

Ministério da Saúde

FIOCRUZ

Fundação Oswaldo Cruz



Assessing the potential impact of COVID-19 in Brazil: Mobility, Morbidity and the burden on the Health Care System

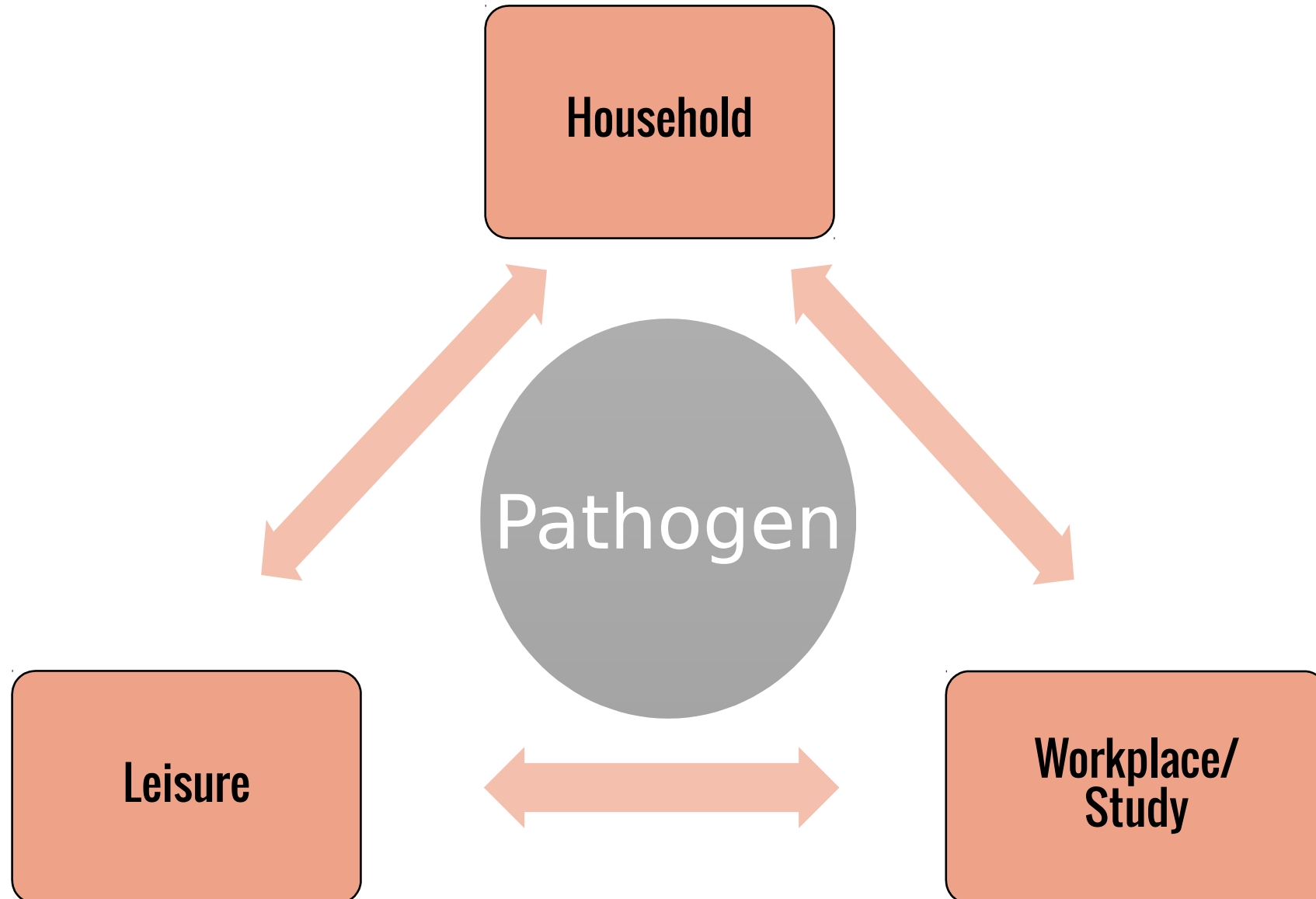
F Coelho, RM Lana, O Cruz, D Villela, L Bastos, A Pastore y Piontti, JT Davis, A Vespignani, C Codeço, Marcelo F C Gomes

Group for Analytical Methods in Epidemiological Surveillance (MAVE)

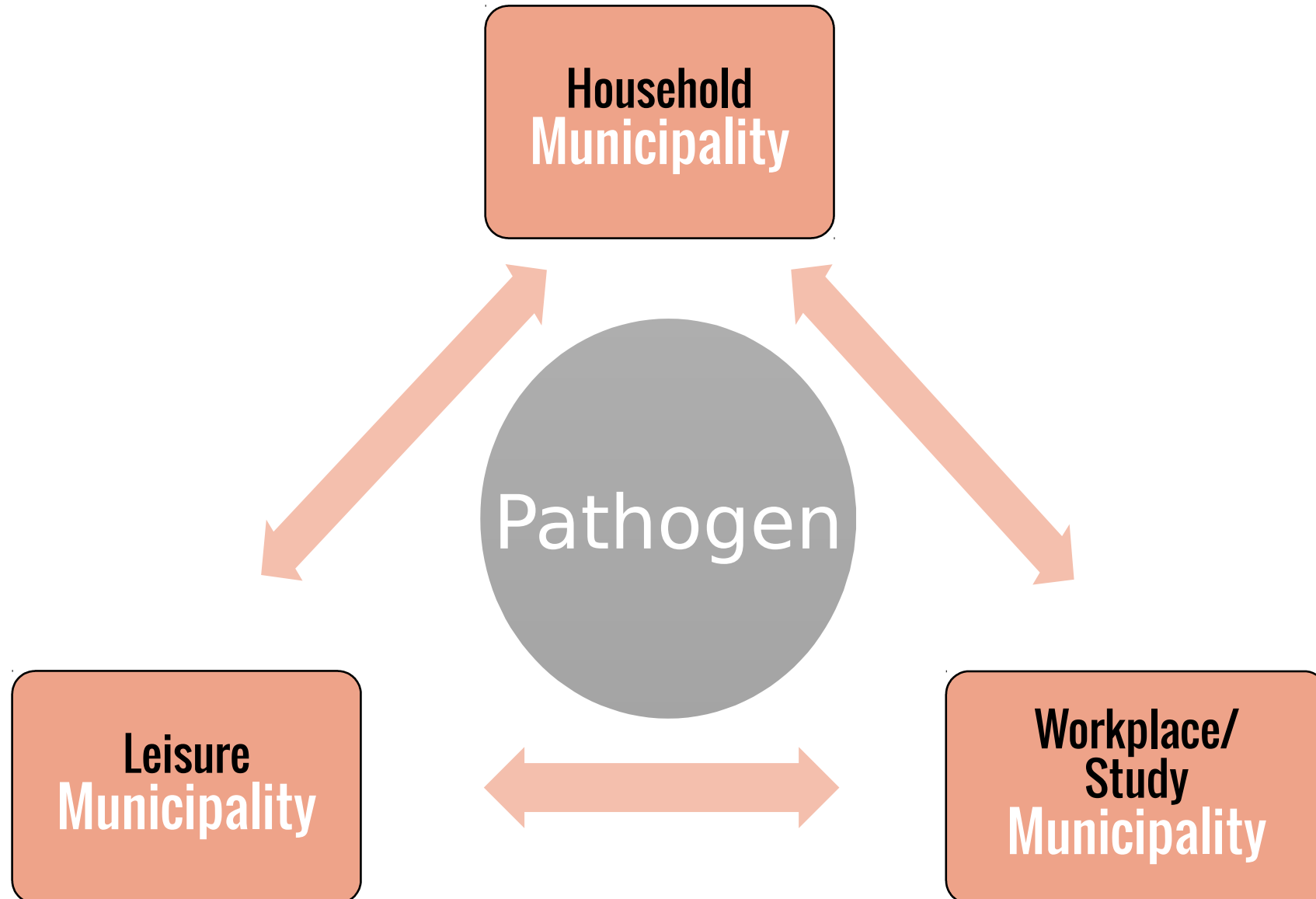
FIOCRUZ, PROCC

Exposure

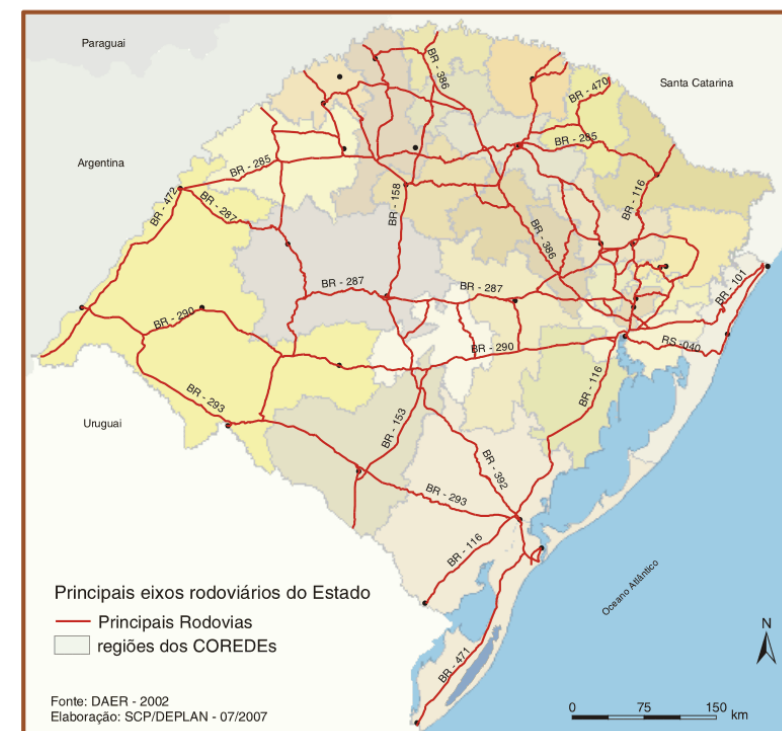
Mobility



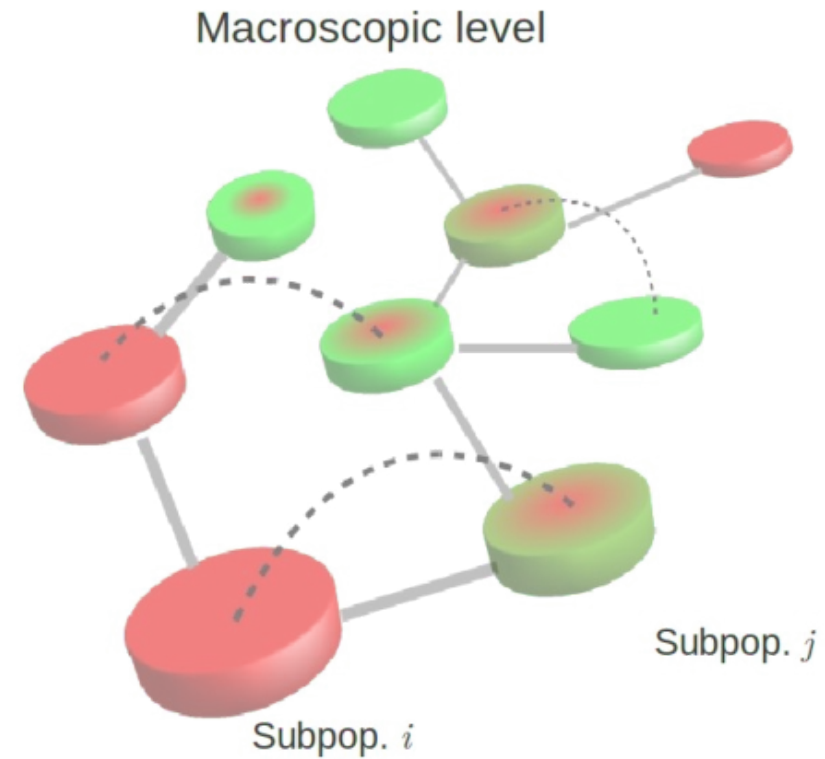
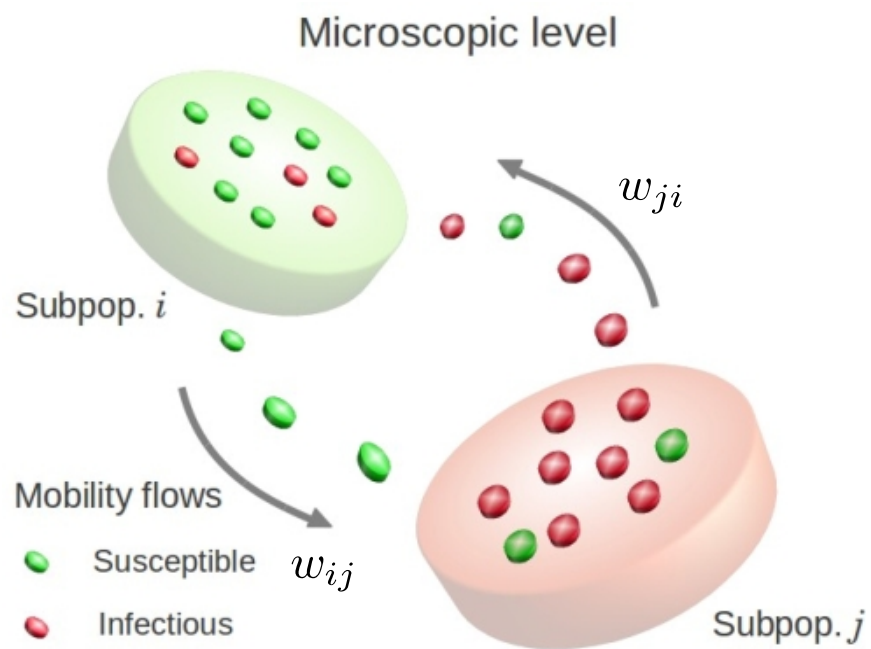
Mobility



Mobility



Metapopulation network



Metapopulation network

- Effective distance:
 - how “far” each locality is from national/state epicenter?
 - how long before reaching a given municipality (time of arrival)?
- Gautreau, A., Barrat, A., & Barthélemy, M. (2008). Global disease spread: Statistics and estimation of arrival times. *Journal of Theoretical Biology*, 251(3), 509–522. doi:10.1016/j.jtbi.2007.12.001
- Brockmann, D. and Helbing, D., The hidden geometry of complex, network-driven contagion phenomena, *Science* 342, 6164, 1337 (2013)
- Iannelli, F., Koher, A., Brockmann, D., Hövel, P., & Sokolov, I. M. (2017). Effective distances for epidemics spreading on complex networks. *Physical Review E*, 95(1). doi:10.1103/physreve.95.012313

$$T_j = D_{ij}^{eff} / v^{eff}$$

$$D_{ij} = \begin{cases} 1 - \ln P_{ij} & \text{Brockman \& Helbing} \\ \ln \lambda - \gamma - \ln \sigma_{ij} & \text{Gautreau et al., Iannelli et al.} \end{cases}$$

$$v^{eff} = \lambda \text{ (e.g., for SIR: } \beta - \mu \text{)}$$

Metapopulation network

- Probability of dissemination:
 - how likely to be invaded in the next generation?
- L. J. Allen , F. Brauer , P. Van den Drissche , J. Wu . Mathematical epidemiology; vol. 1945. Berlin: Springer; 2008.

$$p_i = 1 - (1/R_0)^{I_j}$$

$$I_j = \kappa\tau \sum_i \sigma_{ij} I_i$$

κ : scale up due to subnotification

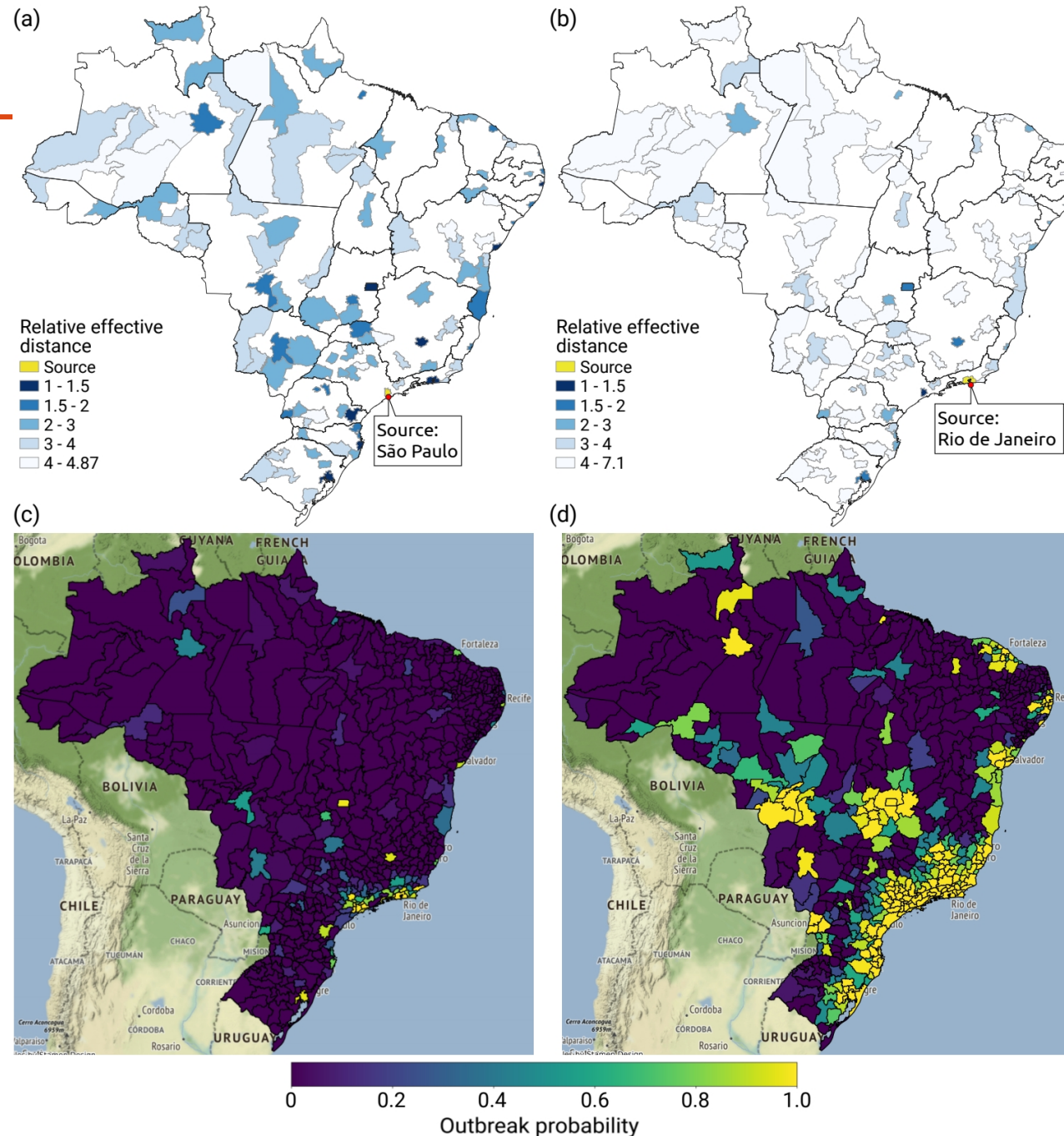
τ : infectious period

σ_{ij} : mobility flux from i to j

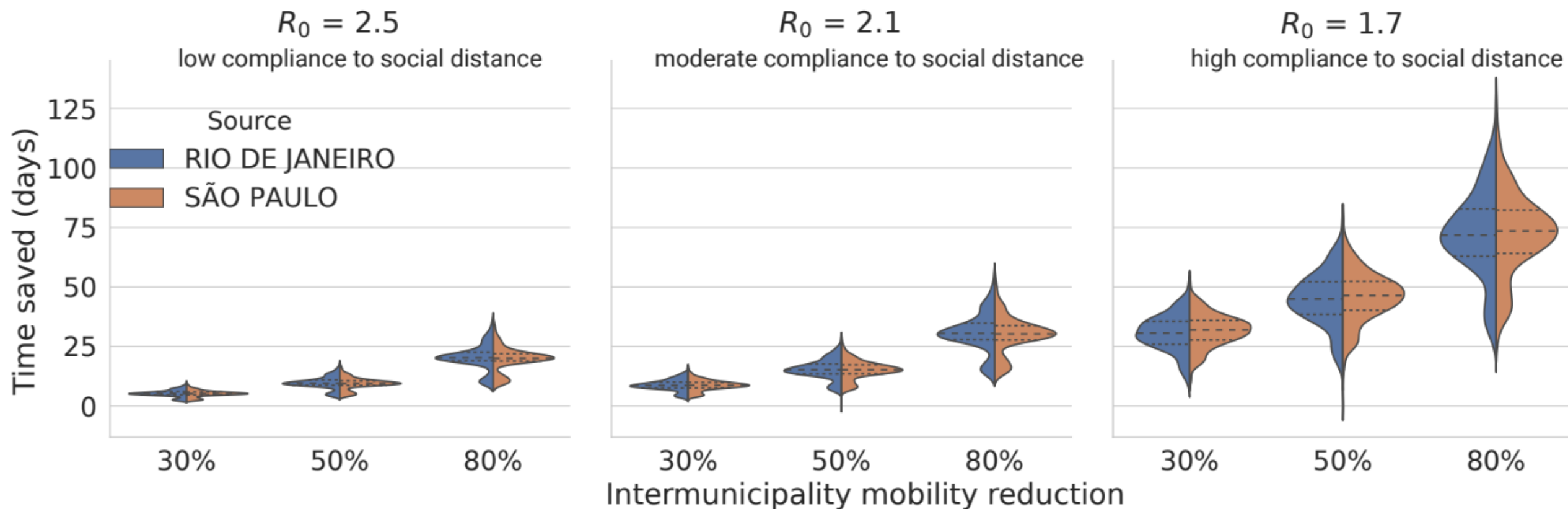
Exposure

Estimates published on
March 23 and 25, 2020.
<http://bit.ly/mave-covid19-relatorio2>

Medrxiv:
[https://doi.org/
10.1101/2020.03.19.2003
9131](https://doi.org/10.1101/2020.03.19.20039131)



Time of arrival: gain from interventions



Estimates published on March 23 and 25, 2020.

<http://bit.ly/mave-covid19-relatorio2>

Medrxiv: <https://doi.org/10.1101/2020.03.19.20039131>

By municipality: <https://bit.ly/mave-covid19-estados2020-04-01>

Vulnerability

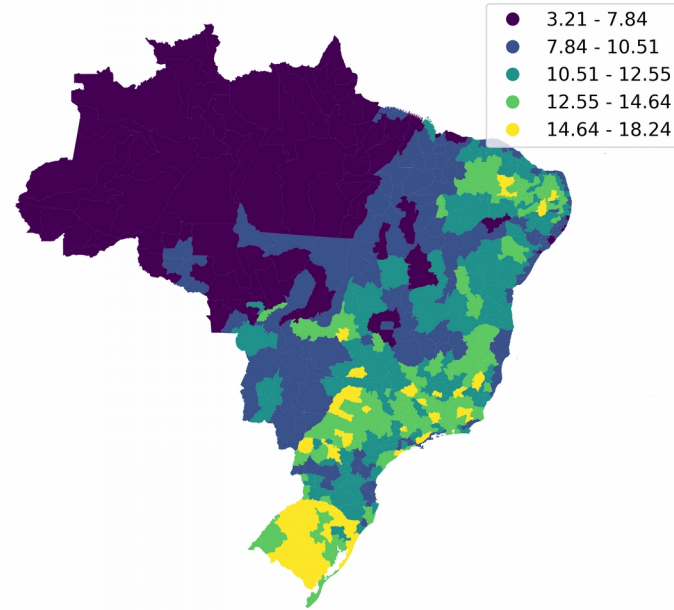
Vulnerability

Estimates published on
March 23 and 25, 2020.

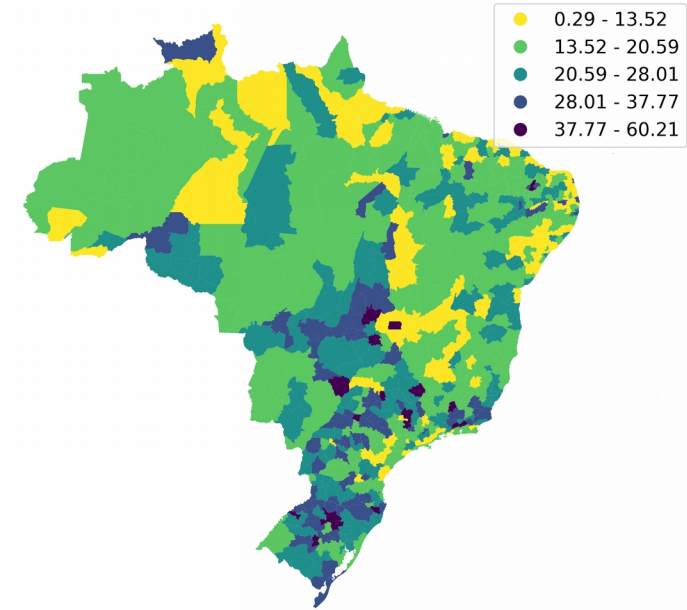
<http://bit.ly/mave-covid19-relatorio2>

Medrxiv:
[https://doi.org/
10.1101/2020.03.19.2003
9131](https://doi.org/10.1101/2020.03.19.20039131)

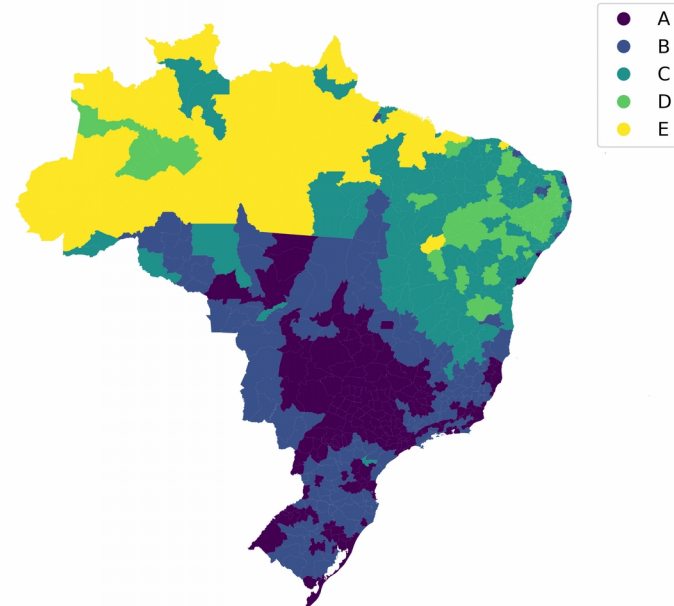
(A) Population above 60



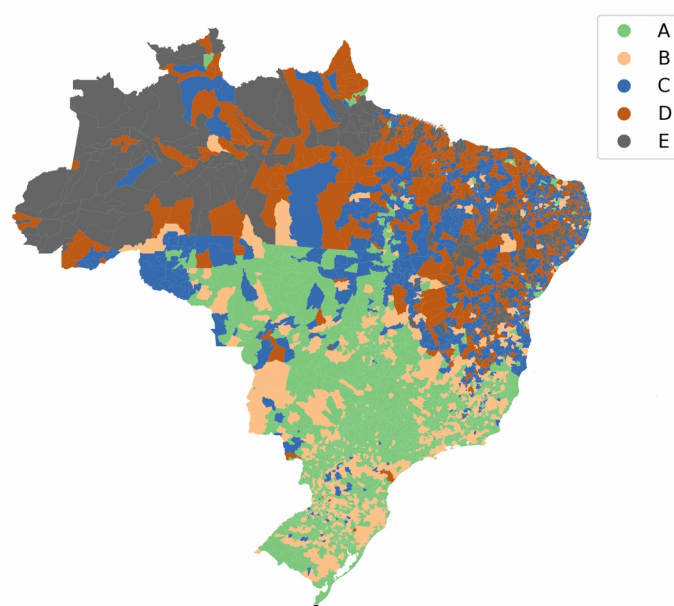
(B) Hospital Beds per 10k inhab.



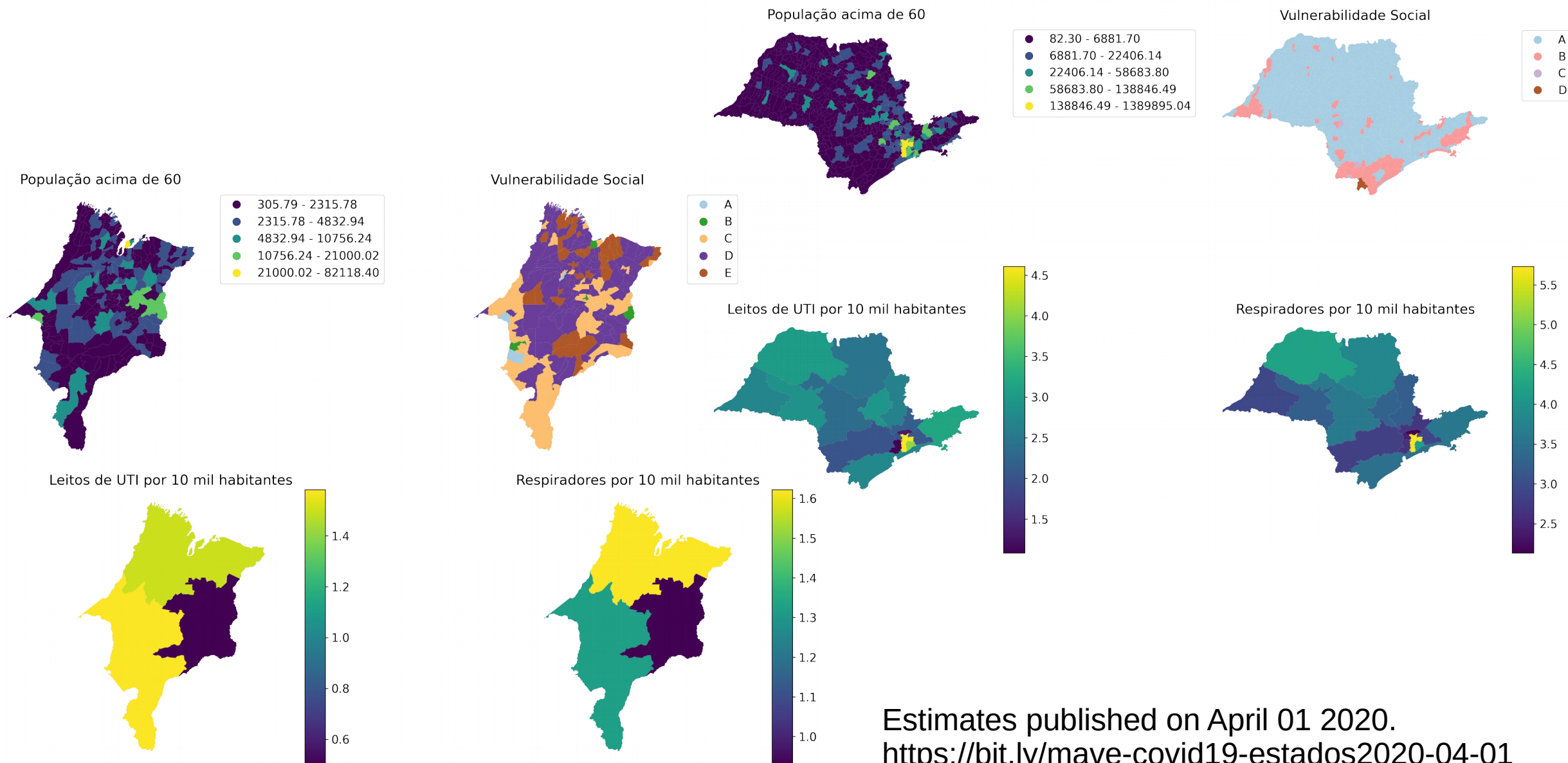
(C) Social Vulnerability classes



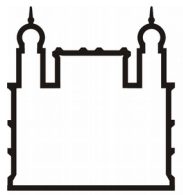
(D) Social Vulnerability classes - municipality



Vulnerability



Estimates published on April 01 2020.
<https://bit.ly/mave-covid19-estados2020-04-01>



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