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My current plan for the structure of this work in progress paper is to recognize multiple hurricanes over the past several decades in order to compare trends in information dissemination. The differences between warnings for predictable and unpredictable hurricanes in the 1960s compared to today are vast, primarily as a result of improved tracking and communication technologies. However, despite the rise of new forms of communication, all levels of government continue to rely on more traditional forums such as television, newspapers, and radio to provide potentially life-saving information. I will track not only the changes in the types of technologies used for disseminating information on incoming hurricanes, but also on the methods of disseminating such information given little warning in the event of hurricane altering its course. I will analyze decadal shifts in communication technologies, with a special emphasis on Southeastern states given the frequency of hurricanes there.

To conduct this research, I intend to visit the National Archives to view the records of the National Oceanic and Atmospheric Administration, and I will also use the National Hurricane Center's Data Archive for meteorological reports and forecasting analyses. I will complement this information on hurricanes with data on the availability and use of communications technologies in the United States from both the U.S. Census Bureau and the Pew Research Center. Furthermore, I will consider historic newspapers and radio and television broadcasts, when available for individual hurricanes considered in this paper.

I would appreciate any advice on locating primary and secondary source materials, as well as any suggestions on my approach to capturing how information dissemination tactics have changed over the past fifty years. I would also welcome any recommendations on how I can structure my paper to best capture how communicating information has improved.

Advance Warning Needed

News alerts of natural disasters often herald boarded windows, horded water bottles, and mass evacuations. Advance notice of tornados clustering in the Midwest, tropical storms advancing to hurricane level winds, and wildfires careening down mountainsides can save lives, property, and money.¹ Forecasting technologies have dramatically improved since the days of “red sky at night,” with analyses of temperatures, winds, and precipitation levels available to the general public at the touch of a button.² However, despite the availability of satellite imagery and advanced forecasting models, many of the challenges associated with disseminating this information from past decades remain true today. Part of this challenge reflects the rapid and unanticipated changes in the direction, speed, and power of large natural disasters.³ No matter how many types of information distribution technologies are available, providing last minute information in the midst of a quickly changing natural disaster remains a challenge.

While some natural disasters, such as earthquakes, are virtually unpredictable, others, such as hurricanes and blizzards, are foreseeable.⁴ For this paper, I will focus on hurricane forecasting and information dissemination. Hurricanes are large and predictable storms that are visible from space, but only a few make landfall in the United States in a given year.⁵ Hurricanes

¹ U.S. National Committee for the Decade for Natural Disaster Reduction et al., *A Safer Future: Reducing the Impacts of Natural Disasters* (Washington, D.C.: National Academy Press, 1991), 37.

² NASA Earth Observatory, "Weather Forecasting through the Ages," NASA Earth Observatory, accessed September 15, 2015, <http://earthobservatory.nasa.gov/Features/WxForecasting/wx2.php>.

³ Marshall Shepherd, "Why Is Tracking A Hurricane Easier Than Predicting Its Intensity?," *Forbes*, August 15, 2015, accessed September 15, 2015, <http://www.forbes.com/sites/marshallshepherd/2015/08/28/why-is-tracking-a-hurricane-easier-than-predicting-its-intensity/>.

⁴ NOAA/ National Weather Service, NOAA Center for Weather and Climate Prediction, and Climate Prediction Center, "NOAA 2015 Atlantic Hurricane Season Outlook," news release, August 6, 2015, accessed September 10, 2015, <http://www.cpc.ncep.noaa.gov/products/outlooks/hurricane.shtml>.

⁵ Atlantic Oceanographic & Meteorological Laboratory, "Subject: E23) What is the complete list of continental U.S. landfalling hurricanes?," Atlantic Oceanographic & Meteorological Laboratory, last modified June 1, 2015, accessed September 17, 2015, <http://www.aoml.noaa.gov/hrd/tcfaq/E23.html>.

also occasionally divert their path away from that predicted by meteorologists.⁶ Furthermore, the National Oceanic and Atmospheric Administration keeps records of hurricanes over the past century and a half, and these disasters affect large swaths of people, making them an excellent case study for analyzing natural disaster forecasts and subsequent warnings of the public.⁷

I will reflect on information dissemination for hurricanes hitting the United States rather than on how successful hurricane responses were. As Americans mark the arrival of Hurricane Katrina across Southeastern states one decade ago, politicians have pounced on the opportunity to denigrate past failures and tout more recent successes. Although derided as a colossal administrative failure, Hurricane Katrina's landfall was well tracked by meteorologists, and warnings populated all available news sources.⁸ Radio, television, newspaper, and Internet coverage provided regular updates for both those on the ground and a nation glued to the non-stop reporting. Few affected by the tropical storm did not know of its impending arrival, although the preparations in place were ultimately deficient due to a diverse set of factors unrelated to meteorological forecasting.⁹

An analysis of the hurricanes that made landfall in the United States over the past half century reveals that every form of available communication employable during that hurricane

⁶ National Science Foundation and The University of Rhode Island Graduate School of Oceanography, "Hurricane Movement," *Hurricanes: Science and Society*, accessed September 12, 2015, <http://www.hurricanescience.org/science/science/hurricanemovement/>.

⁷ Atlantic Oceanographic & Meteorological Laboratory, "Subject: E23) What is the complete," Atlantic Oceanographic & Meteorological Laboratory.

⁸ National Ocean Service, "Katrina: Forecasting the Nation's Most Destructive Storm," NOAA Celebrates 200 Years of Science, Service, and Stewardship, last modified July 12, 2012, accessed September 10, 2015, <http://celebrating200years.noaa.gov/magazine/katrina/welcome.html>.; Msnbc.com staff and news service reports, "Katrina Forecasters Were Remarkably Accurate," *NBCNews.com*, September 19, 2005, accessed September 14, 2015, http://www.nbcnews.com/id/9369041/ns/us_news-katrina_the_long_road_back/t/katrina-forecasters-were-remarkably-accurate/#.Vf8Gtc7mEuR.

⁹ Brian Williams, "Hurricane Katrina: What Went Wrong," *NBCNews.com*, August 28, 2006, accessed September 15, 2015, http://www.nbcnews.com/id/14559053/ns/nbc_nightly_news_with_brian_williams-after_katrina/t/hurricane-katrina-what-went-wrong/#.Vf1P487mEuQ.

season was employed to alert the public of the incoming storm.¹⁰ While residents relied primarily on radio and newspaper reports through the 1950s and 1960s, television became an increasingly common source of information as it became a household staple by 1960.¹¹ Today, residents can expect warnings in the form of Internet stories to text message notifications, in addition to the more traditional sources of radio, newspaper, and television.¹² Disaster-related technological features are also constantly improving; as of 2014, the Facebook “Safety Check” option allows users to announce that they are safe in the wake of a natural disaster.¹³

While hurricanes usually follow the course predicted by meteorologists, some have not followed this convention. Hurricanes Camille (1969), Elena (1985), Andrew (1992), and Charley (2004) exemplify this more atypical hurricane, one that unpredictably alters its course shortly before landfall. Throughout this paper, I will explore how the preparations and information dissemination for these more rapidly changing hurricanes differ from those of the norm, adjusting for technological availability during historical periods. Therefore, I will compare storms of similar categories within the same hurricane season to control for changes in national and local communication trends and to identify what strategies are employed for warning the public of hurricanes either maintaining their expected path or rapidly changing.

Improvements in Forecasting and Communication Technologies

¹⁰ This statement is based on finding evidence of communication technologies used in warning the public for every hurricane that made landfall in the United States since 1960.

¹¹ David R. Davies, "An Industry in Transition: Major Trends in American Daily Newspapers, 1945-1965," (PhD diss., University of Alabama, 1997).

¹² NOAA/ National Weather Service, National Centers for Environmental Prediction, and National Hurricane Center, "Hurricane Preparedness - Watches & Warnings," National Hurricane Center, last modified August 3, 2012, accessed September 12, 2015, <http://www.nhc.noaa.gov/prepare/wwa.php>; National Weather Service, "Email and SMS Weather Alert Services," National Weather Service, accessed September 14, 2015, <http://www.weather.gov/subscribe>.

¹³ Facebook, "Safety Check," Facebook, last modified 2015, accessed September 16, 2015, <https://www.facebook.com/about/safetycheck/>.

Although hurricane tracking records date to 1893, not until the post-World War II era did hurricane forecasting and warning approach moderately acceptable levels of risk aversion. Advances in science and technology, combined with the growing population along the Southeastern coastline, heightened both the ability and need to track hurricanes and warn the affected populace. However, challenges to public awareness measures and evacuation efforts diminished the utility of more advanced forecasting capabilities to prepare residents effectively. The arrival of three major hurricanes in 1954 convinced Congress to invest in crisis management improvements, leading to the establishment of the National Hurricane Research Project and a doubling of the Weather Bureau's annual budget.¹⁴

Hurricane forecasting experienced a major leap forward upon the launch of the first weather satellite in 1959. The Vanguard 2, quickly followed by the TIROS-1 in 1960, provided footage of large weather events from space. By 1975, improvements in satellite technology allowed the United States to capture useful cloud images of the Atlantic Ocean with the launch of the Geostationary Operational Environmental Satellite 1, or GEOS 1. The development of more advanced satellite capabilities and powerful computers improved hurricane forecasting throughout the second half of the twentieth century, although communicating these predictions to the general public proved difficult.¹⁵ For example, Hurricane Camille served as a major turning point in hurricane disaster preparation and communication in 1969 when it became the first category 5 hurricane to hit a densely populated coastal area since 1935. While scientific knowledge of hurricane development and movement had improved and allowed for superior predictions, ineffective communication strategies resulted in substantial damage and the death of

¹⁴ R. H. Simpson, "Stepping Stones in the Evolution of a National Hurricane Policy," *Weather and Forecasting* 13 (September 1998): 617-9, accessed September 7, 2015, <http://journals.ametsoc.org/doi/pdf/10.1175/1520-0434%281998%29013%3C0617%3ASSITEO%3E2.0.CO%3B2>.

¹⁵ Mike Wall, "Hurricane-Hunting Tech: A Brief History," Live Science, last modified August 27, 2010, accessed September 8, 2015, <http://www.livescience.com/8510-hurricane-hunting-tech-history.html>.

256 people. In response to the outpouring of communications research and identification of more appropriate building standards, national policies and procedures evolved to reflect the need for more coordinated and efficient warning systems.¹⁶

Unsurprisingly, hurricane tracking has improved since the middle of the twentieth century, with detailed information on tropical storm tracking, intensity, size, and structure available at least 48 hours before its landfall. Forecasters rely on satellites while the cyclone remains in the open ocean and transition to reconnaissance aircraft, dropsondes, and land-based platforms such as radar when the storm approaches land. The data are used as inputs to hurricane forecast models, or numerical prediction (NWP) models, which generate likely predictions of a hurricane's course and intensity. The results from these NWP models form the basis of official forecasts and warnings, but even small variations among the models can result in distinct paths and wind strength. Forecasters must then weigh their knowledge of environmental observations against the multitude of potential hurricane forecasts to select the most probable course.¹⁷

Meteorologists thus rely on a multitude of forecasting technologies today, all of which have enjoyed substantial development to improve their utility in modeling; similarly, the number of communications technologies used today exceed those from several decades ago, although the government and public continue to rely on these traditional technologies. For example, different forms of media, and most notably television sets, became more prevalent in American households throughout the second half of the twentieth century. In 1950, 91% of households owned a radio, in comparison to 62% with a telephone and only 9% with a television set. Within the next five and ten years, respectively, 63% and 85% of American households had a television.

¹⁶ Simpson, "Stepping Stones in the Evolution," 619.

¹⁷ National Science Foundation and The University of Rhode Island Graduate School of Oceanography, "National Hurricane Center Forecast Process," *Hurricanes: Science and Society*, last modified 2015, accessed September 10, 2015, <http://www.hurricanescience.org/science/forecast/forecasting/forecastprocess/>.

Since 1965, at least 90% of American households have owned at least one television, reaching 98% of households by 1980. In comparison, telephone services stagnated around 94% by the mid-1970s, and radio access remained high, reaching 99% of households by 1970.¹⁸ Despite the rise of television as a form of communications media, the public still relies heavily on the more traditional news sources of radio and newspapers, which have a much longer associated history with disaster warnings.

More recently developed technologies also play an important role in information dissemination. In 1997, 36.6% of households had a computer, but only 18% of households had Internet access. Within one decade, the percentage of households with a computer had nearly doubled, and 61.7% of households had Internet access.¹⁹ As of 2014, more than 78% of American households had a high-speed Internet connection, and nearly two-thirds of households reported owning a hand-held computer such as a smartphone.²⁰ Technologies practically inconceivable only a few years earlier are now becoming major sources of information from and connection to the world. Smartphones connect their users both to their local and global communities; 68% of owners have used their phones to follow breaking news events, and 56% of owners have used their phones to learn about local events or activities.²¹ Mobile phones can even provide text message alerts of severe weather alerts to warn their users of approaching weather-related dangers.²² The development of new technologies, both for forecasting and communications purposes, therefore provides new opportunities to track and predict storms and

¹⁸ U.S. Census Bureau, "Statistical Abstract of the United States: 1999," in *U.S. Census*, 885, accessed September 12, 2015, <http://www.census.gov/prod/99pubs/99statab/sec31.pdf>.

¹⁹ Thom File, "Computer and Internet Use in the United States: Population Characteristics," in *U.S. Census*, 2, accessed September 12, 2015, <http://www.census.gov/prod/2013pubs/p20-569.pdf>.

²⁰ "Nearly 8 in 10 Americans Have Access to High-Speed Internet," news release, November 13, 2014, accessed September 12, 2015, <http://www.census.gov/newsroom/press-releases/2014/cb14-202.html>.

²¹ Aaron Smith, *U.S. Smartphone Use in 2015*, April 1, 2015, accessed September 12, 2015, <http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/>.

²² National Weather Service, "Email and SMS Weather," National Weather Service.

to alert the general public of impending natural disasters.