

CLUSTERISK*



* **A Cluster Analysis of Philippine Municipalities for Disaster Risk Reduction and Management**

Gaspar MJPO, Jayme J, Nepomuceno CAP, Paderes ME



Limasawa, Southern Leyte



Southern Leyte is known for its natural parks and tourist hotspots.



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In 2013, they were ravaged by Typhoon Haiyan, disrupting livelihoods and affecting families.

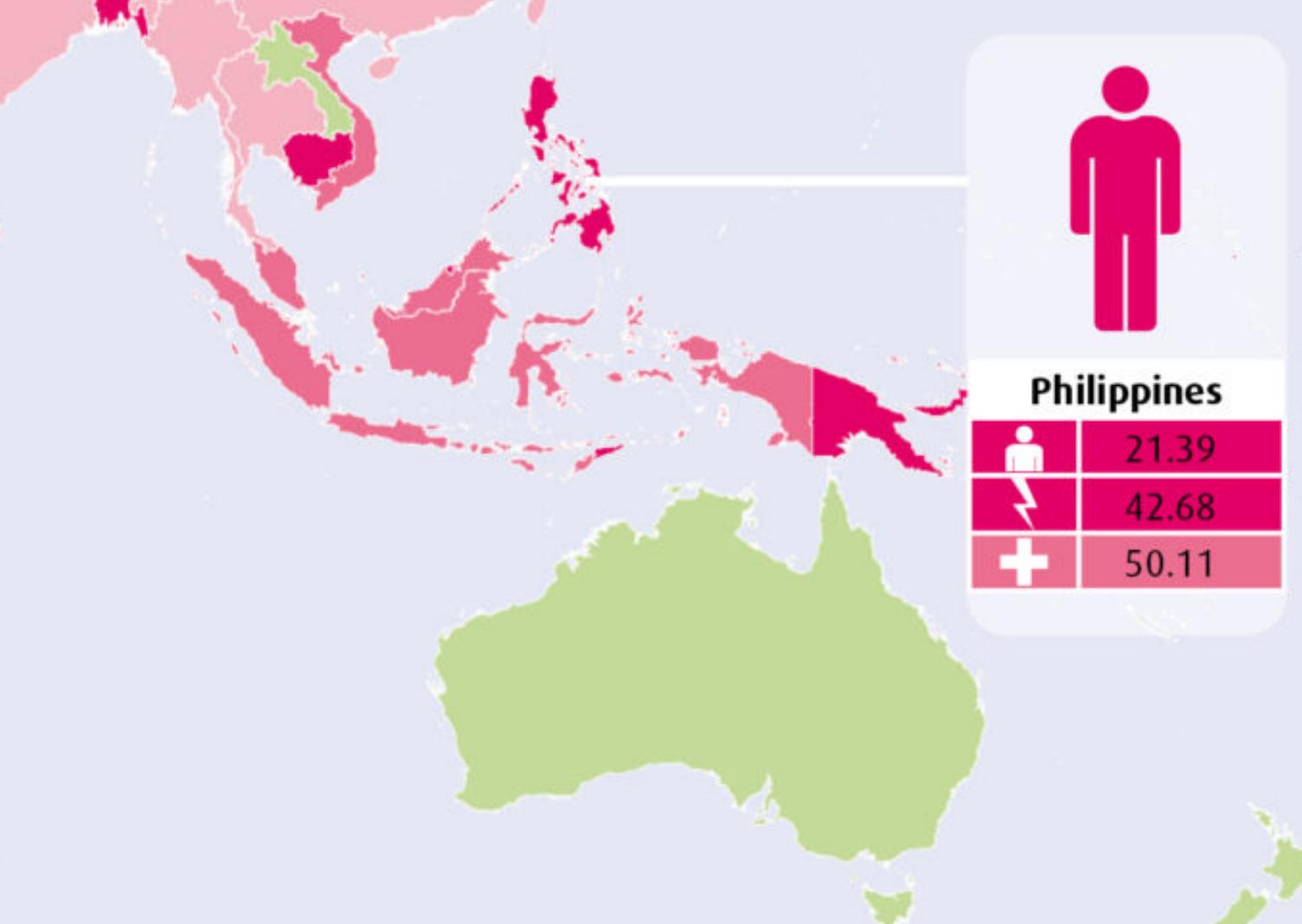


Limasawa, Southern Leyte



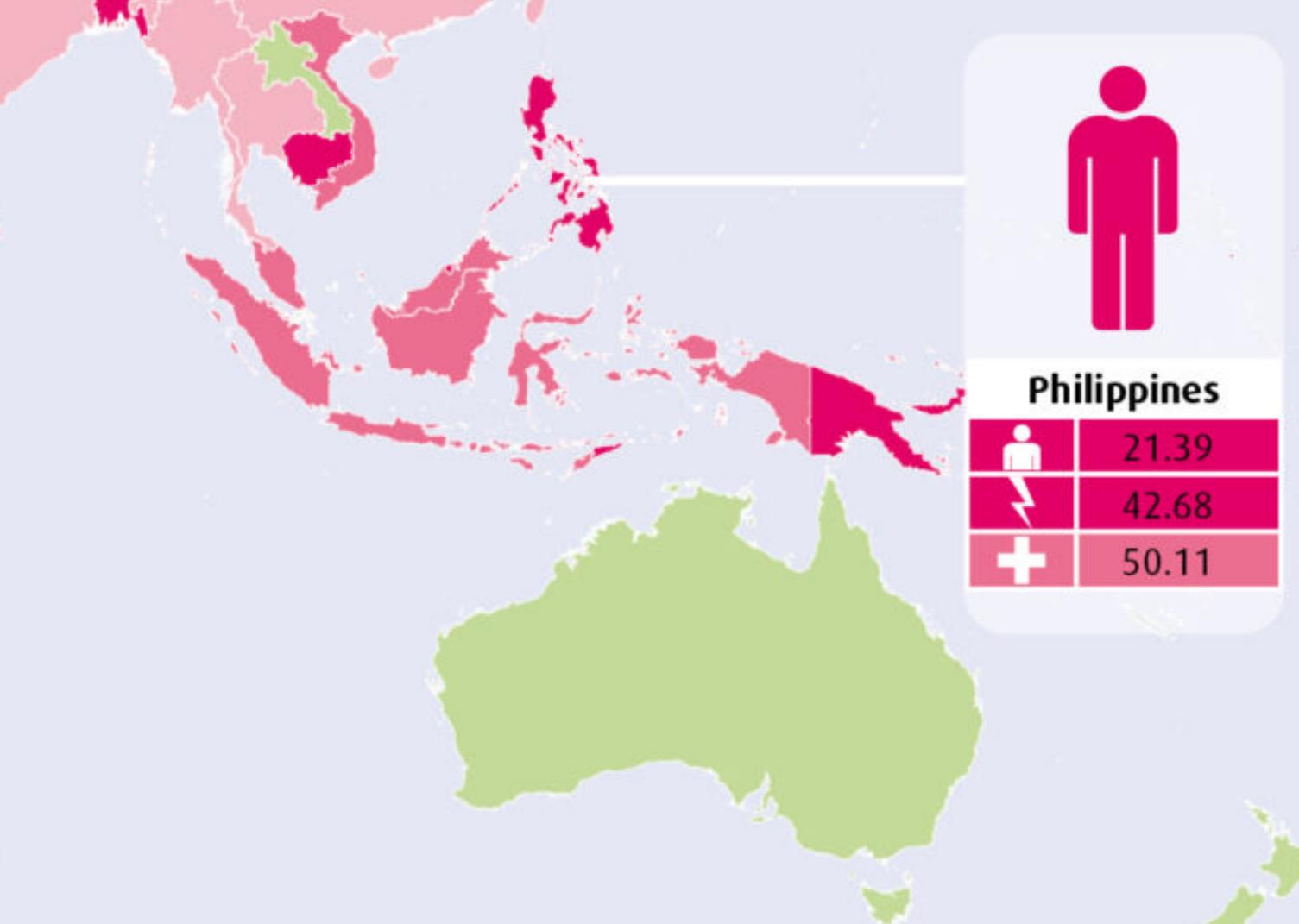
Southern Leyte is known for its natural parks and tourist hotspots.

In 2013, they were ravaged by Typhoon Haiyan, disrupting livelihoods and affecting families. The province is prone to mudslides, as it lies within the Philippine Fault System.



Southern Leyte is not a unique case in the Philippines.

WorldRiskIndex (WRI)	Exposure	Vulnerability	
very low	0.30 - 3.25	very low	22.68 - 34.21
low	3.26 - 5.54	low	34.22 - 42.02
medium	5.55 - 7.66	medium	42.03 - 48.32
high	7.67 - 10.71	high	48.33 - 61.04
very high	10.72 - 47.73	very high	61.05 - 75.83
no data		no data	



Southern Leyte is not a unique case in the Philippines.

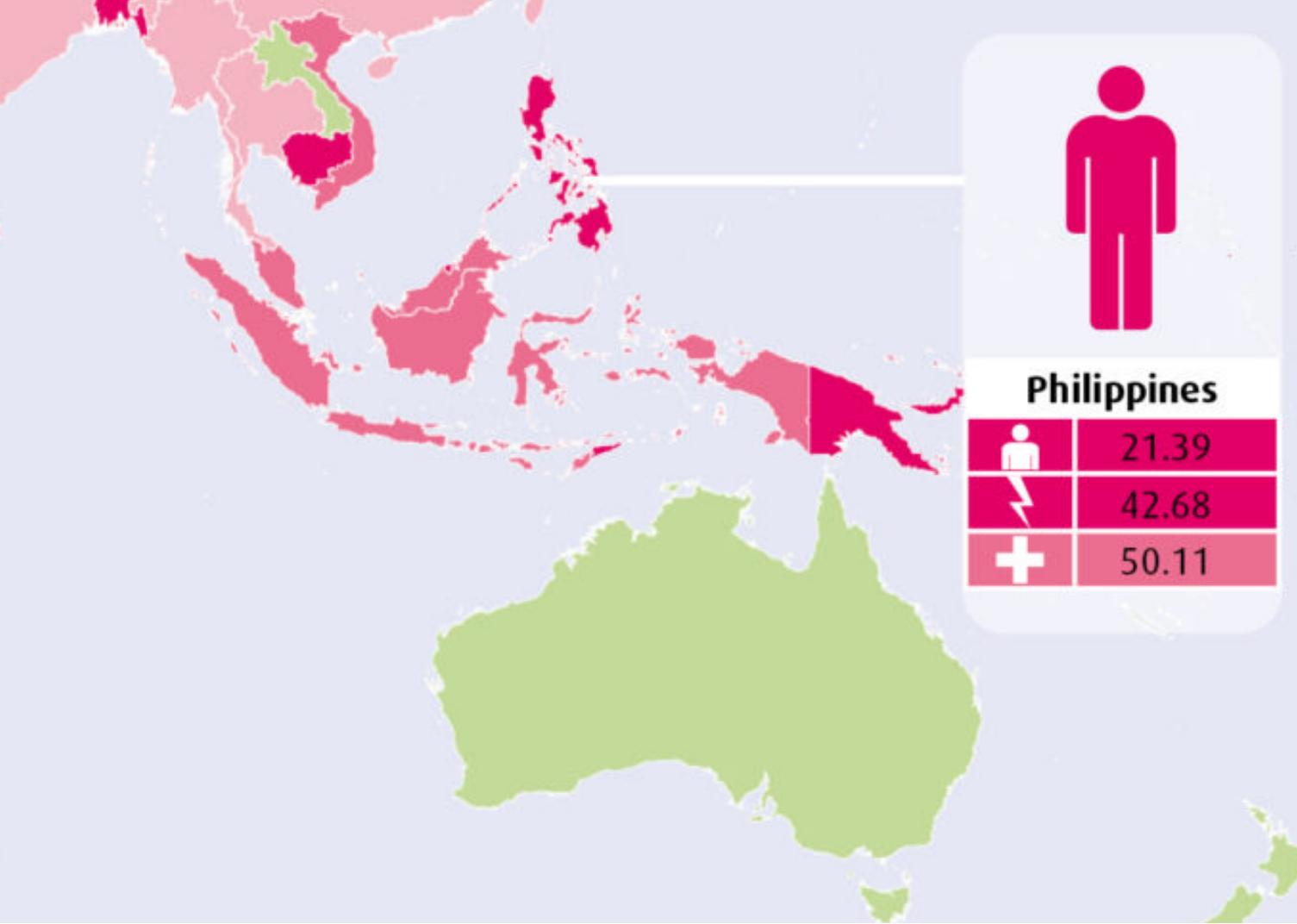
Our country ranked the 8th most affected country from extreme weather events in 2021.



WorldRiskIndex 2021

 WorldRiskIndex (WRI)	 Exposure	 Vulnerability	
very low	0.30 - 3.25	very low	0.85 - 9.57
low	3.26 - 5.54	low	9.58 - 12.04
medium	5.55 - 7.66	medium	12.05 - 14.83
high	7.67 - 10.71	high	14.84 - 19.75
very high	10.72 - 47.73	very high	19.76 - 82.55
no data		no data	

Max. value = 100, classification according to the quintile method



WorldRiskIndex 2021

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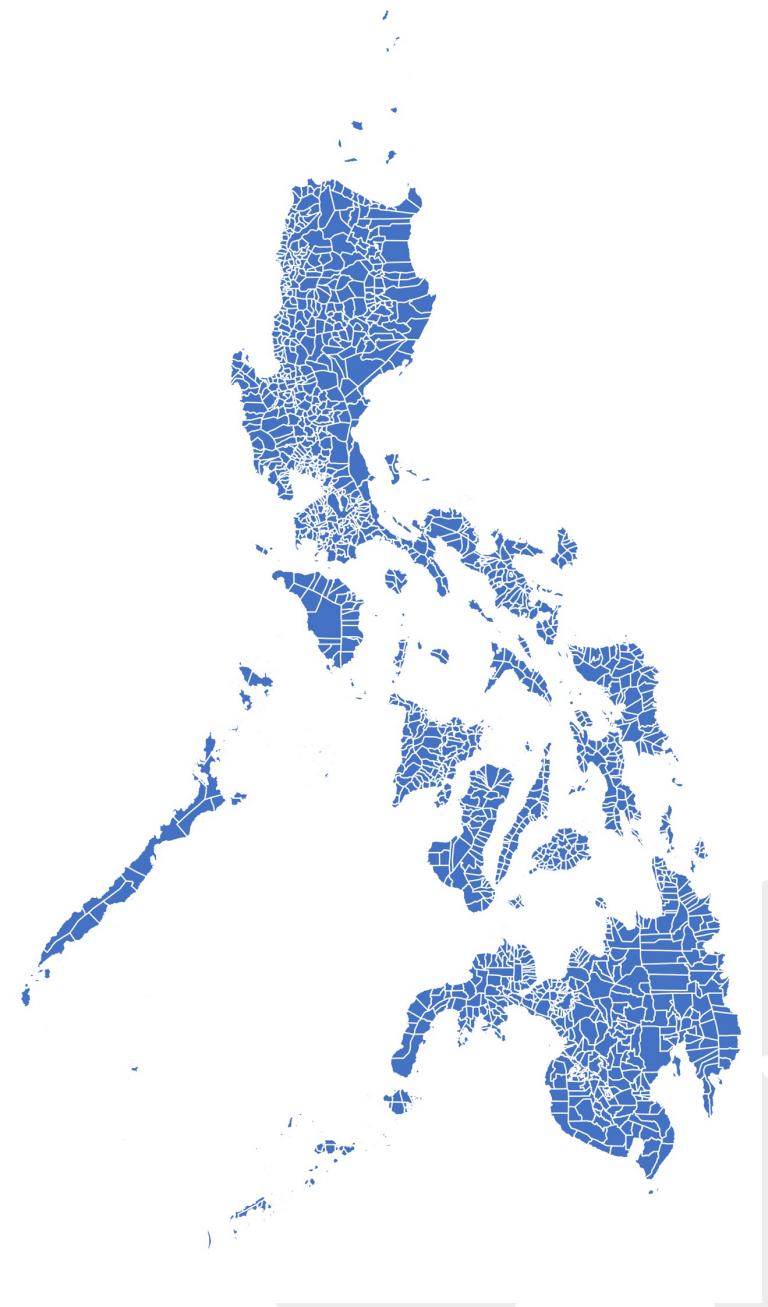
Max. value = 100, classification according to the quintile method

Southern Leyte is not a unique case in the Philippines.

Our country ranked the 8th most affected country from extreme weather events in 2021.

Not only are we **exposed, vulnerable, and susceptible** to national hazards, but the country also **lack coping and adaptive capacities**.

What are the **overarching clusters of Philippine municipalities** based on publicly-available disaster data, and **how might we use them for DRRM***?



* Disaster Risk Reduction and Management



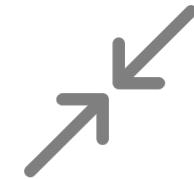
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EDA with
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Reduced
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Earthquake Hazards Program

API Documentation – Earthquake Catalog

This is an implementation of the [FDSN Event Web Service Specification](#), and allows custom searches for earthquake information using a variety of parameters.

i Please note that automated applications should use [Real-time GeoJSON Feeds](#) for displaying earthquake information whenever possible, as they will have the best performance and availability for that type of information.

URL

<https://earthquake.usgs.gov/fdsnws/event/1/> [METHOD]?PARAMETERS]

Methods

application.json

request known enumerated parameter values for the interface.

- <https://earthquake.usgs.gov/fdsnws/event/1/application.json>



We used the **USGS API** to scrape all earthquake data in GeoJSON between 2010 and 2021.



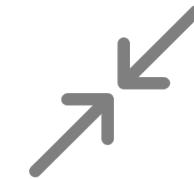
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Category	Magnitude	Buffer/STDWithin
Light	4 – 4.9	5 km
Moderate	5 – 5.9	20 km
Strong	6 – 6.9	100 km
Major	7 – 7.9	200 km



We added categories in the Richter Magnitude Scale, adding *Buffer* as our assumption to the extent in km of each magnitude.



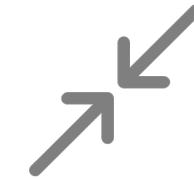
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☰ README.md

GEM Global Active Faults Database (GEM GAF-DB)

DOI [10.5281/zenodo.3376300](https://doi.org/10.5281/zenodo.3376300)

The GEM Foundation's Global Active Faults is building a comprehensive, global dataset of active fault traces of seismogenic concern. The GEM GAF-DB comprises GIS files hosted here of fault traces and small amount of relevant attributes or metadata (fault geometry, kinematics, slip rate, etc.) useful for seismic hazard modeling and other tectonic applications. The dataset is being assembled primarily as a part of GEM's global Probabilistic Seismic Hazard Modeling efforts, although we hope that the data find wide use in research, education and general interest among many users.

The dataset is freely and publicly available here, under a Creative Commons attribution sharealike license.



We used the **GEM Global Active Faults Database** to scrape all active fault traces that traverse the Philippines.



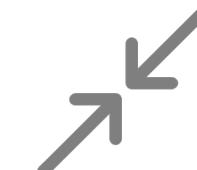
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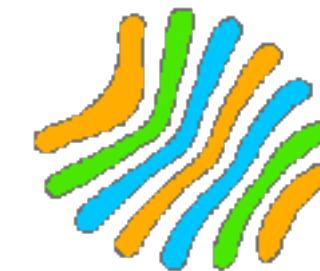


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GADM maps and data

GADM provides maps and spatial data for all countries and their sub-divisions. You can browse our maps or download the data to make your own maps.

MAPS DATA ABOUT



We used the **GADM Database** to access Philippine features.



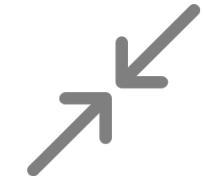
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We combined everything into a single dataset, and used only relevant features as required:

All datasets

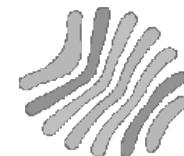
- ✓ Changed to float whenever applicable



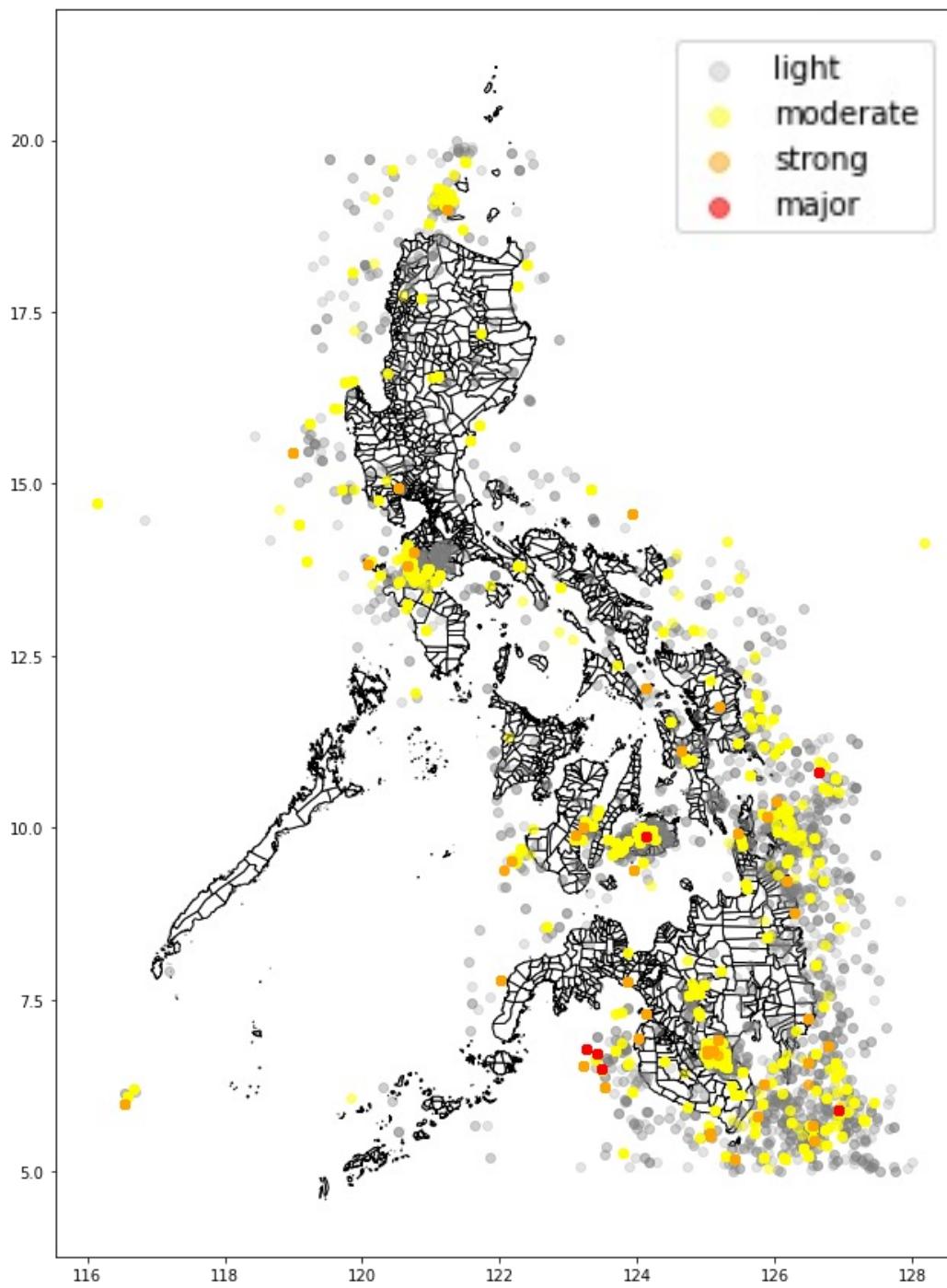
- ✓ Used magnitudes 4 and above only



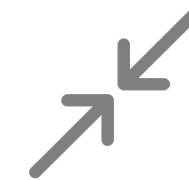
- ✓ Used fault lines traversing the Philippines only
- ✓ Excluded other seismological features



- ✓ Used amenity, income, hospital counts, population for EDA



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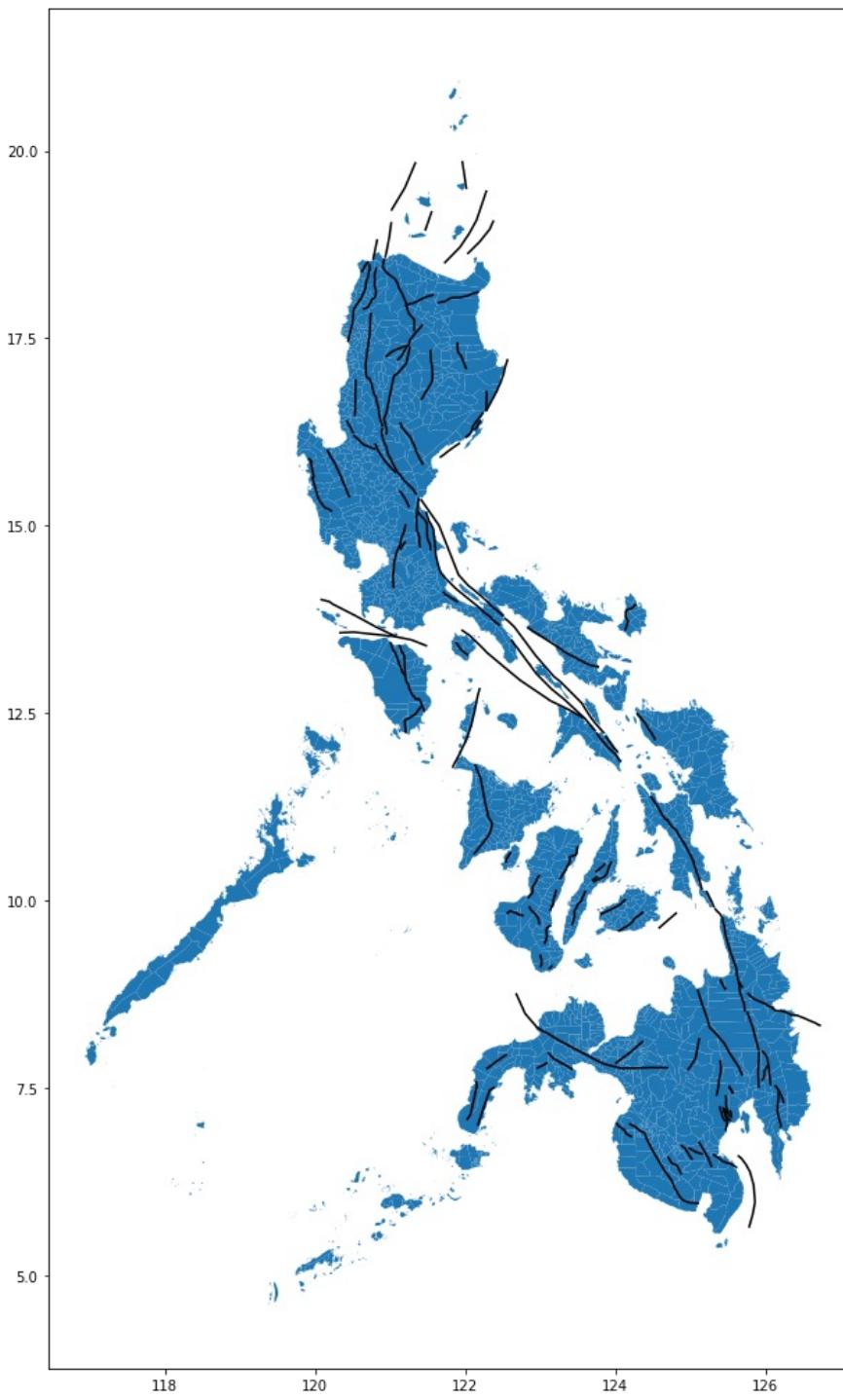


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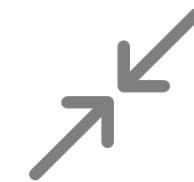


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Light and moderate earthquakes greatly outnumber major ones, of which most were recorded in Mindanao.



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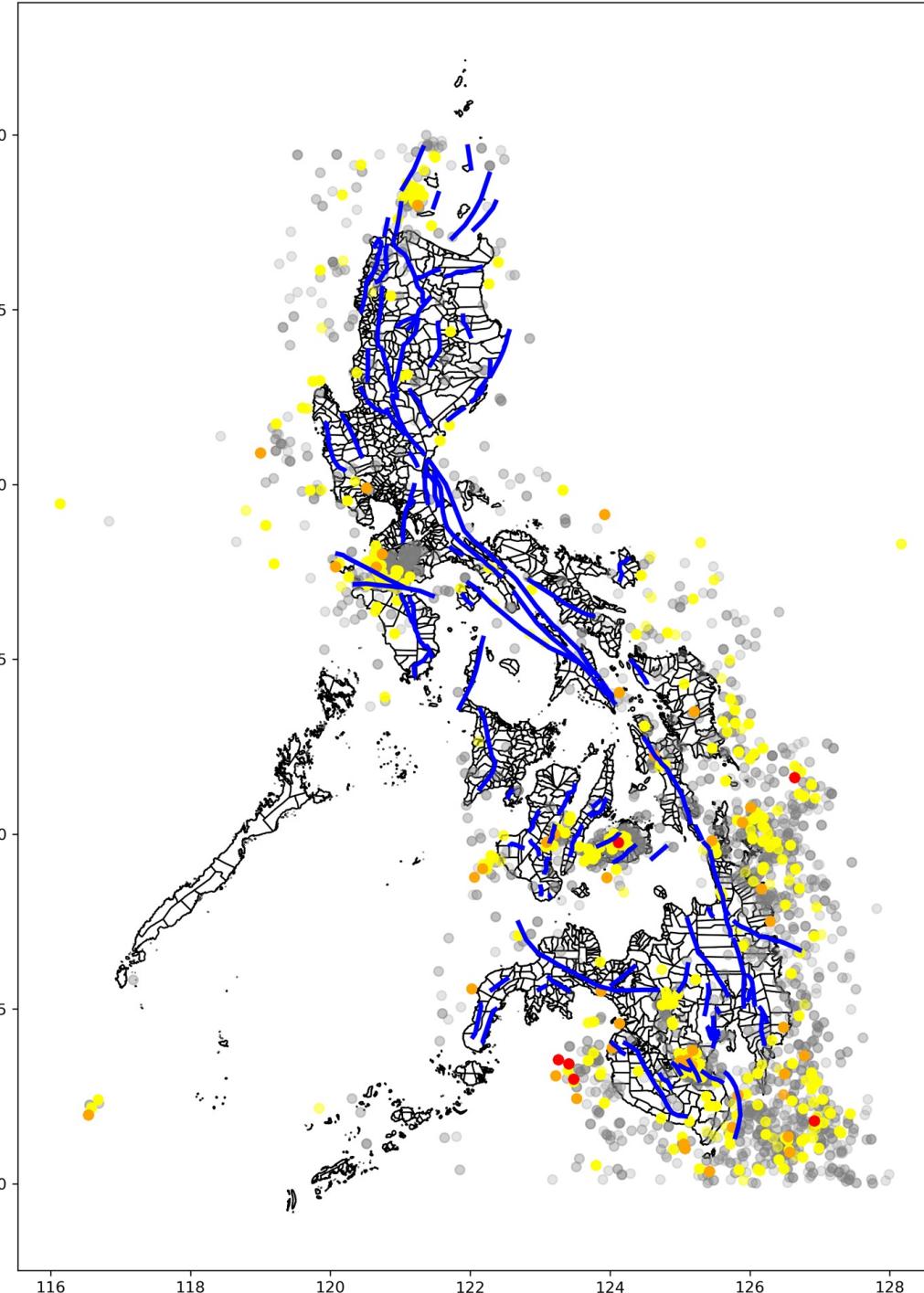


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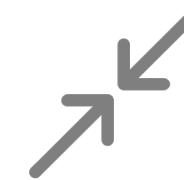


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Several active fault lines
traverse the entire
Philippine archipelago.



**EDA with
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Reduced
dimensions



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Plotting these two maps on top of each other, we see some earthquakes happen near the fault lines.



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the data



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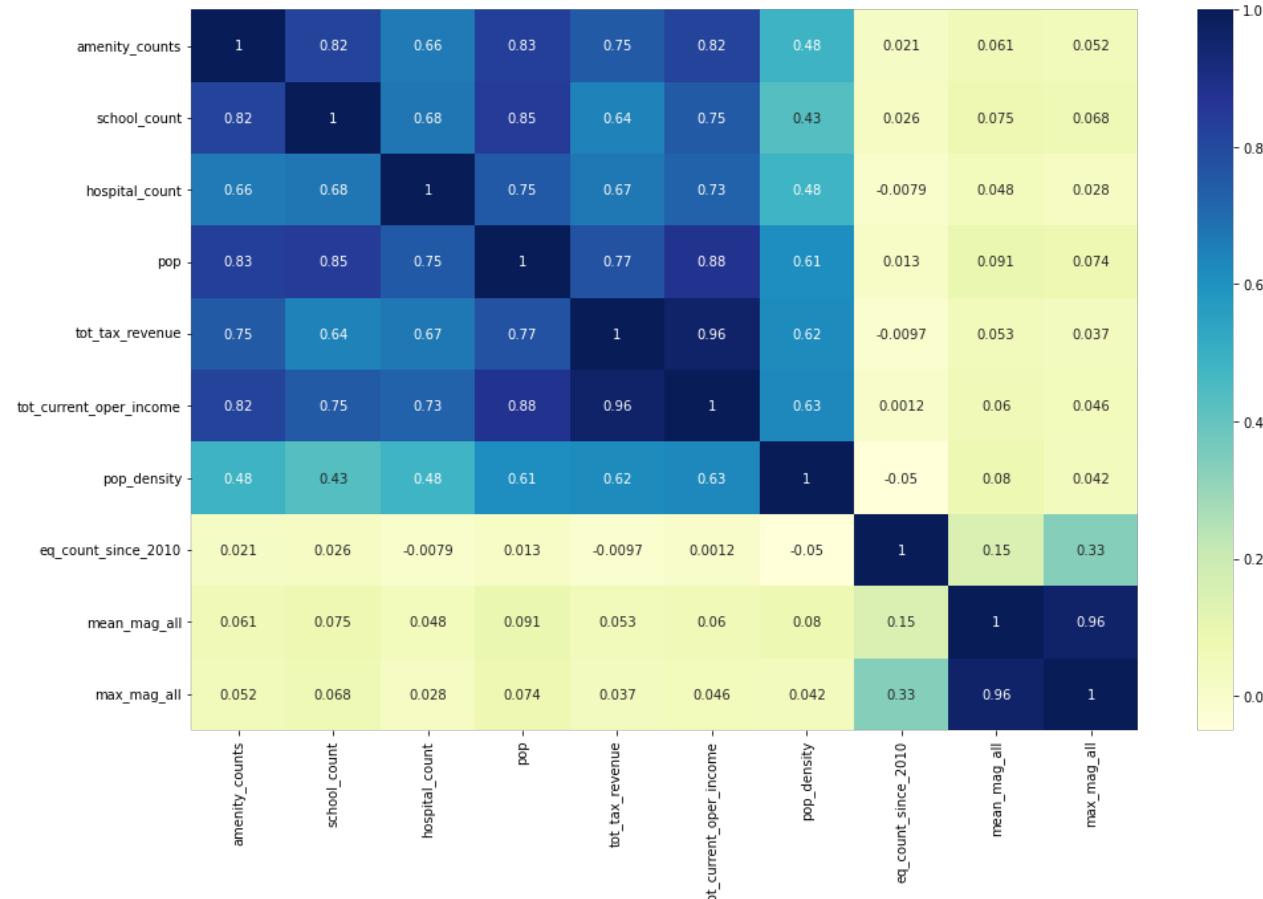
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**Reduced
dimensions**



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We plotted the correlation coefficients to see which variables are highly correlated.

We then use truncated SVD to reduce dimensions as data is sparse.



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the data



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the data



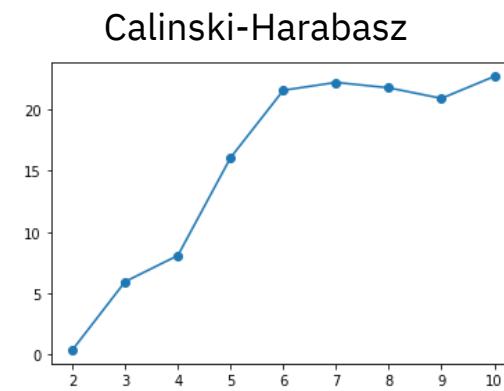
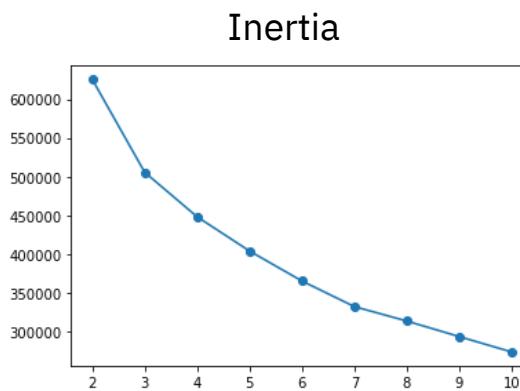
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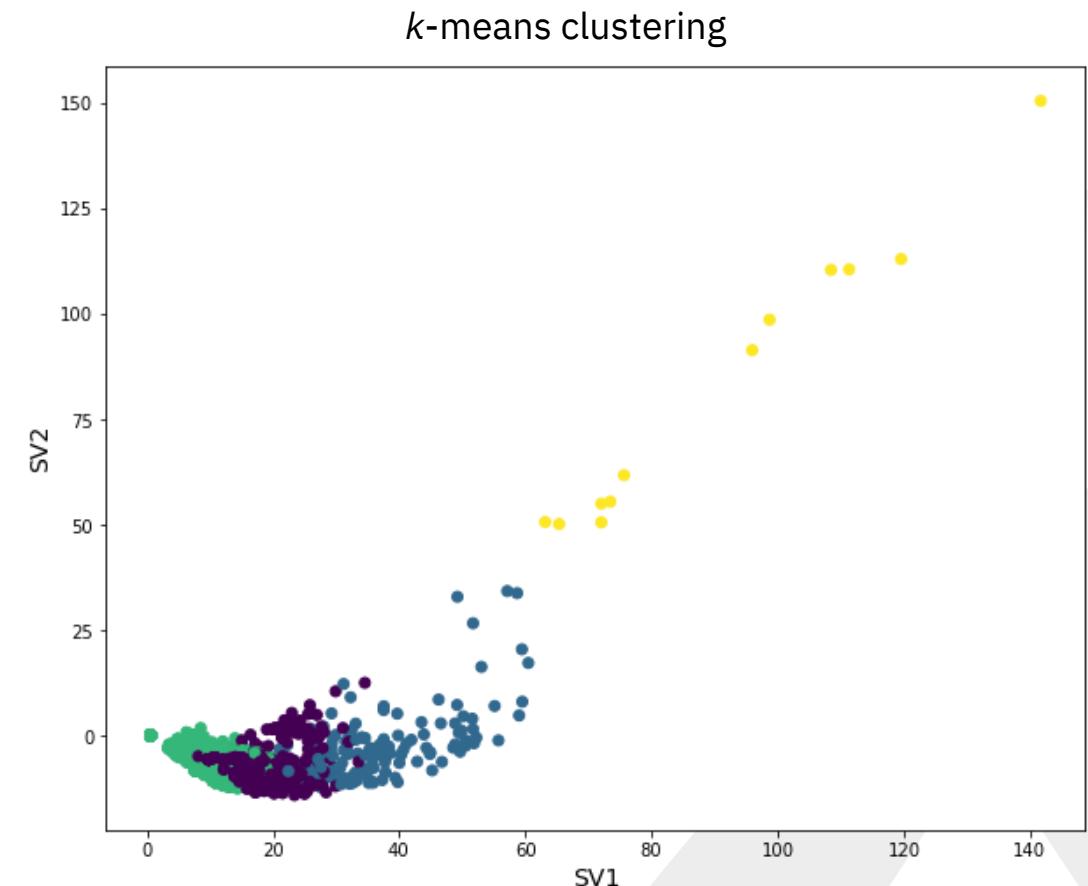
Reduced
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labelled**

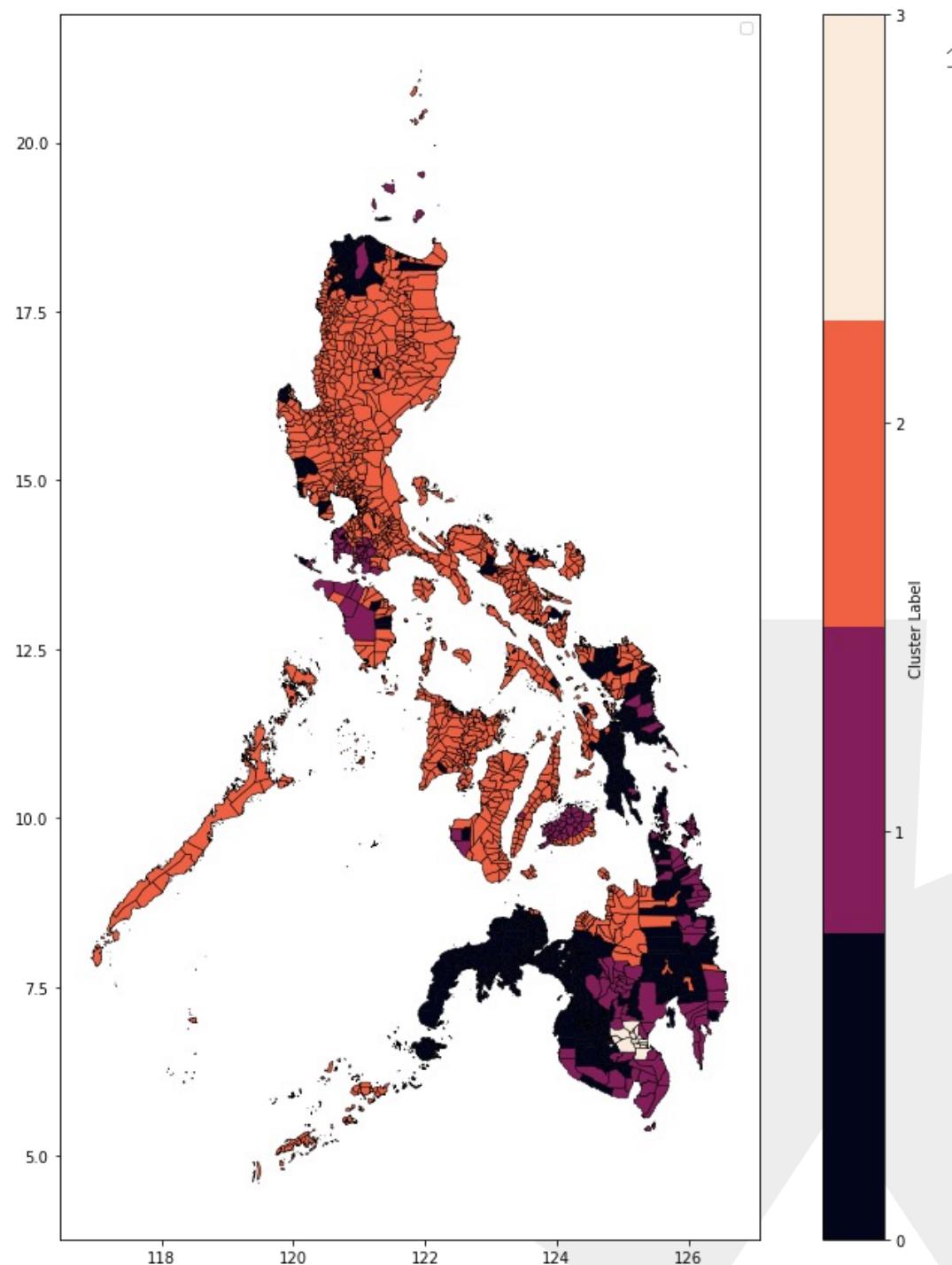


We selected $k = 4$ based on the internal validation criteria.



Cluster Descriptions

EARTHQUAKE RISK CHART

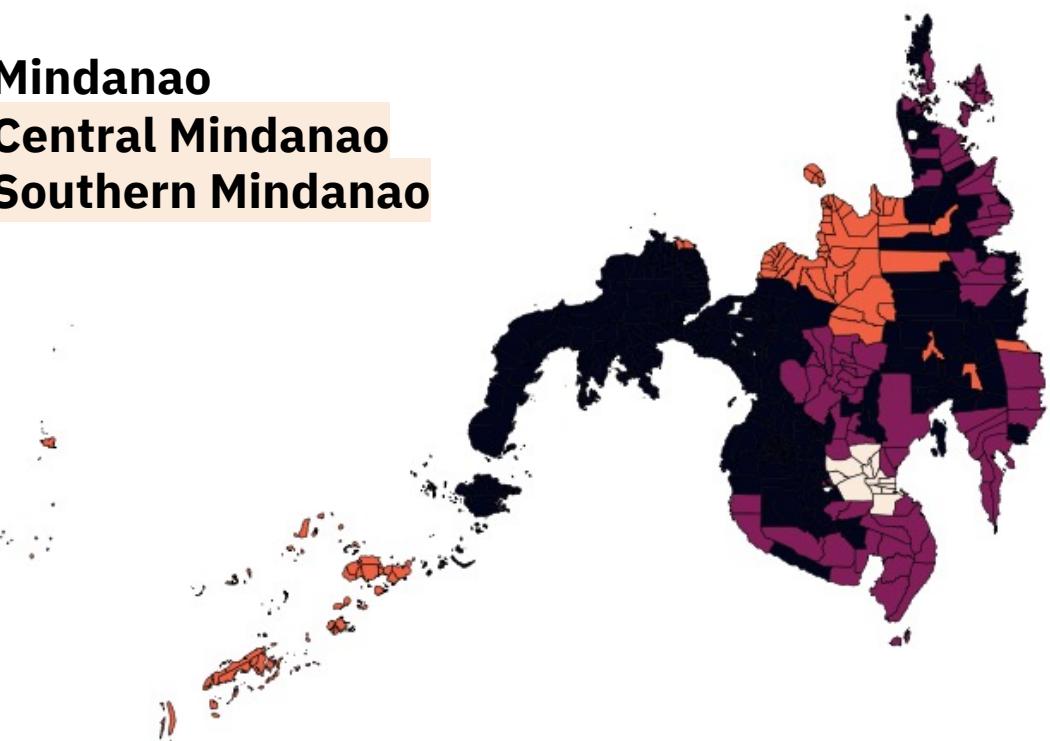


EARTHQUAKE RISK CHART



Cluster D – These municipalities experiences the most earthquakes but not all are damaging. Moderately populated with the lowest amenity counts.

Mindanao
Central Mindanao
Southern Mindanao

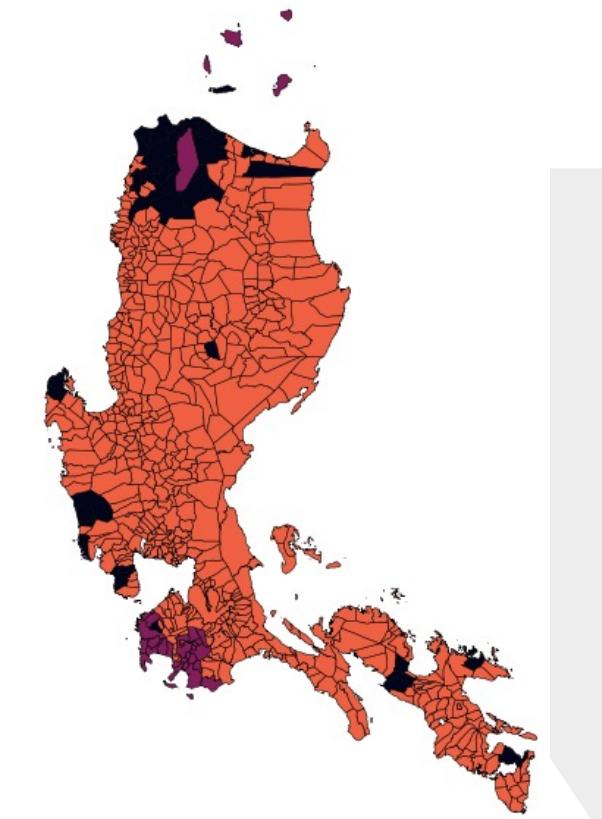


EARTHQUAKE RISK CHART



Cluster A – Municipalities in this cluster have a low earthquake count but when hit, mean magnitudes are highest among the cluster. They have the lowest population density and low amenity counts.

Luzon
Ilocos Region
CAR

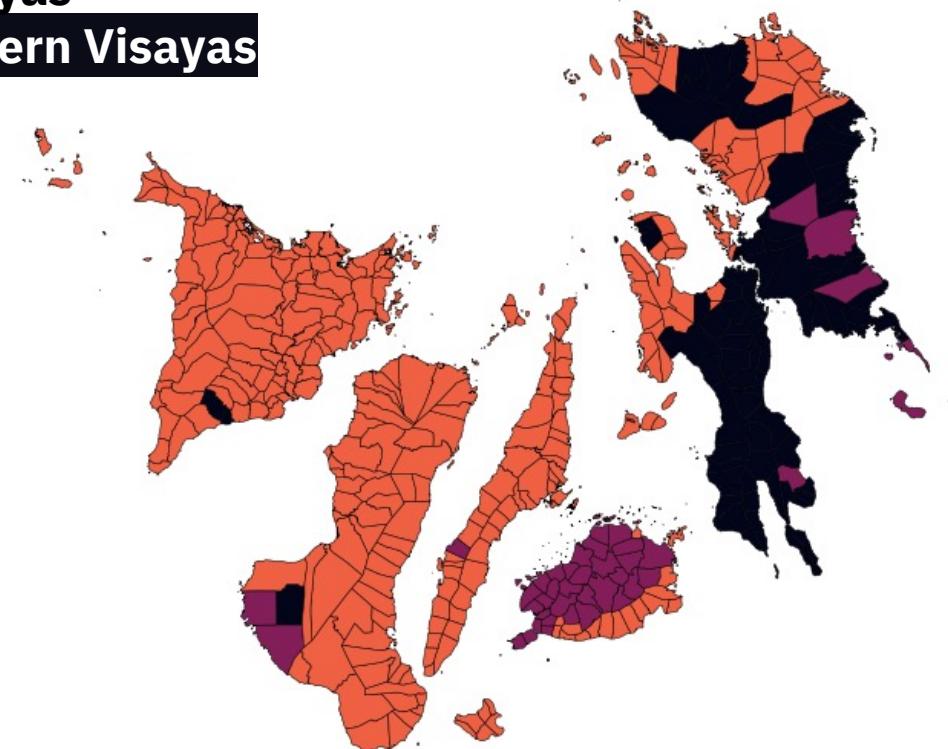


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Visayas Eastern Visayas

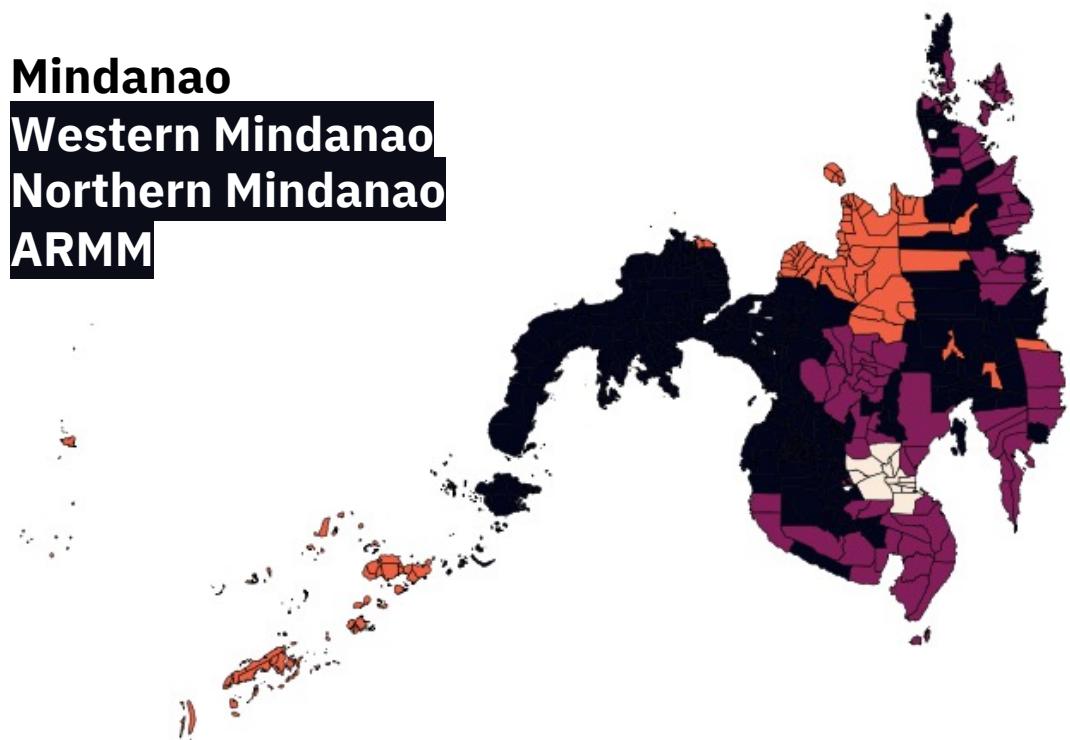


EARTHQUAKE RISK CHART



Cluster A – Municipalities in this cluster have a low earthquake count but when hit, mean magnitudes are highest among the cluster. They have the lowest population density and low amenity counts.

Mindanao
Western Mindanao
Northern Mindanao
ARMM

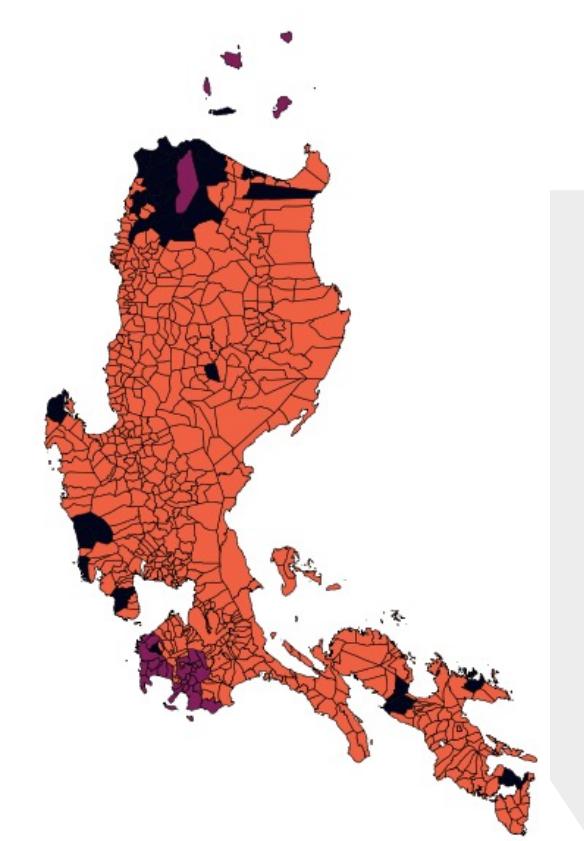


EARTHQUAKE RISK CHART



Cluster C – Highly populated municipalities with the lowest earthquake count. Mean magnitudes are also low.

Luzon
Cagayan Valley
Central Luzon
Bicol Region

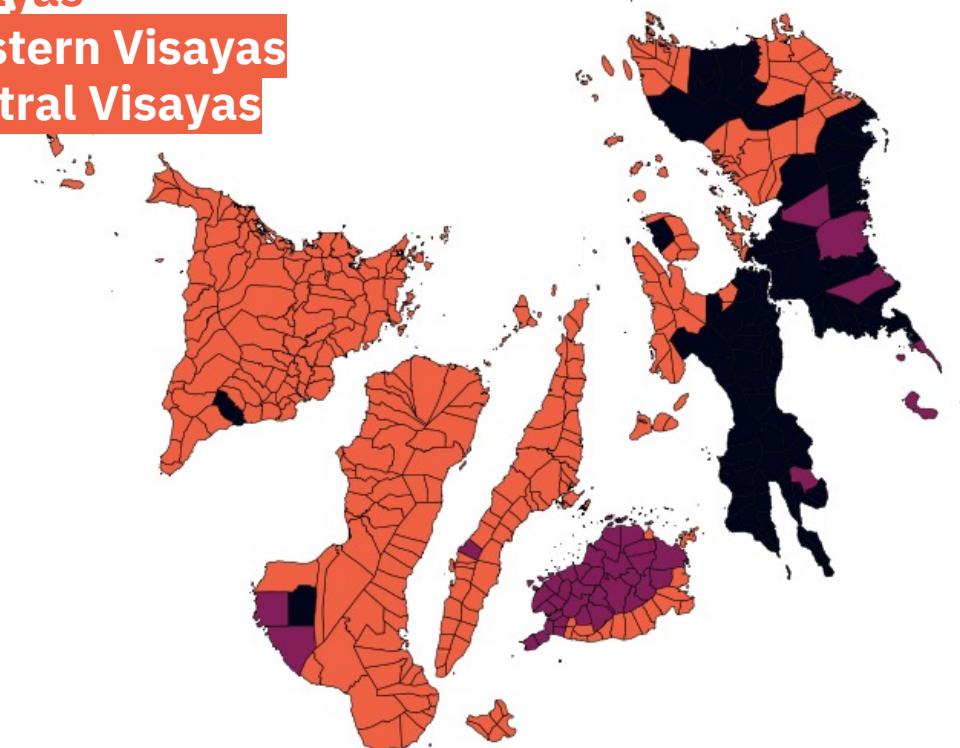


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Visayas
Western Visayas
Central Visayas

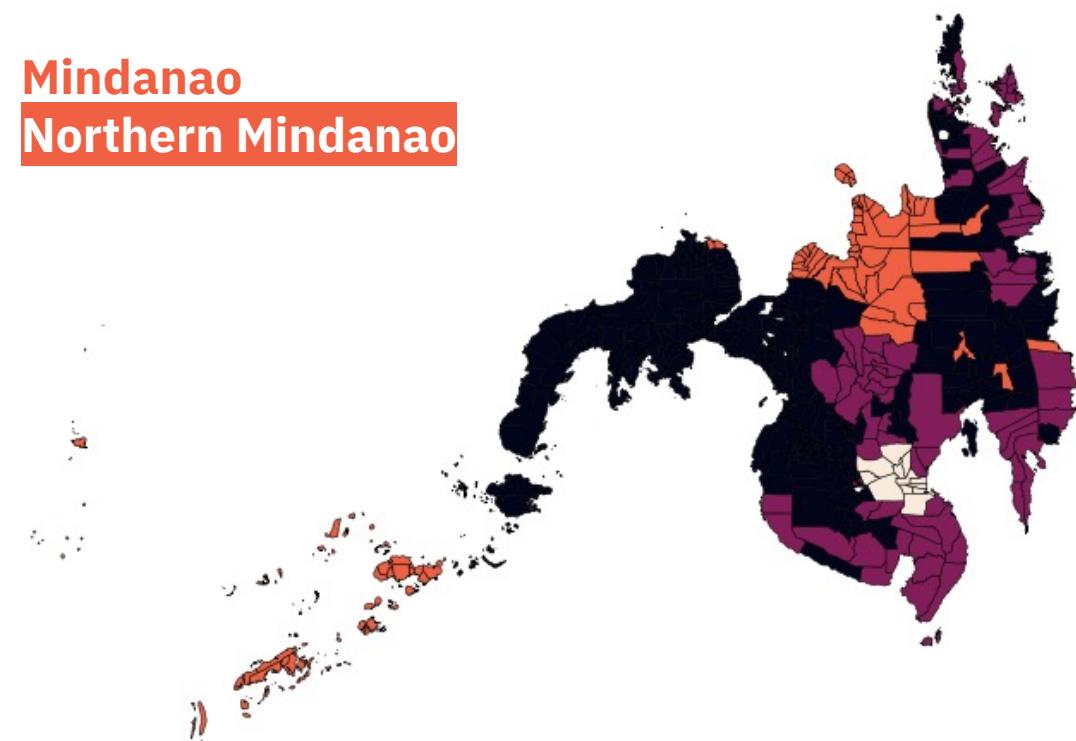


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Cluster C – Highly populated municipalities with the lowest earthquake count. Mean magnitudes are also low.

Mindanao
Northern Mindanao

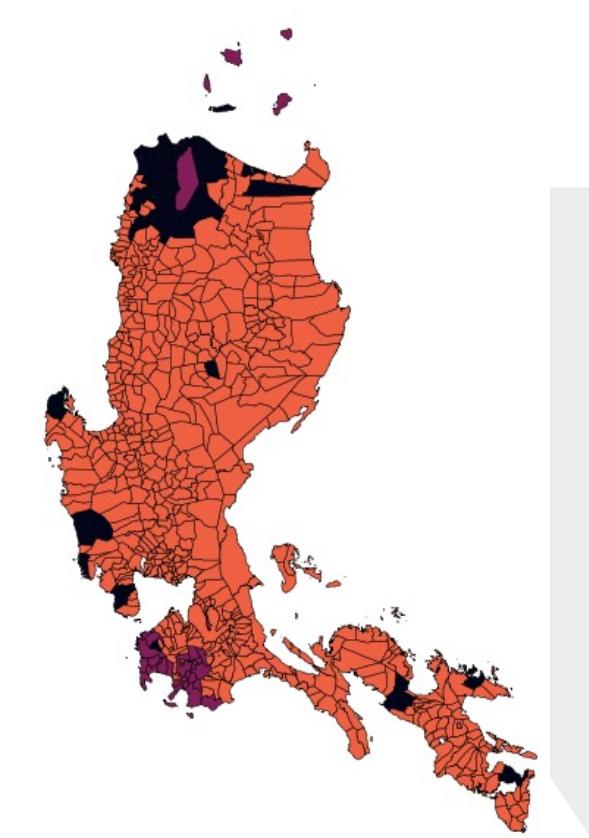


EARTHQUAKE RISK CHART



Cluster B – Municipalities with the highest amenity count and a high earthquake count. Mean magnitudes are in the middle.

Luzon
CAR

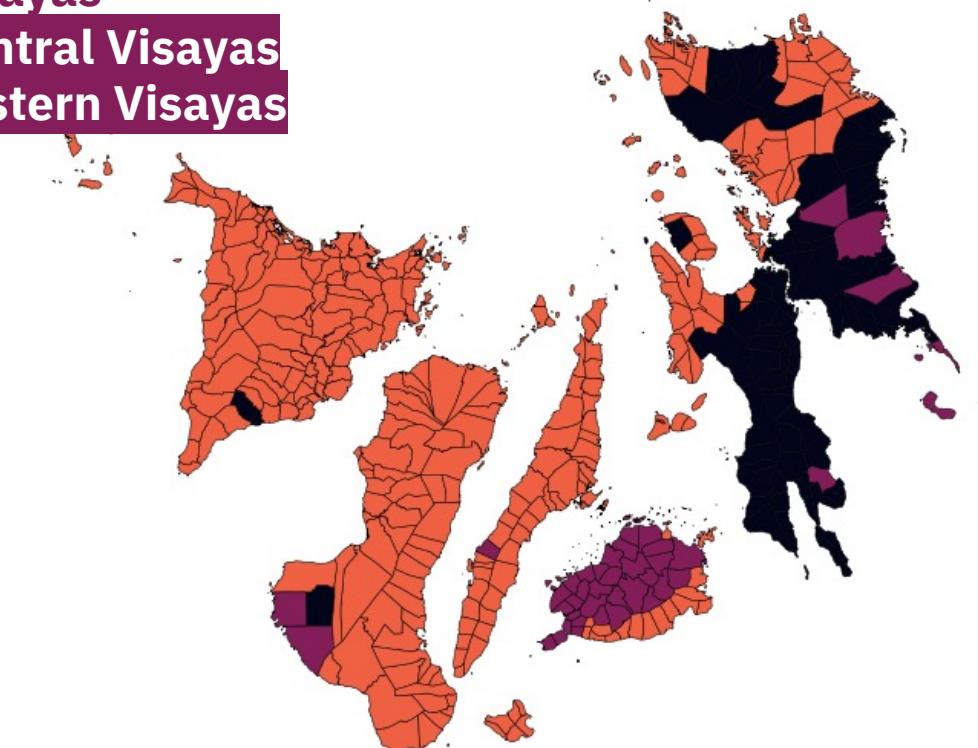


EARTHQUAKE RISK CHART



Cluster B – Municipalities with the highest amenity count and a high earthquake count. Mean magnitudes are in the middle.

Visayas
Central Visayas
Eastern Visayas

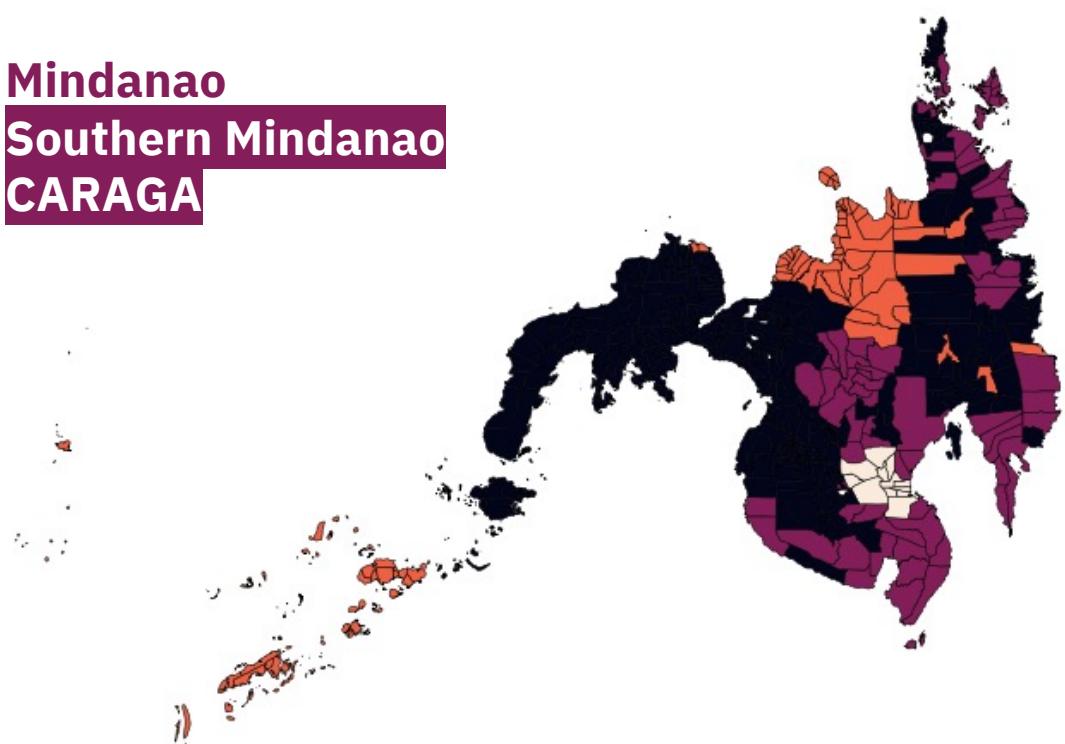


EARTHQUAKE RISK CHART



Cluster B – Municipalities with the highest amenity count and a high earthquake count. Mean magnitudes are in the middle.

Mindanao
Southern Mindanao
CARAGA



We have identified the overarching clusters of Philippine municipalities based on publicly-available disaster data.

Cluster A

Municipalities in this cluster have a low earthquake count but when hit, mean magnitudes are highest among the cluster. They have the lowest population density and low amenity counts.

Cluster B

Municipalities with the highest amenity count and a high earthquake count. Mean magnitudes are in the middle.

Cluster C

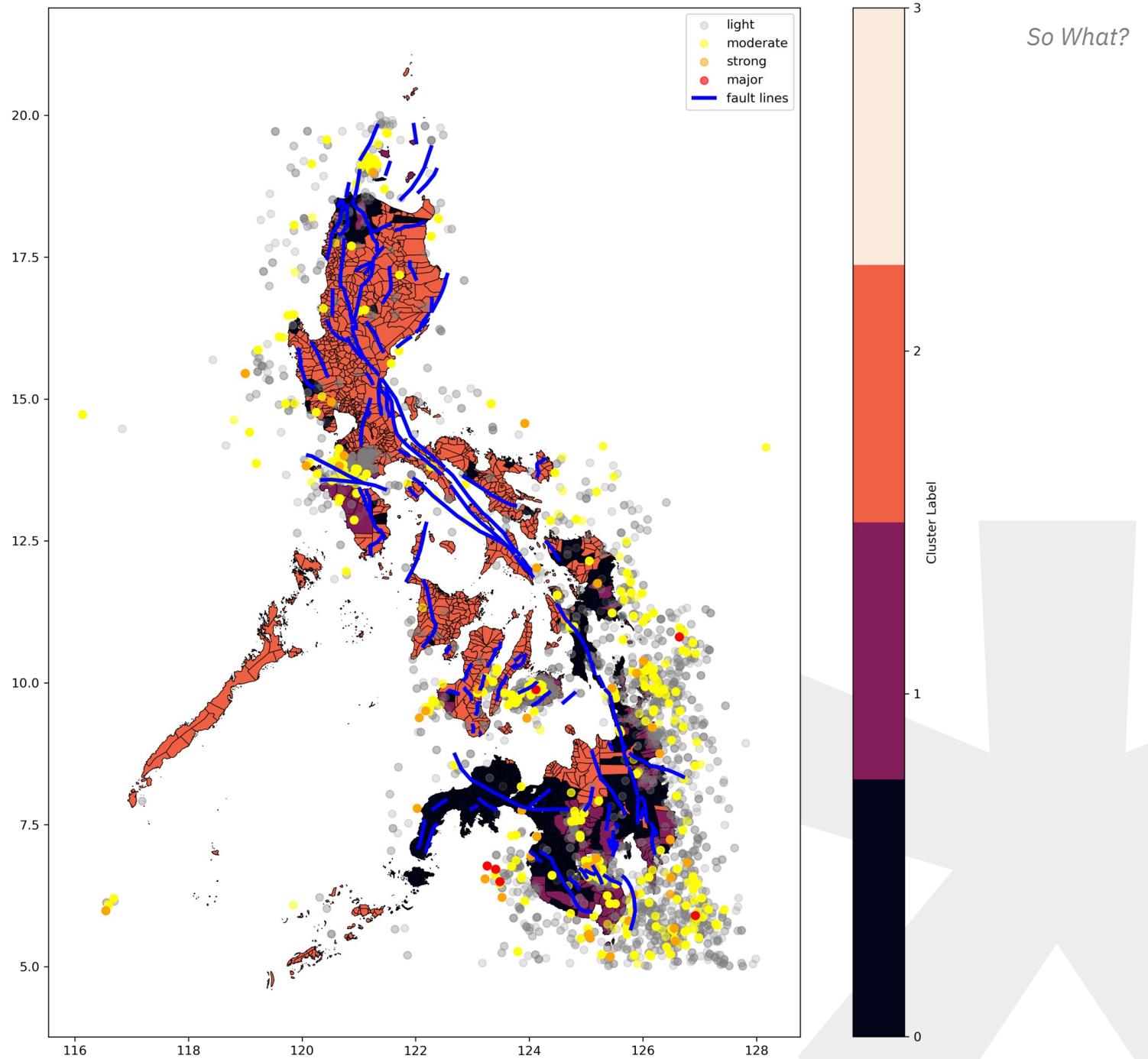
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Cluster D

These municipalities experiences the most earthquakes but not all are damaging. Moderately populated with the lowest amenity counts.

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How might we use them for DRRM?



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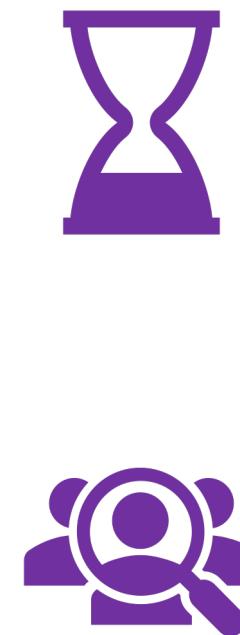
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Clusters can help identify which municipalities require the most attention

The national government can plan better – not only **during or after** a disaster – but **before** it happens

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CSOs can use it to narrow down on and target certain segments

Consumers need insurance and risk transfer instruments – from farmers to white collar individuals – to ensure that they are protected

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Consumers need insurance and risk transfer instruments – from farmers to white collar individuals – to ensure that they are protected

Aids in decision-making for the logistics industry

Establishing new warehouses can become costly, especially when certain areas are more prone to disaster

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