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16-18 November 2020 | Online

Decision Support Model and Visualization for Assessing Environmental Phenomena, Ecosystem Services, Policy Consequences, and Satellite Design Using Earth Observation Data

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Outline

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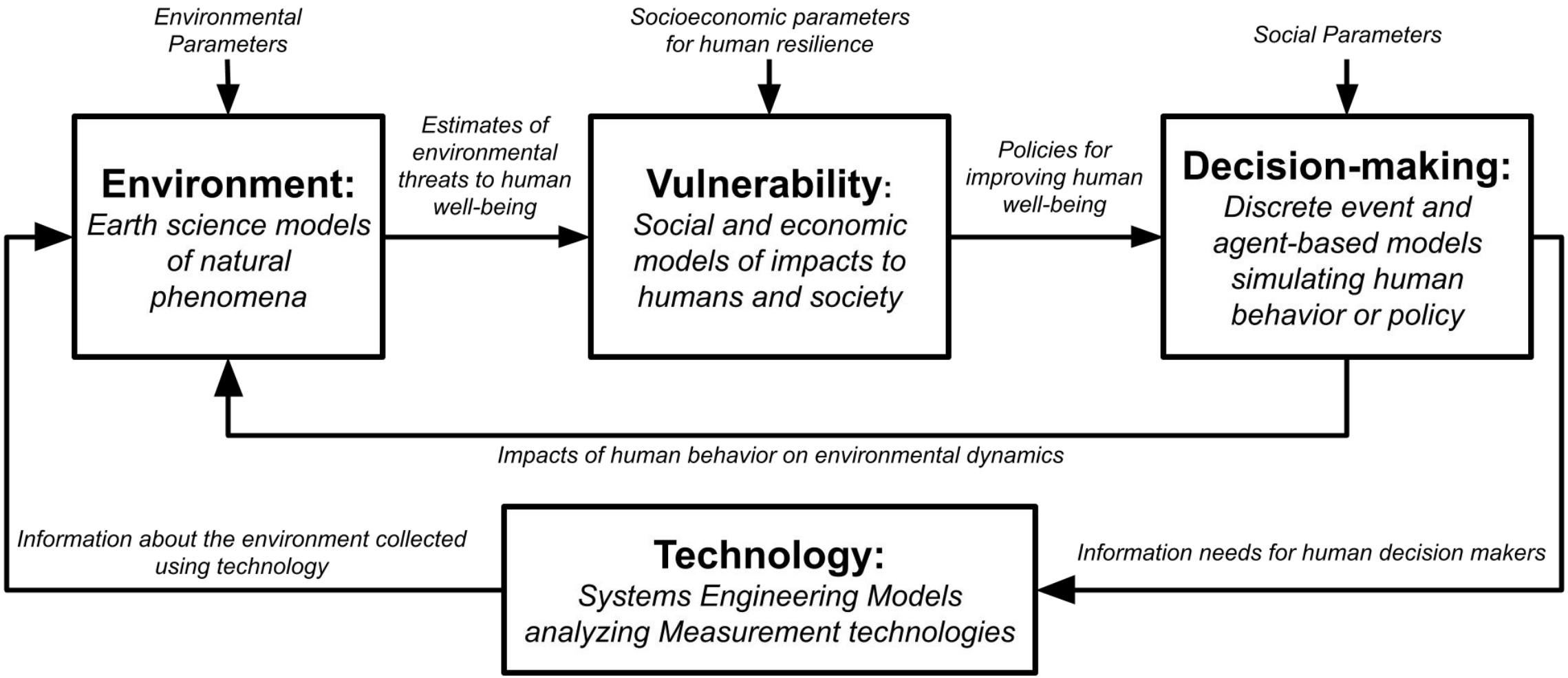
  - *Data & Methods*
  - *User Interface*
- *Discussion and Conclusion*
  - *Key Design Requirements*
  - *Broader Consequences*

Introduction: The EVDT Framework

The EVDT Framework

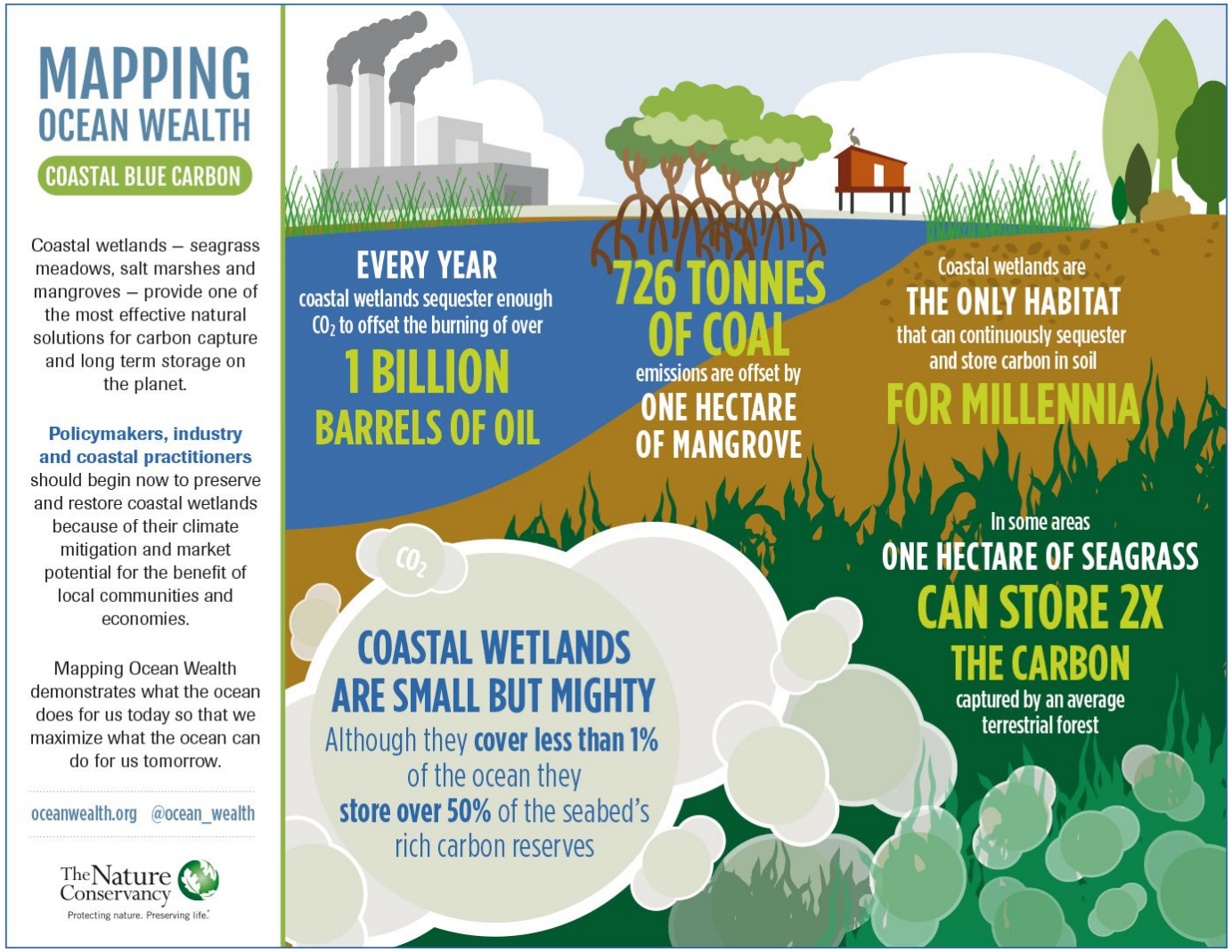


Case Study 1 (CS1): Mangroves of Rio de Janeiro

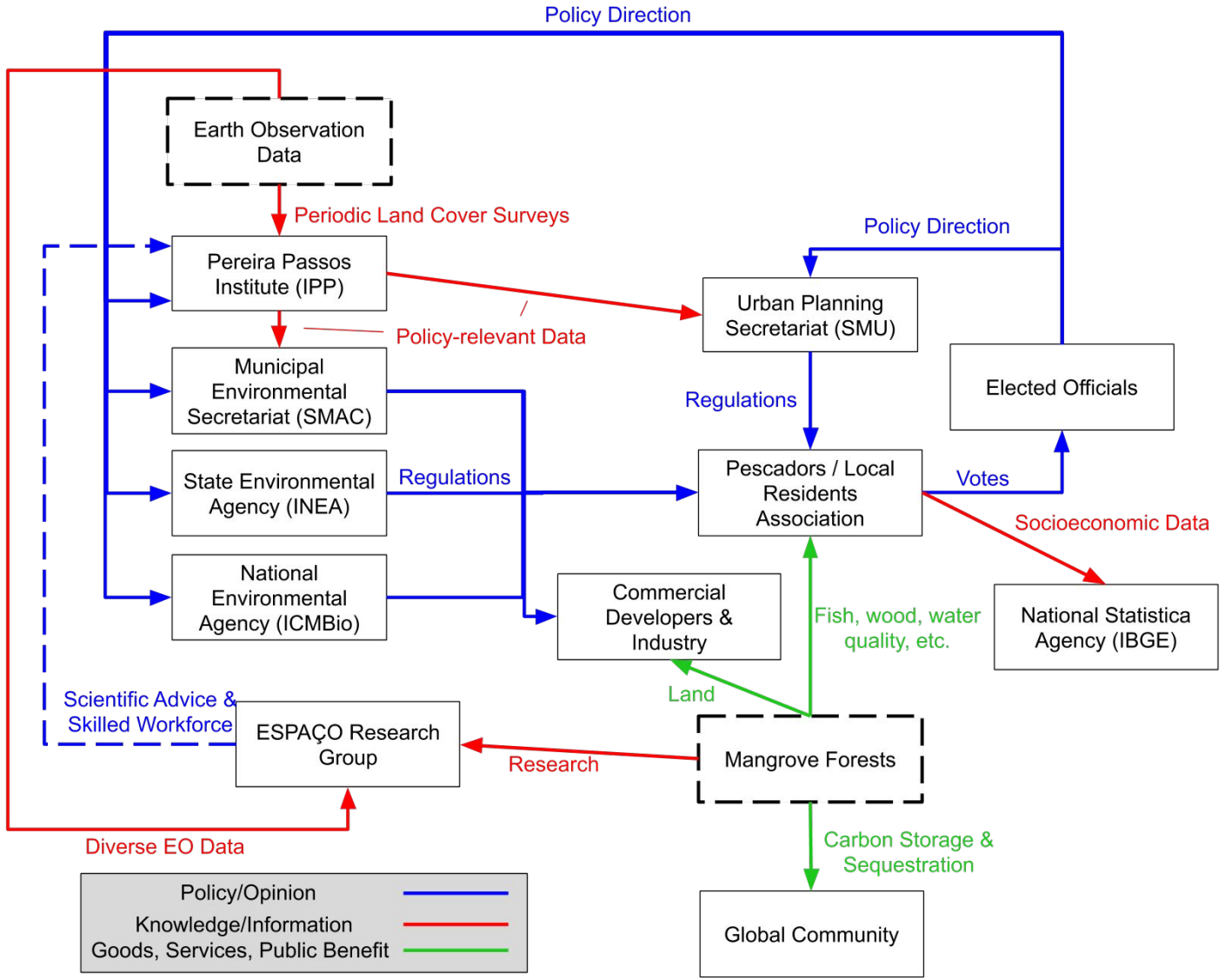
(CS1) Study Area: Mangroves of Rio de Janeiro

(CS1) Study Area: Mangroves of Rio de Janeiro

(CS1) Study Area: Mangroves of Rio de Janeiro



(CS1) Stakeholder Analysis



(CS1) Data & Methods: Environment

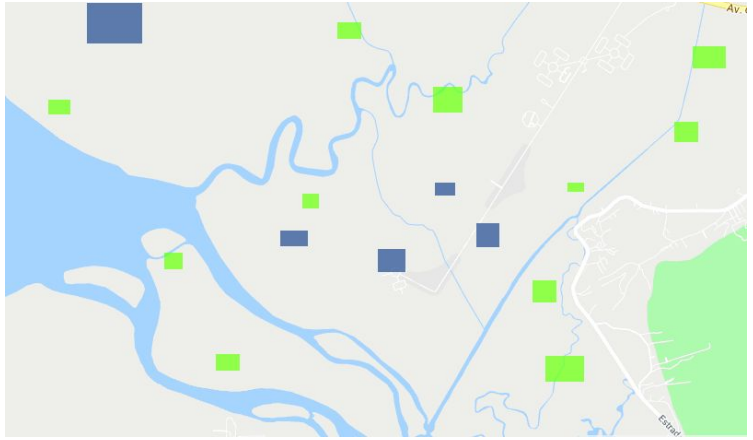
- *Existing Mangrove Maps*
  - *Giri et al. & Global Mangrove Watch*
- *EO Data*
  - *Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Sentinel 2 MSI, & ALOS PALSAR*
- *Processing Techniques*
  - *Extent Tracking: Random Forest Classifier Algorithm*
  - *Health Tracking: NDVI Mean Anomaly*
  - *Height Measurement: LIDAR Aerial Survey (pending data availability)*

For more detail on a similar that inspired and informed this one, see:

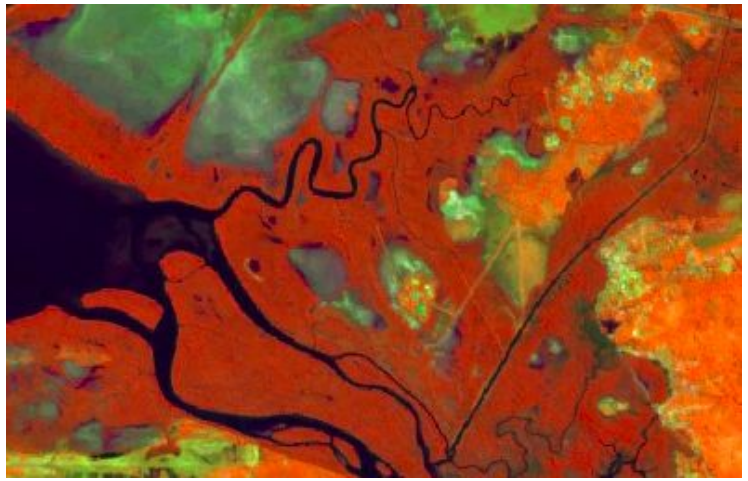
Lagomasino, David, Temilola Fatoyinbo, SeungKuk Lee, Emanuelle Feliciano, Carl Trettin, Aurélie Shapiro, and Mwita M. Mangora. “Measuring Mangrove Carbon Loss and Gain in Deltas.” Environmental Research Letters 14, no. 2 (January 2019): 025002. https://doi.org/10.1088/1748-9326/aaf0de.

(CS1) Data & Methods: Environment, Extent

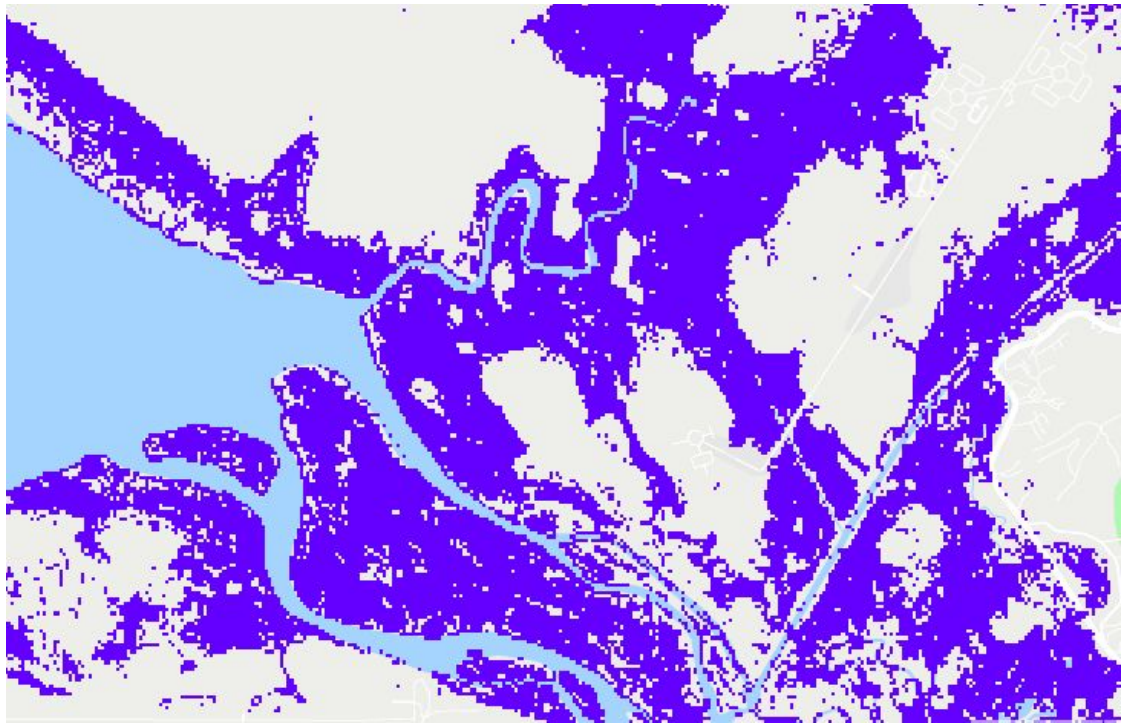
Training Data from Giri and GMW



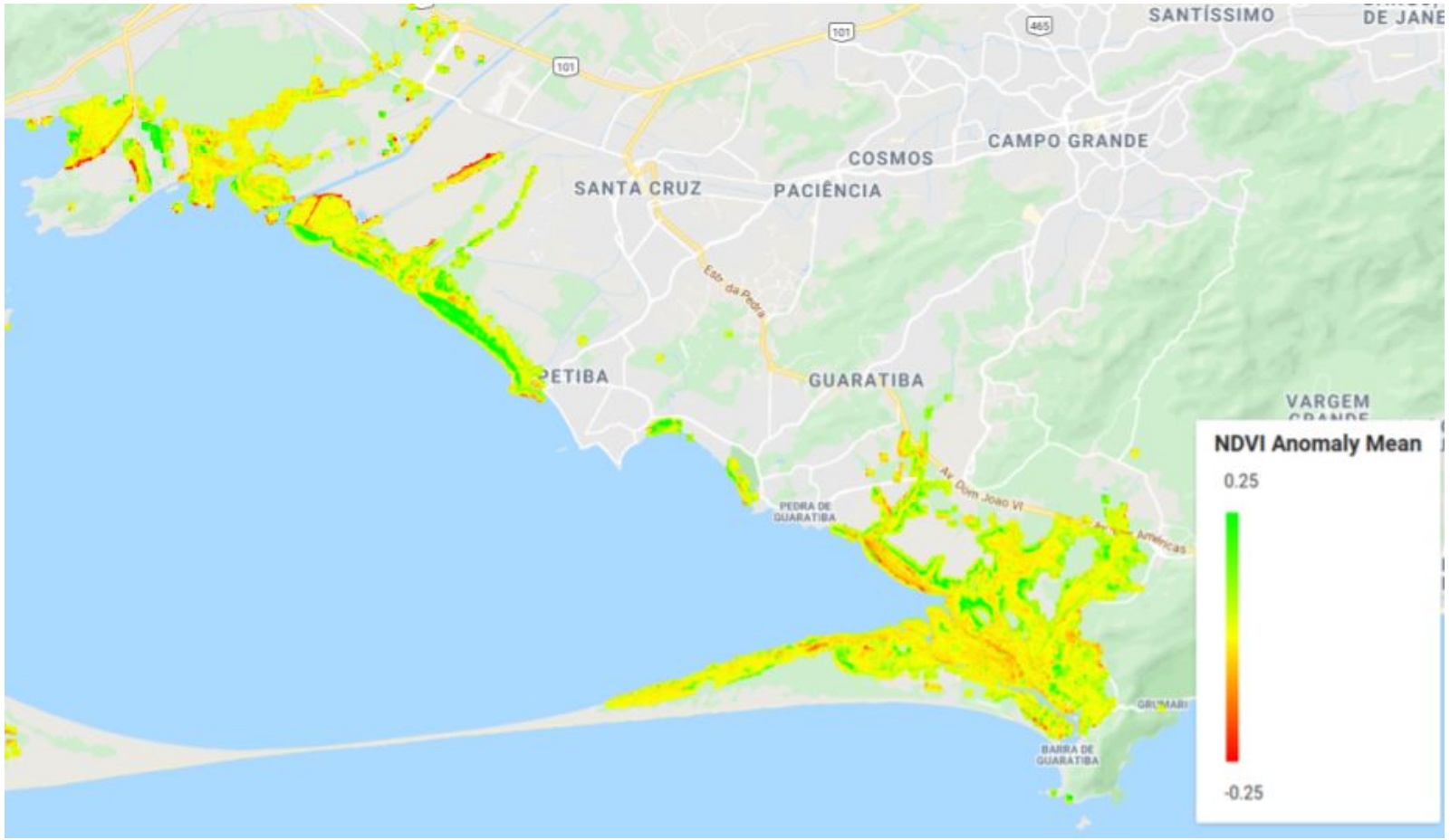
Sentinel, Landsat, and PALSAR Imagery



Classified Mangroves



(CS1) Data & Methods: Environment, Health



- *Reference period: 31/Aug/1999 to 31/Aug/2001*
- *Observation period: 1/Sep/2001 to 1/Sep/2018*

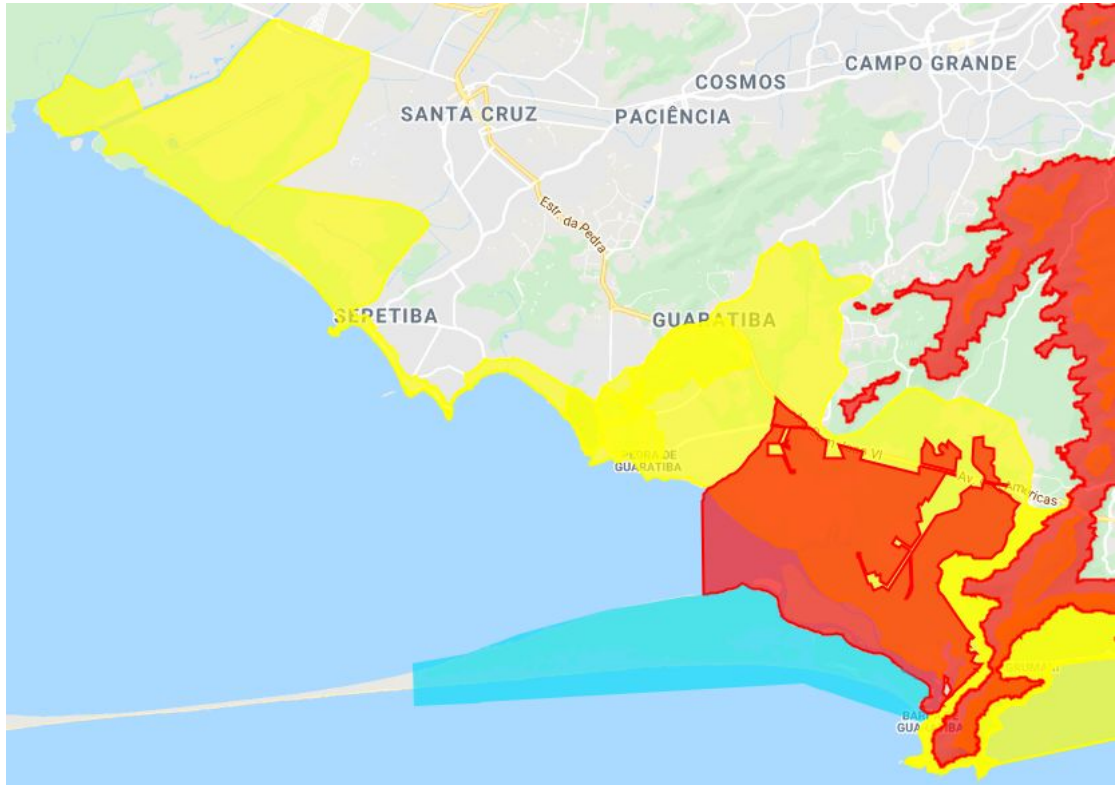
(CS1) Data & Methods: Vulnerability

- *Brazilian Institute of Geography and Statistics (IBGE)*
  - *Population Density, Employment (by industry), Household Size, Sewage Infrastructure, etc.*
- *Pereira Passos Municipal Institute of Urbanism (IPP)*
  - *Detailed land use maps, Multidimensional Poverty Index, Informal Settlement Maps*
  - *Data.Rio Platform*
- *Literature & Planned Information To be Collected*
  - *Social value of carbon*
  - *Raw material value of mangrove ecosystem services*

(CS1) Data & Methods: Decision-making

- *Conservation and Preservation Areas*
  - *Explicitly protected areas*
  - *Categories of urban conservation policies*
- *Urban Zoning Policy*
  - *Types of construction and industry allowed*

Protected Areas	Authority
Ambiental das Brisas	Municipal
Orla da Baia de Sepetiba	Municipal
Parque Natural Municipal da Serra da Capoeira Grande	Municipal
Parque Nacional Municipal da Prainha	Municipal
Parque Nacional Municipal de Grumari	Municipal
Sepetiba II	State
Parque Estadual da Pedra Branca	State
Reserva Biológica Estadual de Guaratiba	State
Centro Tecnológico do Exército	National

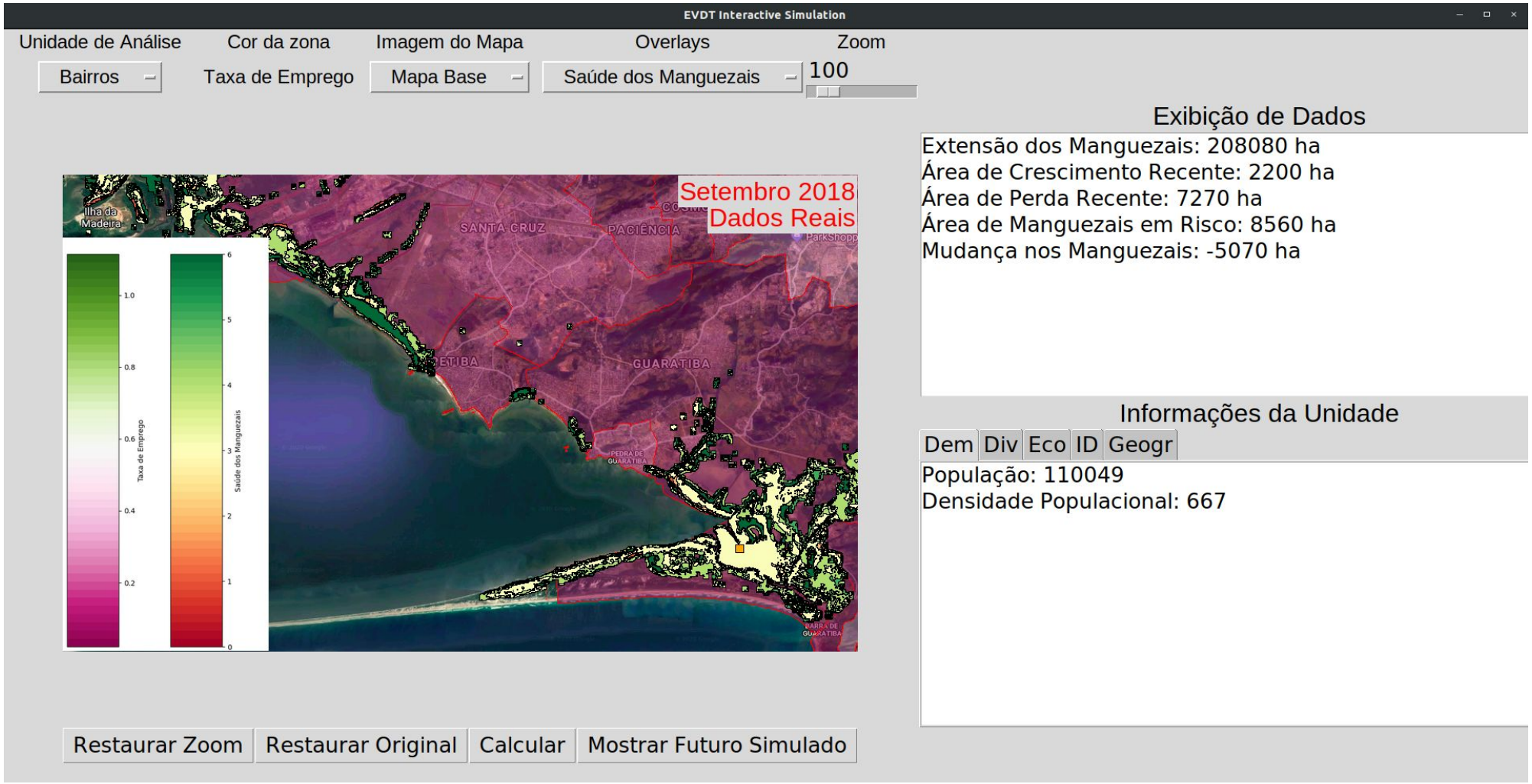


(CS1) Data & Methods: Technology

- *History of EO Data Collection and Usage*
  - *Pereira Passos Municipal Institute of Urbanism*
  - *Environmental Secretariat*
  - *Urban Planning Secretariat*
  - *State Environmental Institute*
  - *Chico Mendes Institute for Biodiversity Conservation*

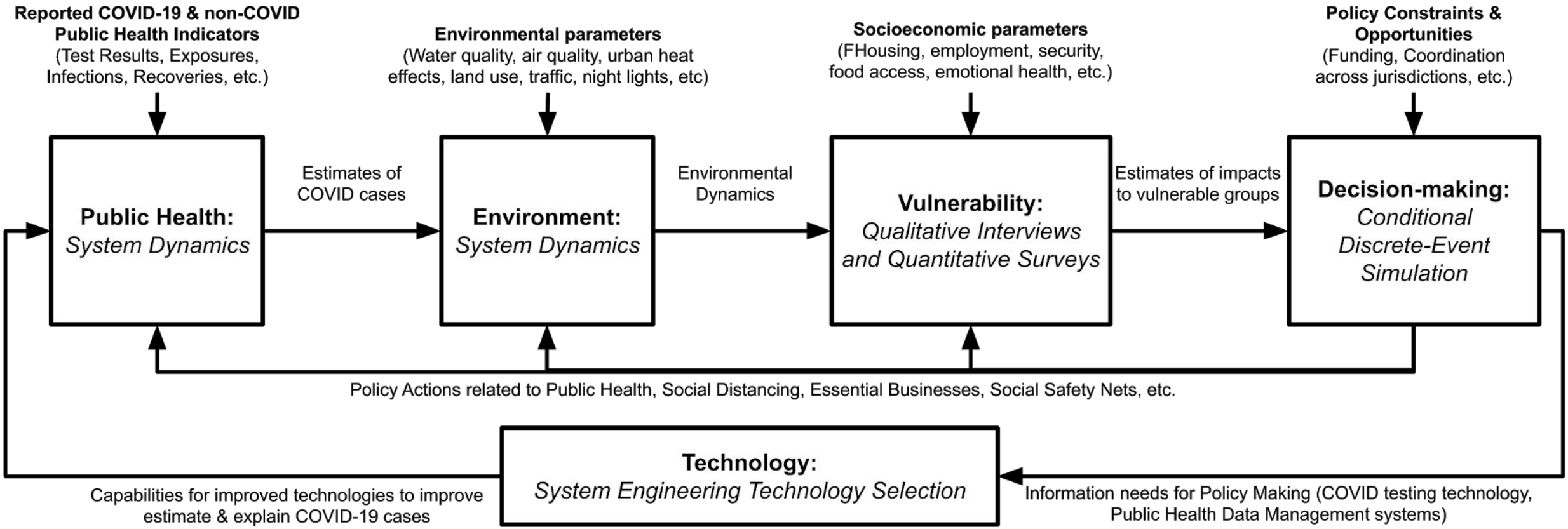
Year	Type of product	Platform
1975	Ortophoto	Aerial (???cm)
1999	Ortophoto	Analog camera (scanned to 85cm)
2004	Ortophoto	Analog camera (scanned to 50cm)
2006	Satellite imagery	Quickbird (60 cm)
2008	Satellite imagery	Quickbird (60 cm)
2009	Ortophoto	Digital camera (25 cm)
2010	Lidar survey	Aerial (10 pts/m2)
2010	Ortophoto	Digital camera (25 cm)
2011	Ortophoto	Digital camera (20 cm)
2012	Ortophoto	Digital camera (20 cm)
2013	Lidar survey	Aerial (2 pts/m2)
2013	Ortophoto	Digital camera (10 cm)
2015	Ortophoto	Digital camera (15 cm)
2016	Satellite imagery	Worldview 3 (30 cm)
2017	Satellite imagery	Worldview 2 (46 cm)
2018	Satellite imagery	Worldview 3 (32 cm)
2019	True Ortophoto	Digital camera (15 cm)
2019	Lidar survey	Aerial (8 pts/m2)

(CS1) User Interface



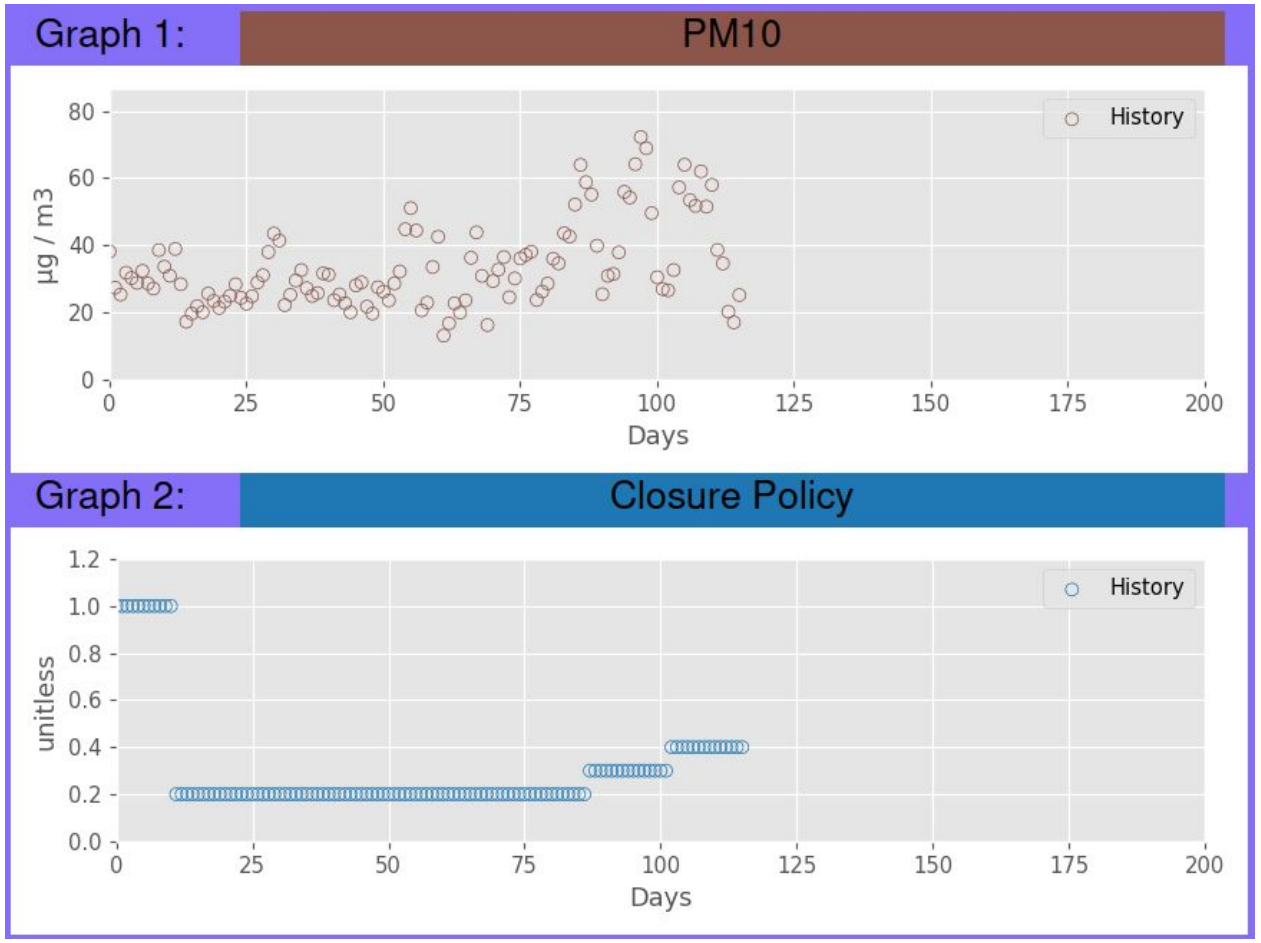
Case Study 2 (CS2): Vida Decision Support System

(CS2) Vida Decision Support System

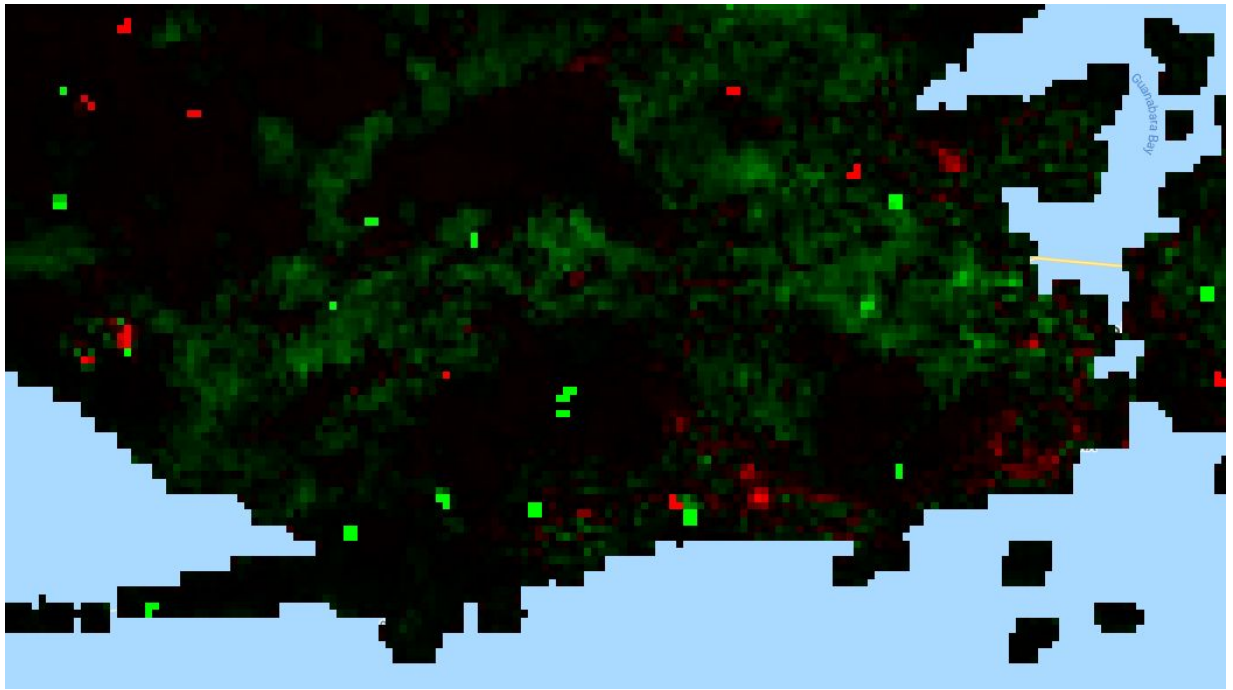


(CS2) Data & Methods: Environment

Air Quality vs. Closure Policy



Post-COVID-Onset Nighttime Lighting Changes



(CS2) Data & Methods: Vulnerability

- *Standard data is starting to "catch up"*
- *Invisible Variables*
  - *Led by Dr. Katlyn Turner*
  - *More information: https://www.media.mit.edu/projects/invisible-variables/overview/*

(CS2) Data & Methods: Decision-making

Recovery Plan Indicators

updated 01/10/2020

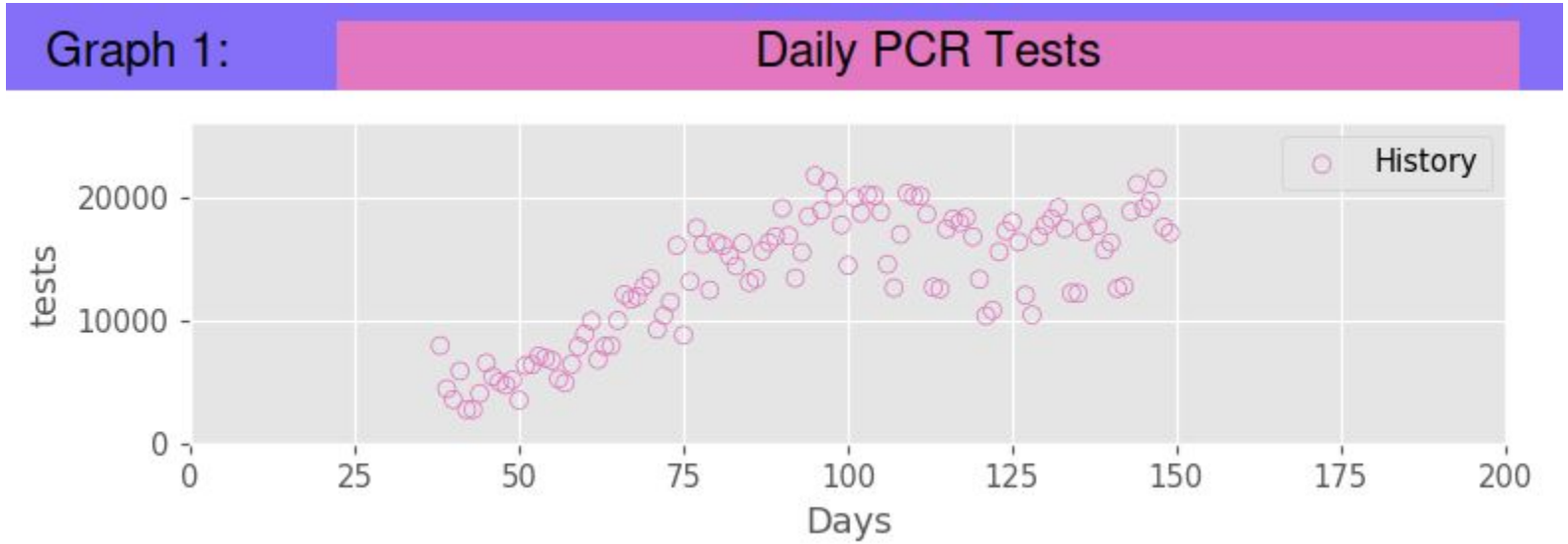
Reference Date: 07/29/2020

GROUP	ANALYSIS PARAMETERS		PRIMARY INDICATORS	F-1	D-5	D-4	D-3	D-2	D-1	Ref. Previous Phase (07/16/2020)	Result (7/29/2020)	PHASE 1	PHASE 2	PHASE 3	PHASE 4	PHASE 5	PHASE 6
			Comparison with previous days									WE ARE IN PHASE 6B (Since 01/10/2020)					
HEALTH SYSTEM RESPONSE CAPACITY	Capacity of ICU beds	1	Percentage of occupancy of dedicated adult ICU beds COVID (ICU SRAG) METRO I SUS bed (7-day moving average)	✗	✓	✓	✓	✓	✓	69.4	71.2	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
		2	Occupancy rate of supplementary sector ICU beds (moving average 7 days) (a)	✗	✗	✗	✗	✗	✗	67.9	70.0	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
		3	Percentage of occupancy of life support beds REDE SUS Territory of the municipality (moving average 7 days)	✗	✓	✓	✓	✓	✓	76.0	77.0	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
		4	ICU COVID beds (REDE SUS) per 100k inhabitants (b)	✗	✗	✗	✗	✗	✓	6.59	6.41	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
TRANSMISSION LEVEL	Variation of deaths	5	Death Variation Rate by COVID19 in each period (Information released at 6 pm on the day, referring to the previous day) (c)	✗	=	✗	=	✓	✓	0.92	0.95	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
	Growth of hospitalized cases	6	Rate of Variation of Inpatients (Clinical + ICU) in each period (Information released at 6 pm on the day, referring to the previous day) (c)	✗	✓	✓	✓	✓	✓	0.92	0.95	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
	Variation of new cases	7	Number of cases reported by Influenza Syndrome (SG) in the last two epidemiological weeks of notification (d)	✓	✓	✓	=	=	=	16,554	13,931	Favorable	Favorable	Favorable	Favorable	Favorable	Not Favorable
OPINION FOR OPENING PHASE ACCORDING TO PRIMARY INDICATORS												Favorable	Favorable	Favorable	Favorable	Favorable	Not Favorable

For more information, see https://riocontraocorona.rio/ and http://inteligencia.rio/planoretomada

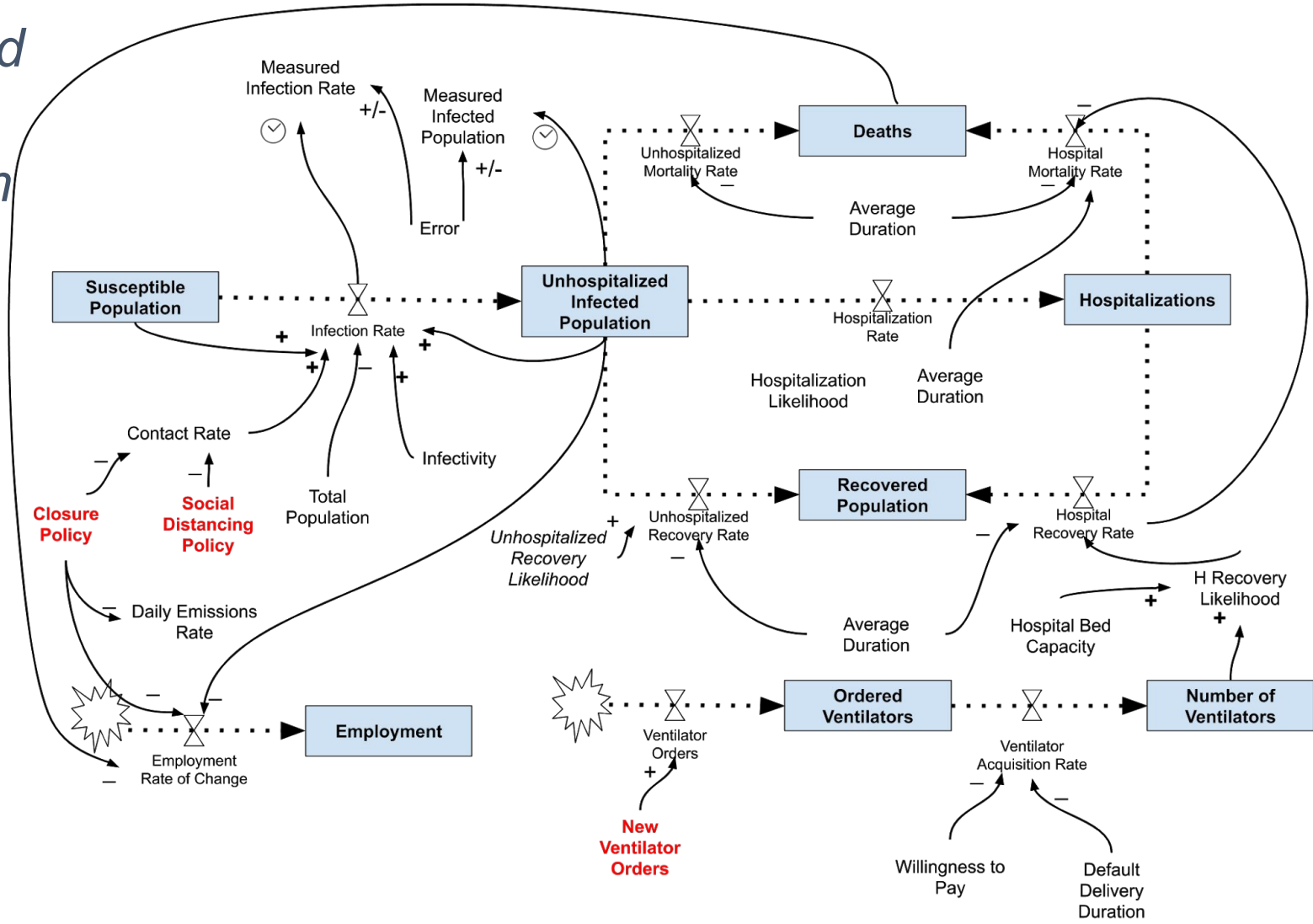
(CS2) Data & Methods: Technology

- *Earth observation systems are still relevant!*
  - *Additional relevant platforms like VIIRS, MODIS, Planet, Maxar, etc.*
- *Various public health sensing technologies and regimes*
  - *PCR and other tests to identify the actively infected*
  - *Antibody tests to identify those previously infected*

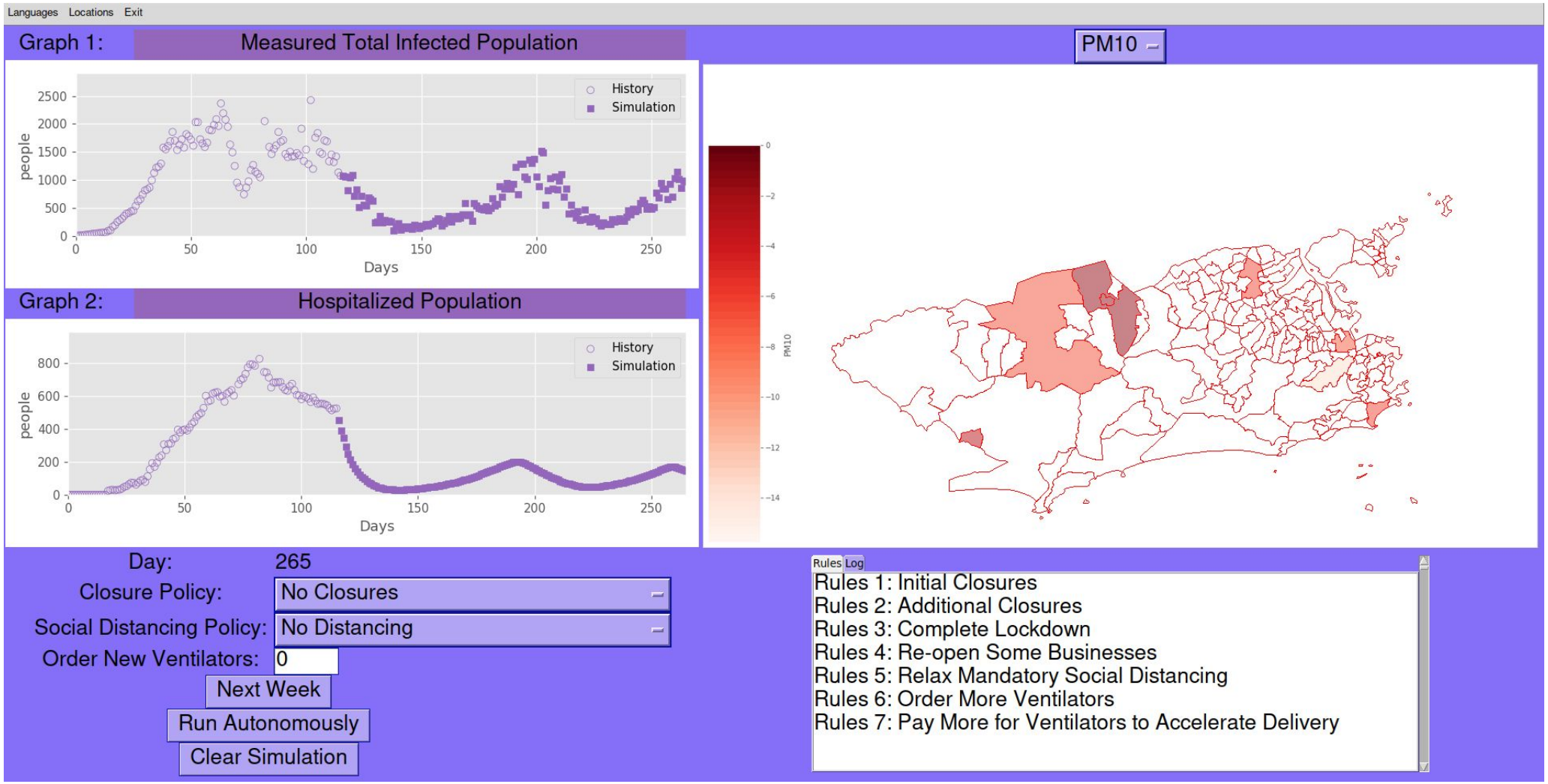


(CS2) Data & Methods: Public Health

- *Susceptible-Infected- Recovered (SIR) Model*
  - *No geographic differentiation*
  - *Literature primarily focuses on epidemiology*
- *Implemented as a System Dynamics model*
- *Currently working on supplementing with an agent-based model and expanding socio-environmental aspects*



(CS2) User Interface



Discussion and Conclusion

Broader Consequences

- *Twin decision support goals*
  - *Support EOS design aimed at sustainable development applications*
  - *Support sustainable development decision-making*
- *Steps to get there*
  - *Expansion, verification, and validation*
  - *Cloud-hosted with an online portal for accessibility*
  - *Open API and library of models*
  - *Community of practice*

Key Design Requirements

- *Rapid Prototyping & Co-Design*
- *Enlist Appropriate Experts*
- *Open Access and Modularity for Adaptation & Reuse*
- *Computational Accessibility*
- *Awareness of Different Stakeholder Needs & Interests*

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