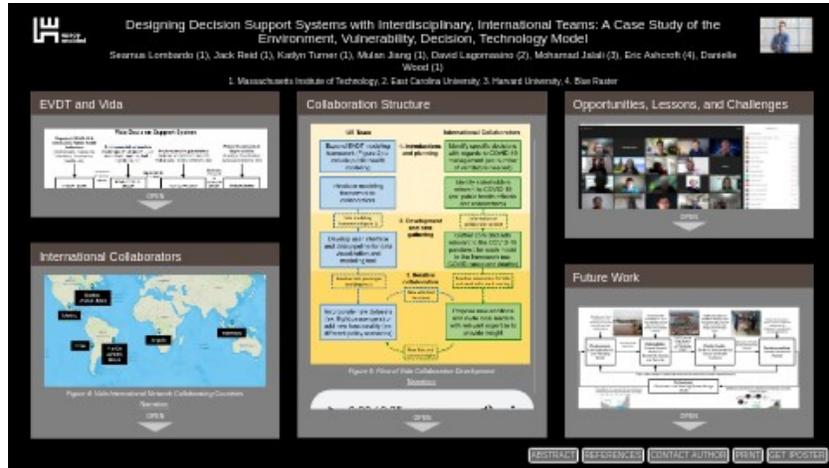


# Designing Decision Support Systems with Interdisciplinary, International Teams: A Case Study of the Environment, Vulnerability, Decision, Technology Model



Seamus Lombardo (1), Jack Reid (1), Katlyn Turner (1), Mulan Jiang (1), David Lagomasino (2), Mohamad Jalali (3), Eric Ashcroft (4), Danielle Wood (1)

1. Massachusetts Institute of Technology, 2. East Carolina University, 3. Harvard University, 4. Blue Raster



PRESENTED AT:



## EVDT AND VIDA

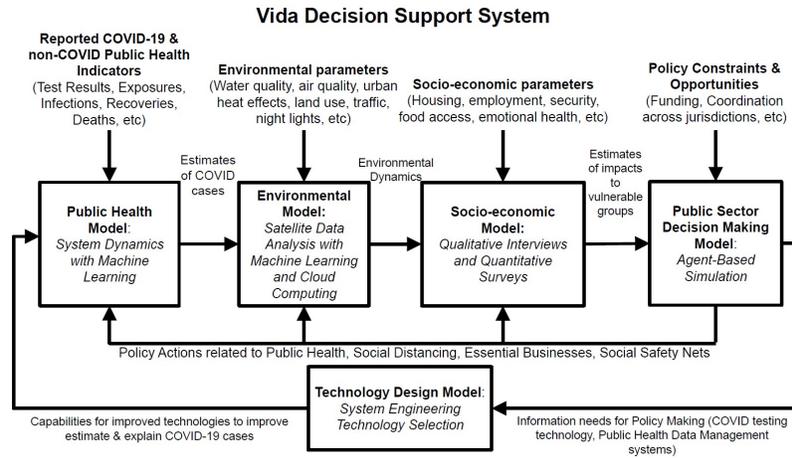


Figure 1: Vida Framework

Narration:

### Motivation

- Policymakers face challenges at the intersection of environmental and socioeconomic factors
- Decision makers must understand complex relationships between these factors, adapt to changes within the community, and address the needs of multiple stakeholders [1].
- Decision support tools utilizing exploratory modeling can facilitate understanding of feedbacks, time delays, nonlinear interactions, and uncertainties to aid decision makers [1].
- Decision support tools that integrate individual models can be used to examine relationships between environmental and socioeconomic factors, public policy, and technology design
- Existing integrated modeling frameworks do not address all of these factors and are often built for users with technical expertise in modeling [2].

### Environment-Vulnerability-Decision-Technology (EVDT) framework

- To address these gaps, the Space Enabled Research Group at MIT has created the Environment-Vulnerability-Decision-Technology (EVDT) framework
- EVDT considers the complex interactions between the environment, societal impact, human decision-making, and technology design (see Figure 2)

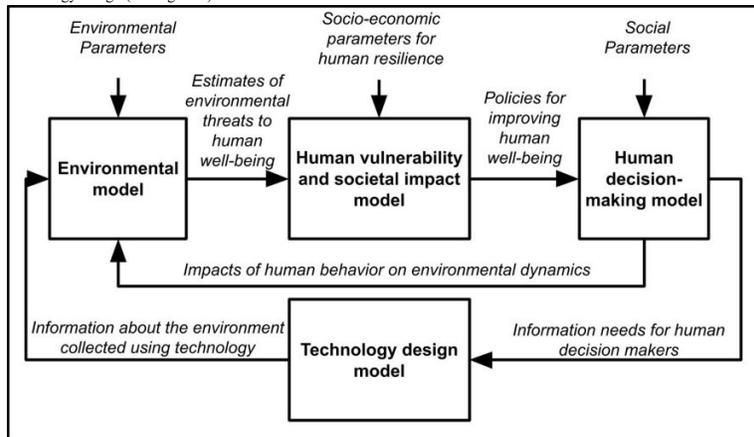


Figure 2: Baseline Version of EVDT [3]

### Vida Decision Support System

- EVDT has been expanded into the Vida decision support tool which includes a public health model to aid decision makers with the COVID-19 pandemic (see Figure 1).

### Vida Prototype Tool

- Prototype decision support tool that combines public health, environmental, socioeconomic, public sector decision making and technology design models
- Examines historical data and explores relationships between these models under different simulated conditions to evaluate potential policies or technological investments with respect to COVID-19

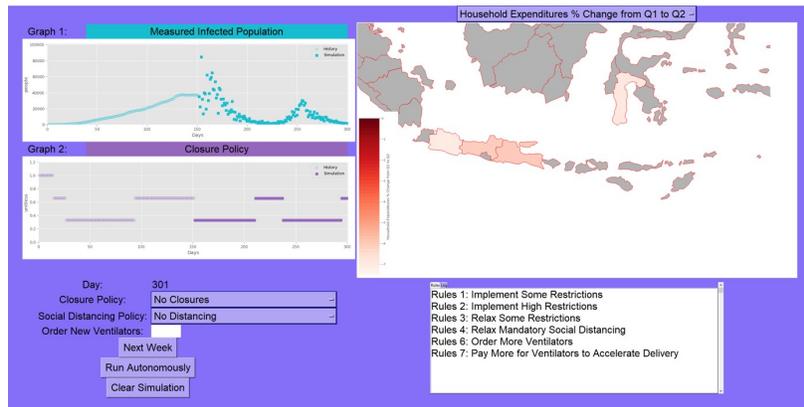


Figure 3: Prototype Vida Tool for Indonesia

## INTERNATIONAL COLLABORATORS



Figure 4: Vida International Network Collaborating Countries

Narration:

### Collaboration Goals

- Vida is currently being designed and evaluated with collaborators in Angola, Brazil, Chile, Indonesia, Mexico and the United States.
- The goal is to create a version of Vida for each collaborator in the network to aid public sector decision making in that country

### Principles of Collaboration

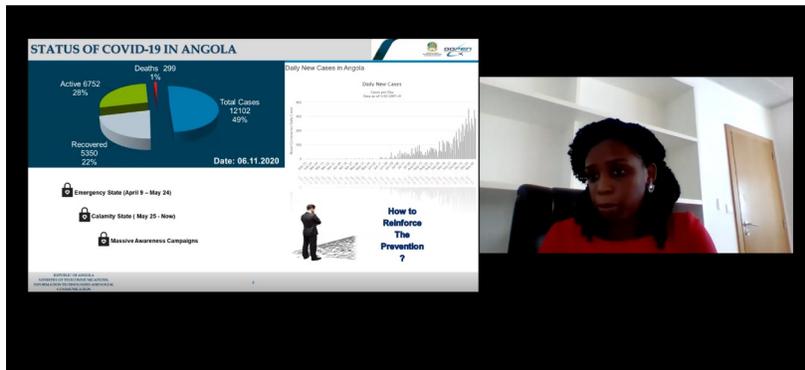


Figure 5: Presentation from GGPEN on Status of COVID-19 in Angola

- To develop Vida versions for each collaborating country, interactive development with our community partners is paramount
- Vida work in each collaborating country has been done at the invitation of local leaders in public services and the work is proceeding under their guidance
- Collaboration with local leaders improves the effectiveness of Vida through identification of important problems, local datasets and relevant stakeholders
- Our collaboration emphasizes the principles of co-creation, inclusive innovation and decoloniality

## COLLABORATION STRUCTURE

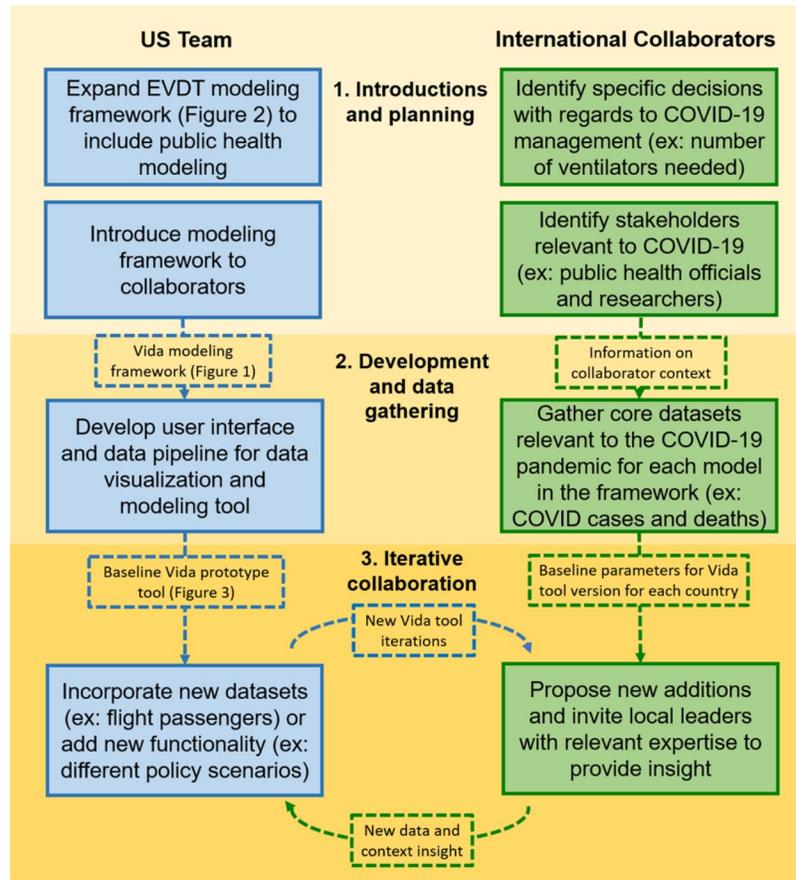


Figure 6: Flow of Vida Collaborative Development

Narration:

**Collaboration Flow**

- Figure 6 shows the general process of collaboration between the US team and Vida international collaborators
- The US team repeated the same general phases with each collaborator with the pace and details of each step unique to each country

**Datasets**

Table 1: Common Vida Data Types

<b>Public Health</b>	<ul style="list-style-type: none"> <li>•Coronavirus cases (active and cumulative)</li> <li>•Hospitalizations and/or ICU occupancy</li> <li>•Coronavirus attributed deaths</li> <li>•Case recoveries</li> </ul>
<b>Environment</b>	<ul style="list-style-type: none"> <li>•Air quality (particulate matter, NOx, CO, etc.)</li> <li>•Water quality (organic material, turbidity)</li> </ul>
<b>Socio-economic Impacts</b>	<ul style="list-style-type: none"> <li>•Local and national unemployment rates</li> <li>•Nighttime urban lighting variation</li> <li>•Air travel rates</li> <li>•Intra-urban mobility rates and patterns</li> </ul>
<b>Public Policy</b>	<ul style="list-style-type: none"> <li>•Business and public activity closures and restrictions*</li> <li>•Individual social distancing and mask requirements*</li> </ul>
<b>Technology Development</b>	<ul style="list-style-type: none"> <li>•Daily testing capacity</li> <li>•Ventilator availability</li> <li>•Sensing technology access</li> </ul>

- Table 1 shows categories of data types common across multiple Vida collaborators

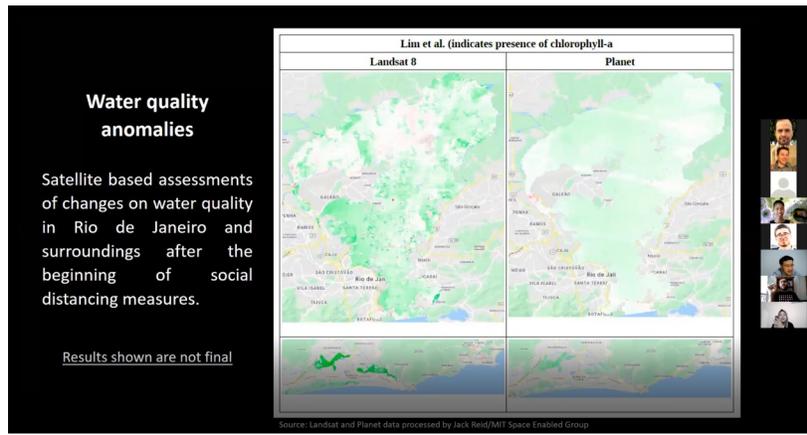


Figure 7: Presentation from Rio De Janeiro Collaborators

- Some datasets were of particular interests due to the specifics of a certain context, such as water quality in the coastal city Rio De Janeiro (see Figure 7)

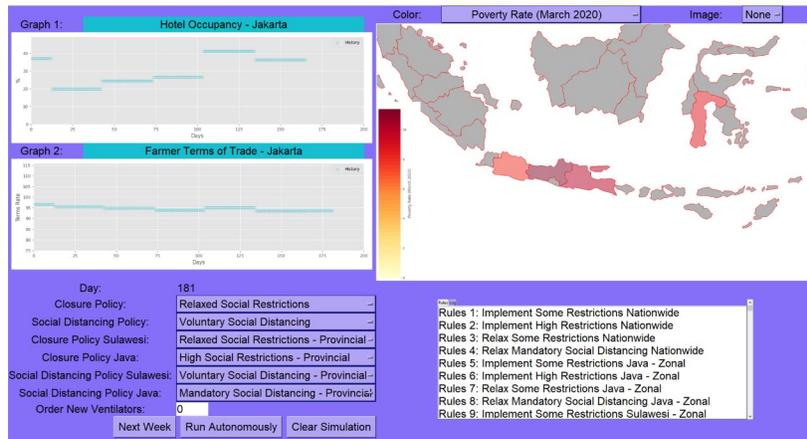


Figure 8: Economic data in Indonesian Vida Prototype

- Other contexts had unique datasets of interest such as hotel occupancy and farmer terms of trade in Indonesia (see Figure 8)

**Communication**

- Communication occurred via regular meetings with each collaborator over Zoom
- Relevant local experts would periodically join meetings to share insights in areas such as public health
- Communication also occurred through other virtual channels such as email and Whatsapp

## OPPORTUNITIES, LESSONS, AND CHALLENGES

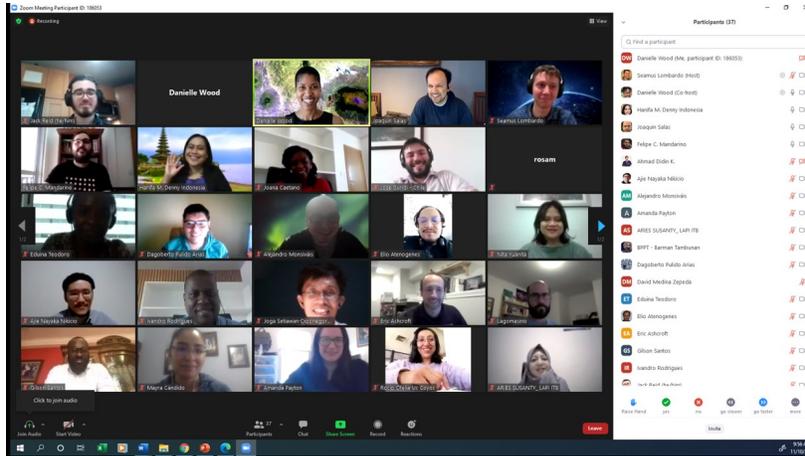
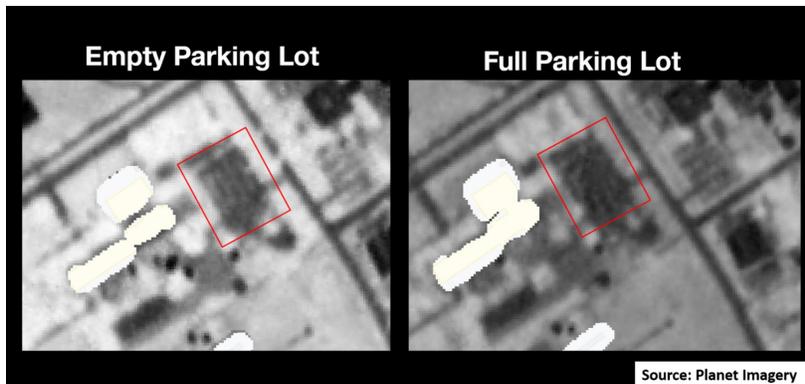


Figure 9: Vida International Network Meeting

### Narration:

#### Opportunities

- **International collaboration** - the Vida International Network has facilitated international meetings where collaborators can share innovations and insights gained from their COVID-19 related efforts (see Figure 9)
- **Intra-country collaboration** - meetings between government officials, academic researchers and community leaders facilitates identification of data gaps and new avenues for collaboration



Source: Planet Imagery

Figure 10: Preliminary Analysis of Traffic Using Satellite Data

- **Increased Awareness and Use of Satellite Earth Observation Data** - use of earth observation data in Vida analyses has demonstrated the utility of this data source to collaborators (see Figure 10)

#### Lessons

- Allow for time to learn the best way to combine diverse data types and find the tools each collaborator prefers

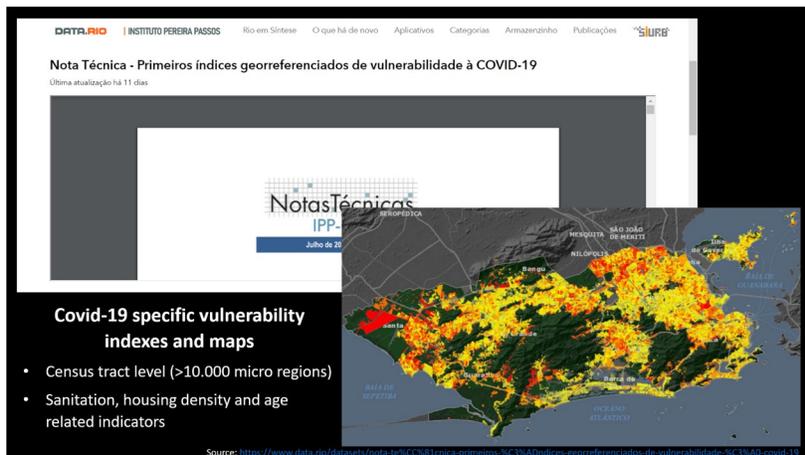


Figure 11: Georeferenced COVID-19 Vulnerability Index for Rio De Janeiro

- Encouraging the use of the preferred language of collaborators has led to cross-country collaborations
  - Ex: Brazil and Angola were able to conduct meetings in Portuguese regarding socioeconomic questionnaires (see Figure 11)

Challenges



Figure 12: Cases Steady in Indonesia (left) but Rising in Angola (Right)

- The state of the rapidly developing COVID-19 pandemic varies from country to country (see Figure 12)
- The temporal and spatial frequency of datasets varies between collaborators

## FUTURE WORK

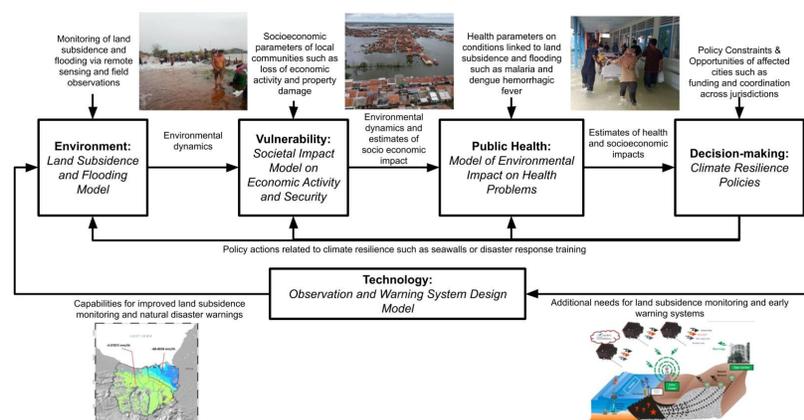


Figure 12: Application of Vida Framework to Land Subsidence in Indonesia

### Narration:

#### Future Work

- Continued intra-country meetings to delve further into modeling and eventually pass on fully functional Vida prototype to decisionmakers
- Continued Vida International Network meetings to share lessons learned on specific topics
- Use of developed networks to collaborate on other important applications of the Vida Framework at the intersections between public health, environmental, and socioeconomic factors
  - Potential examples include the effects of air quality, natural disasters or land subsidence (see Figure 12) on human health

## ABSTRACT

The Environment-Vulnerability-Decision-Technology (EVDT) integrated modeling framework considers the interactions between the environment, societal impact, human decision-making, and technology design to support decision making. EVDT has been expanded to include a public health model in the Vida Decision Support System, which will help local leaders understand the relationships between societal factors relating to COVID-19. Key to the development of Vida are collaborative design and mutual learning with international and interdisciplinary teams. Collaborations with researchers and government officials (including public health, economics, environmental, and demographic data collection officials) in Angola, Brazil, Chile, Indonesia, Mexico and the United States provide in-depth understanding of local contexts. Lessons learned from these collaborations include the value of dialogues with teams from the same region but different topic areas (such as a space agency compared to a public health agency), allowing for time to learn the best way to combine diverse data types and find the tools each collaborator prefers, and encouraging the use of the preferred language of collaborators. During Vida's development, each collaborator has worked to create their own version of Vida using local data sources, the US team has provided prototype analyses and models, and collaborators have shared individual insights among the whole network. These partnerships have yielded promising initial results to support decision making, with prototype tools incorporating local data on COVID cases, the environment, and socio-economic factors from Rio De Janeiro and Chile being evaluated. This collaborative design process will develop insights for decision-making, create a network of international collaborators that can exchange technical methods beyond the pandemic, and emphasize the principles of inclusive innovation and decoloniality by submitting to the preferences of local leaders in each country.

## REFERENCES

1. Marchau VAWJ, Walker WE, Bloemen PJTM, Popper SW, eds. Decision Making under Deep Uncertainty: From Theory to Practice. Springer International Publishing; 2019. doi:10.1007/978-3-030-05252-2
2. M. Masutani, T. W. Schlatter, R. M. Errico, A. Stoffelen, E. Andersson, W. Lahoz, J. S. Woollen, G. D. Emmitt, L.-P. Riishojgaard, and S. J. Lord, "Observing System Simulation Experiments," in *Data Assimilation: Making Sense of Observations*. New York City, NY: Springer, 2010, ch. VI.2, pp. 647-679.
3. Reid J, Zeng C, Wood D. Combining Social, Environmental and Design Models to Support the Sustainable Development Goals. In: 2019 IEEE Aerospace Conference. ; 2019:1-13. doi:10.1109/AERO.2019.8741623