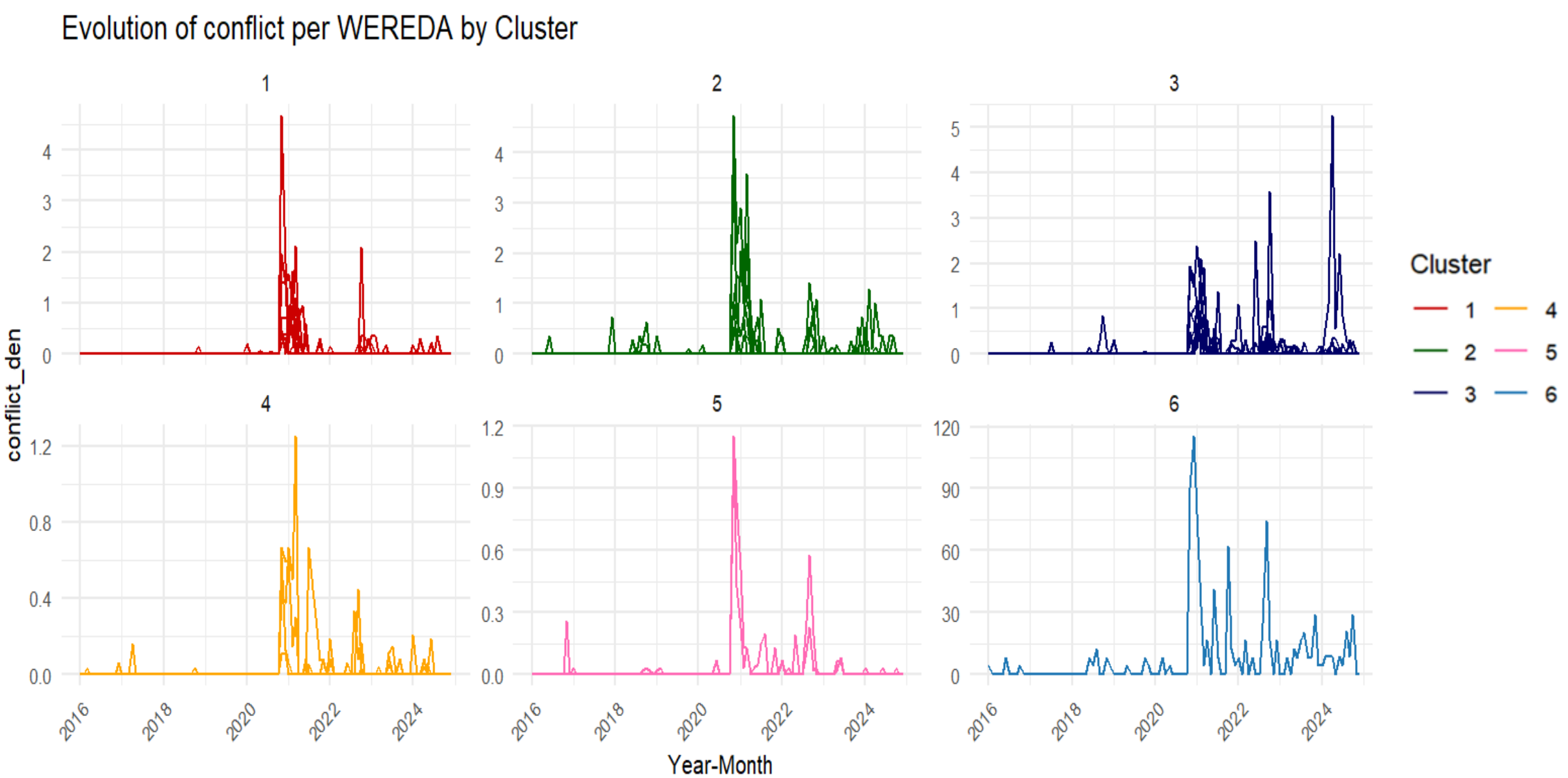




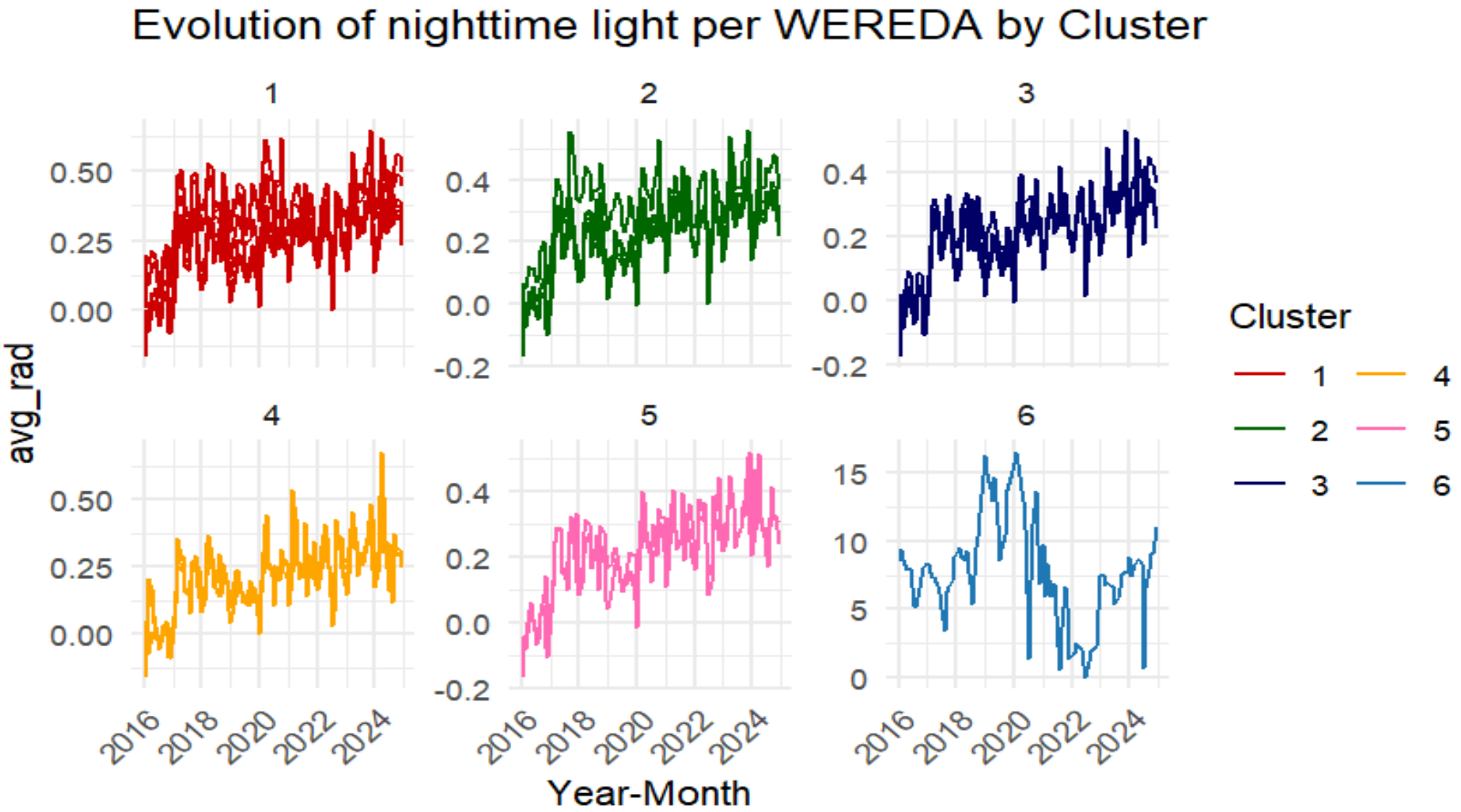
- Initial Heterogeneity
- Justify the hierarchical clustering

Variable	Df	MS	Sig.
avg_rad	5	1189.4	***
population	5	$1.2x10^8$	***
trees	5	1.3021	***
crops	5	0.9545	***
built	5	10.37	***
substation	5	200267	***
road	5	1459.1	***
elevation	5	$1.28x10^8$	***

Cluster	Urbanization level
6	Highly urbanized
1 & 2	Moderately urbanized
3	Less urbanized
4 & 5	Rural weredas



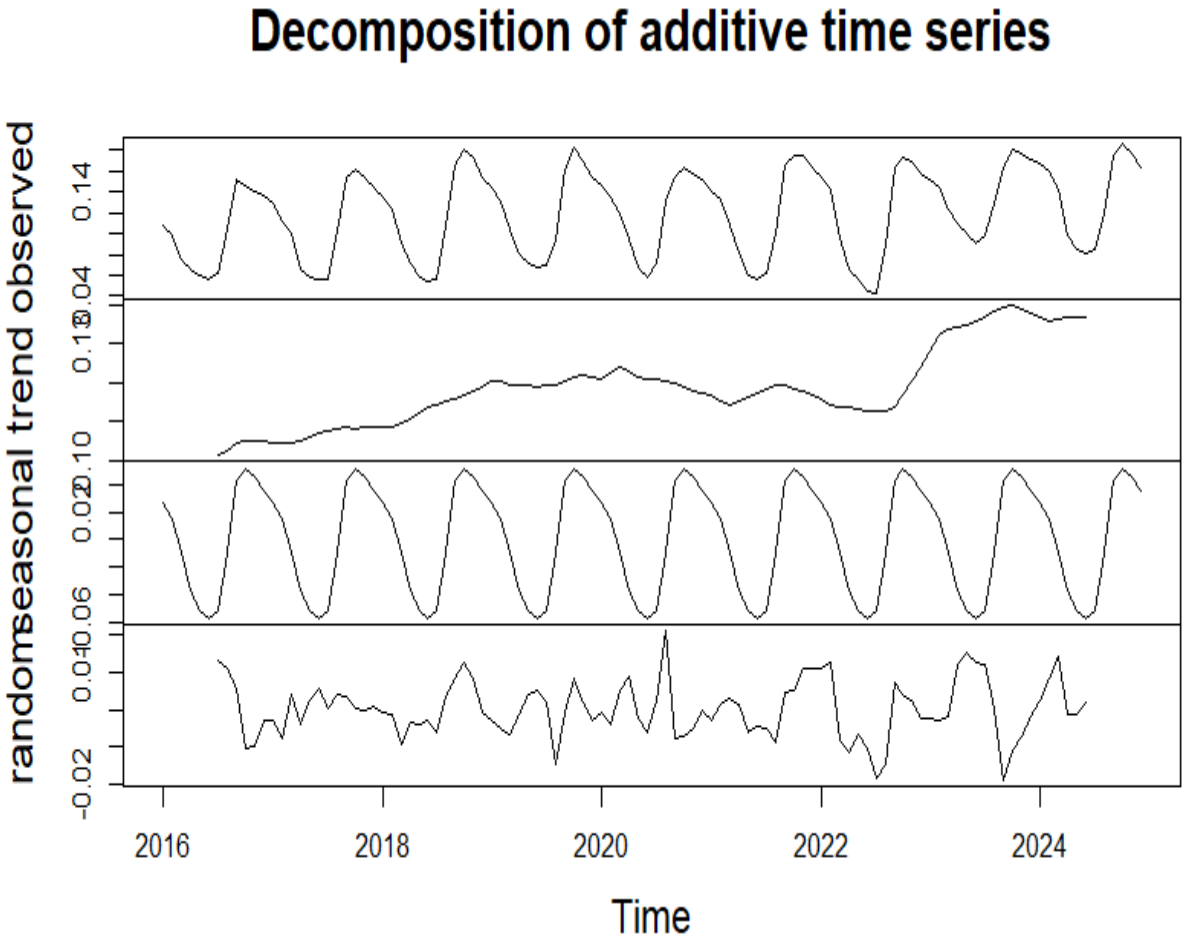
- **Intensity and duration vary**
- **Peaked late 2020**
- **Recurring conflict**
- **Linking to changes**



- Improving before the conflict
- Energy access per wereda/cluster
- Notable decline during the conflict

Analytical step 2: understand temporal variation per cluster

- Decomposed time series of tree cover for single weredas
- Dynamic of tree cover over time, isolate components
- Intension - separate conflict related changes



Ofla wereda: raw data on tree cover

TREND → For all Wereda per Cluster

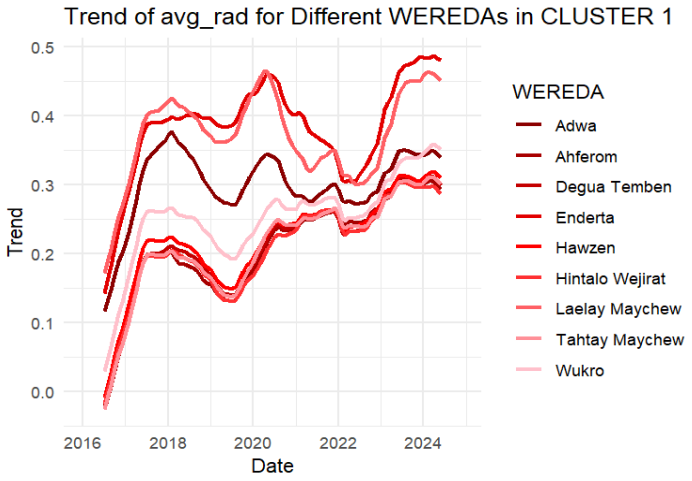
Seasonal variation

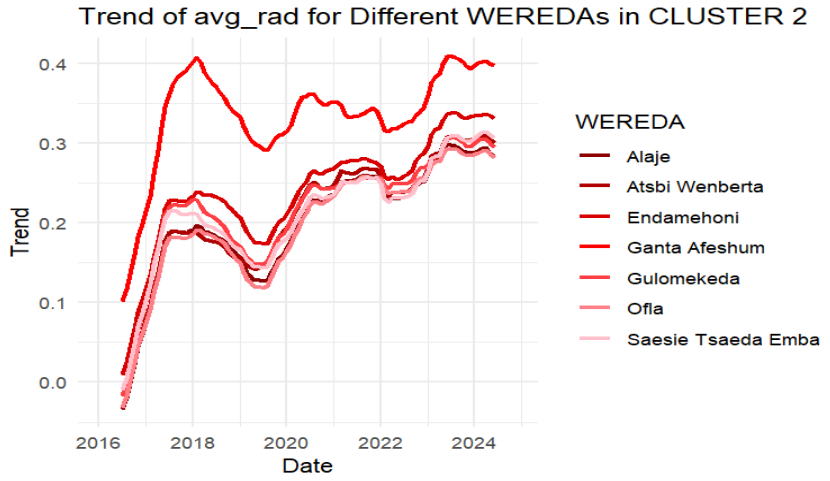
Random fluctuation

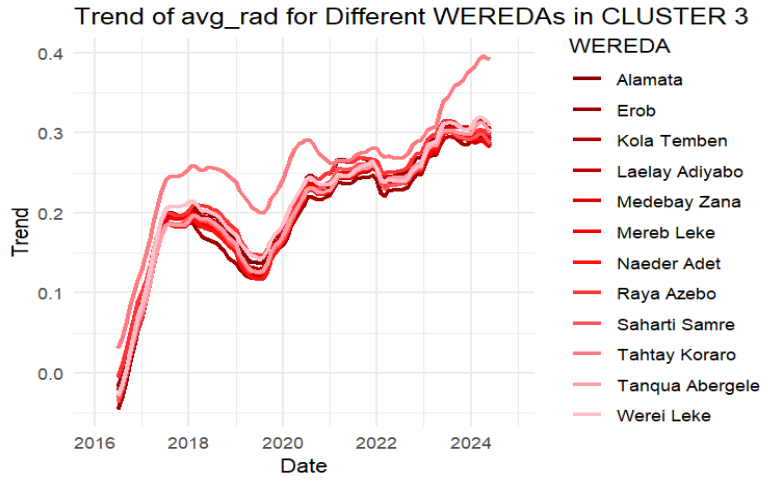
Analytical step 2: understand trend per cluster

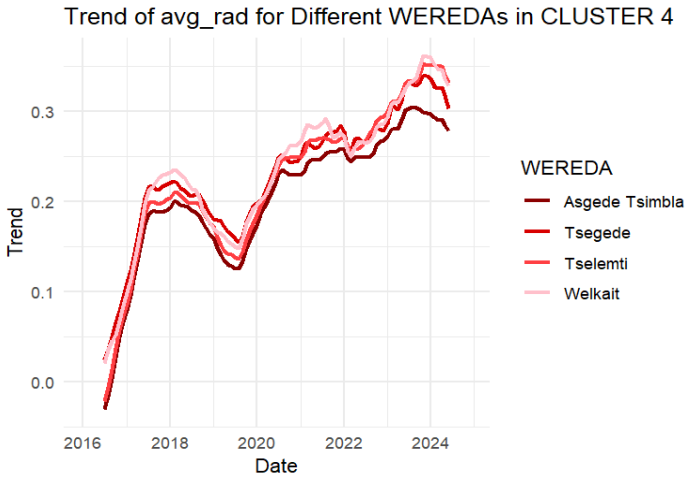
- Removal of components & focus on long-term trend

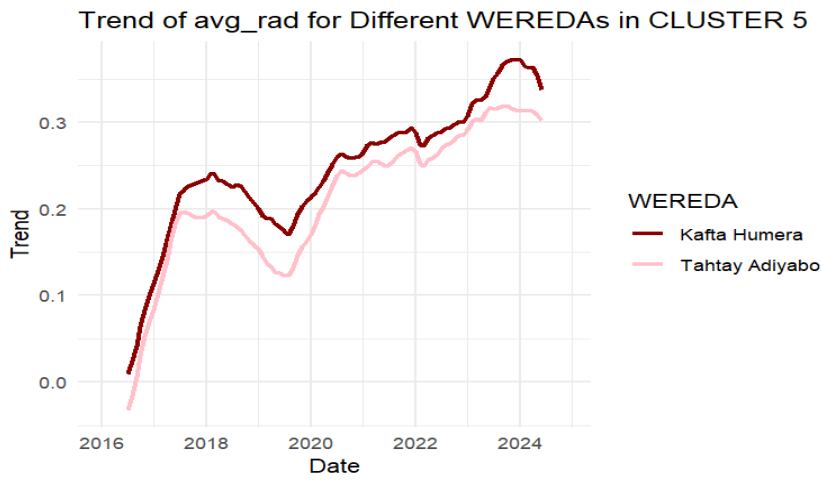
1. Electrification by nighttime light

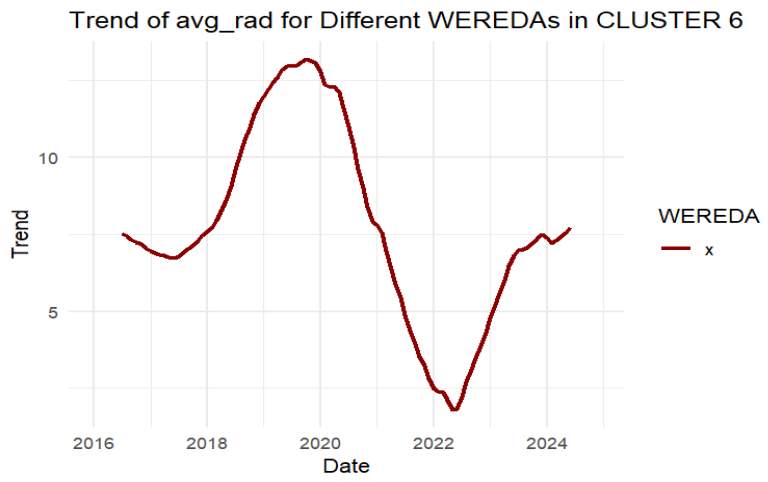


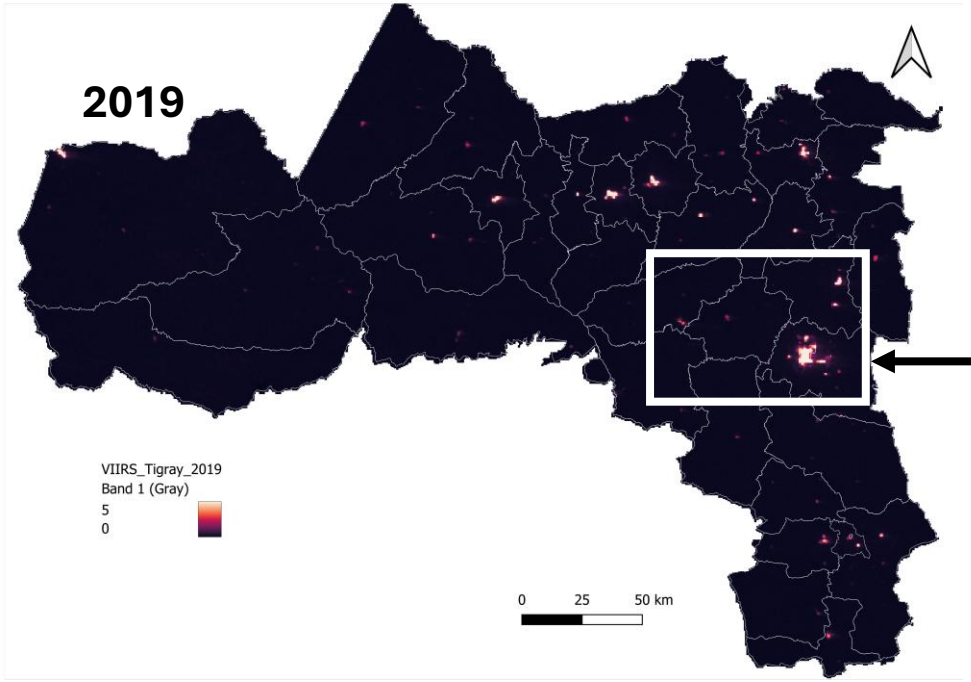




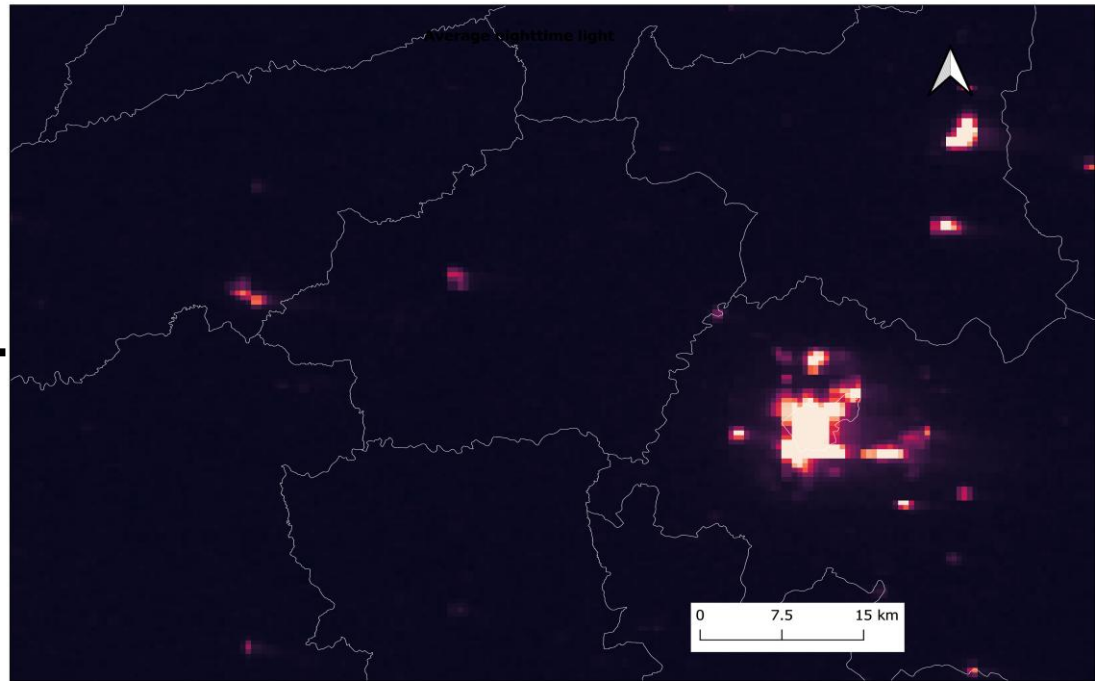


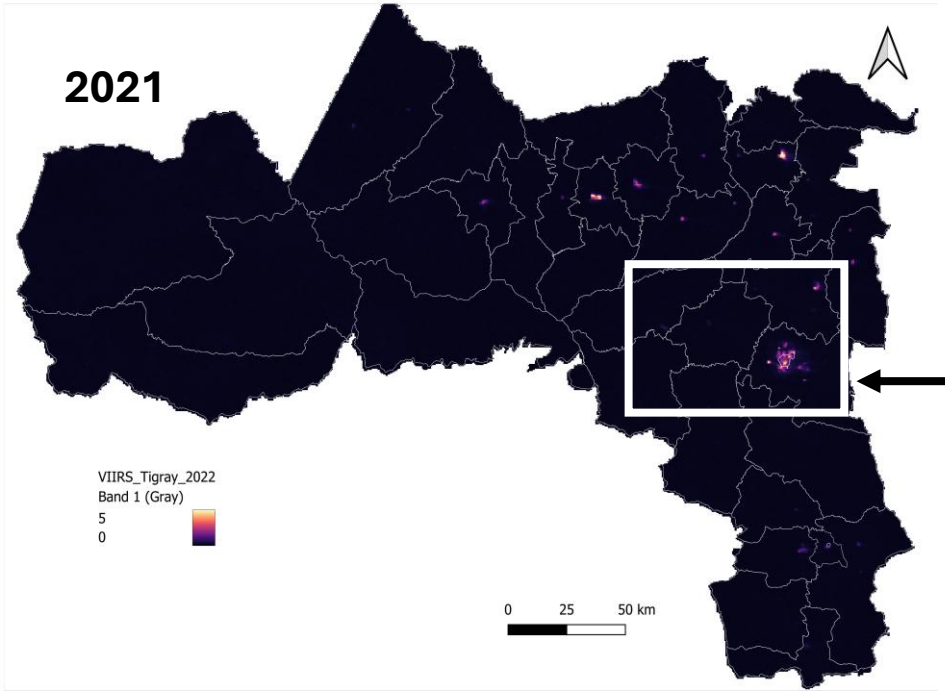




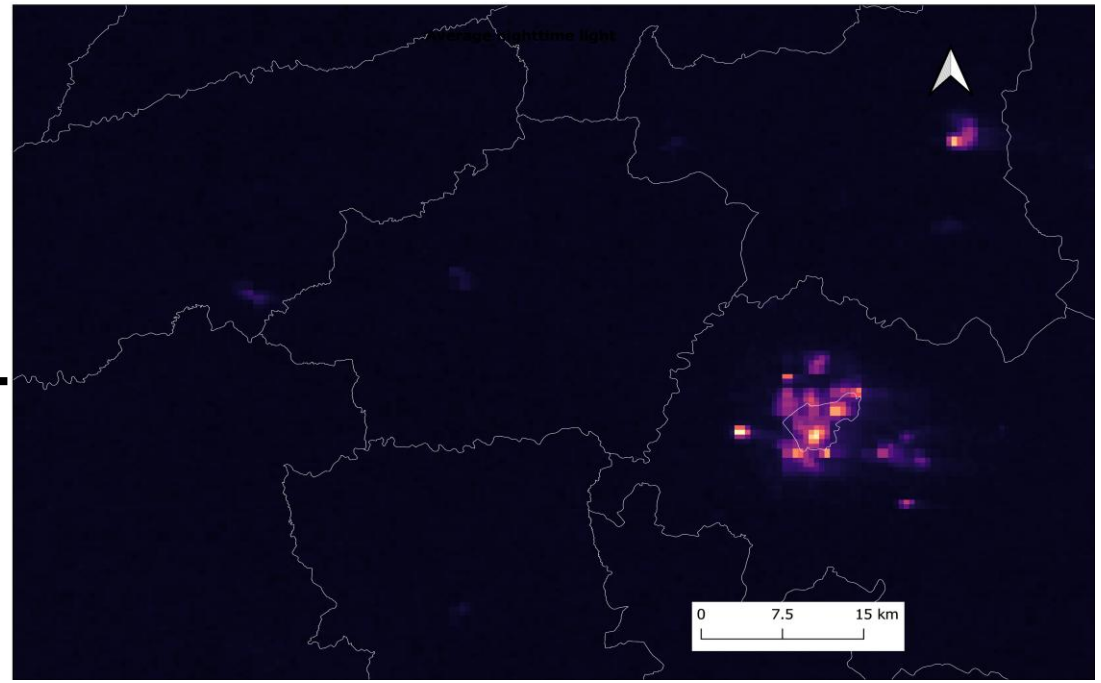


Mekelle





Mekelle



Analytical step 3: understand impact of conflict per cluster

- Fixed effect linear regression model for NTL

	Estimate	Std. Error	df	t value	Pr(>|t|)
(Intercept)	-0.00195	0.00798	3738	-0.24	0.807
Lagged avg_rad	0.83801	0.00855	3738	98.06	0.000***
Lagged conflict_dens	-0.01403	0.00217	3738	-6.46	0.000***
Conflict/100km2	-0.00133	0.00216	3738	-0.61	0.540
Lagged rainfall	0.00053	0.00008	3738	6.48	0.000***
Rainfall	-0.00051	0.00008	3738	-6.29	0.000***
Built	1.92499	0.10726	3738	17.95	0.000***

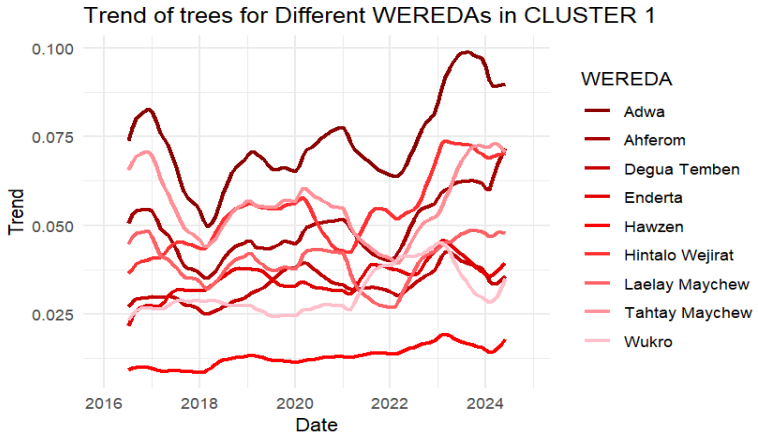
$$\text{NTL radiation} = -0.00195 + 0.838\,\text{lagged avg_rad} - 0.01403\,\text{lagged conflict_dens} - 0.001326\,\text{conflict/100km2} + 0.0005277\,\text{lagged rainfall} - 0.000511\,\text{rainfall} + 1.925 \cdot \text{built}$$

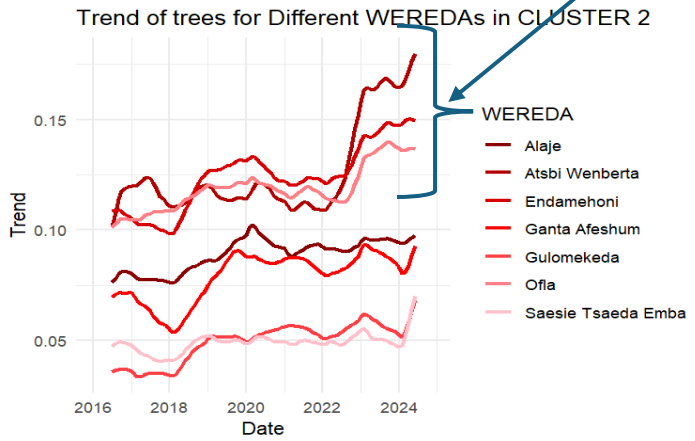
Analytical step 2: understand temporal variation per cluster

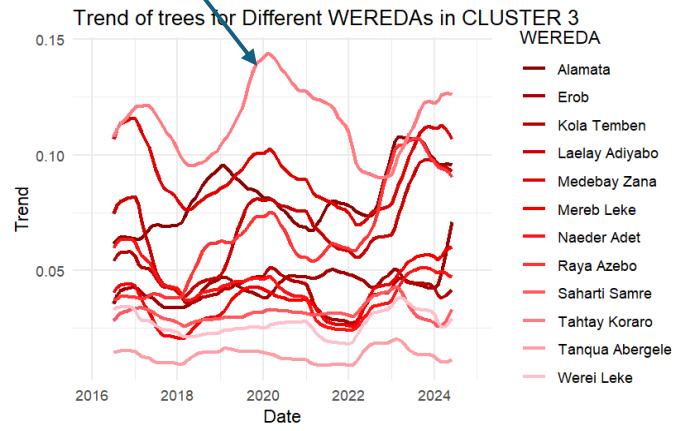
2. Tree cover trend

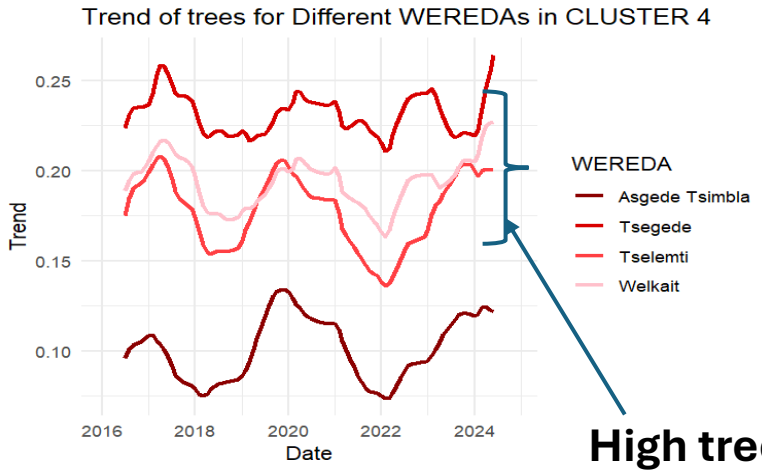
- Long-term change
- What is going on?
- Relation to conflict and NTL?

High tree cover

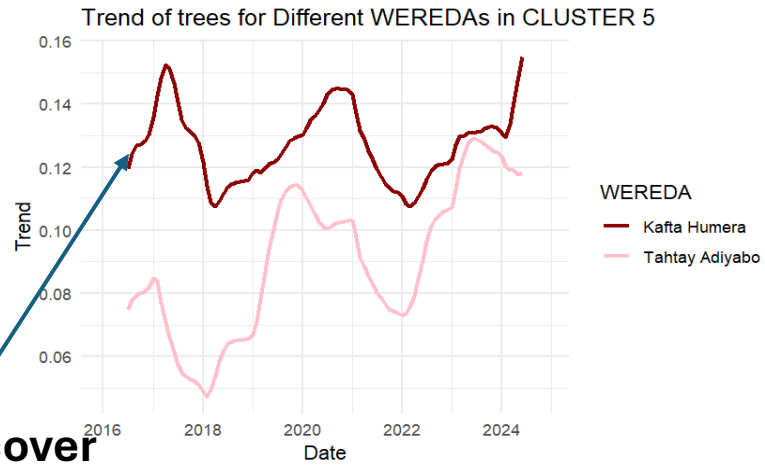


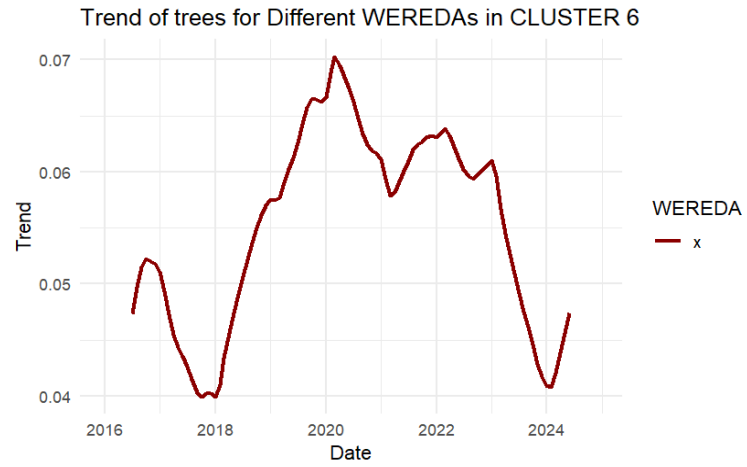




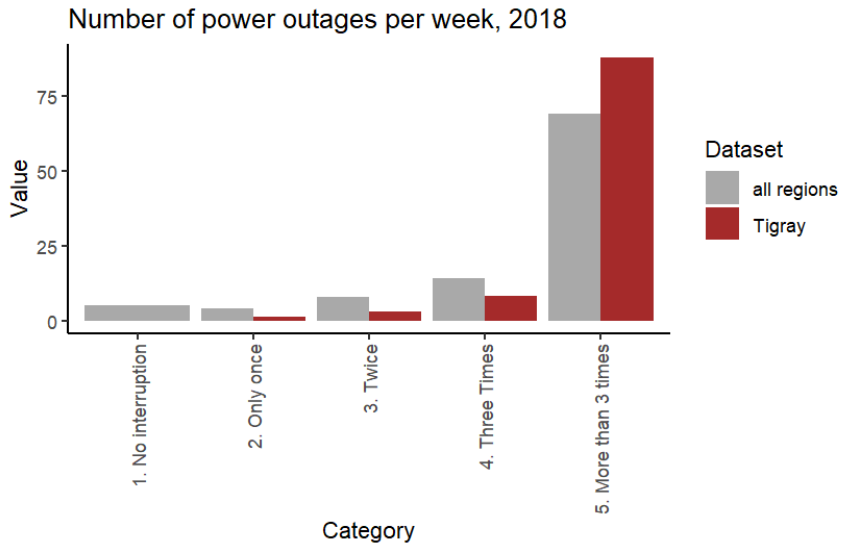


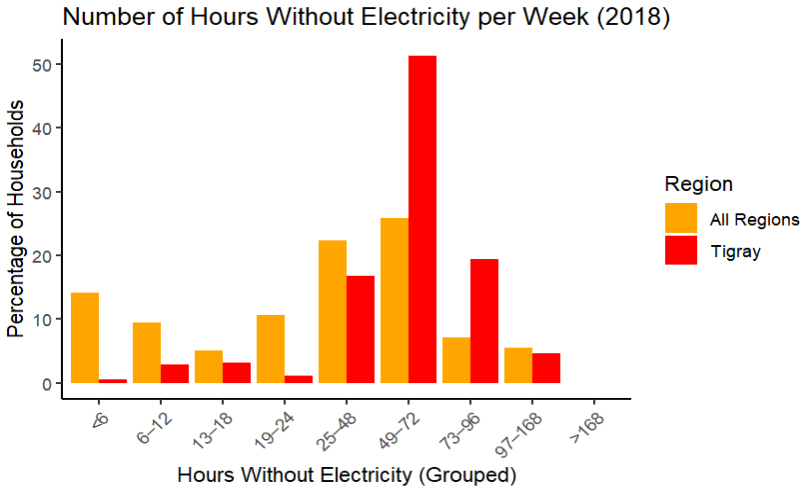
High tree cover

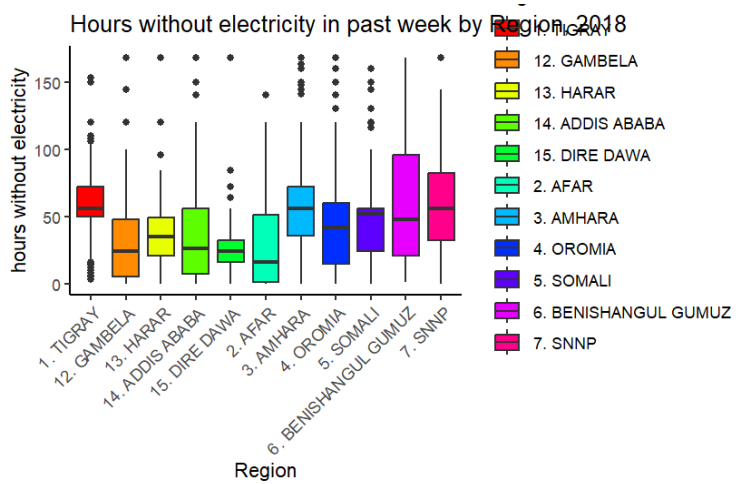


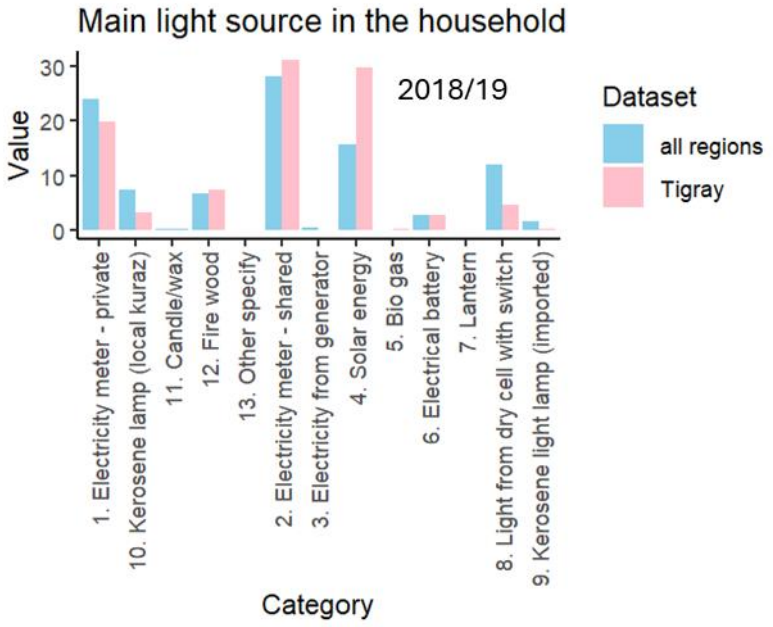


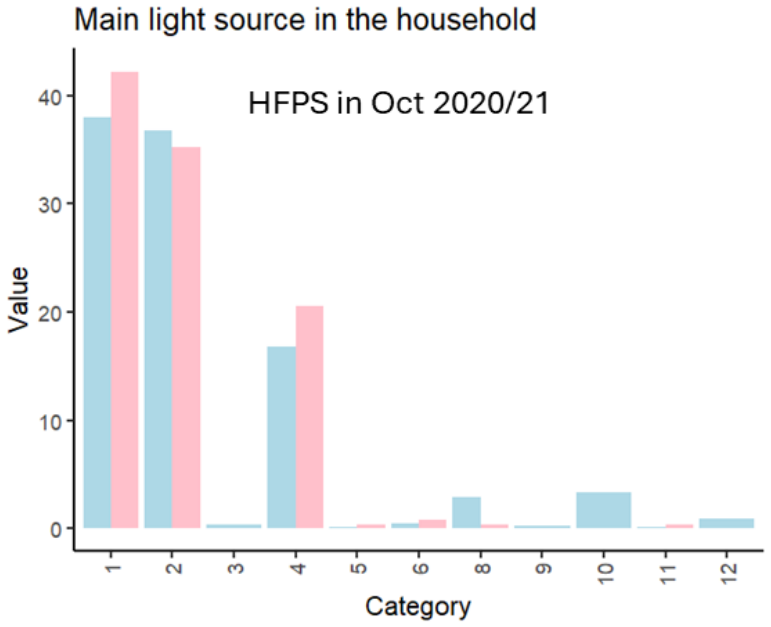
Triangulation of our results with WB hh survey

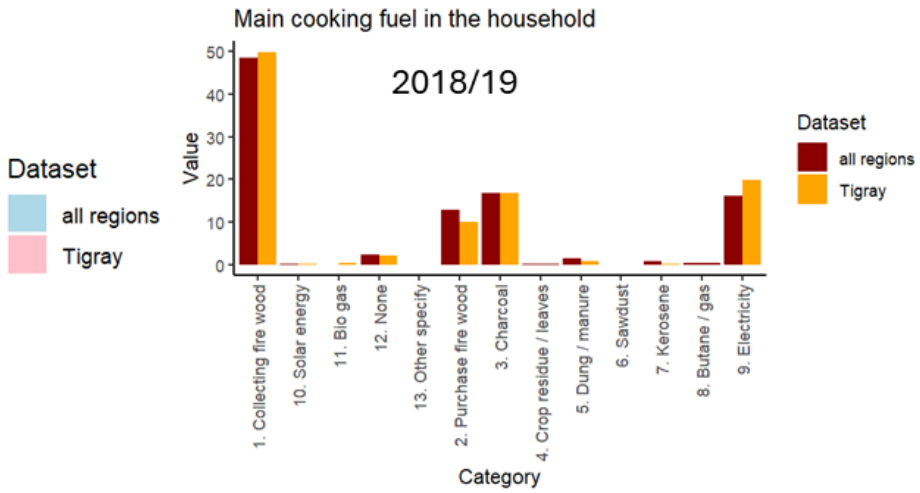




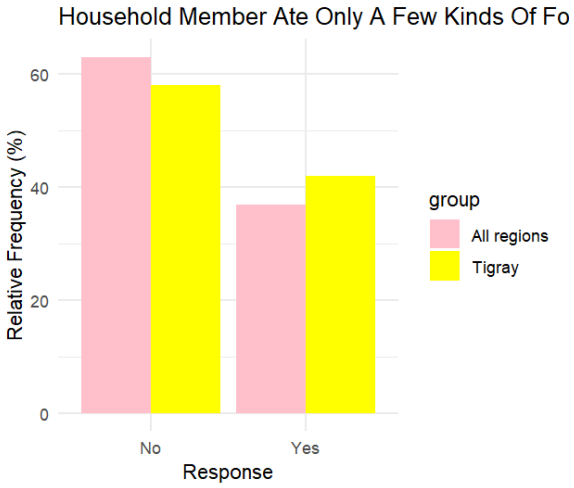


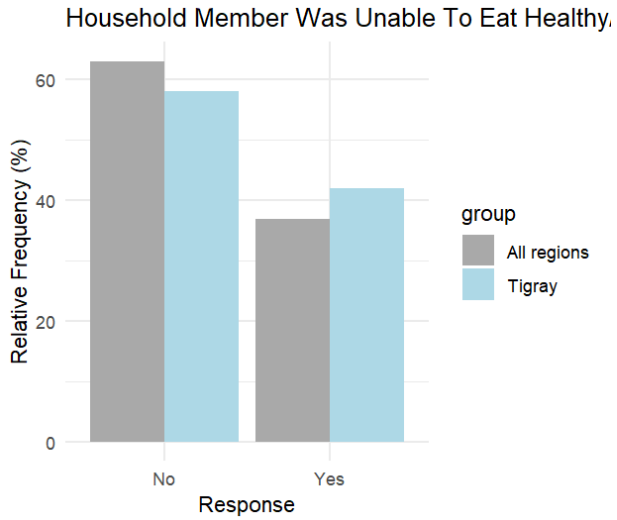


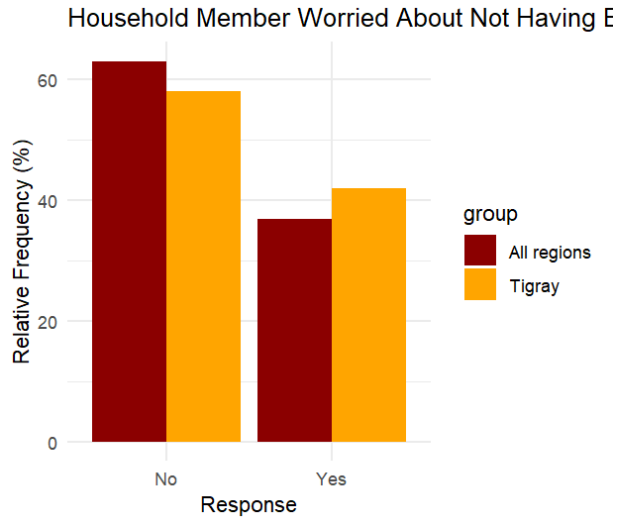


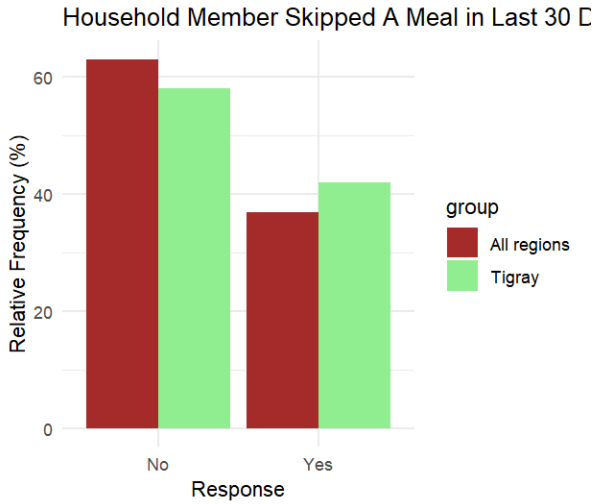


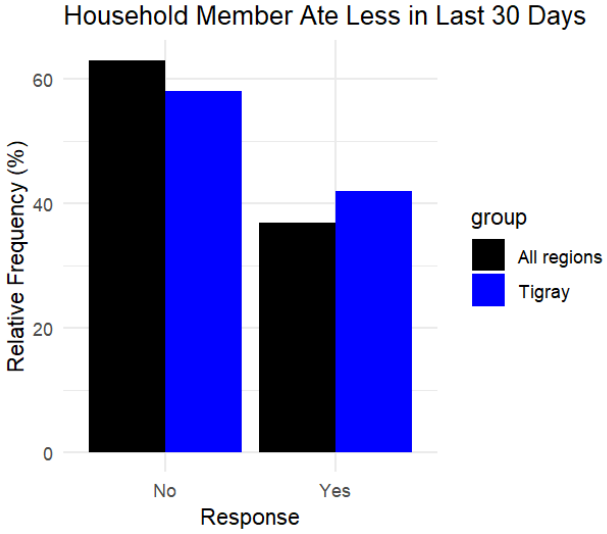
Food security status 2020/21

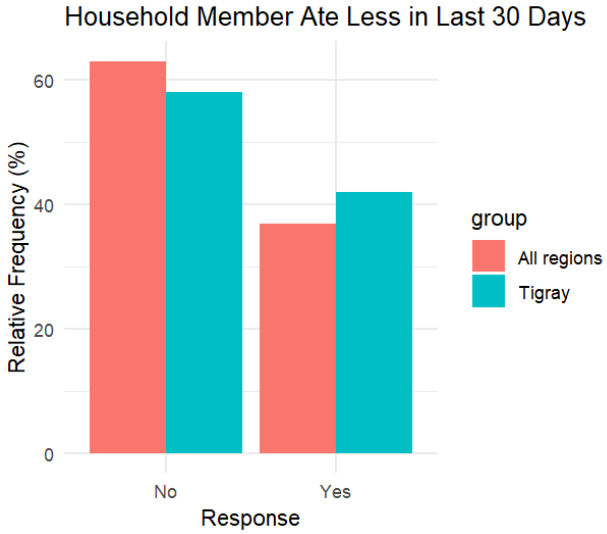


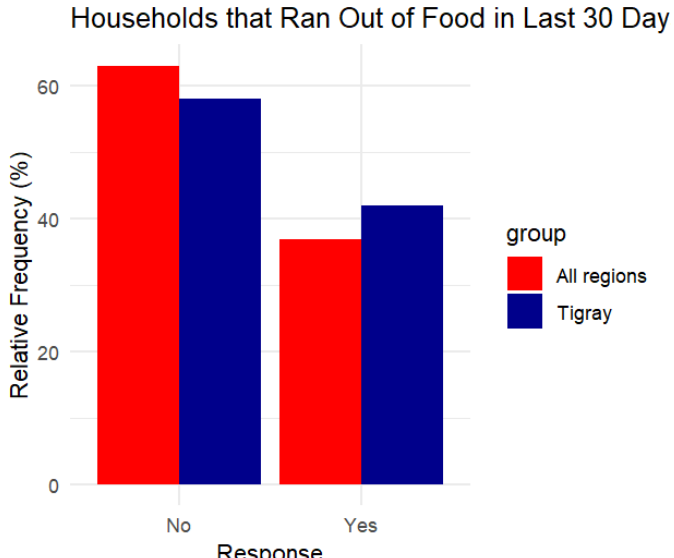












Lessons learned and next steps

Lessons learned

- Spatiotemporal patterns matter
- Publicly available datasets – inaccessible areas
- Triangulation to understand why
- Applicablity of the method

Next step:

- Detail analysis of socio-economic impact of conflict using remte sensing and existing survey data
- Cellular automata to develop plausible future scenarios

Impact of ENLENS Fellowship Funding

I thank ENLENS

- Provided flexibility and support for additional academic activities
- Enabling me to write another research project proposal (pre-proposal) of LEAWEF call by NWO.
- Enhanced overall research capacity and
- Creating connections.

Limitations

- Time
- Field data

Challenges

- Fund to continue the research after May 2025

Thank you for listening!