

Adapting the InTeGrate “Natural Hazards and Risk: Hurricanes” module in the wake of Hurricane Matthew

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INTRODUCTION: In the fall of 2016 the impacts of Hurricane Matthew caused 26 deaths and estimates of over \$1.5 billion in damage in North Carolina. The University of North Carolina at Pembroke was evacuated, closed, and many students and faculty lost homes and possessions due to the damages incurred by the storm. As part of the InTeGrate research team, Dr. Nelson was adapting and implementing the “Natural Hazards and Risks: Hurricanes” module into my Earth Science courses. The fall 2016 term was also our “treatment” term where the implementation of this and other modules were in full swing. However, it was hypothesized that the students perceived interest would increase due to the storm by further adapting the module to use Hurricane Matthew as an additional case study.

InTeGrate Research Implementation Team: A team of researchers has been implementing InTeGrate modules throughout classrooms around the nation. As part of the research, instructors were to teach their courses without the modules as a control group, followed by a pilot term to practice the modules, and then a treatment term to improve the implementation of the modules. As part of the research, the students completed a group of attitudinal surveys and Geoscience Literacy Exams to assess the students’ views and understanding of the geosciences.

UNCP Implementation: Dr. Nelson implemented portions of the following modules in his Earth Science courses: “Environmental Justice & Freshwater Resources”, “Humans’ Dependence on Earth’s Mineral Resources”, “Living on the Edge: Building resilient societies on active plate margins”, and “Natural Hazards & Risks: Hurricanes”.

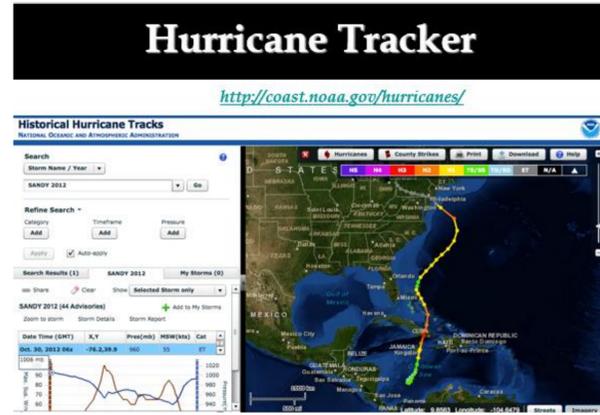
UNCP Implementation of “Natural Hazards and Risk: Hurricanes” module: During the pilot term the module was slightly adapted. However because of Hurricane Matthew, the module was further adapted to use the current event as a case study that students would be more familiar having just experienced the event that same term.

DAY 01: UNIT 2 – Hurricane Formation: Unit 2 is discussed first (discussion and video regarding how hurricanes form). Clicker (Q&A) questions are completed to check the students understanding (min).

UNIT 1 – Risk: The topic is shortened because the topic is also discussed when earthquakes and volcanoes are discussed earlier in the term. A brief – think-pair-share and then short group worksheet is completed to calculate risk of hurricanes in NC (20 min).

DAY 02: UNIT 2/1 – Risk: The concept of cone of uncertainty is discussed and then the Container Ship risk assessment activity from unit 2 is completed as another think-pair-share (20 min).

UNIT 3 – Hurricane Tracks & Energy: Students are asked to bring their laptops, or use their mobile devices in preparation for the class. Hurricane Sandy and Irene are discussed and then their tracks are investigated. Students then get in groups and find the reoccurrence intervals (RI) for specific cities in North Carolina. Students compare the RI they calculated with other groups (35 min).



DAY 04: UNIT 6 – Predictions and Evacuations: We complete a role playing activity regarding a case study of a particular hurricane track and what individual stakeholders would do as the storm progresses. I use Hurricane Matthew as the case study but do not tell them what storm it is until we are complete. The students debate when they should evacuate, how they would mitigate the storm, and environmental justice issues (45 min).



- Role Playing Groups**
- Government Official (Mayor, Governor)
 - Federal Agency (FEMA or other federal government representative)
 - Scientists with knowledge of storm information
 - Business owners (department store, grocery store, or gas stations)
 - Single parent property owner (does not have reliable transportation for herself and 3 kids)
 - Wealthy property owner of nice beach house (family and 2 kids)
 - Mass transit officials
 - First Responders
 - Hospital Officials



Hurricane Matthew hit SE North Carolina on Oct 8, 2016.

Matthew was a Cat 1 storm when it hit but brought in up to 14” of rain to a region that was already saturated from a large thunderstorm a week earlier that brought in up to 18” of rain.

The stage of the Lumber River peaked on Oct 9 at 24’, over 12’ over its flood stage.

UNCP closed its doors for 1.5 weeks and local schools were closed for an average of 3 weeks.

Local residents and the campus was without power and clean water for 1 week.

The storm was not expected to hit campus very hard. Therefore there was no mandatory evacuation order on campus.

~ 200 students were stranded on campus during the event.

Most students felt that they were abandoned during the event and that the University did not do enough to help them.

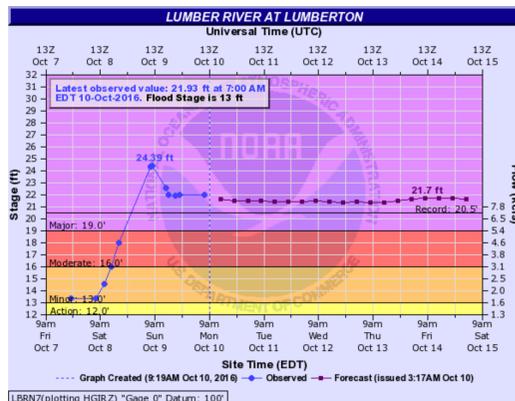
Lumberton, NC



DAY 03: UNIT 5 – Hurricane Risks and Coastal Developments: We very briefly discuss coastal change and use before and after pictures of Hurricanes Sandy and Matthew. This is shortened because covered earlier when coastal processes were discussed. (10 min)

UNIT 4 – Hurricane Impacts Unit 4 uses Hurricane Sandy and Irene as case studies to discuss how different hurricanes can act and have such different impacts. This is also where Hurricane Matthew is introduced and we discuss how the hurricane was similar to Irene. We also investigate Google Earth photos of the region to discuss what happened to our community. (35 min)

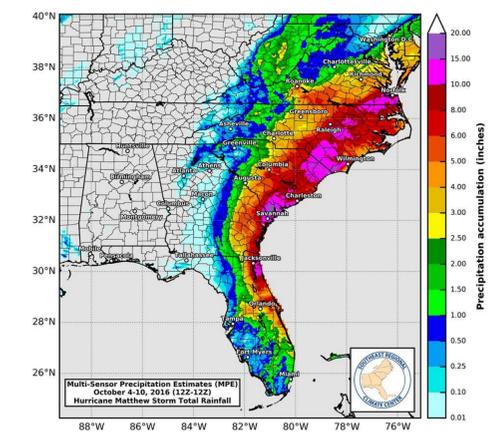
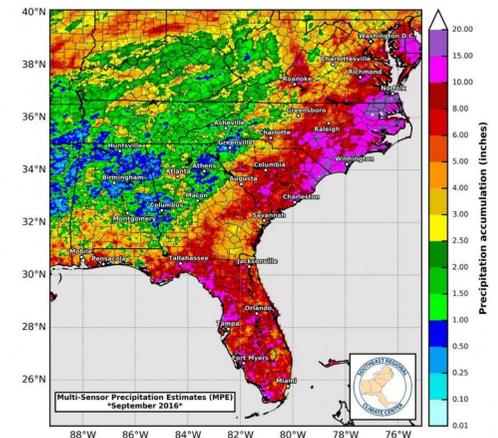
Activity - Students are then asked to share their Hurricane Matthew stories with each other and the class. (15 min)



- | Historic Crests | Recent Crests |
|----------------------------|----------------------------|
| (1) 24.39 ft on 10/09/2016 | (1) 24.39 ft on 10/09/2016 |
| (2) 20.48 ft on 09/11/2004 | (2) 16.34 ft on 10/05/2016 |
| (3) 20.04 ft on 10/19/1999 | (3) 18.09 ft on 01/02/2016 |
| (4) 19.47 ft on 02/05/1998 | (4) 18.31 ft on 12/26/2015 |
| (5) 18.31 ft on 12/26/2015 | (5) 14.64 ft on 11/24/2015 |



Low-altitude oblique photography taken before Hurricane Matthew (Sept. 6, 2014) and after (Oct. 13, 2016) shows the storm cut a new inlet between the Atlantic Ocean and the Matanzas River near St. Augustine, Florida, stripping away a 3.7 meter (12-foot) dune and carrying sand into the estuary Public domain.



Assessment: Final exams included material related to Hurricanes. Based on these assessments there was no significant grade difference based on the way the material was presented.

	S17 Treat	F16 Treat	S16 Pilot	F15 Pre
Median	70.00	69.29	68.10	70.5
Avg	70.82	67.38	68.77	68.6
Max	95.33	86.07	94.80	93
StDev	8.51	11.4	6.61	14.8
Num	92	31	31	90

There are too many other factors that could impact student understanding to confirm that the experiences related to the hurricane or the active learning activities from InTeGrate impacted student understanding.

Even though I did not quantitatively assess the interest level of students, students did ask more questions, participated more, and seemed more interested in the topic of hurricanes during and after Hurricane Matthew.

Comments of students: “Learning about Hurricanes have increased my buoyancy to confront with such disasters. Even though there are risks associated with such disasters, I would consider those as an exam not a challenge. Lastly, I will make sure that I have more awareness in such situation otherwise I might be a victim no matter how knowledgeable I am. The person who is aware can make their way to survival comparing to those who are knowledgeable but not aware.”

“Learning about hurricanes has helped me better understand the risk. It has helped me understand better because of all of the flooding that happened. I never really understood just how much flooding could happen until I saw it all around my home.”

“Learning about hurricanes has helped me to be more risk-minded as I now know what can happen and what you should do to prepare.”

“Learn the signs for hurricanes, and how to be prepared, it makes it easier for when a hurricane comes and we can be better prepared.”