



COVID-19 Healthcare Workers Vaccination Logistics

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Cities with hospital beds in Brazil

Concentrated in the largest cities and most developed regions, there are no hospitals and beds in most cities

In fact, patients from 43% of the country's cities will need to travel if they have serious Covid-19 symptoms. This is because only 53.1% of the 5,570 Brazilian municipalities have hospitals with beds



Healthcare workers

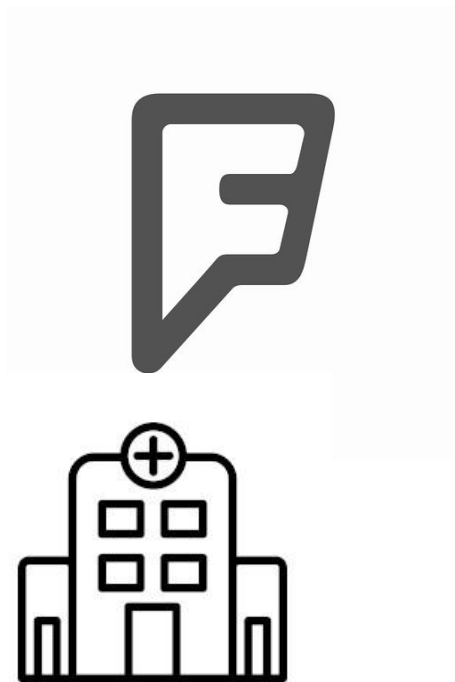
In Brazil, unlike hospitalization beds, the healthcare workforce is more evenly distributed among all states, in thousands of municipalities.

They work mainly in healthcare centres, including clinics, doctor's offices, etc. Not all of them are located in cities with available hospitals.



Goal and data sources

This project aims to use **Foursquare location data** combined with **the number of healthcare workers by municipality** and **GPS data** to **suggest the closest cities with hospitals** that could be used as vaccination centers for those professionals



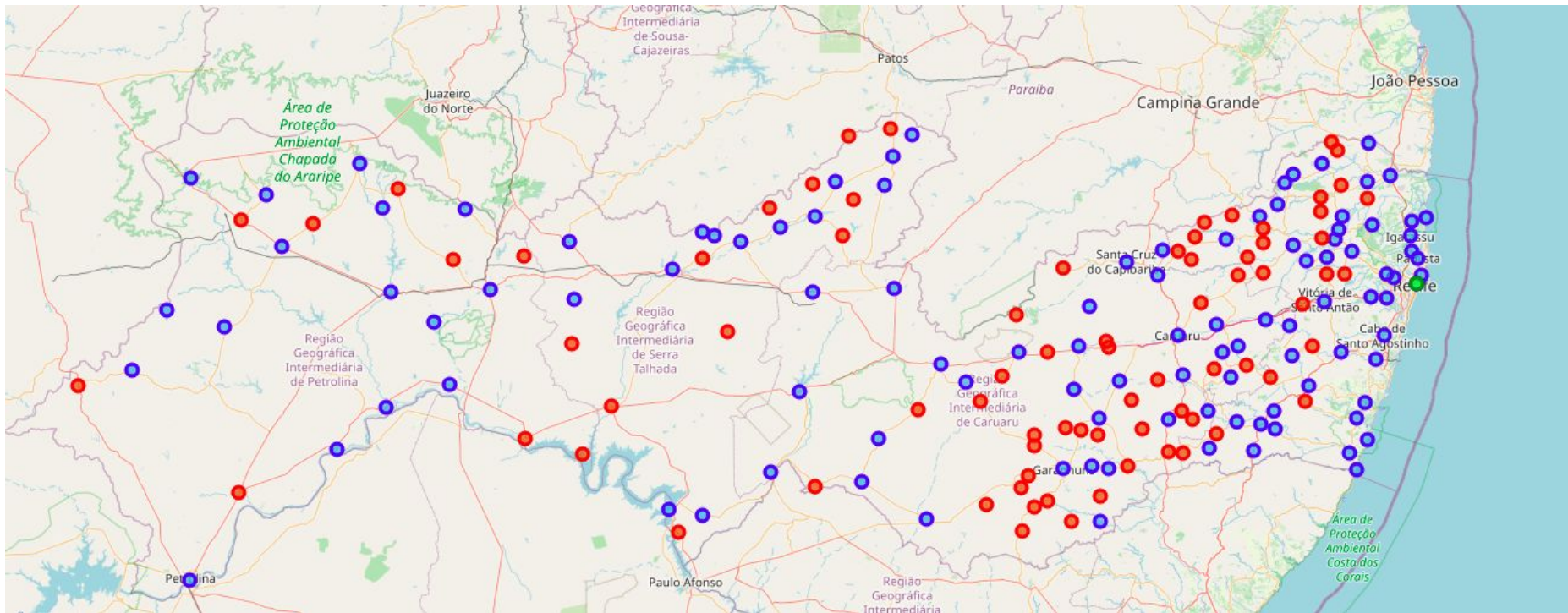
Data acquisition and cleaning

- [Foursquare API](#) - Was used to count the number of hospitals within 5 km of the city center (i.e. find cities with hospitals). Because of limited API calls, we restricted our search to cities in the [Pernambuco](#) state. Venues names and other details were removed and we kept only the total hospital count.
- [The National Registry of Health Facilities \(CNES\)](#) (In portuguese) - Has the number of healthcare workers by municipality. Numbers for each profession/occupation (nurse, medics, etc) were removed and only the total workers kept, as we are equally interested in all healthcare workers.
- [Municípios Brasileiros](#) (In portuguese) - Has the latitude and longitude of 5,570 Brazilian municipalities. We dropped the cities that were not in the Pernambuco state and also calculated their positions in a 2D coordinate system (UTM) so we could find the nearest cities with hospitals. We also cleaned up the data on IBGE codes, to follow the same format as the CNES datasource

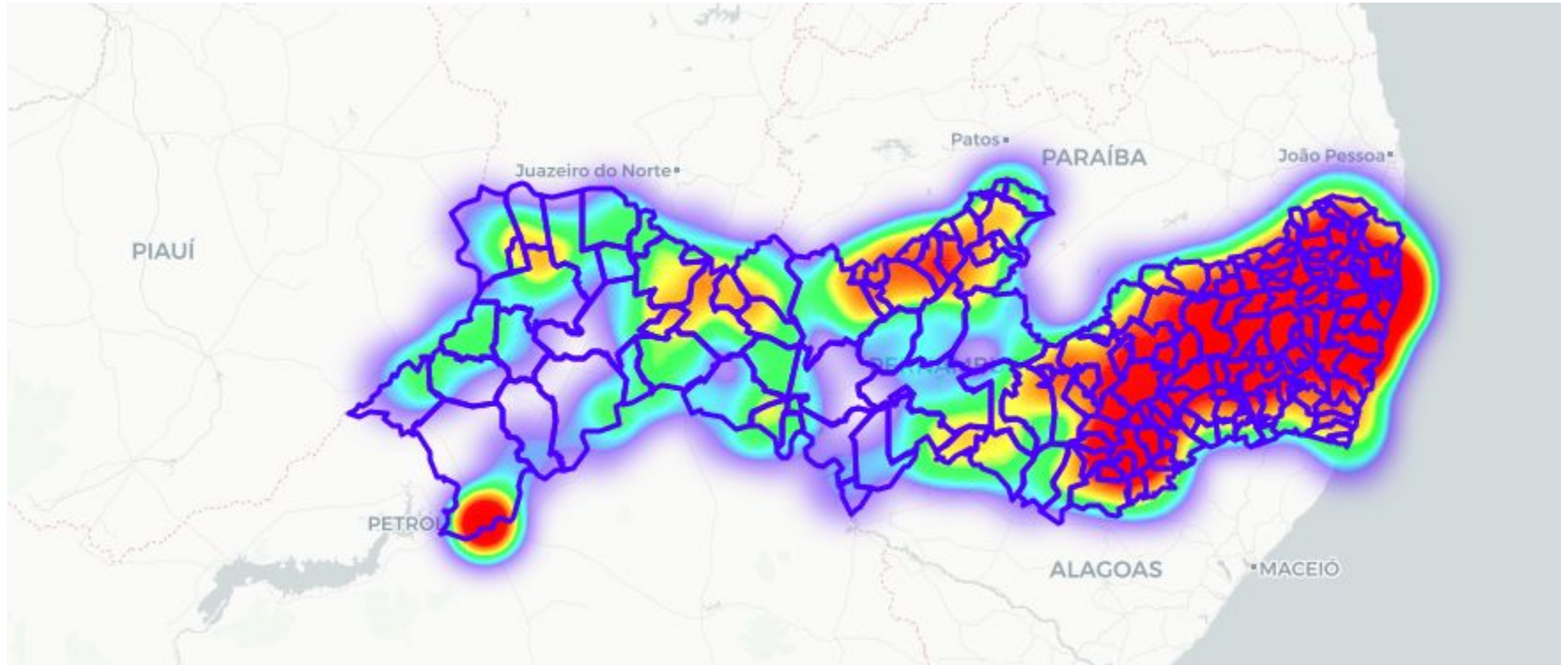
Combined data: Municipalities in Pernambuco

Blue = Has hospital with beds within 5km of the city center

Red = Does not have a nearby hospital



Healthcare workers density

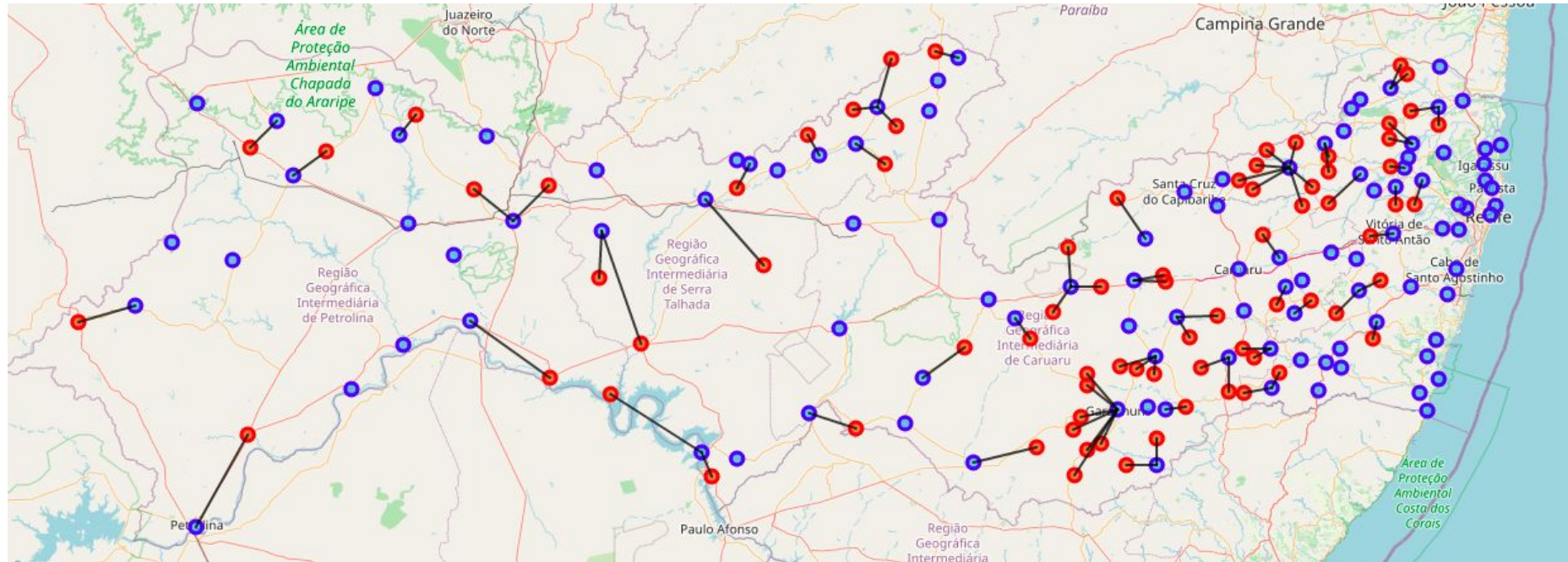


Suggested travels

Blue = Has hospital

Red = Does not have a nearby hospital

Black line = Suggested travel route for healthcare workers to be vaccinated



Vaccine counts (after travelling to cities with hospitals)

Municipality	Healthcare workers to vaccinate	Municipality	Healthcare workers to vaccinate	Municipality	Healthcare workers to vaccinate	Municipality	Healthcare workers to vaccinate	Municipality	Healthcare workers to vaccinate	Municipality	Healthcare workers to vaccinate
Abreu e Lima	588	Camocim de São Félix	244	Ibimirim	138	Nazaré da Mata	534	Santa Cruz da Baixa Verde	60	Timbaúba	419
Afogados da Ingazeira	638	Carnaíba	158	Igarassu	765	Olinda	2415	Santa Cruz do Capibaribe	400	Toritama	135
Agrestina	251	Carpina	743	Inajá	182	Orobó	393	Santa Filomena	58	Tracunhaém	55
Água Preta	143	Caruaru	6923	Ipojuca	1127	Orocó	75	Santa Maria da Boa Vista	140	Triunfo	117
Águas Belas	278	Catende	81	Ipubi	276	Ouricuri	674	São Bento do Una	147	Tupanatinga	255
Amaraji	256	Cedro	69	Itaíba	105	Palmares	771	São João	159	Tuparetama	48
Angelim	203	Chã Grande	136	Ilha de Itamaracá	208	Panelas	315	São José da Coroa Grande	71	Vitória de Santo Antão	1606
Araçoiaba	91	Condado	325	Itambé	175	Parnamirim	104	São José do Belmonte	132	Xexéu	100
Araripina	411	Correntes	262	Itapetim	142	Paudalho	474	São José do Egito	216		
Arcoverde	1085	Custódia	191	Itapissuma	182	Paulista	2258	São Lourenço da Mata	635		
Barreiros	154	Dormentes	292	Jaboatão dos Guararapes	5091	Pedra	267	São Vicente Ferrer	87		
Belém de Maria	308	Escada	297	Joaquim Nabuco	73	Pesqueira	716	Serra Talhada	1419		
Belo Jardim	587	Exu	139	Lagoa de Itaenga	279	Petrolândia	352	Sertânia	185		
Bezerros	464	Feira Nova	143	Lajedo	420	Petrolina	6216	Sirinhaém	97		
Bonito	261	Fernando de Noronha	55	Limoeiro	852	Recife	47065	Surubim	915		
Brejo da Madre de Deus	287	Flores	84	Macaparana	133	Ribeirão	223	Tabira	296		
Cabo de Santo Agostinho	2654	Garanhuns	2672	Machados	92	Rio Formoso	106	Tacaratu	93		
Cabrobó	296	Goiana	900	Maraial	165	Sairé	77	Tamandaré	93		
Cachoeirinha	243	Granito	115	Mirandiba	258	Salgueiro	1086	Taquaritinga do Norte	92		
Camaragibe	1003	Gravatá	447	Moreno	385	Santa Cruz	80	Terra Nova	55		

Conclusion and future directions

Purpose of this project was to identify the healthcare workers that are located in cities without hospitals and to suggest the closest hospitals that could be used as vaccination centers for those professionals. We also displayed a dataframe with the number of people that would be immunized in each city to help with transportation and logistics.

Because the COVID-19 is a serious matter and lives are at stake, final decisions on optimal vaccination locations should be made by the Health Ministry taking into consideration additional factors that were not covered by this exercise.