Evacuation with Efficiency:

An Inland and Coastal Flood Based Emergency Evacuation Planning Scorecard Proposal

Applied Research Paper:
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Abstract

Numerous communities of all sizes and in all regions of the United States face chronic natural hazard events every year. Flood events account for the economically costliest disasters in the United States and have become particularly more dangerous with the onset of climate change and the crumbling state of American infrastructure. These natural hazards are also considerably dangerous in account to the lives lost per year. Though universities and government agencies have created natural hazard resilience scorecards for planners and engineers to fill out, these are either tied to fiscal or public relations incentives, can be daunting to fill out, and do not cover an integral piece of natural hazard mitigation and resilience planning—emergency evacuation efficacy.

This paper focuses on the need for flood-based natural hazard resilience planning in 2021 and beyond, as well as the importance of having an implementable quantifying scorecard for communities to assess their current status as it comes to emergency evacuation plans and programs. This paper will present a transferable and implementable scorecard, named the Flood Emergency Evacuation Scorecard (FEES) for planners, emergency management professionals, and engineers to rank and score their communities on their community's level of flood-emergency evacuation, mitigation, preparedness, response and recovery efforts. Given the diverse nature of flood origins, a sample scorecard for these professionals will be the paper's proposal. The city of Baltimore, Maryland, Tulsa County, Oklahoma and New Orleans, Louisiana are the three earliest adopters of the FEES, and have agreed to fill this scorecard out for their own jurisdictions after this paper's publication. Given the increasing demand for flood-based mitigation, preparedness, response and recovery efforts in particular regions of the United States, actions need to be made to include and consider the economic, environmental and social implications of necessary flood-based natural hazards planning, evacuation planning, and the necessary economic and policy directions for progress.

This paper-a product of the Georgia Institute of Technology School of City and Regional Planning-is part of the effort to produce applied research for students that are not on track to complete a Ph.D. Previous applied research papers are posted on the internet at https://planning.gatech.edu/mcrp-research-papers. The author may be contacted at iannewman91@gmail.com.

Key Words: scorecard applications; emergency evacuation planning; natural hazards; infrastructure; New Orleans; Baltimore; Tulsa; floods; chronic; communities

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Introduction:

The presence of the ongoing COVID-19 Pandemic has overwhelmingly illustrated the dire consequences stemming from a lack of preparation in emergency management planning. The year 2020 has not only held the world victim to biological disasters but has also borne witness to the continuation of natural disasters. The combination of both have proved devastating to some communities, especially those that face these disasters chronically. Though the world grapples with the Coronavirus Pandemic through 2021, both natural, and human-induced disasters/failings, such as the ERCOT systems power outages across the state of Texas in February 2021, will not cease in their vitiation of communities and jurisdictions, and the incurring socioeconomic damage cannot be ignored. This paper will discuss the implications that can be derived from one way in which the regional planning and emergency management communities can work together to lessen the socioeconomic communal burden that flood events, whether they be chronic or not, impose on communities.

Flooding is not only an incredibly prevalent natural disaster in the United States, but it is also a unique hazard since it can be derived as a result of the crumbling state of flood-mitigation infrastructure and structural measures found across the United States. The American Society of Civil Engineers (ASCE) reported a letter grade of 'D' in their "Report Card for America's Infrastructure," citing a lack of funding for dam safety programs, dam abandonment, ageing of the country's infrastructure and downstream development. Further, The Association of State Dam Safety Officials (ASDSO) estimated that there are more than 2,000 dams nationwide categorized as high-hazard dams in deficient condition (Graber, 2020). The crumbling state of flood mitigative infrastructure and structural measures highlights the necessity for stricter building standards and structural measures policy, in order to address risk of fatalities, injuries and economic damage.

One example that highlights ASCE's D letter grade for the United States of America's state of infrastructure occurred during the May 20, 2020 Midland, Michigan flood. The Central Michigan city of Midland witnessed a once in 500-year flood event on May 20, 2020 due not only to the floodwaters from several days of heavy rain from the churning off of Tropical Storm Arthur, but from the consequence of this heavy rain that breached the already-substantially cracked Edenville

Dam. Boyce Hydro LLC's license to operate the Edenville Dam was revoked two years prior by the Federal Energy Regulatory Commission (FERC) which cited noncompliance issues including spillway capacity and the inability to withstand a major flood. Due to the failing of the Edenville Dam, flood water was able to flow over and around the compromised Sanford Dam, downstream in the Tittabawassee River. The Tittabawassee River crested at 35 feet, 10 feet above flood level, and broke the river's previous record of 33.9 feet; its crest at 35 feet was only three feet away from reaching the direst projection of 38 feet (Donnelly & Dickson, 2020). This left Midland and its surrounding towns of Edenville and Sanford to evacuate approximately 10,000 residents not only during this declared 500-year flood event, but also during the ravaging presence of COVID-19 throughout Michigan in Spring 2020. Fortunately, there were no reported injuries or fatalities in the evacuation of residents to nearby high schools and family centers; however, 2,500 homes, businesses and nonprofits in the area were either destroyed or damaged with estimated losses of $175 million, according to Mark Bone, chairman of the Midland County Board of Commissioners (The Detroit News, 2020 & Detroit Free Press, 2020).

Though there were no reported injuries nor fatalities resulting from the Midland flooding in May 2020, in the last three decades, an average of 86 people die in floods each year. In the last decade that number has increased to 95, and since 2015 there has been more than 100 annual deaths due to flooding. These floods have not only been occurring in coastal states but have been occurring most prominently in inland states, which is expected to continue as climate change increases the risk of heavy rainfall events and an increase in other natural hazards that can bring heavy rainfall events along with them. In fact, eight of the 10 states with the most flooding disasters are inland states (Lam, 2018). Coastal flooding is also projected to increase due to heightened sea levels as well as the increase in intensity of hurricanes and coastal storms since the 1970s (Union of Concerned Scientists, 2019).

Flooding is unique compared to other natural hazards because of its distinct, yet interrelated, origin types: inland flooding, coastal flooding, flooding as a result of other natural hazards such as hurricanes and tsunamis, and infrastructure failure. The United States experienced 108,600 flood events, with an average of 1,810 flood events per year in the time frame from January 1, 1960 through January 1, 2020. The minimum amount of flood events the United States experienced in

this time frame was in 1962 with 180 floods and the maximum amount of flood events occurred in the year 1993 with 5,027 floods. Since 1960, 21,858 of the 108,600 total flood events were Presidentially Declared Disasters (PDDs). A PDD is a disaster for which the president of the United States issues a major disaster declaration and authorizes the provision of individual and/or public assistance from federal agencies such as FEMA (Texas Department of Housing and Community Affairs, n.d.). **Figure 1** shows the number of flood events/records recorded in the time frame of 1960 - 2020, in addition to the 17 other declared natural hazards from the Spatial Hazard Events and Losses Database United States (SHELDUS) for comparison. **Figure 2** also shows the number of flood evets/records from this time frame, but with fewer hazards (six total) for greater visual clarity, the same y-axis values, and with the same colors for the hazard types.

Figure 1: 1960 – 2020 Records of all SHELDUS Natural Hazards with Floods in Yellow Green

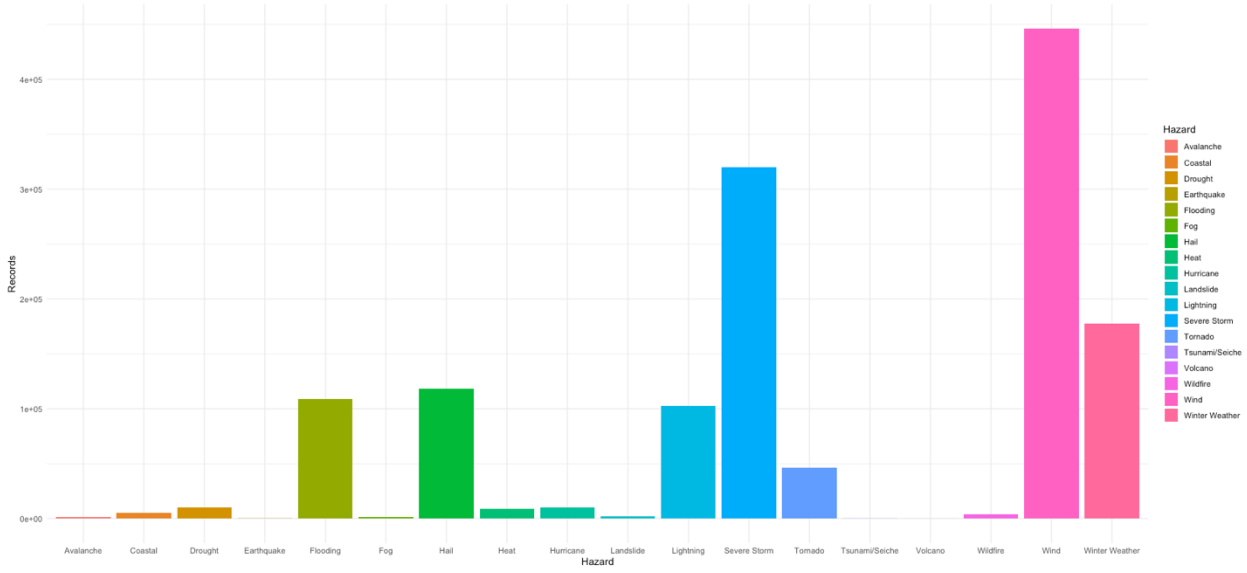
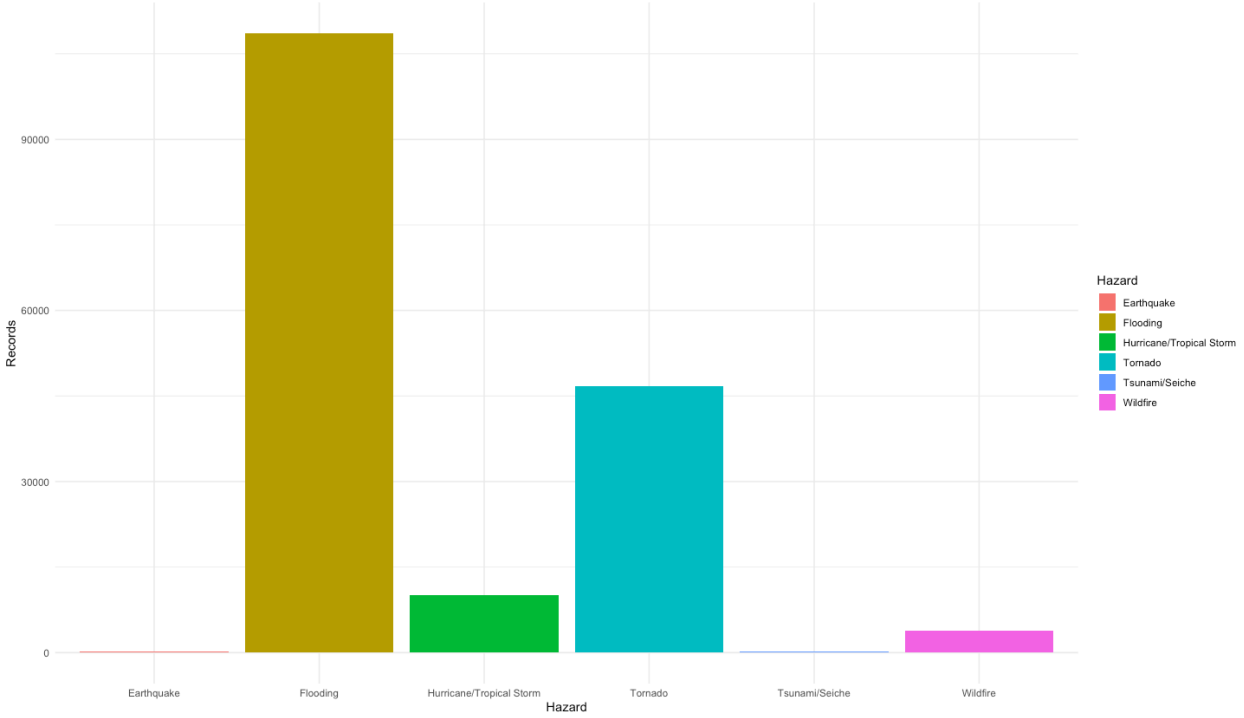


Figure 2: 1960 – 2020 Records of Six SHELDUS Natural Hazards



Flooding is the natural hazard responsible for the highest amount of property damage in the United States in the last 60 years. The amount of property damage from January 1, 1960 through January 1, 2020, adjusted for 2019 United States Dollars, as compared with the 17 other declared hazard events in SHELDUS is presented in **Figure 3.** Flooding is, again, shown in the yellow-green coloring and is the highest of all 18 hazards. The total amount of property damage from 1960 – 2020 as a result of floods is $296,540,387,302 with an average annual loss of $4,942,339,788, median annual loss of $1,898,266,816, maximum property damages amount recorded in 2017 at $69,282,906,835 and a minimum property damages amount recorded in 1968 at $53,171,066 (SHELDUS, 2021). **Figure 4** shows the property damage inflicted by floods but across a fewer number of hazards (same hazards as figure 2). Flooding's color remains the same and has the same y-axis values.

Figure 3: 1960 – 2020 Property Damage (ADJ 2019 US Dollar) of all Natural Hazard Events

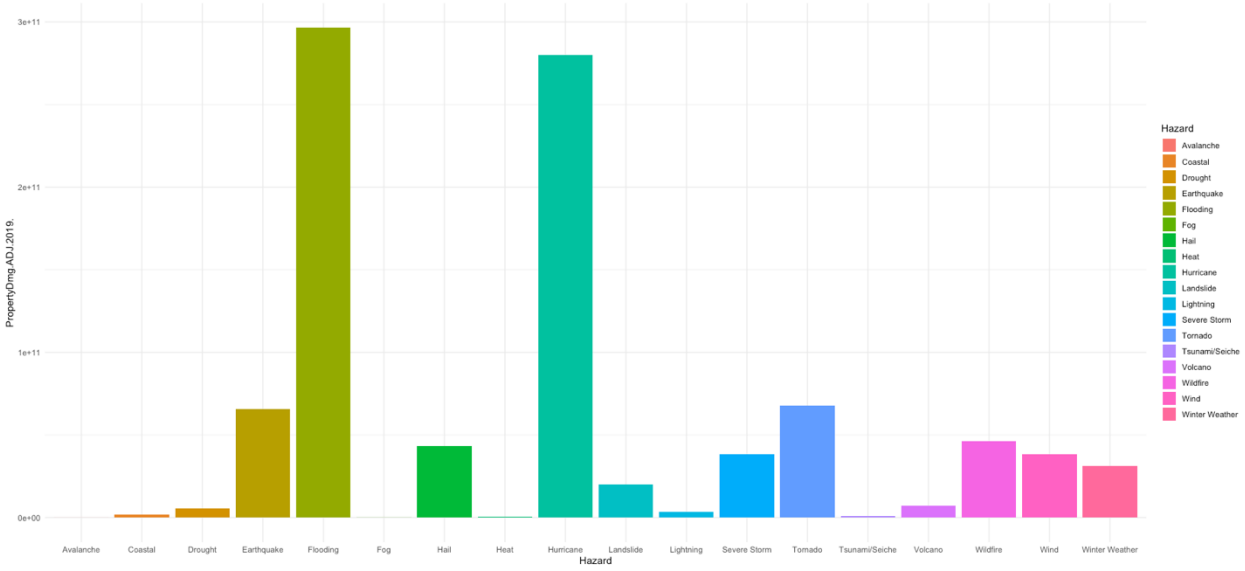
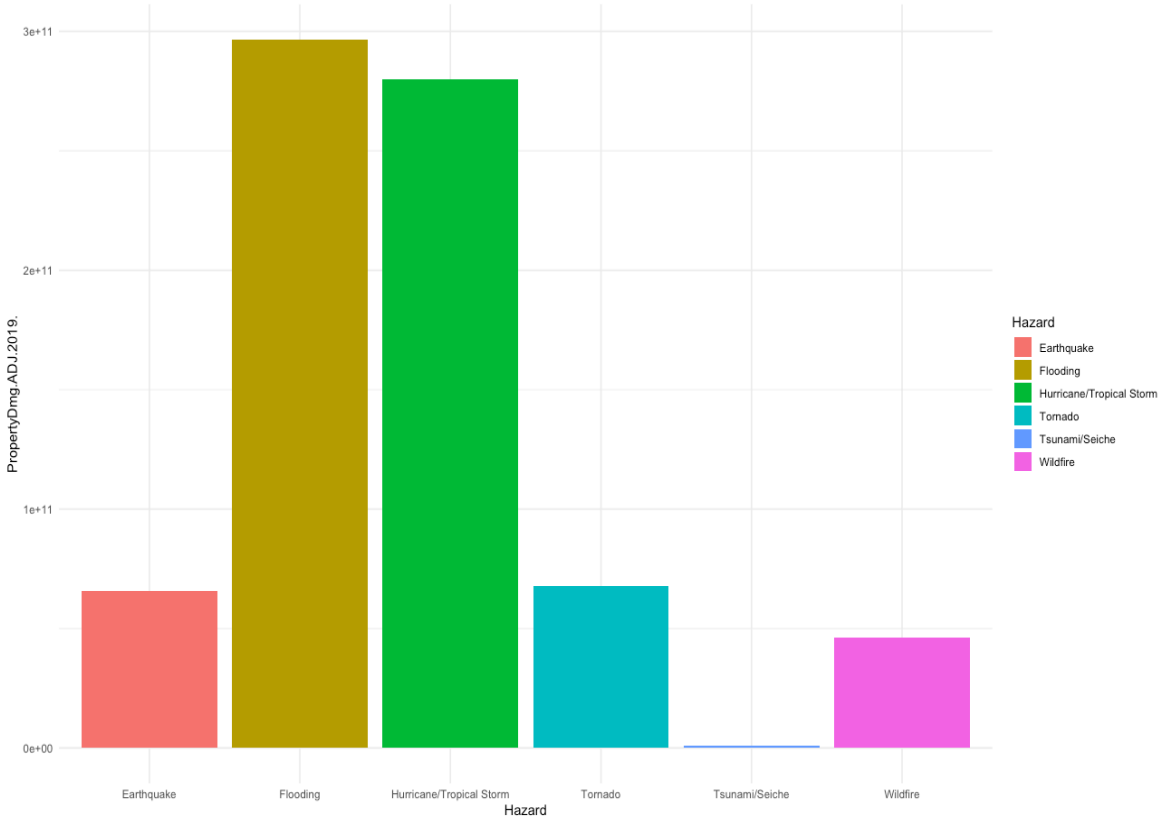


Figure 4: 1960-2020 Property Damage (ADJ 2019 US Dollar) of Six Natural Hazard Events



Flooding inflicts significant fatalities on communities throughout the country as well. During the same time frame, floods accounted for a total of 4,638 fatalities. Fatalities from floods and the 17 additional hazard events are presented in **Figure 5**, and **Figure 6** shows flood-induced fatalities across the same fewer number of hazards presented in earlier figures. Per year, since 1960, the United States experiences an average of 77 deaths to flood events, with 1972 being the year of the highest number of fatalities from floods, 343, and 1960 being the year with the fewest number of fatalities from floods, 10 (SHELDUS, 2021).

Figure 5: 1960 – 2020 Fatalities of Floods and all 17 Other Natural Hazard Events

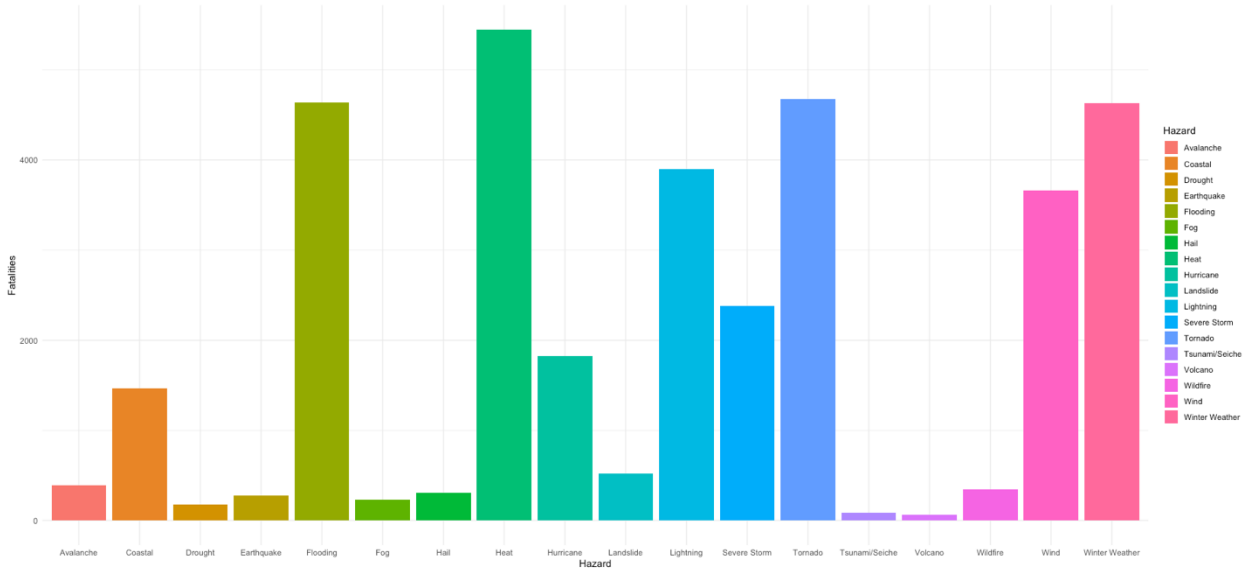
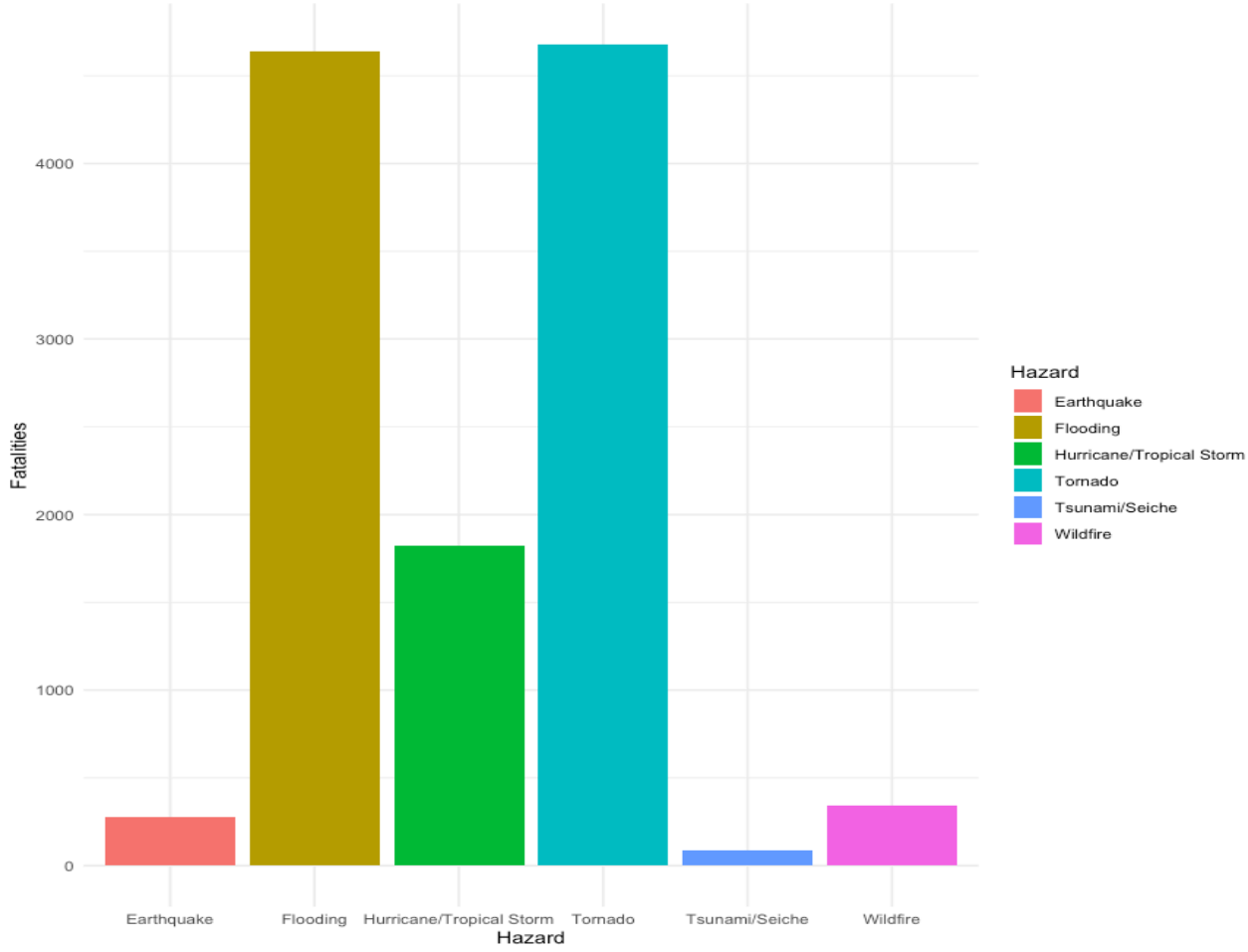


Figure 6: 1960 – 2020 Fatalities of Floods and Five Additional Other Natural Hazard Events



Dennis Mileti, author of, *Disasters by Design* and one of the most prominent figures in the natural hazard planning community, observed that "Human beings – not nature – are the cause of disaster losses, which stem from choices about where and how human development will proceed" (Mileti, 1999). If policy choices can create natural hazard losses, they can also create more resilient communities. One method in policy decisions can be derived from comes in the form of easily and quickly scoring how resilient and prepared communities that face different types (e.g., inland, hurricane derived, and coastal) of flooding are in order to better address areas that need policy change and/or prioritization, and those that do not. This includes addressing a community's plan in emergency evacuations but is not limited to this one area of natural hazards planning/emergency management planning.

Literature Review:

This literature review attempts to answer the following questions by examining current emergency management, regional planning, and evacuation planning literature and materials. The sections of this literature review will be divided based on the question it attempts to answer. The review will draw on not only literature from academic journals but will also include web pages from private consulting firms and government agencies, jurisdictional plans and programs, dissertations, interviews, scorecards and guidebooks, and even class notes I found helpful to the objective of a comprehensive literature review.

1) **What is the Emergency Management Cycle/Continuum (also known as the Disaster Management Cycle or the Disaster Cycle) and what phase(s) of this cycle does emergency evacuation planning aim to enhance a jurisdiction's emergency management operations?**

2) **What existing emergency management planning and operations scorecards exist, and are there any quantitative or qualitative scorecards that focus specifically on evacuation planning? If so, what are its details, elements, implications, and usability? If not, how can my FEES scorecard use existing scorecards to help it in its design, implementation, and effectiveness?**

3) **What case study counties/cities/towns ought this scorecard be applied to, and why?**

Question 1:

The Disaster Cycle is comprised of four phases that form a circle, as can be seen in **Figure 7** on the following page, to represent the continual nature of not only the phases, but the necessity for this continued attention and resources due to the fact that natural hazard events do not cease. These phases are Mitigation, Preparedness, Response, and Recovery. This cycle helps to showcase the measures that can be taken before, during and after a natural hazard event, in addition to what can be learned from each natural hazard event, in order to frame a comprehensive picture in the goal

of increasing a jurisdiction's overall resilience in wake of the next natural hazard to strike. This section of the literature review breaks each phase of the Disaster Cycle to help describe its functions and duties and relate it back to the topic of flood emergency evacuation planning. It is vital to have a good sense of the current literature on this topic in order to include the most relevant metrics in the FEES. An examination of these four phases will also help to answer the first question posed in the review.

Figure 7: An Example Visual on the Standard Disaster (Management) Cycle

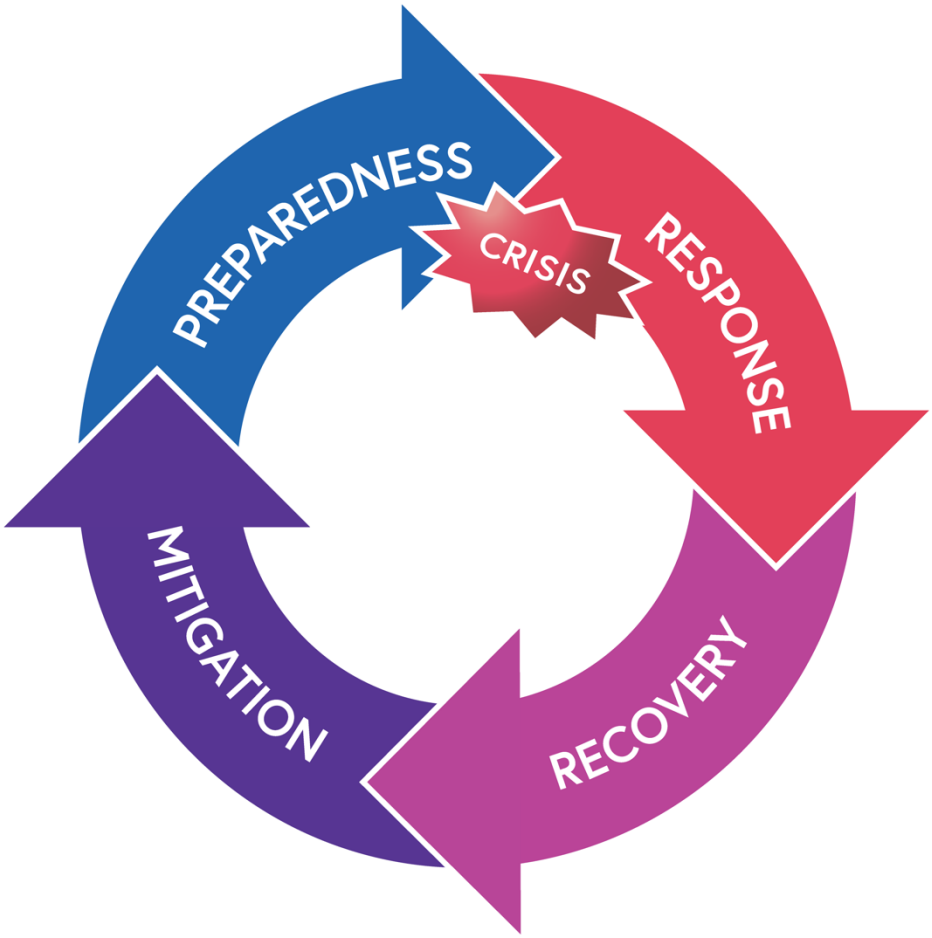


Image Source: futurelearn.com

Mitigation:

Mitigation activities in the context of flood planning are designed to significantly reduce or even prevent the risk of flood from occurring. Common practices in flood planning designed with mitigation include reviewing building codes and standards to ensure that buildings are resilient to floods of certain magnitudes, updating a zoning code and/or considering alternative uses to existing land to help prevent loss of life and economic when a flood event occurs, and conducting vulnerability analyses using different modeling programs. These can help indicate where flood-prone areas are located and can then inform zoning decisions and building standards decisions (Pichelmann, 2021).

Often, a community that faces chronic flooding will invest in a combination of structural and nonstructural mitigation measures. Structural mitigation measures are built structures including traditional flood protective structures such as floodwalls/seawalls, floodgates and levees. These structural measures are involved in reconstructing landscapes to mitigate the harm from a flood event or prevent the flood from coming into contact with the greater built environment in general. Nonstructural measures of mitigation are measures designed to also reduce damage once the flood event occurs and include measures such as property buyouts, elevation requirements, considering land use changes and changes to a zoning code (National Conference of State Legislatures, 2019).

Preparedness:

Preparedness is the second phase of the Disaster Cycle in which these activities are designed to achieve a sense of readiness for the flood event. Planning is one of the most important aspects to the preparedness phase of the Disaster Cycle, as having a developed hazard mitigation plan and updating it at least every five years (set by the standards of FEMA) will ensure at least a degree of preparedness for the occurrence of a flood event. Hazard mitigation plans ought to be specific to the community's needs and should clearly state the roles and responsibilities of community agencies involved as well. This is especially crucial in the aspect of evacuations when timing is a key variable, and possibly under the pressure of life and death for a community's citizens. Other

strategies that can be involved in the preparedness stage of the Disaster Cycle include utilizing emergency warning systems, flood insurance requirements for residents and businesses, stockpiling resources, conducting analyses on existing infrastructure in the community to gauge its vulnerability to flood events and ensure their upkeep and maintenance, and even having evacuation drill events (Pichelmann, 2019 & O'Connor, 2004).

Response:

Response is the third phase of the Disaster Cycle. Response is the phase of the Disaster Cycle that occurs during and immediately after the flood event strikes. Response involves providing the immediate assistance to flood victims and ensuring people's basic needs are met until the recovery phase begins. Response measures can include performing search and rescue operations to those trapped in or on buildings/structures, ensuring that government agency organization and coordination is in place so that there is no confusion nor missteps during timely flood disasters, which could result in delays of helping those in need, and the ability to ensure flood victims' basic needs can be met (Pichelmann, 2019).

Recovery:

Recovery is the fourth phase of the Disaster Management Cycle and is the phase of the cycle that is most often overlooked as it occurs after the event occurs. Recovery is an attempt to bridge the gap between emergency times and normalcy and include numerous actions that can be taken to help ensure the impacts and consequences of floods are diminished to a community's increasing level of overall resilience. Actions in recovery often include grant applications for funding opportunities for disaster mitigation. For example, FEMA offers three Hazard Mitigation Assistance grant programs: Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, and the Flood Mitigation Assistance Grant Program. Documenting the flood can also serve as an important step in the recovery phase, but documenting is not only marking high water lines to document the maximum flooding condition. Documenting also includes interviewing business owners and residents to collect information on their experiences with the flood and taking photographs from a safe location. These pieces of documentation can prove helpful to justify the

need for financial assistance and should also be used in community education on the severity of floods in that community (Pichelmann, 2019).

Often, response measures include the evacuation plan being put into action, but evacuation is not tied to solely the response phase of the Disaster Cycle. In fact, evacuation transverses all four phases. This is because a community can mitigate the impact of a flood by having the structural and non-structural measures in place to quell or cease the flood, in addition to having an evacuation plan in place, which additionally awards a community a sense of preparedness, and executing it to a certain degree quality (response). A key step for evacuation planning includes evaluating the evacuation plan in the recovery phase after the flood struck to determine its positive and negative features and identify where improvement is necessary.

Question 2:

Currently, there is no scorecard for quantifying the preparedness of a jurisdiction, community, city or even county in the niche field of natural hazard evacuation planning, let alone flood-specific emergency evacuation planning. However, it is an included element in numerous local and regional plans and programs, as well as throughout scorecards and guidebooks. Nevertheless, there is no *quantitative* way to compare how separate communities currently handle, and could better handle, their flood emergency evacuation plans and operations. This scorecard can serve planners, engineers and emergency management professionals in a unique way since the two principal values of the proposed FEES scorecard are (1) the planning process of filling this scorecard out as opposed to obtaining a final scorecard and (2) the policy recommendations that ought to accompany the scores and be considered by those with advisory and decision-making positions in the jurisdiction. With a primary value being found in the process of filling out a scorecard, a false sense of security might be found by the professional who decides to rank their community based on aspiration and not reality. However, since there are no external fiscal nor public relations incentives attached to performance on this scorecard, unlike other more general natural hazard preparedness scorecards and programs found in the natural hazard resilience community, there is zero benefit to attributing falsehoods when filling out the FEES scorecard.

Nevertheless, there are four existing scorecards, guidebooks, and quantitative or qualitative assessments that emergency management professionals, planners, and engineers can fill out to gauge their jurisdiction's status as they relate to certain phases of their plan in emergency management in the face of natural hazards. The scorecards used in helping to inform and construct the FEES scorecard include: (1) The National Cooperative Highway Research Program (NCHRP's) Maintaining System Resilience Concepts into Transportation Agencies, (2) Federal Emergency Management Agency's (FEMA's) National Flood Insurance Program's (NFIP's) Community Rating System (CRS), (3) the National Weather Service (NWS) *Storm*Ready Program, and (4) Texas A&M University's Plan Integration for Resilience Scorecard Guidebook. Each of these four scorecards are discussed in this section to provide context on what they measure and greater detail on the value each brought to this paper and the FEES scorecard.

NCHRP Maintaining System Resilience Concepts into Transportation Agencies:

The National Cooperative Highway Research Program (NCHRP's) Maintaining System Resilience Concepts into Transportation Agencies is a guidebook that is designed to account for transportation system resilience in the case of extreme weather and natural hazard events. This guidebook uses a tool known as the Framework for Enhancing Agency Resilience to Natural and Anthropogenic Hazards and Threats (FEAR-NAHT) or referred to after its introduction as the "Framework". Similar to the FEES, the Framework is a self-assessment tool concerning efforts to identify and improve a community's current efforts, through its transportation system, at providing emergency response, including evacuation response, to major disruptions (NCHRP, 2017). This is crucially important in conjunction with professionals identifying the nodes that are most critical to network flow and those that are most vulnerable to a specific hazard such as flooding (Testa et al., 2015).

Much of the information found in this guidebook as it pertains to transportation route networks, critical facilities, and actions that can be taken to enhance a community's transportation system resilience were incorporated into the FEES metrics as well as the reasonings behind these metrices over others in the phases of the Disaster Cycle. In addition, I found its simplicity in using a scale of 1 – 3 for the users to score their agency with respect to each factor, both simple and timely, and

proved to be an important consideration in the FEES. Its self-assessment nature is another piece of this scorecard considered applicable for the FEES nature. However, the FEES differs from this scorecard as it has considerably fewer steps than the Framework, and recommendations are left to the community to value and decide on, which is not the case with the Framework. The NCHRP provides useful themes in its design of its Framework such as collaboration, communication, leadership, institutional capacity, and hazard threat assessment which are also incorporated into the FEES (NCHRP, 2017).

FEMA's National Flood Insurance Program's Community Rating System (CRS):

The Community Rating System is one of the most well-known scorecards for communities to assess mitigation, preparedness, response and recovery planning. It is operated by the National Flood Insurance Program (which is under the branch of the federal government through FEMA) and offers incentives/discounts on insurance premium rates based on a community reaching certain scores. In addition to the metrics it uses for its rating system, its 2017 coordinators manual provides a wealth of information on the context and reasoning behind using certain metrics and parameters, as well as suggestions for planners, engineers and/or emergency management professionals to utilize for their communities. The CRS has over 1,500 communities participate nationwide (FEMA, 2017).

There is a significant difference between communities that choose to participate in the CRS program than those who opt out of this program, in terms of reducing insured flood losses. The program's incentivization tactics to help communities move beyond National Flood Insurance Program minimum standards are a draw to the program, and a differentiation between the FEES which has no incentive and the CRS. However, the CRS program functions as an instrument to verify and record flood mitigation tools implemented in CRS participating communities (Highfield & Brody, 2017). This, in addition to the mitigative, preparedness and response and metrics used in the CRS helped guide the metrics I used in the FEES but to also consider the importance of recovery metrics and the benefit of flood management recordings and verifications.

National Weather Service's *Storm*Ready Program:

The next scorecard considered and used for influential purposes was the National Weather Service's *Storm*Ready program's application scorecard. This scorecard is designed principally to help communities with their preparedness in natural hazard/disaster management. The program requires significantly fewer metrics than the CRS program, only five that focus on these preparedness measures, and has a simple, functional design in its application form. Its only incentive is that it gives recognition to the community who becomes certified but could be costly in order to have an assessment team come to a community to determine whether they qualify. The program has been in existence since 2000 and has recognized 721 communities in the US as *Storm*Ready (US DOC - NOAA, 2013).

The *Storm*Ready program and application helped to lower the FEES scorecard metrics per phase of the Disaster Cycle and had influence on its preparedness metrics. It also followed a similar format at the beginning with having the user fill out similar background and general information on their town/county/city before beginning. *Storm*Ready also helped construct the context and reasonings for FEES metrics for the preparedness section of the scorecard as its application form and website provides information on each of the five metrics it specifically tests. The notes section of the FEES was influenced by the notes section found in the application of *Storm*Ready, for an example of its design influence on the FEES scorecard.

Texas A&M University's Plan Integration for Resilience Scorecard Guidebook:

Texas A&M University's Plan Integration for Resilience Scorecard is a larger, regionally-scoped scorecard that measures a community's network of plans score based on policy intervention that serves to increase or decrease vulnerability to certain hazards. It is a self-assessment scorecard and has seen success since its adoption in 2017. The scorecard proves effective in modeling district-hazard zones with each zone receiving a score of '+1', '-1', or '0' for each policy based on how it affects vulnerability. The Guidebook is available for a free download and has been in effect since

July of 2017 to help address concerns of plan effectiveness on community resilience (Texas A&M University Institute for Sustainable Communities, 2021 & Masterson et al., 2017)

This guidebook helped influence the design of FEES not only in terms of the metrics, especially in mitigation, but also in terms of it being a policy direction device. In fact, it could best be thought of as a scorecard that could work in conjunction (as a precursor specifically) with the Guidebook as the Guidebook's focus is more on the policy effectiveness of certain plans in addressing community resilience, and natural hazard evacuation programs. This Guidebook can be used to support ambitious goals in the United States, and abroad, such as the Room for the River program in the Dutch city of Nijmegen which used the Guidebook as part of their flood resilience and safety analyses (Yu et al., 2020). Though I do not intend for the FEES scorecard to have international applications, the comprehensiveness of the Guidebook geared the FEES in both its structure and style.

Question 3:

The FEES scorecard is not designed to be "stored on a shelf" and not utilized. Its design is specific for its implementation in real-world counties/cities/towns. Therefore, it shouldn't take a planner/engineer/emergency management professional more than approximately 20 minutes to fill out, has only three metrics per phase of the Disaster Cycle, and is designed for the professional to gauge their jurisdiction's current status of flood emergency evacuation plans. To test its effectiveness, though, three case study jurisdictions were chosen to fill out the FEES, score their flood evacuation plans, and then use the scorecard in order to direct policy and economic attention to their weaker metrics. These case studies represent different types of flood origins, and contacts at each of the three have already expressed an interest in filling out the FEES. They include Tulsa County, Oklahoma, which will continue to suffer from flood events as a result of heavy rainfall events, the City of Baltimore, Maryland, which primarily contends with coastal riverine flooding, and New Orleans, Louisiana, which suffers from flooding as the result of coastal storms such as hurricanes, heavy rainfall events and low elevation. This section is divided into more in-depth reasonings for why each of these three jurisdictions were chosen.

<u>Tulsa County, OK:</u>

Tulsa County, Oklahoma is a county in the Great Plains state of Oklahoma that contains the major cities of Broken Arrow, OK and Tulsa, OK. Its population is 651,552 (2019) and has been growing steadily by approximately 1% per year since 1980 (Data Commons, n.d.). Tulsa County is not commonly affiliated with flood events, as tornadoes are the most common and most popularized natural hazard event across the state of Oklahoma. Tulsa County, though, is representative of increased rainfall phenomena, from climate change as well as other natural hazards that bring along numerous inches of rainfall, that cause the communities in the County, especially the City of Tulsa along the Arkansas River, to have major flooding events (Bostian, 2020). Due to the warming atmosphere and higher evaporation levels, there is an increasingly higher amount of water during precipitation events.

Tulsa County, Oklahoma has an extensive history with flood events and was declared by the federal government as a flood disaster area more than any other community in the nation in the 1980s, nine times in 15 years. After the most devastating flash flood from heavy rains struck Tulsa on Memorial Day Weekend 1984 (which accounted for 14 fatalities and the destruction of eight bridges) the county invested heavily in a flood control program which has since been recognized as a success by several federal organizations including FEMA. Tulsa's floodplain and stormwater program utilizes existing natural systems to extend a comprehensive watershed management program, dedicate funds for maintenance and operations, acquire damaged and flood-vulnerable homes, invest in a $200 million capital improvements program, and install a prototype alert system, all in an attempt to save as many lives as possible and minimize economic damage from flood events. Tulsa County has expressed tremendous pride in their flood control program especially in its utilization of existing greenspaces in floodplains and stormwater detention basins to help mitigation efforts of future flood events. Through these efforts, Tulsa is looked at as a model and gold-standard in urban floodplain management (Wertz, 2017 & City of Tulsa, 2021).

<u>City of Baltimore, MD:</u>

The city of Baltimore, Maryland is a city in the Mid-Atlantic state of Maryland, is the largest city in the state with a population of 602,495 (2018) and has been declining by approximately 0.6% per year since 1980 (Data Commons, n.d.). The city of Baltimore has approximately 52 miles of shoreline, which often rise during certain weather conditions, and has numerous tributaries that are subject to riverine flooding (City of Baltimore, 2018). High-tide flooding or nuisance flooding due to the city's location on the Patapsco River and Chesapeake Bay, by extension, can result in significant damage for the city of Baltimore. This is expected to worsen due to sea level rise and increased tropical storms bringing in additional riverine and coastal flooding Baltimore experiences.

The City of Baltimore Department of Planning Office of Sustainability was awarded Federal funds in 2020 by the National Oceanic and Atmospheric Administration to create the Baltimore City Nuisance Flooding Plan. This plan was also funded through the Maryland Department of Natural Resources' Chesapeake and Coastal Services Grant. The city of Baltimore projects their sea-level rise to range from 0.9 to 2.1 feet over the next 30 years and up to 5.7 additional feet by 2100. These high-tide flooding events/nuisance flooding events will become considerable stressors on emergency services and public health as they begin to become more chronic in nature for the city and are exacerbated by sea level rise, an increase in the frequency and magnitude of coastal storms, and heavier rainfall events. Further, in this plan, equity dimensions are being considered in relation to the Disaster Cycle planning, especially in mitigation efforts to quell the impacts of these floods in underserved communities, but also in terms of evacuation planning (Baltimore City Department of Planning Office of Sustainability, 2020). The city's Office of Sustainability has expressed interest in completing a FEES assessment for the city of Baltimore.

City of New Orleans, LA:

The city of New Orleans, Louisiana is the largest city in the Southern state of Louisiana with a population of 391,006 (2018) which witnessed a rapid population decline of approximately 56% from 2004 to 2005, but growth since 2005 at a rate of approximately 3% per year (Data Commons, n.d.). New Orleans, Louisiana is one of the rainiest cities in the United States with an average of 62 inches of rain each year, is sinking in its low-lying elevation with considerable impermeable

surfaces and is not stranger to heavy rain events which outpaces the city's drainage system's capacity (National Weather Service Forecast Office, 2021). Since 1996, New Orleans has had 73 recorded flood events, most notably in 2005 from Hurricane Katrina. The absolute destruction brought upon the city, parish, state and surrounding communities across the Gulf of Mexico from Katrina spurred motivation to have New Orleans as a case study for the FEES, but also for the city to invest in disaster management and evacuation plans and programs (FEMA, 2021).

New Orleans adopted an updated Hazard Mitigation Plan in 2020 to add to its arsenal of city-wide hurricane and flood resilience plans and programs, and an adoption date for this updated plan by August 2021. However, this plan will then be, assuming its passing by the state of Louisiana and FEMA, multi-jurisdictional and extend across regional agencies and organizations, including Sewerage and Water Board of New Orleans, Housing Authority of New Orleans, Orleans Parish School Board and Tulane University. A draft of this plan was made available to the public for download through https://ready.nola.gov/hazard-mitigation/home/. This plan is prioritizing the joint mitigation efforts, increased attention to federal and state grant opportunities, increase risk education, community outreach, and, specific to the purposes of this paper, a City Assisted Evacuation Plan (CAEP). The CAEP aims at increasing evacuation equity by creating a special needs registry for those that require special assistance during an evacuation, which includes but is not limited to lack of transportation access and medical/mobility issues paired alongside a prioritization to minimize impacts on human health while evacuating. Further, increased importance on designating "Evacuspots" throughout the city for people to safely gather for evacuations assistance is made clear in this plan. There is clear emphasis on collaboration between communities with New Orleans toward increasing participation in funding opportunities and available mitigation programs as they relate to evacuation plans. The New Orleans Office of Homeland Security and Emergency Preparedness (NOHSEP) has expressed interest in completing the FEES scorecard for their jurisdiction and to see if it could be helpful in this plan.

Additional plans from the City of New Orleans that consider evacuations in flood and hurricane events, to a considerable degree, include the *Resilient NOLA, Climate Action for a Resilient New Orleans,* and *Taking Steps Together On Equity & Climate Change: A Report By And For New*

Orleanians (City of New Orleans, Office of Homeland Security and Emergency Preparedness, 2021).

Methods:

In conjunction with conducting a literature review to gain understanding of the current state of practices in the field of flood emergency evacuation planning, quantitative scorecard efficacy, and emergency operations plans for the paper's case study jurisdictions, additional means of extracting information and insight ought to incur. Via the help of a LinkedIn post on January 29, 2021, requesting the help of planners, emergency management coordinators and directors, or anyone with professional experience in emergency evacuation planning, I attained two interviews with Mr. Justin Kates, Certified Emergency Manager (CEM) who holds the title of Director of Emergency Management at the city of Nashua, New Hampshire and with Mr. Jack Krolikowski who is the Deputy Manager, Hazard Mitigation Department at the Georgia Emergency Management and Homeland Security Agency. Both of these interviews were held over Zoom Video Communications, Inc. on February 1, 2021 and were recorded, with their consent, for transcription purposes. I also conducted an interview on February 2, 2021 with Dr. Michael D. Meyer, former Frederick R. Dickerson Chair of Civil and Environmental Engineering and Director of the Georgia Transportation Institute and current civil engineering consultant with Parsons Brinckerhoff. This interview was also held over Zoom Video Communications, Inc. and was recorded with Dr. Meyer's consent.

These interviews are transcribed in the following pages with a primarily denaturalized transcription, used to convey the meeting, and the relevant content of the conversation. The questions to my interviewees are near-verbatim, and the transcribed responses by the interviewees below were for the purposes of having a clearer and more relevant transcription that can be used for the purposes of my research. The full responses and questions for each interview are in the tables at the end of this report in the *Appendix* section, and if a response was not relevant for the purposes of my research at hand, it is listed as an 'N/A'. The Questions with 'N/A' responses were used primarily to set contextual environments for the forthcoming, more relevant interview

questions. This *Methods* section describes the key highlights from each of the interviews in the paragraphs below.

Mr. Jack Krolikowski: During my interview with Mr. Krolikowski, he mentioned the key duties of the Georgia Emergency Management and Homeland Security Agency (GEMA), the structure of conducting resiliency hazard analyses for communities and jurisdictions in Georgia through GEMA, and how Mr. Krolikowski views and understands risk, professionally. Mr. Krolikowski mentioned the importance of utilizing community input in qualitative flood hazard risk modeling, that Georgia has an emergency operations plan, and that each county in Georgia has their own emergency operations plan and are influenced by not only the communities of each county but also different state government agencies that provide services to help create a plan. These agencies include the Georgia Department of Transportation (GDOT), the Georgia Department of Community Affairs, the Georgia Department of Natural Resources, and GEMA.

Mr. Krolikowski also mentioned the importance of examining existing scorecards such as the National Flood Insurance Program's (NFIP) Community Rating System's (CRS) scorecard in order to examine the structure of existing scorecards in the emergency management planning and operations field, but to also consider how the FEES would differentiate. Mr. Krolikowski stressed the importance of policies and scorecard elements that focus on the mitigation element of the emergency management cycle, as well. He quoted "Floods are only hazards when they interact with the built environment. Floods are supposed to happen geomorphologically. If a flood happens, then we've already failed at our job." Included in those policies that ought to be considered with more weight, according to Mr. Krolikowski, are designated emergency evacuation routes, critical facility preservation, structural mitigative measures such as flashers, gates, and stream gages, and warning systems. **Table 1** in the *Appendix* section outlines my questions for Mr. Krolikowski and his responses more thoroughly.

Mr. Justin Kates, CEM: Mr. Kates discussed how his role as the director of Emergency Management for the city of Nashua, New Hampshire helps him to work across organizations and agencies within the local government to develop programs and plans for involvement in especially the response and recovery phases of the Disaster Management Cycle for the city of Nashua, NH.

Mr. Kates mentioned that the way I had been approaching the scorecard, up to this point, was not as practical as it ought to be, and helped by recommending that I consider it across a different phase of the Disaster Management Cycle (mitigation), with careful consideration on preparedness related activities as well. Here, I thought it would be an integral feature of the FEES scorecard to consider metrics across all four phases of the cycle. Mr. Kates also mentioned that since emergency management professionals often come from a first responder background, that the pairing between these professionals, who don't place too many efforts or much emphasis on mitigation or risk reduction, and city planning professionals who would consider more mitigation and risk reduction issues, such as proper zoning and having flood insurance in place, is a smart pairing but that cooperation between planners and emergency management professionals is key.

Mr. Kates also mentioned to me that considering the *Storm*Ready accreditation program from the National Weather Service would make sense for the purposes of the FEES. This scorecard exists to help determine vulnerable areas in a community and their levels of preparedness to help their populations shelter in place or evacuate. It isn't specific to floods and focuses principally on warning systems in place, if there is an evacuation plan to begin with, and uses qualitative metrics. *Storm*Ready also requires an assessment team to come out to the community, but that the application is available to download for free to help me with my research. Mr. Kates then discussed that Nashua specifically has an Emergency Action Plan (EAP) and that Nashua invests in their levee system for flood structural mitigation practices, has pre-defined, designated evacuation routes in and out of the area, and that I ought to consider the technology of apps like Waze for communities that utilize a *Just in Time* or a *Case-by-Case* model to see where evacuation routes could be interfered with due to the flood or any other issue that could arise before or during the flood.

In addition to the *Storm*Ready application, Mr. Kates pointed me in the direction of the Texas A&M's Plan Integration for Resilience Scorecard GUIDEBOOK, which Nashua uses as part of their *Resilient Nashua* initiative to help gauge districts in Nashua that are more risk-prone than others, and to measure levels of resilience across the city, in a quantitative manner. This scorecard proved quite helpful to me in my design of the FEES scorecard and is discussed in more detail in the second section of the literature review in this paper. Mr. Kates also mentioned a scorecard from

the UN's Office of Risk Reduction, the Making my City Resilient scorecard, but this scorecard had an international focus to it and did not prove helpful to me in constructing my FEES scorecard.

Mr. Kates and I ended our interview on the note of him mentioning to me that one significant challenge I would find towards creating a transferable scorecard across communities is that there are three different types of flooding (coastal, riverine, and urban due to infrastructure failure). Therefore, Mr. Kates mentioned it is important for me to designate categories within the scorecard to compare the results of one scorecard representing a jurisdiction to another jurisdiction that face a similar flood hazard. For example, flood hazards in neighboring jurisdictions that have a relatively equal population and face flood events that are derived from a common origin source. I considered this to be helpful in the *Next Steps* category. Nevertheless, Mr. Kates cautioned about the difference in resource funding from federal agencies such as FEMA when it came to the transferability variable I intend for the FEES. This is because coastal communities have significantly higher levels of funding than inland communities to combat flood hazards. Mr. Kates then mentioned that the value of the FEES, from his perspective, is in the policy recommendations that would be derived from the scorecard's scores, especially since there are no external incentives involved. I agreed with Mr. Kates on this point, and later decided that policy intervention recommendations ought to be left to the community to weight and consider for themselves, since each community will prioritize different flood emergency evacuation plans and policies as their community best sees fit.

Dr. Michael D. Meyer: Last, I conducted an interview with Dr. Meyer on February 2, 2021 in order to gauge the necessary emergency evacuation and management, as they relate to transportation, knowledge and elements that we would see best fit for the FEES. Dr. Meyer discussed his role as the director of transportation planning and development for the state of Massachusetts (from 1983 to 1988) which was his first experience with emergency management and evacuation. His experience of working across public state and local agencies in wake of hazards and disasters proved vital to this report and the FEES. Dr. Meyer also held the role as the Frederick R. Dickerson Chair of Civil and Environmental Engineering at the Georgia Institute of Technology (from 1988 to 2012) and recalled conducting research on traffic safety during emergency evacuation events ranging from natural hazards such as floods to hypothetical terrorist

attacks. Dr. Meyer emphasized the importance of quick and safe decision making during an emergency. Dr. Meyer mentioned, though, that throughout his experiences in his professional career, local governments and local police forces often never considered how their community would actually evacuate residents. Because of this gap in emergency management operations on the local level, Dr. Meyer emphasized the need for local governments to utilize travel demand models that could provide information in helping to pre-designate routes as emergency evacuation routes.

Dr. Meyer also mentioned how FEMA requires an evacuation plan in place and designated transportation routes for coastal communities but that this is not the case if a jurisdiction is not coastal. Some of the Massachusetts communities he had worked with in his role as the state's director of transportation planning and development operated on a *case-by-case* or *by-incident* approach for emergency management instead of having a designated plan established. Though Dr. Meyer agreed with me that having designated routes for evacuating from flood events is important, the challenge that faces jurisdictions is in performing the analysis to determine where and what streets in a jurisdiction are vulnerable to floods. He then mentioned that planners, emergency management professionals, and engineers ought to identify the top-10 to top-25 routes that have relatively lower vulnerability to flooding as evacuation or detour routes. Additionally, Dr. Meyer mentioned that work/profession-cultural difference pose an issue in agency coordination as there are often miscommunications between planning professionals and emergency management professionals. He then mentioned that, when it came to the FEES scorecard, I ought to not assign weights to any metric/criteria I write in the FEES, out of respect for the community's individual values and plans.

At the end of our interview, Dr. Meyer mentioned that when it comes to a transportation perspective on emergency evacuation operations it is vital to understand where the flood is and where people are evacuating to. The second consideration Dr. Meyer felt was vital to this analysis is in after-incident analyses (the Recovery phase of the Disaster Management Cycle). In his role with the state of Massachusetts, Dr. Meyer noted that his biggest problem in emergency evacuation planning was with local police forces. This is because, in his experience, he felt as though these police forces wished to allow evacuees/residents back into their communities before the

Department of Transportation (MassDOT) were able to ensure that the infrastructure, especially highways and major bridges, after a natural hazard were safe. In his experience, state police officers were arresting local police officers for allowing residents to return too quickly to their communities from evacuation shelters. Therefore, inter-agency coordination on the local and state levels is an element to the FEES that ought not be overlooked.

In addition to these interviews, and an examination of the current literature and materials in the field of emergency management operations and planning, through the literature review, I also utilized Adobe InDesign in order to help create the FEES scorecard, and to understand it in the context of how effective it can be for professionals that use it. InDesign proved to be a helpful graphic editing software to design an aesthetically attractive scorecard, but more importantly, through its export features, it is able to generate an interactive PDF scorecard for the professional to check boxes and write/type in no matter their PDF viewer. Since it is in a PDF format, it would furthermore be easy to share with colleagues or even on a website (which is discussed further in the *Next Steps* section).

Meetings and discussions throughout the course of approximately nine months (August 2020 through April 2021) with my advisor to this paper, Dr. William J. Drummond, also proved helpful in constructing the FEES, the incentivization strategy to have professionals complete the scorecard, the next steps after the FEES scorecard is completed, and overall guidance throughout the research process.

Flood Emergency Evacuation Scorecard (FEES):

In order to best allow for accessibility for planners, emergency management professionals and engineers to fill this scorecard out in a timely, simple, and efficient manner, the FEES was created using Adobe InDesign. From InDesign, it was exported into an interactive PDF document in which the person filling out the PDF will be able to simply click on the box they wish to check, write, and aggregate their scores. Below, in this section, are screenshots of the FEES, take from the exported PDF document. Descriptions of each screenshot are provided below the screenshotted page. There are seven total pages of the FEES. The FEES interactive PDF document could not be

attached with this paper during the submission process, and so after these screenshots is the link for downloading the FEES scorecard at zero cost.

Page 1:

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Page 1:

Instructions and Context

Flood Emergency Evacuation Scorecard (FEES)

Tulsa, Oklahoma | 2019 | Image Source: oklahoman.com

Instructions and Context for the Flood Emergency Evacuation Scorecard

The Flood Emeregncy Evacuation Scorecard is designed to help communities evaluate their current status of mitigation, preparedness, response and recovery (the phases of the Disaster Cycle) efforts, in relation to emergency evacuation planning, in order to highlight areas of opportunity to be better prepared for the next flood event that strikes that community.

Please evaluate each metric on a scale from one (1) to five (5) with one being the weakest score and five being the strongest. There are three (3) metrics per phase of the Disaster Cycle, which are asked in order to best gauge that community's overall status on emergency evacuation planning in response to floods.

Sum your score across the measures at the end of each phase, and for all phases at the end of the scorecard to determine next steps and where your community's plan needs addressing. The value of this scorecard is in the planning process of filling out the scorecard **honestly**, there are **zero** outside incentives to any score. Please score responsibly.

This is the first page of the FEES scorecard. Here it explains the instructions for completing the scorecard, context for why it ought to be filled out by a county/city/town, and states that there are zero outside incentives to filling this scorecard out.

Page 2:

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Page 2:

Community Information

Flood Emergency Evacuation Scorecard (FEES)

Tulsa, Oklahoma | 2019 | Image Source: kjrh.com

Community Information

1. County/City/Town:

Example county/city/town would be written in here. For example, Cuyahoga County, OH

2. Population:

Cuyahoga County has a population of 1.235 million (2019) people (US Census Bureau)

3. Primary Contact: Name, Office, Title, City, State, ZIP, Phone Number, E-Mail Address

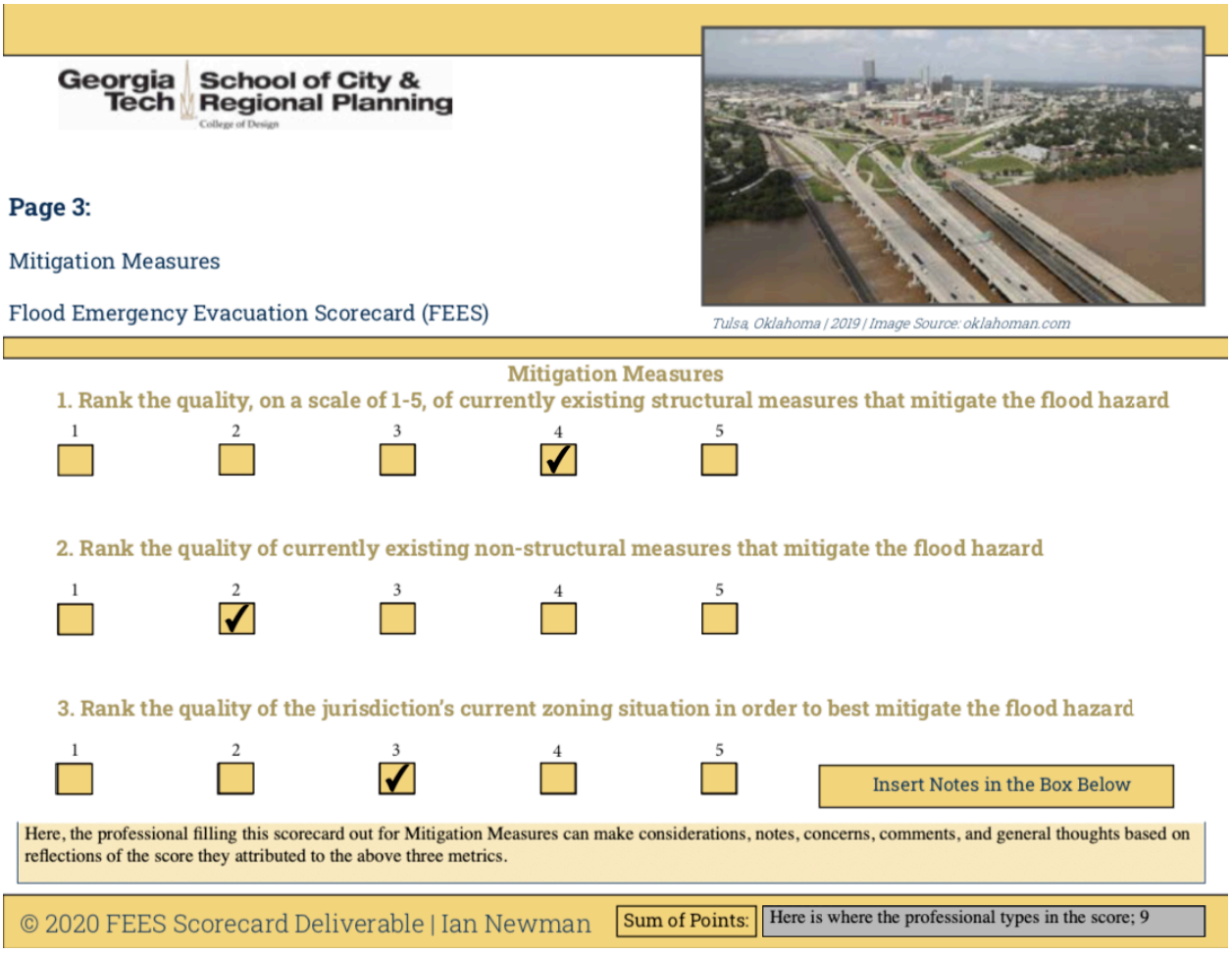
Mr. Ian Newman, Georgia Tech School of City and Regional Planning, Atlanta, GA, 30332, (440) 785-6523, inewman3@gatech.edu

4. Secondary Contact: Name, Office, Title, City, State, ZIP, Phone Number, E-Mail Address

Dr. William J. Drummond, Georgia Tech School of City and Regional Planning, Atlanta, GA, 30332, (404) 894-3880, bill.drummond@design.gatech.edu

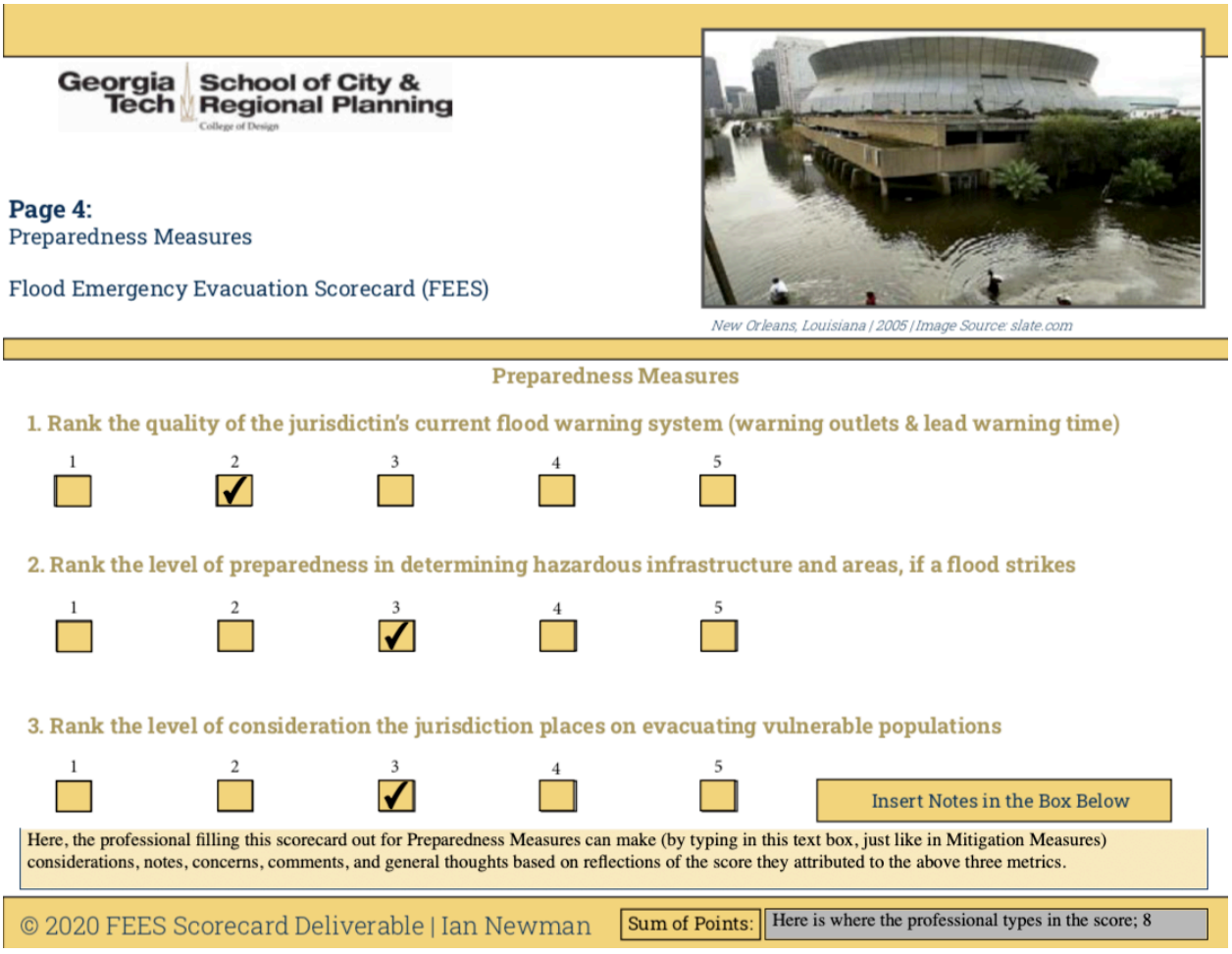
Here is page 2 of the FEES scorecard which establishes the base community context and information before the FEES scorecard is scored. It asks the professional filling this scorecard out to list their county/city/town, its population, and the primary and secondary contacts responsible for this scorecard and its completion. I filled this scorecard out with example text using my home county of Cuyahoga County, Ohio and using myself as the example primary contact and my advisor, Dr. William J. Drummond, as the example secondary contact. ***Note:** I did NOT fill the remainder of this scorecard out in considering Cuyahoga County across these variables. It is only used as an example to show the appearance of text in the textboxes and checks in the checkboxes.

Page 3:



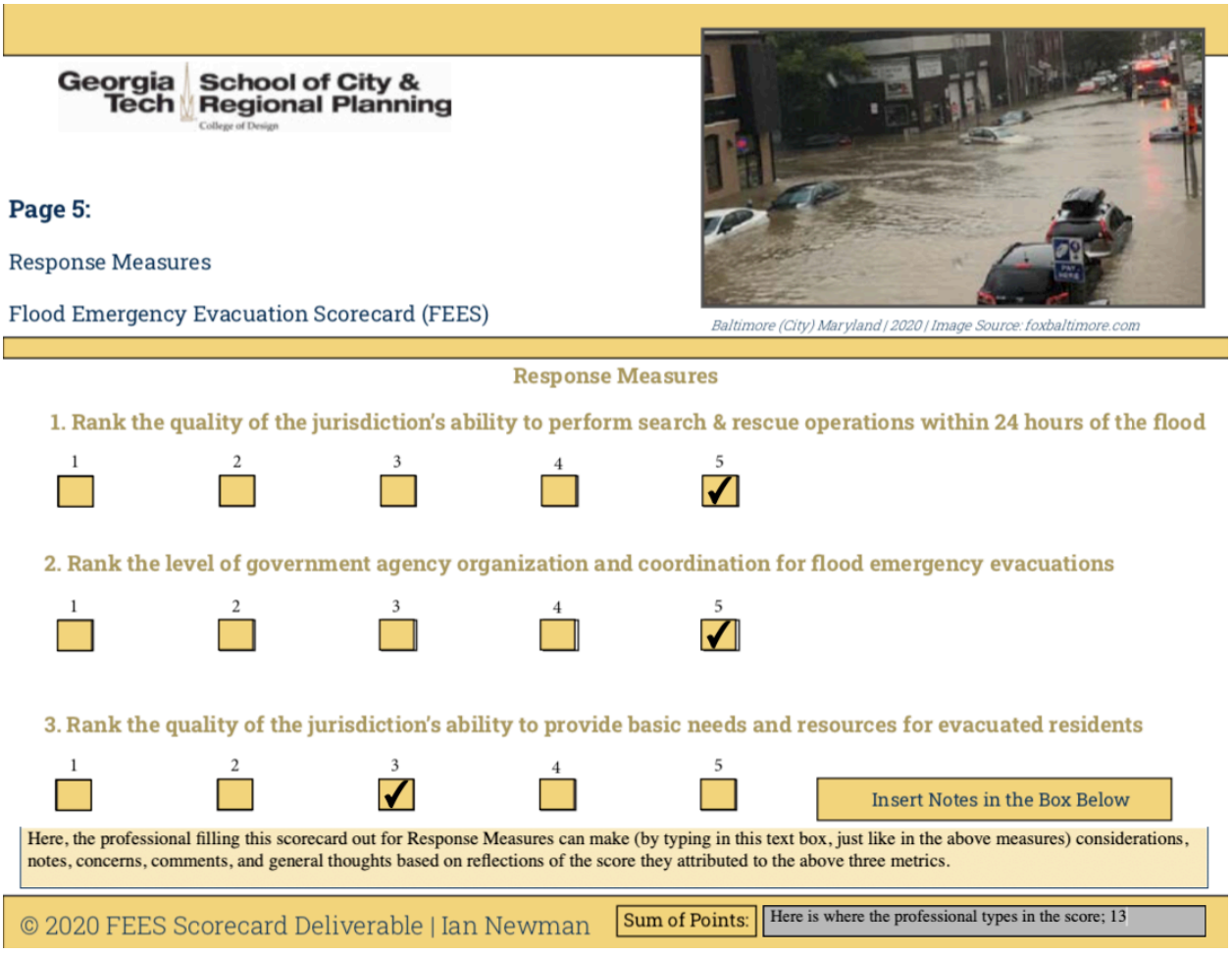
For the next four pages of the FEES, the professional will check, by clicking in or on the check boxes, represented as gold rectangles with scores ranging from "1 – 5" with one being the lowest and five being the highest on what the professional believes their scores on the above three mitigation-phase measures. The professional can then insert notes based on their above scores, by clicking in the long, gold rectangle towards the bottom of the page, and aggregate their score of the above three metrics in the grey rectangle at the bottom right corner of the page. The professional filling out the FEES can easily edit their scores and text by simply clicking in the checkboxes to uncheck it and click in or on the gold "Notes Box" and grey "Sum of Points Box" if typing and text edits are necessary. ***Note**: The text or the checkmarks above would not appear for the professional filling this scorecard out as this is an example of what the text and checkmarks appear as. Please download the FEES interactive PDF document for the pages without example text and checkmarks.

Page 4:



The professional will check, by clicking in or on the check boxes, represented as gold rectangles with scores ranging from "1 – 5" with one being the lowest and five being the highest on what the professional believes their scores on the above three preparedness-phase measures. The professional can then insert notes based on their above scores, by clicking in the long, gold rectangle towards the bottom of the page, and aggregate their score of the above three metrics in the grey rectangle at the bottom right corner of the page. The professional filling out the FEES can easily edit their scores and text by simply clicking in the checkboxes to uncheck it and click in or on the gold "Notes Box" and grey "Sum of Points Box" if typing and text edits are necessary.

Page 5:



The professional will check, by clicking in or on the check boxes, represented as gold rectangles with scores ranging from "1 – 5" with one being the lowest and five being the highest on what the professional believes their scores on the above three response-phase measures. The professional can then insert notes based on their scores, by clicking in the long, gold rectangle towards the bottom of the page, and aggregate their score of the above three metrics in the grey rectangle at the bottom right corner of the page. The professional filling out the FEES can easily edit their scores and text by simply clicking in the checkboxes to uncheck it and click in or on the gold "Notes Box" and grey "Sum of Points Box" if typing and text edits are necessary.

Page 6:

Page 6 reviews the last phase of the Disaster Management Cycle, Recovery, across three final measures of the FEES. Just like with the Mitigation, Preparedness and Response pages, the professional will click in or on the checkboxes to declare their score for the measure, in or on the long, gold "Note Box" to insert any notes, concerns and/or comments they wish to raise in response to these three metrics and will sum their points for the Recovery Measures by clicking in or on the grey "Sum of Points" box, and then typing in their points.

Page 7:

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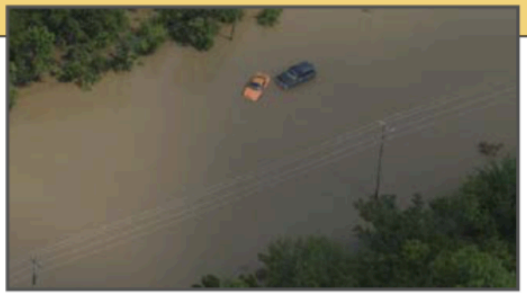
Page 7:

Final Scoring Measures

Flood Emergency Evacuation Scorecard (FEES)



Tulsa, Oklahoma | 2019 | Image Source: oklahoman.com

Final Scoring Measures

1. Aggregated Score out of 60 Total Points:

Here the professional filling the FEES would aggegate their four grey "Sum of Points" boxes. Here, in this example, the professioal filling this scorecard out for Cuyahoga County, OH would find their aggregated score to be 39 points out of 60. The box below then offers considerations.

2. Scale and Considerations Based on Aggregated Score:

Point Score Ranges	Point Score Range Considerations
0 - 15 Points	Plan needs a timely and considerable upgrade across the four stages of the disaster cycle. Policy intervention is **strongly** encouraged.
16 - 30 Points	Plan is below average and needs upgrades across low-scoring stages of the disaster cycle for community.
31 - 45 Points	Plan is average-to-good and needs policy intervention for improvement. Consider intervention on the stages that performed lower than others for timelier needs.
46 - 60 Points	Plan is good, but can be improved and needs to be maintained at this level of quality or higher.

Page 7 is the final page of the FEES scorecard. This page asks the professional filling out the FEES to aggregate their four grey box scores across Mitigation, Preparedness, Response and Recovery to arrive at a final score out of 60 points. It then directs them to part two of the page in which the professional is able to assess their score across the point score ranges presented, with further considerations the professional can consider in moving forward with the jurisdiction of focus. In this example case study of Cuyahoga County, Ohio, the jurisdiction scored a 39 out of 60 possible points in their current flood emergency evacuation plans and operations.

The FEES interactive PDF scorecard can be downloaded for zero cost from, https://sites.gatech.edu/giscc/fees/. It was unable to be incorporated into this paper due to its interactive PDF format as opposed to it being in a word document format.

Findings with Recommendations and Next Steps:

There are further steps and actions to be taken after the completion of the FEES, for the planner, engineer, and/or emergency management professional to consider for their jurisdiction of focus. These primarily include policy and economic investment decisions and considerations to help address the metrics in which the jurisdiction scored poorly on. Nevertheless, all communities and jurisdictions are different, and so it is the decision of the jurisdiction's emergency management planning leadership and staff to consider the following next steps. Those in advisory or decision-making seats may: (1) Assign weights to certain metrics and/or phases of the Disaster Management Cycle in the FEES, (2) Consider budget allocation decisions, for upcoming Fiscal Years and/or Quarters, to help direct resources towards the areas that highlighted attention from the FEES, and/or (3) Evaluate policy decisions that can be enacted for the jurisdiction in order to combat lower scores in metrics in certain phases of the Disaster Management Cycle and analyze the implications of implementing such policy in short, medium and long-term scenarios.

In terms of continuing research on the FEES, one area to consider is establishing a website for communities that have filled out their community's FEES to publish their scorecard anonymously, but with certain community characteristics, such as population and/or city/county reported, so that users could compare to similar and different areas, and show a percentile distribution of the communities that have filled out these scorecards to see what percentile that jurisdiction ranks in. This can occur on a website such as through sites.gatech.edu; it does not have to be intricately designed. If 100 jurisdictions have filled out their own FEES, and all decide to publish solely their scores on this website, then a community considering filling out the FEES would be able to see which communities perform very well, well, average, poorly and considerably poorly in their flood emergency evacuation operations. This would be helpful in order for other jurisdictions to see the scores of communities that face similar flood hazards, are of similar sizes, and have similar economic resources at-hand. It can also lead to networking between professionals to discuss what considerations these other communities are planning or taking in order to address their lower-scored metrics.

This scorecard will be sent to contacts that have already expressed interest in scoring their jurisdictions through this method. These include contacts that work in emergency management in Tulsa County, the city of Baltimore, and in the city of New Orleans, With these professionals' permission, I hope to create a LinkedIn post, with the professionals tagged in said post, explaining the FEES's design and objective and highlighting that its implementation has been put into effect. From the original LinkedIn post asking for help from professionals in these fields, I came into contact with interested parties in each of these three jurisdictions.

Conclusion:

Flooding is one of the costliest, deadliest and unpredictable natural hazards not only in communities in the United States, but across the globe. Floods can come from heavy rainfalls, tides, and hurricanes, but as mentioned earlier in this paper, can also come from the breaking of large civil works and even tornadoes, and floods are becoming increasingly more chronic in communities. When floods occur, it ought to be the goal and first priority of every community to save as many lives as possible. This inevitably involves evacuation planning, and though some communities prefer to evacuate on a *case-by-case* basis, it is clear from the interviews conducted for this research and a review of the current literature that there remains a considerable lack of attention paid to this element in regional planning and emergency management. This research and the FEES scorecard attempt to offer an opportunity for communities to not only gauge their current status on flood-specific evacuation plans and programs and possibly share their results for greater collaboration between similar communities through the *Next Steps* of this research, but to also highlight a looming threat that far too many communities and jurisdictions will soon see if business as usual or minimal intervention occurs.

Acknowledgments:

This paper could not have been produced without the consistent mentorship and guidance by my Option/Applied Research Paper Advisor, Dr. William J. Drummond, and my Graduate Research Assistantship (GRA) boss, Dr. Steven P. French. Both men helped me significantly with conducting the research process, from deciding on a topic and writing a literature review, to

discussing the business strategy for community planners, emergency management coordinators, and engineers to filling out the FEES. To both men, I owe a sincere and deep token of gratitude.

Additionally, without the help of Mr. Justin Kates CEM, Mr. Jack Krolikowski, and Dr. Michael D. Meyer, this paper could not have been produced. I owe sincere gratitude to these three people on not only their willingness to help me with my Applied Research Paper by taking the time out of their schedules to have a ZOOM interview with me, but for their considerable insight into my topic through these interviews. These people have extensive work backgrounds in emergency management and regional planning, and if the FEES scorecard were to ever be an implementable scorecard, which is its intent, it could not have been without the insight from actual planners and emergency management professionals.

Lastly, the FEES scorecard would not be able to achieve its intended purpose if it were not for the professional contacts made with Tulsa County, the city of Baltimore and the city of New Orleans, who are willing to fill out the FEES and provide feedback for its improvement. These contacts wished to be kept anonymous.

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Appendix (Full Interview Transcriptions):

Table 1: Mr. Jack Krolikowski and Ian Newman Interview, February 1, 2021

Questions	Responses
Hi Mr. Krolikowski, can you talk more about the position that you have at the Georgia Emergency Management and Homeland Security Agency (GEMA), just to establish some background?	**N/A**
I'm wondering what are the current practices that are qualitative or quantitative for assessing whether a jurisdiction in Georgia for a natural hazard and is prepared for this hazard. Are there practices for floods specifically, or for tornadoes or even for hurricanes out on the coast near Brunswick and Savannah. So, what are the current practices that are qualitative or quantitative for assessing whether a jurisdiction that falls under your geographic scope is prepared for that hazard?	Mr. Krolikowski **answered this question by discussing how he views risk, which he believes is the intersection of the Venn Diagram of hazard, exposure and vulnerability. The Georgia Emergency Management and Homeland Security Agency tries to be as data driven as possible in risk identification and then ask how they'll address that risk depending on where it will be.** Mr. Krolikowski **also mentioned that community risk preparedness planning is community driven, and interest driven.** Mr. Krolikowski**'s agency invests in trying to get the word out for funding opportunities from the state and provide data for their jurisdictions. Finally,** Mr. Krolikowski **mentioned that tax assessor data, building codes for structural resilience, and social vulnerability is important for natural hazard risk measurement though not included by federal and state guidelines.**
Thanks Mr. Krolikowski, you talked about risk assessment in that answer, and when it comes to risk assessment is this more so the	**In this answer,** Mr. Krolikowski **mentioned that in terms of the risk assessment, the qualitative aspect includes county plans led**

part of the Disaster Management Cycle that the Georgia Emergency Management and Homeland Security Agency tends to prioritize over others? And if so, how do you look at risk specifically? Is there a way you can quantify or qualify risk for a community and then relay that information back out to the community?	**by both the county and the jurisdictions and communities that fall within. GEMA provides the resources and a floor of data quality for the counties.** Mr. Krolikowski **mentioned that for non-spatially defined hazards, GEMA tends to make these risks up and often do a worst-case scenario. From a qualitative standpoint GEMA helps communities rank the hazards they are most concerned about for each community and bring in subject matter expertise from across state government (GDOT, Department of Community Affairs, Department of Natural Resources) lay out these natural hazards, and let people put sticky notes up there and ask the community "What natural hazards keep you up at night?"). Essentially GEMA is vital in providing geospatial data so that communities in Georgia do not need to contract out for that data.**
Could there be a need for a tool or a need to create a quantitative scorecard that could be useful to essentially determine a community or a jurisdiction's level of preparedness, their mitigative strategies, and to have this scorecard transferable across communities that tend to face similar hazards and are generally close by to each other. Could a quantitative scorecard be useful to share not only with your colleagues and also with the colleagues you work with, but also to other agencies and jurisdictions?	**Yes, and the value is in the process of filling out the scorecard.** Mr. Krolikowski **mentioned that a community would not want to get an A+ because that would give them a false sense of security, and no community should get an A+.** Mr. Krolikowski **then mentioned a scorecard I'm familiar with from my literature review, the Community Rating System from NFIP through FEMA, but the scores in this scorecard are tied to premiums and reductions on flood insurance policies.** Mr. Krolikowski **mentioned I want to examine this scorecard further, to see where my scorecard could add value. He also mentioned that I need to consider the business case for why this should be filled out, if there is no incentive to filling this out.**

[*I reiterated here that my scorecard won't have any sort of and is tied to a more niche area of emergency management planning, and that the value is inherently in the process of scoring as it will lead to policy recommendations.*] In your experience, what would be the more important considerations to include in my scorecard? For example, is it most important to have warning systems? Shelters? Pre-defined, mapped transportation emergency evacuation routes? Or do you think it is more important from the preparedness side to emphasize and consider these variables more for emergency evacuation planning, when the objective is to save as many lives as possible and lessen the economic damage as possible?	Mr. Krolikowski **passed along another contact for me to interview here, as his colleague deals more in evacuation plans since he believes that if we need to do response, then he and his team have already failed. A flood is only a hazard when it interacts with the populace and the built environment. Floods are supposed to happen from a geomorphology standpoint.** Mr. Krolikowski **them mentioned stopping the development, addressing pre-existing exposure to minimize the need for the response. He did mention that the routes are more important, because as it comes to the infrastructure and community lifelines, that's where it becomes dynamic between mitigation and the response phase. As an example, if this artery is cut off, then fire trucks need to drive an additional 14 miles to get to the site. Critical facility preservation is also of the utmost importance when dealing with a natural hazard and the evacuation of people, so that water, electric, and heat area all available.**
[*I talked here about the subjectivity of weighting different variables. I also mentioned that this is a reiteration of the previous question, but I mentioned the wish for the scorecard to be transferable and to be used by engineers, planners, and emergency management coordinators.*] Again, in your experience what has come to light as being the variables that are most important in addressing the readiness and preparedness for a community as it comes to flooding and emergency response?	**For floods, typically, when lives are lost it comes from people who are in cars.** Mr. Krolikowski **mentioned the Atlanta 2009 flood and how the majority of deaths in that flood were from people who were in cars during those floods. A straightforward application includes flashers, gates, and stream gages that will prevent people from trying to drive through flooded routes. The gates would be a straightforward element to addressing this issue. The warning element is key, the integration of how well a community involves property considerations, critical facilities and**

	community lifelines, and the linear infrastructure and transportation.

Table 2: Mr. Justin Kates, CEM and Ian Newman Interview, February 1, 2021

Questions	Responses
Hi Mr. Kates, can you talk about what you do as the director for emergency management for Nashua?	Mr. Kates **mentioned that he and his team are responsible for mitigation programs, preparing citizens and city departments, developing emergency plans, involvement in the response phase, and involvement with recovery for the city of Nashua, New Hampshire.**
[*Here I reiterated the purpose and mission for creating the scorecard in a way almost identical to how I addressed it for Jack Krolikowski.*] I want to gain some insight from you on the elements for this scorecard that I have yet to make and am wondering what in your opinion would constitute the most important aspects in emergency management coordination and emergency evacuation. In other words, with the hypothetical of having this scorecard out and available for the city of Nashua, and to therefore be able to gauge your levels of preparedness, your mitigative strategies levels of preparedness, specifically when it comes to evacuations and flood evacuations. What comes to mind? What have you seen in your practice that would make you want to see a community such as Nashua have in an example scorecard?	Mr. Kates **told me that I must look at this scorecard from the standpoint of mitigation and adaptation measures, since preparedness related activities are most common in the emergency management realm. He then mentioned that most emergency management directors do not have a community planning or a community resilience background where they are examining the things that make communities more at risk, but come from first responder backgrounds, more-so, and are more focused on preparedness and response. Their efforts directed toward mitigation or risk reduction are quite small.** Mr. Kates**'s agency places much more emphasis on mitigation. The majority of** Mr. Kates**'s peers would look at the preparedness systems, warning system, and sandbags in place (if this is a strategy) teams of volunteers to help evacuate people if needed. However, he mentioned to me that if one starts talking to a planner about this, they probably won't look at those issues. A planner would look more at like having flood insurance planning in place, and proper zoning.**

	Mr. Kates **recommended to me here that it is important to consider the StormReady Program from the National Weather Service which is a program put in place to help emergency management agencies to determine their populations in vulnerable areas to evacuate and shelter in place (not specific to flood, but flooding is a major one here). It is an accreditation program that helps planners and emergency management coordinators identify the warning systems in place, if there is an evacuation plan, etc. and must have a certain number of these met to be accredited. It is free for an agency, but they must do the work.**
[Here I tell Mr. Kates that I don't want my personal scorecard to be tied to any incentive either, and that similar to StormReady, the value is in doing the work and in the process and planning and not in gaining fiscal incentives.] One area that has been interesting is that mapped evacuation routes have not been appearing on community evacuation routes. What are the current practices, quantitative or qualitative of assessing natural hazards, specifically floods, in Nashua? How does Nashua gauge their levels of preparedness and resilience in this regard?	**Depending on the flood hazard, there may be a different level of interest in moving forward with predefined evacuation routes. Nashua has an Emergency Action Plan (EAP) and has a levee system in conjunction with key routes in and out of the area, designated as evacuation routes. Depending on the flood hazard for a jurisdiction, they may not be required to identify specific routes. An important component though is shifting to a *just in time* model with apps like Ways in order to re-route traffic. This would add a concern to a predefined map in case there is a blockage which could impede on the plan's quality.** Mr. Kates **then went on to say that in the city of Nashua, there are a few sources in use including StormReady, which is a more qualitative than quantitative, and mentioned another scorecard reference which is the Emergency Management**

	Accreditation Program (EMAP). He mentioned though that Nashua is not accredited as there is too much money involved in having an assessment team come out, but this is something I could use to judge your community without putting forward significant investment; it works as another qualitative approach to measuring the performance of emergency management. **Another item that** Mr. Kates**'s department did as part of the Resilient Nashua Initiative is using the Texas A&M's Plan Integration for Resilience Scorecard GUIDEBOOK scorecard which helps determine hazard districts identified in Nashua to see if some districts are more risk-prone than others to measure resilience across the city in a quantitative manner.**
At this point I ask Mr. Kates if he has any questions for me, and that I have already asked him the questions I had prepared for him.	Mr. Kates **then told me that another scorecard that came to his mind is the UN Office of Risk Reduction's, Making my City Resilient Scorecard, which takes the framework of resilience for a community and breaks it down to specific actions that a city must do to be more resilient. It's more focused on international activities but something worth looking at for additional activities, especially for qualitative scorecards.**
[Here I think of one last additional question]. Do you think that a scorecard such as this one would be useful to be shared across jurisdictions at similar size and face similar hazards, and have there be some sort of partnership through this?	Mr. Kates **told me that the one big challenge I would find with that is that there are three different types of hazards: coastal flooding, riverine flooding, and the urban flooding due to infrastructure failure. He then told me that I would need to come up with categories in order to compare the results of one scorecard to**

	another jurisdiction. Jurisdictions that have flood hazards in each of these three categories could be compared, but Nashua would have a significant hazard difference and there are far more different resources to be put in place. For example, coastal communities have much more funding than inland communities, to deal with flood hazards. He then said that the value of what I am looking to do comes from the recommendations and therefore it is important and helpful to a jurisdiction if the scorecard provides a series of recommendations to (a) resources that could be helpful you could recommend to them (b) whatever the community can do policy or economic-wise to "check that checkbox". This is important especially if there are no incentives involved. There is not much benefit involved in comparing to other communities.

Table 3: Dr. Michael D. Meyer and Ian Newman Interview, February 2, 2021

Questions	Responses
Dr. Meyer, can you talk about what you have done in the positions you have held, including director of transportation planning and development for Massachusetts, Director of the Georgia Transportation Institute, and as Chair of Civil and Environmental Engineering, to name a couple, relating to emergency management planning?	**During his role as the director of transportation planning and development for Massachusetts, Dr. Meyer was first exposed to emergency management and evacuation in the context of a hypothetical major incident at a power plant. He also mentioned how much he worked with police in Massachusetts and that they had to work quite closely with local police departments when emergency declarations were enacted by the governor or the president.** **At Georgia Tech, Dr. Meyer said that he did not have involvement in emergency management. At the research center, he remembers doing research and work on traffic safety, the *Snowpocalypse Atlanta* of 2014, and the role for planning agencies in responding to terrorist attacks-all in relation to emergency management and some in emergency evacuation planning. Dr. Meyer then reiterated the importance of quick and safe decision making during an emergency. He also mentioned that in his career, when he's worked with police and other institutions on how they would evacuate in case of a terrorist incident or a natural hazard, they were unsure on how to actually evacuate the people. Lastly, Dr. Meyer mentioned how travel demand**

	models could provide information to the police and others in helping to pre-designate routes as emergency evacuation routes.
To the best of your knowledge, what are the current quantitative practices of assessing if a community is prepared for flood emergency evacuations specifically?	**Dr. Meyer mentioned that FEMA requires on the state level and at least for coastal areas, that there must be an evacuation plan in place and designated routes. He's unsure if a requirement is in place from FEMA if a jurisdiction is not coastal. Dr. Meyer also mentioned that some jurisdictions he worked with in Massachusetts have a case-by-case or by-incident approach towards emergency management. Dr. Meyer agreed with me that having designated routes for evacuating from flooded areas is important, but the challenge comes beforehand in performing the analysis of where the most vulnerable streets are. Dr. Meyer mentioned that one needs to identify the top 10 to top 25 routes as evacuation or detour routes, and that the planner/coordinator needs to focus these route designations as those that have less vulnerability to flooding.** **Dr. Meyer mentioned that the planner needs to consider professional incongruities across the "planning world" and the "emergency management world". He then expressed the vitality of communication systems for all agencies in coordination, and Dr. Meyer suggested I look to see what exists on the state level for emergency management communication coordination. Dr. Meyer then mentioned that another important aspect for the scorecard is that I shouldn't assign weights to the criteria, and instead leave that to the local**

	government to assign their own weights. He followed this up by saying that I don't want to be in the position to say I know more about what's more important to their community than they do.
Thank you for that answer Dr. Meyer, and are there any other elements that come to mind from a transportation perspective that would be important when considering flood emergency evacuation planning?	**There are two things Dr. Meyer said he would point to: (1) where the flood is and where people are evacuating to when a flood strikes. The DOT is a very important source of information for people who are trying to evacuation for communication purposes to let people know the status of roads, and (2) The aftermath of the disaster must be taken into consideration. The biggest problem he had when it came to emergency evacuation planning as the director of transportation planning and development for the state of Massachusetts was with the local police. Since, from his experience, local police chiefs want to let people back into the communities as soon as possible, but the DOT is responsible for the infrastructure especially major bridges and highways and is unsure of their safety status and needs to evaluate before letting people drive back to their homes. Dr. Meyer told me I must make sure I consider post-incident criterions such as coordination with state police for state highways in terms of when access will be allowed after the incident.**