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working paper series: RIDA+

ADVANCING RIDA:

Rising Above the Deluge

EXECUTIVE SUMMARY

The National Disaster Preparedness Training Center (NDPTC) is developing a decision support tool known as the Rapid Integrated Damage Assessment (RIDA) model. The RIDA model aims to assist early disaster recovery efforts, such as distribution of financial assistance or needed supplies through enhanced understanding of damage and vulnerability. The objective of the RIDA model is to provide decision support and prioritize hazard mitigation efforts so that resources are distributed to those most in need post-disaster. It is conceptually designed to encourage and enable integration of machine learning imagery analysis into damage assessment processes. Additional ways to understand disaster recovery in local communities include vulnerability assessments, asset mapping, and social network analysis.

This project explored such solutions in a case study observing Southeastern Louisiana following Hurricane Ida to interview local community organizations and visit impacted areas amid the early recovery period. From this case study, we find RIDA, in its current form, to be a powerful tool necessitating the incorporation of equity and local knowledge into its evaluation of disaster environments alongside improved technological processes.

This collection of papers focuses on how the local and technical support interventions provided in this project seek to augment NDPTC's RIDA model. To convey this, the paper will discuss the current RIDA model; the utility of the current RIDA model; the need for an evolved model (RIDA+); field work findings; technical support recommendations; local support recommendations; the gaps in the overall model; specific interventions and deliverables produced in this research, and a prioritization of RIDA+ interventions.

1.1 Introduction

A deluge of impacts and information face communities and disaster recovery professionals amid disaster events. The National Disaster Preparedness Training Center (NDPTC)'s decision support and prioritization tool, the Rapid Integrated Damage Assessment (RIDA) model, aims to assist early disaster recovery efforts. Enhanced understanding of damage and vulnerability can allocate resources such as financial assistance or protective materials more equitably. The objective of the RIDA model is to improve the decision support process so that resources are distributed equitably to the most impacted communities post-disaster. It is conceptually designed to encourage integration of aerial and street level imagery analysis through machine learning processes that assess damage. There are additional ways to understand damage, including vulnerability assessments. Vulnerability evaluates a household's ability to recover and complements the aim of understanding damage. Therefore, we recommend that the model adapt its processes to include other tools such as community network analysis, asset mapping, and a refined social vulnerability index to work toward a more equitable recovery following disasters. Specifically, this paper focuses on how the local and technical support interventions provided in this project fit into the NDPTC's RIDA model. To convey this, the paper will discuss the current RIDA model and its capabilities. Then, we will address our fieldwork findings and the need for tools like RIDA in the early recovery environment. Additionally, we will highlight necessary model improvements that advance the RIDA model by integrating equity, localization, and technical progress into its processes. We will then comment on the gaps in the overall model, highlight the interventions proposed, and line out the related working papers that further detail how to advance RIDA to a next iteration. Finally, we prioritize the interventions for the next iteration of this work.

1.2 The RIDA Model

Figure 1.1 illustrates the elements of the RIDA decision support model. In the first stage of the model, pre-storm data is collected from public agency reports and weather trajectory maps to understand highly susceptible areas for weather destruction. To further narrow the potential geography of damage impacts, the model then assesses vulnerability using the spatial areas identified in the initial storm trajectory step. The CDC/ATSDR Social Vulnerability Index is applied to census tract data to indicate neighborhood-level vulnerability to damage. Once these steps are complete, the resulting areas in the storm trajectory with a likelihood of damage impacts are mapped for further assessment post-storm. After the storm hits, aerial imagery is captured in those predetermined areas to triangulate roof damage and changes to building footprints. Using ArcGIS deep learning, modeling algorithms use imagery pre- and post-disaster to detect the presence of damage at a parcel level. Thus far, the process is non-invasive since it can be conducted remotely and without human input or on-the-ground collection of data.

However, the proposed RIDA+ model takes things one step further to categorize severity of damage while also tracking geolocation data. The framework then applies machine learning damage detection models to street level imagery which is captured based on the reports from the aerial imagery step. Once aerial detection and vulnerability narrows the scope of perceived and probable damage, a vehicle geared with 360 street level capture capabilities drives around the post-disaster destruction and takes images of parcel level damage. This step helps categorize the severity of damage while documenting and validating actual damage. The current RIDA model leaves room for iteration and produces damage assessment information, however a concrete, final output must still be defined. How can the RIDA model produce an assessment of damage for every structure in a defined area of need? How can this deluge of data, images, and unique local response be distilled in a solution that is actionable, equitable, and impactful for people in need?

1.3 Utility of RIDA Model

In the recovery process, it can take months to evaluate the extent of damage to a community after a natural disaster. To accelerate this process, emergency managers and disaster recovery professionals are developing data driven tools like RIDA that can expedite damage assessment and supplement planning decisions. Expedited damage assessment processes allow communities to receive more timely aid where it is most needed. However, the RIDA model's current operational period spans several months. In the initial steps, the gathering of pre-event data in the weeks and days before the event takes considerable time and local capacity to conduct. Analysis of pre-event modeling and actual event tracking to identify sites to target for the next phase must be expedited. While analysis of aerial damage detection influences street level imagery capture, it is unclear how each of these data points contribute to overall decision making or planning support related to damage. Since there are no indicators or thresholds to determine where to send field crews for on-the-ground street level machine learning, it is conducted via processes and assessments which need more rigor and robustness.

To summarize, there are two main areas of improvement needed in the current RIDA model. First, analysis of social vulnerabilities is only conducted during the pre-event stage of RIDA's deployment. As the impacts of natural disasters are unpredictable, integration of social vulnerability and equity of assessments should be intentionally designed in each step of RIDA's deployment. Secondly, each type of data collection and analysis within the current RIDA process is only linked by manual processes. Integration of systems as well as use of end-to-end software solutions is necessary to improve the capacity of RIDA, from a technical standpoint. A truly integrated RIDA model will enable the equitable distribution of aid to vulnerable communities in an automated and efficient fashion. Collecting and processing massive amounts of data, the RIDA model can quickly analyze the situation on the ground for emergency responders and more rapidly deliver aid to communities.

1.4 Field Visit Observations

The next iteration of the RIDA model offers an opportunity to build more robust processes that honor local community knowledge and streamline recovery decision support. Further integration of field work experience, research, and technical experimentation influenced our view of the RIDA tool and its methods. To better understand disaster recovery and where

RIDA Interventions

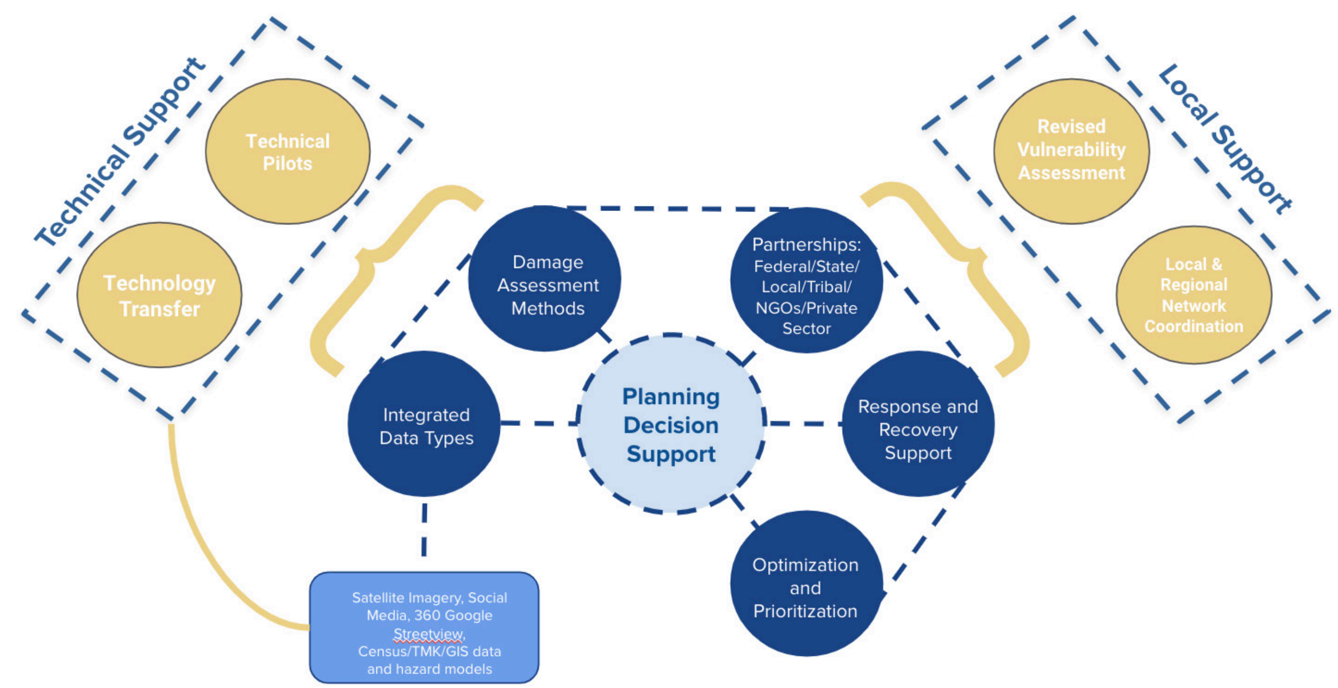

Figure 1.1: Diagram of RIDA+. Existing RIDA framework is featured in blue while the RIDA+ additions are shown by the yellow extenstions of the diagram. Iterating on the existing RIDA framework creates opportunity for greater efficiencies and equity.

RIDA+ Model

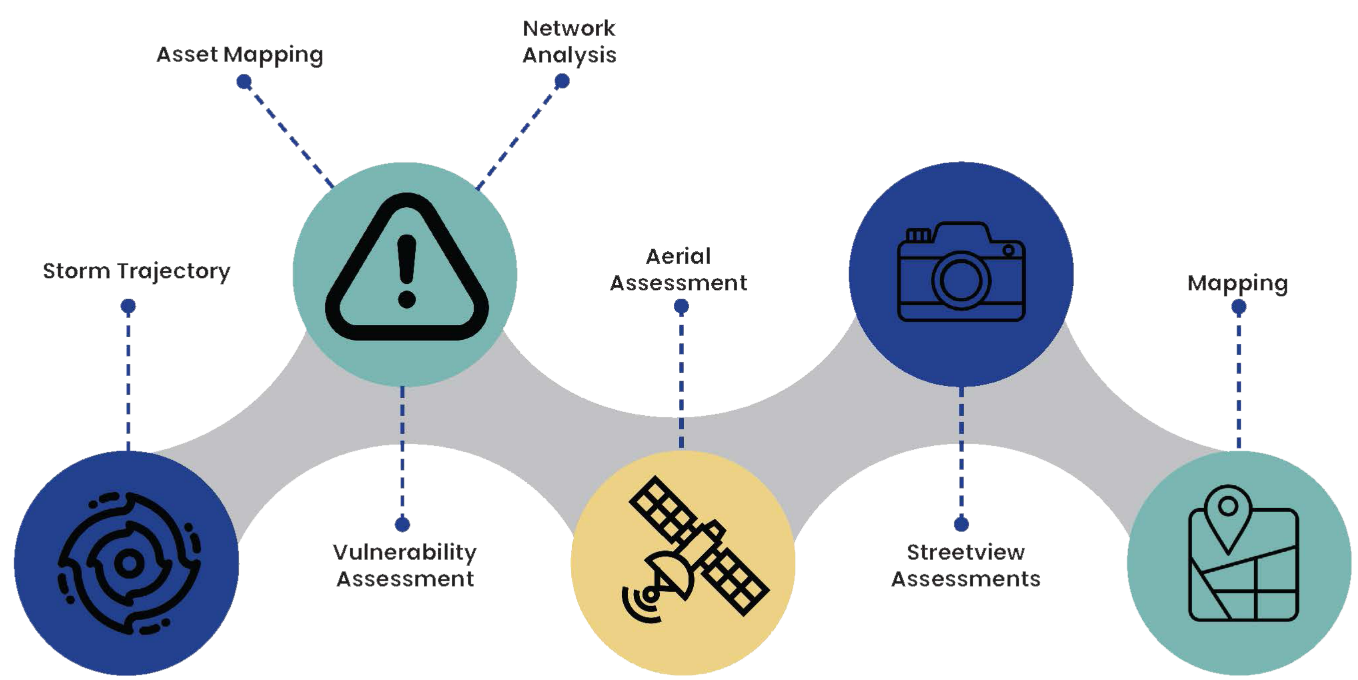

Figure 1.2: Diagram of RIDA+ model indicating the chronological order of steps and interventions

RIDA fits in, our research team visited Southeast Louisiana in February 2022 to meet with and learn from communities and organizations who responded (and continue to respond to) devastation from Hurricane Ida. Intentionally, we visited at time when Louisiana was still in recovery, yet the community and timing offered the benefit of hindisght with regard to response and relief as early recovery was underway. We entered the field with our own assumptions about disaster recovery; some notions were solidified while other hypotheses were interrogated. We were able to get a sense for the challenges professionals on the ground face. Through discussions with community advocacy groups, relief organizations, governmental partners, individuals in academia, and through informal conversations with residents, we garnered a more complete understanding of relief and recovery efforts in addition to the challenges communities in the region have faced since Ida. This field visit aided our understanding of disaster recovery, early recovery, where damage assessment fits in, and why RIDA is a needed tool.

IMAGE COLLECTION

The field visit was a prime platform to test hypotheses and collect relevant data aligned within the context of our work on street level machine learning. We were particularly interested in gathering a wide range of built environment imagery that included varying levels of damage encompassing structures such as stilted homes, multi-dwelling structures, and commercial buildings. In addition to collecting images, some were posted to Twitter to test social media data collection. Using Twitter 's API, our team attempted to extract both geotagged and non-geotagged images to use for machine learning algorithm training. In total, we posted 286 tweets using different hashtags and keywords attached to each image and had success identifying 60 percent of the images that were posted. While the results of social media data collection were mixed, the overall takeaway was that data collection using only event images can be skewed for machine learning purposes.

Imagery collection beyond in-person collection is limited in the field. Local emergency managers and FEMA offices do not typically share nor post Hurricane Ida datasets containing street level images with damage. Often datasets are found through third parties. This comments on the perishability of disaster related damage. Perishability and collection tactics are important considerations as expressed from local residents who have been previously neglected as a result of imagery based damage assessments.

ORGANIZATIONAL CONNECTIVITY

Communication channels between organizations and actors was a central focus of many of our conversations. Multiple organizations conveyed how strong their relationships were with partner agencies, and how fundamental they were in disaster situations to extract insights following an event. From the first meteorological forecasts to the days and weeks following a storm, organizations we talked to, such as the Second Harvest Food Bank and the United Houma Nation, use email and phone as their primary way to talk with partner organizations and residents. The Second Harvest Food Bank relies on the information that is gathered through these channels to coordinate where the need is for resource distribution. Though, the deluge of information (about power outages, urgent rescue needs, where shelter locations are, and more) following a disaster is so rapid that it is difficult to reliably coordinate resource distribution efforts. Further, organizational networks often find themselves siloed from one another leaving certain underserved communities left without vital access to information.

When further questioned about communication techniques, organizations began to acknowledge the limitations of the current methods they relied on and how there were missing links. While strong relationships are important, there was consensus that better communication methods existed to see who was doing what, where resources were going, and where there was still a need. Improving coordination following a disaster can have significant impact in generating effective and equitable resource deployment to guarantee those who are most vulnerable are getting the resources needed to recover. In hearing these sentiments, our team saw RIDA as having the potential to intervene and build better connectivity among local organizations. In integrating the layers of data and networks together under a single platform, organizations can rapidly identify areas most affected by a disaster, see what resources are needed, and what other organizations are responding in the area.

DISJOINTED RESPONSE

Our findings from the field visit also conceptualized the disconnects that impede an integrated disaster recovery. The misalignment and inaction of governmental responses often creates gaps that fall on non-governmental organizations. Professor Robert Collins at Dillard University in New Orleans noted that the resources required for disaster response and recovery greatly exceed the resources of local governments. This demands resources from FEMA, and it also requires support from non-profit organizations to fill any void in local response. Already beyond their means, organizations attempt to meet a range of community needs with limited resources. Information sharing has its own difficulties, and while damage assessments have proven to be successful in creating reliable insights post disaster, if damage information is not properly shared, it can leave organizations excluded from broader relief efforts. These are just some of the ways in which the fractured nature of disaster response and recovery in Ida manifested, but they represent primary points of friction currently in the disaster recovery field.

While we heard about the many challenges in disaster recovery, we also learned of the many efforts underway aimed at a successful recovery. Second Harvest Food Bank runs a massive operation to face disaster events with an extensive network of assets and people. Community organizations maintain local knowledge of the area and individual households. We heard how the United Houma Nation had an image database of residential properties, how the Cajun Navy provided critical post disaster imagery, and how the St. Charles' Assessor uses aerial imagery to assess damage and provide discounts on properties as a form of aid. However, we found that these actions were disjointed and isolated from one another. We learned that this is often caused by local communities being left out of decision making. When outsiders came into communities, they weren't considering the social networks or culture of neighborhoods. In this vein, we saw the need to bring local knowledge and support into the RIDA process. By taking steps within community structures, disaster recovery can have more alignment in the coordination of efforts and resource distribution.

1.5 What is RIDA+

Based on the field visit, we infused observations from this experience and research into various steps of the RIDA model. Further research and testing helped guide our iterations and recommendations as discussed in supplementary working papers. Our team ran pilot programs and experiments on the ground to test and validate certain approaches. Our pilots include a SVI method at the parcel level, a community asset mapping process, a range of scalable methods for aerial and street level imagery machine learning analysis, an evaluation of various technical solutions, and a repository of annotated images. Working papers included in this document outline the finer details of the three core steps in the RIDA process: community network analysis, aerial assessment, and street-level assessment (see Figure 1.2). The working papers dig into each approach. Chapter 2 will cover the "Basics of Machine Learning" and "Street-level Imagery: Machine Learning for Damage Detection." Chapter 3 evaluates the technical tools and processes involved with "Aerial Imagery Deep Learning for Damage Detection." Local support and community network analysis methods are then discussed in Chapter 4, "Community Assets and Networks for Resiliency," and Chapter 5, "Recovery Social Vulnerability Index for Improved Equity."

In general, our final iteration of methods engages with data processing and advancement of local support analysis. The following depictions provide a high-level view of these iterations.

TECHNICAL SUPPORT

Enhancements to Machine Learning Algorithms
Damage assessment machine learning algorithms cannot predict a household's ability to recover from a natural disaster by looking at a single image. Tools like RIDA can be improved to increase damage assessment performance through process standardization and increased representation of communities. To improve the existing RIDA model, disaster professionals should curate a tailored dataset for damage assessment that will lead to higher recall and avoid using trained algorithms that fail to address the needs of vulnerable communities. While all model performance metrics are important

Image 1.1: Sign for a FEMA Disaster Recovery Center in Houma, Louisiana

for analysis, recall improvement should be prioritized at this stage of model development. Recall in damage assessment refers to the number of correct damaged structures detected divided by the total number of structures considered as damaged by the algorithm. A higher recall value can better avoid false negatives in damage detection. This assesses how correctly a machine learning algorithm can determine damage classifications based on its training. Curating a context-specific dataset supports the model in accurately identifying various levels of damage. Incorporating context-specific datasets into machine learning models produces more accurate identification of damage severity to homes within a community. This identification can provide emergency responders with the information needed to quickly identify and prioritize aid in areas that are hardest-hit by a disaster. Damages from disasters can vary by event, by region, and by home type, so it is imperative that neighborhoods are adequately represented when training and implementing the RIDA model.

Additionally, the RIDA model should pivot away from its current damage annotation process provided by CrisisNLP. When dataset annotations are boiled down to none, mild, or severe classifications, this opens the potential for introducing bias into the algorithm. To mitigate potential biases in the model, RIDA should be trained using FEMA's Preliminary Damage Assessment Guide classifications of affected, mild, major and destroyed. Homes are considered affected if the damage is mostly cosmetic. Homes in the minor damage classification have repairable non-structural damage. Homes in the major classification have structural damage or other significant damage that requires repairs, and homes in the destroyed classification have an imminent threat of collapse. These classifications are specifically defined and supplemented with examples in the Preliminary Damage Assessment Guide to prevent subjective classifications that could negatively influence the model.

Finally, the RIDA model should be audited regularly to determine who is not included in the model and to continue training it on a variety of home types. Auditing the performance of a machine learning model for damage assessment is necessary for two reasons. First, comparing the model-predicted damage severity with actual damage categorization of structures determines to what extent the machine learning algorithm is performing its intended function. Analyzing damage classification after each event keeps the model up to date with the changing conditions of natural disasters. Additionally, a qualitative analysis of which impacted communities are not represented in the training datasets provides a foundation for addressing equity concerns using machine learning models. Equity remains of the utmost importance as disaster recovery efforts “often help white disaster victims more than people of color, even when the amount of damage is the same.”[2] Disaster recovery, in its current conception, can often exclude marginalized and vulnerable populations, making it even more crucial to audit damage assessment models regularly. Through curating a tailored dataset, standardizing annotations, and auditing damage assessment machine learning algorithms like RIDA, the damage assessment process can highlight communities most affected by disaster and accelerate the recovery process.

For more information, please review Chapter 2 which includes “Basics of Machine Learning” and “Street-level Imagery: Machine Learning for Damage Detection.”

Enhancement to Aerial Damage Assessment

The utility of aerial damage assessment can be significantly increased by adopting a classification

Image 1.2: Street-level imagery of disaster damaged stilted homes

scale for damage based on the FEMA framework's 1-4 scale. Additionally, the model can incorporate multiple layers of assessment to increase accuracy and provide a more holistic view of damage. Implementing a classification for damage assessment results in faster disaster declarations and more equitable distribution of aid. Further, by aligning damage assessments with FEMA, it helps individuals ensure they receive the maximum amount of aid since the system is contingent on the verification of damage. In addition, since FEMA uses geospatial inspections to verify losses, it is already a proven way to determine expedited eligibility and delivery of initial assistance, especially for large numbers of individuals.[1]

Aerial imagery also supports other objectives in disaster recovery outside of streamlining aid. Through the creation of a multi-faceted model, aerial imagery provides additional support for debris removal and roof repair. For instance, using deep learning techniques like object detection in combination with the damage classification supports individuals in accessing the blue roof program through FEMA. Openly providing this information to residents can support their insurance claims and significantly reduce the burden of providing documentation to access support through these programs. More broadly, the proliferation of aerial imagery via drone and satellite operations can allow for a more open source approach to disaster recovery. Analysis of photos can also be opened up not just to any GIS analyst but community members and volunteer actors operating online to evaluate on-the-ground circumstances. That open source imagery analysis can support local recovery organizations in efforts to understand damage and community needs. This can reduce friction in resource distribution and speed up recovery.

A key argument going forward is that aerial imagery has tremendous possibilities beyond just assessing damage hotspots. The analysis of imagery can still highlight areas of need but the output of this analysis can also factor into the broader RIDA model. Building and roof damage can be assessed at the structure or parcel level and factor into a broader model which ties in street level imagery and social factors. The tools and capabilities exist to merge all of these variables together.

More information is reviewed on the details of this process and specific techniques in Chapter 3 "Aerial Imagery Deep Learning for Damage Detection."

LOCAL SUPPORT

To increase the robustness of the existing RIDA model, modifications to the vulnerability assessment process and additional local support practices are recommended. Doing so will help RIDA+ to better adapt to local contexts, prioritize tool deployment, and ultimately provide equitable and holistic disaster recovery. Iterating on the traditional social vulnerability index (SVI) to include disaster recovery specific variables can help disaster managers and local officials to better identify communities that may experience slower recovery times. Additionally, the creation of a parcel level SVI provides a greater level of nuance in vulnerability assessments, especially in rural communities where census tract level data may not accurately reflect the spatial distribution of resources. Importantly, these innovations help to better prioritize the deployment of street level damage assessments to help provide aid to communities who need it most following a disaster.

In addition to the social vulnerability index, participatory asset mapping processes and community network analyses provide a more comprehensive look at disaster recovery. A community's ability to prepare for any type of disaster is strengthened by acknowledging and supporting existing resources, knowledge, and relationships. When identified, community assets and networks present a roadmap for disaster preparedness that reflects the unique experiences, vulnerabilities, and capacities of an area. This community network-based approach to disaster management shifts the reliance on distant, higher levels of government to networks of established community partners. By training disaster responders to work with communities to create asset maps and network analyses, NDPTC can help to build trust between disaster planning and management professionals and the communities they work in. Further, this information can be used to create locally contextualized vulnerability assessments that are able to incorporate characteristics of a community not captured in standardized datasets.

Image 1.3: Initial Hurricane Ida impacts (New York Times)

Local support is more fully investigated in the working papers contained within this book: Chapter 4, "Community Assets and Networks for Resiliency," and Chapter 5, "Recovery Social Vulnerability Index for Improved Equity."

1.6 Closing the Gaps

There remain gaps both in the current RIDA model and in the scope of what this research was able to achieve in recommending an advanced RIDA+ model. Key domains which can close the major gaps in the RIDA tool going forward include building a map which integrates both aerial and street level imagery, advancing the incorporation of a social vulnerability index, and more fully connecting local support and technical support in one final product.

INTEGRATIVE MAPPING OF AERIAL AND STREET LEVEL IMAGERY DATA

Intersecting information gathered from both aerial and street level imagery is critical to gathering granular information on structures for damage assessments. If an aim of rapid damage assessment methods is to not only understand where areas of need exist following a disaster, but to also provide a textured and specific analysis of damage to structures, then the pairing of data is paramount. Key to the pairing of such aerial and street-level imagery data is a unique geolocated identifier. To evaluate structure by parcels, it makes sense for parcel IDs to be the link. Coordinates or another geolocated spatial fabric are other potential options. The spatial nature of geoTIFFs and other aerial imagery allows for a comparison with assessing parcel polygons to associate an ID number with a damage assessment score. However, street-level imagery is not as simple to associate with a parcel ID or individual home address. The geolocation of each photo is often the location of the vehicle mounted camera on the road. Thus, a process should be implemented which would capture the address, a more clear and informed association with the parcel number, as well as tagging a photo with more exact geolocated info in order to pair the information. Solving this geolocation issue will allow an exact pairing between the output of imagery analysis from the bird's eye view with the ground level.

FURTHERING SVI

To increase the efficacy of the social vulnerability index (SVI), it is necessary to integrate additional measures that add nuance to our understanding of vulnerability. One way of accomplishing this is by using multiple units of analysis to capture both macro and micro perspectives of vulnerability. On the macro level, it is important to cater social vulnerability indices specifically to disaster contexts to capture the variables that speak directly to a household or individual's capacity to seek out recovery resources. These types of indicators, such as renter occupancy, and access to internet connections are widely available on the census tract level. Aggregating and averaging these types of variables across the census tract provide a sweeping overview of a large population and allow users of RIDA+ to make first level prioritizations for tool and resource deployment. For rural and sparsely populated regions where census tract level measurements are inadequate, parcel level SVIs provide a closer glimpse of vulnerability and enable us to identify clusters of at-risk households. This can further support the prioritization of RIDA+ deployment. For a more detailed look at SVI development, refer to our working paper on the topic.

In addition to the inclusion of a parcel level measurement of vulnerability, incorporating asset mapping processes can help the NDPTC and other emergency managers identify resource gaps in a region. This type of analysis contributes to our understanding of vulnerability and indicates which households may lack access to valuable resources that aid in the recovery process. Including an assessment of local assets and community networks will contribute to the overall equity embedded in the

RIDA+ model. In addition, the process of asset mapping in tandem with local communities can increase the level of trust that residents and local leaders have in disaster recovery frameworks such as RIDA+. These relationships can be leveraged to improve crowdsourced data and image collection following a disaster.

BRIDGING LOCAL AND TECHNICAL SUPPORT

Output from this project focused on two discrete angles in bolstering the rapid damage assessment framework and decision support model: local support and technical support. However, incorporation of these interventions is not the final output. The connection between local knowledge and technological innovation is a critical juncture. These two arms of research and recommendations are deeply intertwined and each ought not exist in the absence of the other or independently in a vacuum. The two must be integrated and speak to each other coherently.

It can be tempting to deploy technology to solve a problem at a distance using computing capacity. However, reliance on technical solutions alone can do real harm. This trust in the machine can leave out particular communities and populations given certain programming or decision-making biases. Machine learning damage assessment without reference to social vulnerabilities and the historic context of a community may lead to interventions that further expand resource and recovery gaps among communities within a region. And while local knowledge is absolutely essential to understanding recovery processes following disasters, when this information goes uncaptured or unshared it can limit recovery timelines and resources delivered. Analog methods which utilize human processes to gather data, do so with less efficiency than machines, yet capture qualitative and unstructured data. Joining the output of SVI information, network analysis, and asset mapping with damage assessment date (output from machine learning analysis of imagery) at the parcel or structure level is key to bridging this gap in a future version of RIDA.

TECHNOLOGY TRANSFER

To ensure that the technical support interventions outlined in this project are adopted, technology transfer needs to be carried out between all participating entities. In order to fully realize a more accurate, equitable, and powerful RIDA, entities engaging in research need to both produce findings and clearly communicate such output openly. This is crucial so that teams which run the gamut from technical to local, academic to disaster recovery can continue the work to build and improve the model.

This team is making available a Github repository and public website that hosts datasets, coding notebooks, and video tutorials on how to customize a machine learning algorithm. Additionally, process recommendation documentation, ample background in white papers, a presentation, and other means will transfer this information to NDPTC and those investing time and capacity in RIDA. However, while this technology transfer between organizations with planning and technical capacities should be sufficient for the project to be carried forward, a real question exists on how technology transfer to local communities can be executed. Local support relies not simply on analysis of the community using secondary data, but input directly from stakeholders, residents, and neighbors. These perspectives are critical to understanding community needs and capacities. But there is also value in opening the capabilities of the digital tools and technical processes necessary to rapidly assess damage to local communities. The technology transfer from technologists to community advocates is key to developing the process of decision support and analysis most fully and equitably. Opening the tools, processes, and data collection up to the community can allow for unlimited potential. Laboratories of experimentation will form and local knowledge will organically pair with technical analysis.

PUTTING IT ALL TOGETHER

The research, experimentation, and evaluation of approaches undertaken in this project has produced local and technical support interventions which form an array of deliverables for the team at NDPTC to explore and pursue further.

While these products do not completely solve all of the challenges outlined here, these deliverables contemplate and craft approaches to close the gaps. There is not one final packaged solution or fully built out RIDA+ model. Instead, an evaluation of tools, methods, experiments, research, and recommendations are included. All of these products argue for advancing a RIDA+ model which incorporates equity, information sharing, open source tools, and local knowledge alongside emerging machine learning techical capacities. These deliverables outline a vulnerability index, community asset mapping, network analysis, a data repository, aerial imagery deep learning analysis, and street level imagery machine learning analysis. Now, the subsequent decision is where to focus attention in the next phase.

1.7 Advancing RIDA, Prioritizing Interventions

To advance RIDA, close the aforementioned gaps, and build upon the original conceptions and interventions proposed in this research proposal, more work must be done. More time, human capital, energy, resources, and funding must be marshalled. Building RIDA+ will require grant dollars, academic research, and technical capacities. Five key projects should be considered for funding going forward:

1) Vulnerability Assessment
2) Community Asset Assessment
3) Data Collection Repository
4) Advanced Aerial Damage Assessment
5) Advanced Street Level Damage Assessment

In this section, each project is evaluated and prioritized for future efforts that may include a grant funding proposal. Each effort will provide critical dimensions to the RIDA+ framework and model in the next iteration. The interventions are assessed based on cost, time, impact, innovation, and growth potential. Scored on a scale of low to high (1 to 3), the most points equate to the highest priority assigned. Cost is the anticipated dollar figure, and time required the expected amount of hours needed for research and production. These two criteria are scored with a higher point score for a lower number of dollars and hours required. Impact is the benefit to the public in a scenario where public grant funds are utilized in advancing research to benefit people in communities. Innovation expresses a novelty and uniqueness in approach which can be a technical solution or a

RIDA INTERVENTION PRIORITIZATION SCORING

	Cost ($)	Time Required	Impact (Public Benefit)	Innovation	Potential	Total
Vulnerability Assessment	Low (3)	Low (3)	Medium (2)	Low (1)	Medium (2)	11
Community Asset Assessment	High (1)	High (1)	High (3)	Low (1)	High (3)	9
Data Collection Repository	Medium (2)	Medium (2)	Medium (2)	Low (1)	Medium (2)	9
Aerial Imagery Damage Assessment Analysis +	Medium (2)	High (1)	High (3)	Medium (2)	High (3)	11
Street Level Imagery Damage Assessment Analysis +	Medium (2)	Low (3)	High (3)	High (3)	High (3)	14

Figure 1.3: Table reflecting the scoring of recommended interventions/projects. The total signifies the prioritization based on scoring of 1-3 for each project.

reconfiguration and reenvisioning of existing concepts. Finally, potential outlines the opportunity for expanded utilization and implementation of a method. Impact, innovation, and potential all weight more points towards high scoring projects.

Based on this assessment, the highest priority project in the next iteration is the Street Level Damage Assessment Analysis. This aspect of RIDA is high in impact, innovation, and potential. Next, the Aerial Imagery Damage Assessment Analysis and Vulnerability Assessment should be prioritized. Further improvements to the SVI and incorporation of vulnerability add value to RIDA by incorporating equity. Aerial analysis is also a significant public benefit and opportunity for growth potential. Aerial imagery analysis should be prioritized due to the critical capabilities this imagery has in identifying structural damage over wide regions and the ideal geolocated connection at the structure level which can be forged between aerial photos and street level photos. This project is a necessary companion to street level machine learning analysis. While the time required to advance this method is higher, there will be significant public benefit and there is growth potential as satellite and aerial imagery become more readily available.

Image 1.4: Street-level imagery of disaster damaged homes

Finally, Community Asset Mapping and Data Collection are important projects that are lower priority, however it should be noted that in both cases the mapping and data collection may be a necessary step in other higher priority projects.

1.8 Conclusions

Processing information in the aftermath of a disaster event is an enormous undertaking. This is true for impacted individuals, emergency responders, community-based organizations, disaster recovery professionals, communities, regions, and governments. The resources needed often exceed the those available in the community. Organizations must rapidly unleash efforts to distribute supplies in an equitable and efficient manner. A homeowner must interpret the rules and procedures for filing a FEMA claim for a roof destroyed by wind damage. A mother and her child must face the realities of a flooded apartment and lack of funds to recover or relocate, let alone pay the rent.

In early recovery, a confluence of residual storm impacts and long-term planning decisions must be navigated. All along the way, data and facts regarding real world devastation can be captured. Documentation of such damage and perishable data early on is valuable. Automated analysis of such data adds even more value. This is vital if emergency professionals, planners, and communities seek to effectively and efficiently manage the deluge of data as disaster events increase in frequency.

RIDA, in its current form, is an advanced model with unique capabilities and much potential. The next iteration can advance this powerful technology and include key components from the outset: equity, openness, and information sharing. The facts on the ground illustrated in street level imagery, aerial orthophotos, and other available data will point to built environment damage. But it is the impact on communities, households, and people that must be integral to the RIDA model and disaster recovery efforts. Taken further, the information must be made public, shared with little friction, and open sourced. More access will spur innovation and interest to innovate and advance RIDA. We offer a set of technical and local interventions, recommendations on how to advance RIDA, methods that can build a robust RIDA+, and a desire to rise above the deluge.

ENDNOTES

1. Flavelle, Cristopher. (2021). Why Does Disaster Aid Often Favor White People?. New York Times.

2. Individual Assistance Program and Policy Guide, FEMA. p 74

RISING ABOVE THE DELUGE

ADVANCING RIDA: RISING ABOVE THE DELUGE

Prepared by U-M Deluge Capstone Team

about this project

This project is a joint effort by students and faculty within the Master of Urban and Regional Planning program at the University of Michigan and the National Disaster Preparedness Training Center (NDPTC) as a Capstone project for the Winter 2022 semester.

A key focus of the University of Michigan team is to work in a manner that promotes the values of equity, valuing local voices, transparency and honesty. As a result, the outcomes of this capstone aim to speak to both our collaborators at the NDPC and the local communities impacted by disasters across the United States. Our responsibilities as researchers will also include the implementation and/or recommendation of innovative solutions to issues surrounding machine learning, damage assessments, prioritization determinations, and social infrastructure networks.

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