

Navigating the Uncharted Outbreak – Spatio-Temporal Dynamics of the COVID-19 Outbreak in the Amazon

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Aim and Objectives

The Amazon region, delimited by the Amazon ecoregion, covers 9 countries and is home to hundreds of indigenous peoples, a vulnerable population. This study aims to identify the space-time distribution of COVID-19 cases in the Amazon region and determine areas disproportionately affected.

Methods

- Daily confirmed cases of SARS-CoV-2 were collected at country, first, and second administrative levels for each country
- Data was collected from March 15 to July 15, 2020.
- A retrospective space-time scan statistic method, with a discrete Poisson model, was used to identify spatial-temporal clusters using SaTscan, evaluated using Monte Carlo hypothesis testing.
- Maps were generated using ArcGIS Pro.

Results

Figure 2: Hotspots Identified in the Amazon region (with Background of Incidence Rate of COVID-19 by administrative divisions)

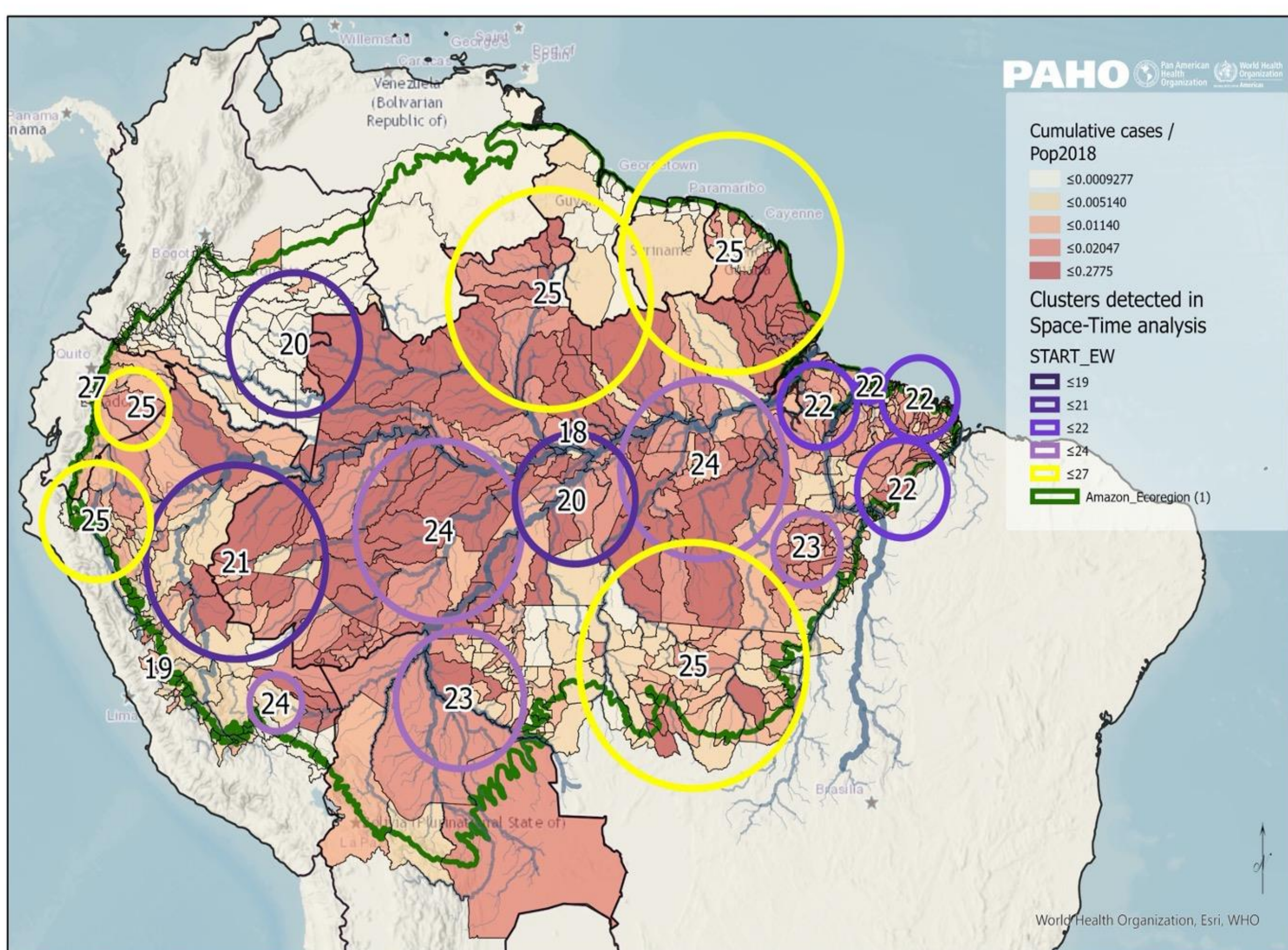


Figure 1: Cumulative Incidence Rate of COVID-19 in the Amazon region

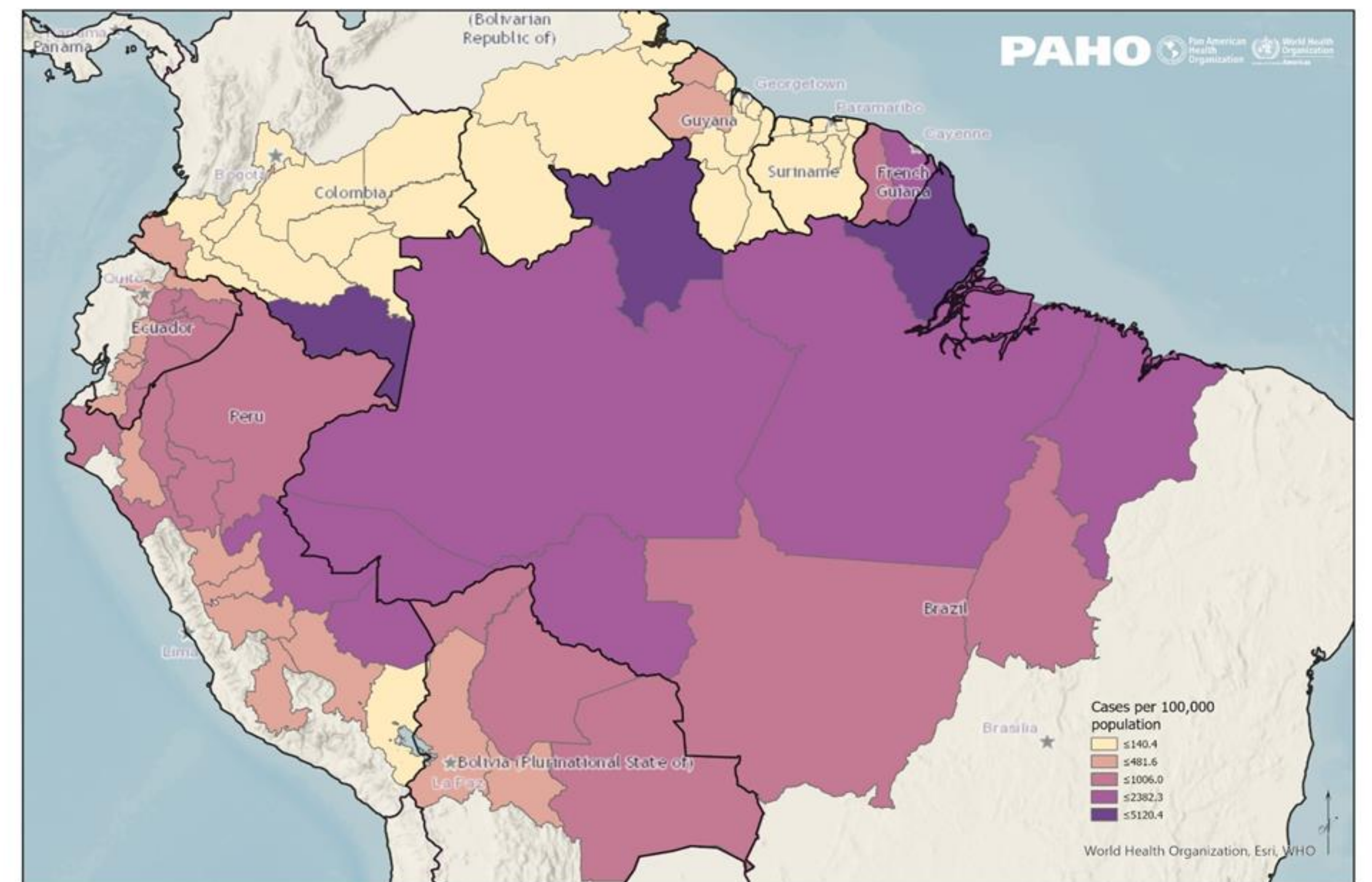


Table 1: List of Spatio-Temporal Hotspots/Clusters identified in the Amazon Region with the Respective Relative Risks

Cluster	Region	EW(Time Frame)	Observed	Expected	Relative Risk	P-value
20	Peru (Tungurahua)	27-28	338	232	1.46	<0.001
1	French Guiana, Brazil (Amapa)	25-29	23166	2021	11.95	<0.001
17	Ecuador	25-29	2373	805	2.96	<0.001
4	Guyana, Brazil(Roraima)	25-28	14319	1091	13.46	<0.001
12	Brazil (Mato Grosso)	25-28	5754	1499	3.87	<0.001
15	Border of Peru, Ecuador	25-28	4988	1546	3.25	<0.001
3	Porto Velho	24-28	16628	1550	11.05	<0.001
7	Santarem	24-27	11484	2081	5.62	<0.001
16	Madre de Dios	24-27	1268	156	8.13	<0.001
2	Tocantin	23-26	16358	1417	11.88	<0.001
13	Bolivia border	23-26	6191	1738	3.59	<0.001
5	Brazil (Maranhão)	22-25	11735	2003	5.97	<0.001
8	Near Belem	22-25	9370	1911	4.97	<0.001
10	Sao Louis (Costal Para)	22-25	8531	2017	4.28	<0.001
14	Castanhal (Costal Para)	22-25	4370	1109	3.97	<0.001
6	Brazil (Acre)	21-24	11731	2029	5.89	<0.001
9	Colombia (Vaupes, Amazonas)	20-23	3860	289	13.45	<0.001
11	Manaus	20-23	5802	1009	5.81	<0.001
19	Peru (Junin)	19-20	67	12	5.7	<0.001
18	Manaus, Rio Preto da Eva	18-21	419	57	7.32	<0.001

Figure 3: Hotspots identified in the Amazon region (with Background of Indigenous Territories and Ethnic groups)

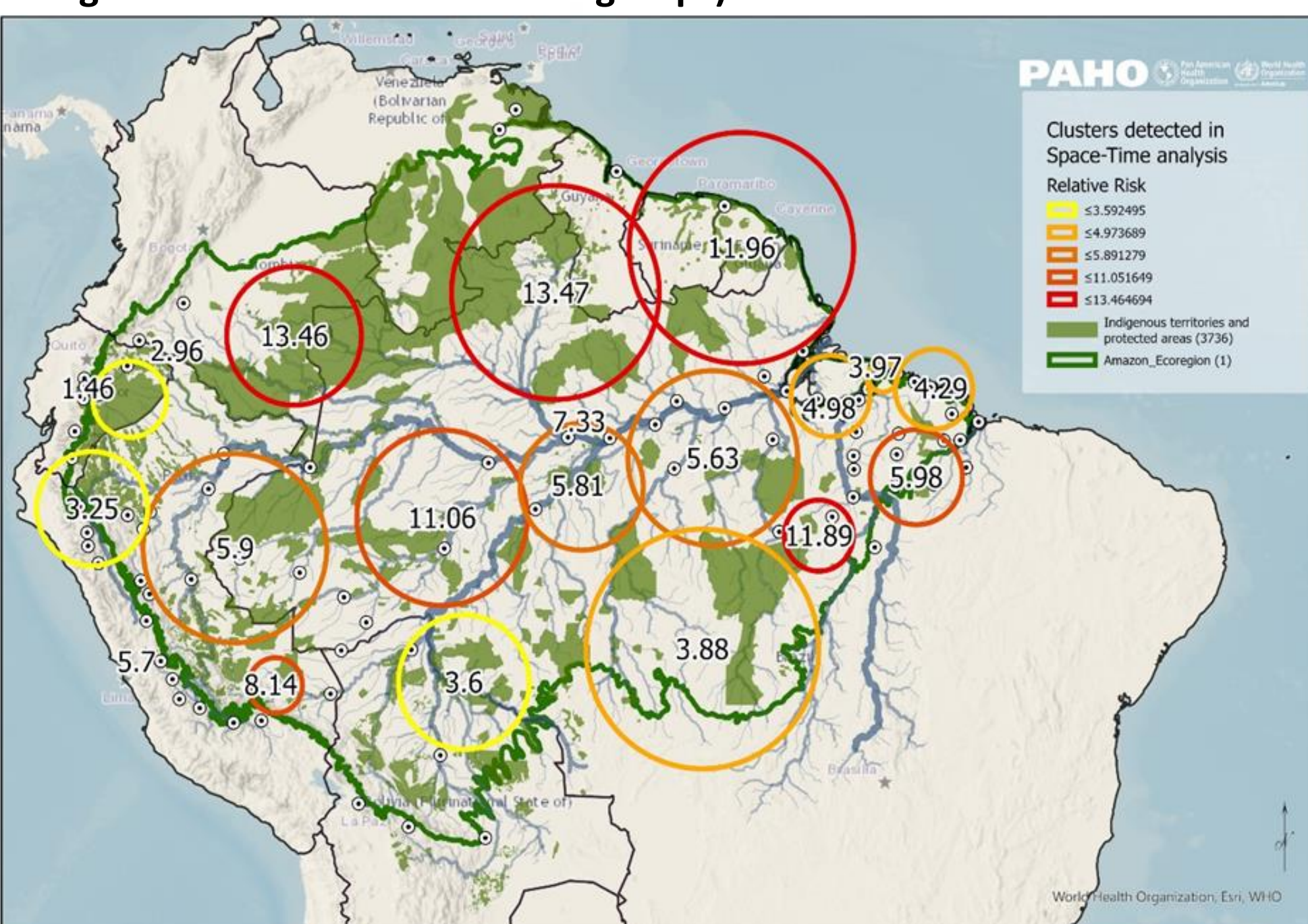
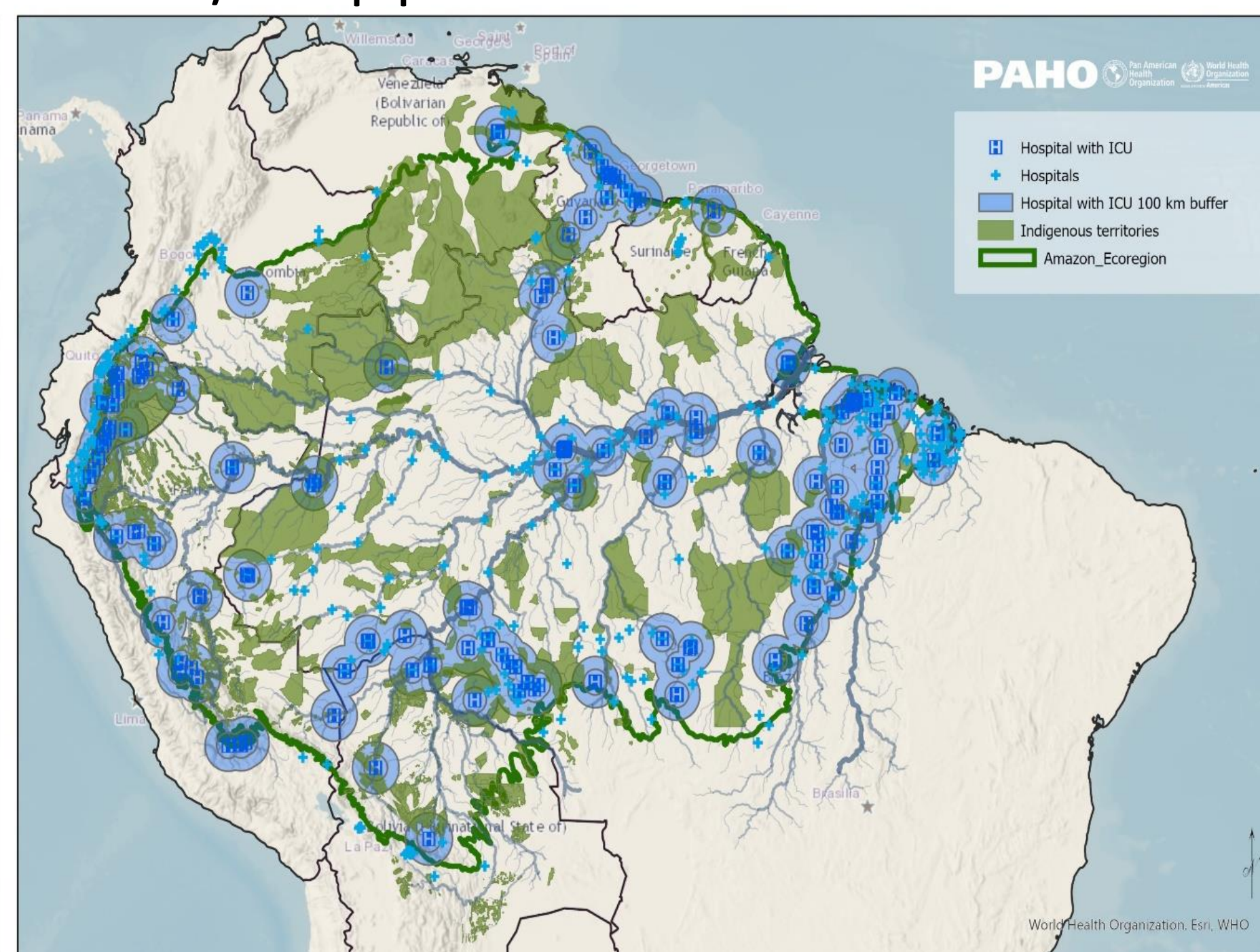


Figure 4: Access to Health Care Facilities in Indigenous Territories/Ethnic populations in the Amazon



Discussion

- The first cluster was near Manaus, Brazil, with the next clusters identified along the Amazon river, and subsequently in less populated area.
- The spread of the infection from Manaus to the neighbouring areas along the Amazon river occurred within 2-4 weeks, with the most remote areas being affected after about 8 weeks.
- While high relative risk of infection is observed around major cities, 2 clusters in the northern part of the Amazon had the highest relative risk.
- Most clusters include a large part of indigenous territories that lie more than 100km away from hospitals.

Conclusions

- Spatio-temporal characteristics of the outbreak suggest that river travel was the main driver of infection.
- Indigenous population appear to be particularly vulnerable to spread of the infection, which along with limited access to healthcare, makes them a priority in the Amazon region



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References

1) Kulldorff M, Heffernan R, Hartman J, Assunção R, Mostashari F. A space-time permutation scan statistic for disease outbreak detection. *PLoS Med* 2005;2(3):e59.

Data sources

1) Protected areas and indigenous territories in Amazon: WWF, Langues amérindiennes de Guyane française, Suriname Country Office
 2) Cases: COVID-19 PAHO data, Ministries of Health of Brazil, Colombia, Bolivia, Ecuador, Suriname, French Guiana, Guyana, Venezuela
 3) Population: Landscan 2018, Ministry of Health - Brazil