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## Emerging Technology in the Humanitarian Field: MIT Early Issue Identification and Further Applications Today

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*The Think Series showcases the creative and scholarly work of the UVA Humanitarian Collaborative's Summer Research Cohort. Each student explored a pressing issue in the humanitarian field and developed a final product that reflects their unique perspective, highlighting the diverse ways students are engaging with global challenges and imagining new solutions. The views expressed in these projects are those of the author(s) and do not necessarily reflect those of the Humanitarian Collaborative.*

### Overview

Following the 2017 hurricane season in the Atlantic, during which three storms caused over \$275 billion in damages across South Florida, Puerto Rico, and Texas, MIT released a report analyzing FEMA's disaster responses and supply chains to engage in early issue identification. To do so, they employed a model typically utilized in public health and epidemiology called sentinel surveillance. Sentinel surveillance is a holistic monitoring method that uses a variety of indicators and nodes in a network. In adapting this model to fit humanitarian aid delivery systems, researchers identified a set of indicators that humanitarians should monitor to optimize performance, efficiency, and supply chain health. They also created metrics and models that prescribe solutions to identified issues, which they analyzed by hand, but can be streamlined using AI today.

### Sourcing Data

The first thing that humanitarians look at in terms of aid delivery is supply and demand. Under MIT's model, aid-delivering entities should identify the goods or services that they supply along with the sources of demand. In the 2017 case, MIT researchers analyzed bottled water as the supply of interest. As such, they identified the entities from which suppliers were sourcing their bottled water, going all the way to the top of the supply chain. Sources of demand included points of distribution (e.g. centralized locations where affected populations were directed to go to receive supplies) and retail stores, who had supply chains parallel to that of FEMA-based disaster response. Sites of on-the-spot consumption like shelters, fire stations, and responder support camps also accounted for a small portion of total demand. Researchers then collected all the data available to them from these points and players, along with all available situation reports. Given that data in ongoing crisis response can be difficult to obtain and verify the accuracy of, having sets from multiple sources, when available, is beneficial to this form of analysis.

## **MIT's Data Analysis**

MIT's first step in this process was to create a data set of the open/close status of key infrastructure (e.g. bridges and highways), points of distribution, and retailers higher up in the supply chain. A data set like this has two uses: identifying regions or locations with the most outages and identifying supply chains that have not yet been affected at the bottom but will be disrupted soon. Responders can then make more informed decisions about shipment routing, where to prioritize repairs, and re-entry access of those displaced. Descriptive tools are often already used by humanitarians, but data from different sources is not often visually overlaid, identifying one area that emerging technology in GIS could prove useful.

From this initial collection, MIT researchers created a binary set of data that identifies the accessibility of a commodity (1 if accessible, 0 if not) at a given time  $t$ , which could then be used in a predictive nature. Accessibility was determined by the data already collected, in addition to available data on things like inventory levels, shipment data, geographic data, power and communications viability, operational capability (e.g. volume of aid workers), and financial viability of affected populations as available, along with other factors relevant to a given crisis. A formula can be used to determine accessibility based on this data, or humanitarians can use a framework to make a reasonable judgement about whether a commodity appears accessible or not. In terms of time, data may be collected at different points, so humanitarians should identify the most recent time that data was collected as time  $t$ , and note the time of the other data in relation to time  $t$ .

## **Analyzing Data with AI**

With this step of data analysis, AI may prove effective in expediting the process. Existing data can be given to AI, along with a framework for AI making a judgement about availability, and AI will produce accessibility outputs at a faster rate than an individual. Human discretion and situational knowledge may prove more accurate during this part of data analysis, since AI may lack necessary nuances and situational awareness in each given crisis. However, human analysis can also overlook these nuances and can include biases that can sometimes even implicitly influence AI analysis. Success of AI in this process would therefore hinge upon its programming and training.

## **Further Applications**

Once the binary set of data has been determined, MIT researchers have developed complex algorithms that analyze this data and make spatial-temporal judgements in order to identify bottlenecks or other disruptions days before they happen, enabling aid workers to maximize and redirect supply flows. These algorithms can also be used to identify underutilized aid delivery routes; MIT researchers have created not only a baseline prediction algorithm, but also an algorithm that prioritizes restoring outages and therefore indicates where aid workers should focus their efforts, as well as an interdiction model that indicates which parts of the supply chain are weakest and most vulnerable. In the past, one would need a complex mathematical knowledge and understanding to utilize these algorithms, but today, it is fairly simple to copy-paste the mathematical formula into AI, have it write a code that applies the formula to a data set, and then

run the data set through Python or another coding language to make these identifications. The heavy lifting for this mathematical work does not need to be done by human personnel, and aid workers could therefore be trained in what data to collect and how to feed it through AI without having to do complex math or geospatial analysis themselves.

### **Takeaways**

With the use of predictive algorithms and artificial intelligence, humanitarians have access to many new tools that can enhance aid response and disaster preparedness. With every new technology and application of artificial intelligence that emerges, so do ethical considerations. Humanitarians have a responsibility to uphold their principles and mandates as they make these considerations, so while new possibilities are emerging, so are new questions in the field. These include questions about the energy and climate implications of using AI, where to source information from and if and how humanitarians can partner with the private sector, and how to ensure responses and research are both timely and accurate. So, while this innovation is incredibly useful, it comes with a need to consider and mitigate consequences of that utility.

### **Reference:**

Justin J. Boutilier, Jarrod Goentzel, and Michael Windle. Disaster Supply Chains: Moving from Situational Awareness to Actionable Analysis. Massachusetts Institute of Technology: Humanitarian Supply Chain Lab, Center for Transportation and Logistics (May 31, 2019). <https://humanitarian.mit.edu/wp-content/uploads/2020/05/053119-Disaster-Supply-Chains.pdf>.