Communicating Hurricane Risks To Local Officials For Protective Action Decision Making

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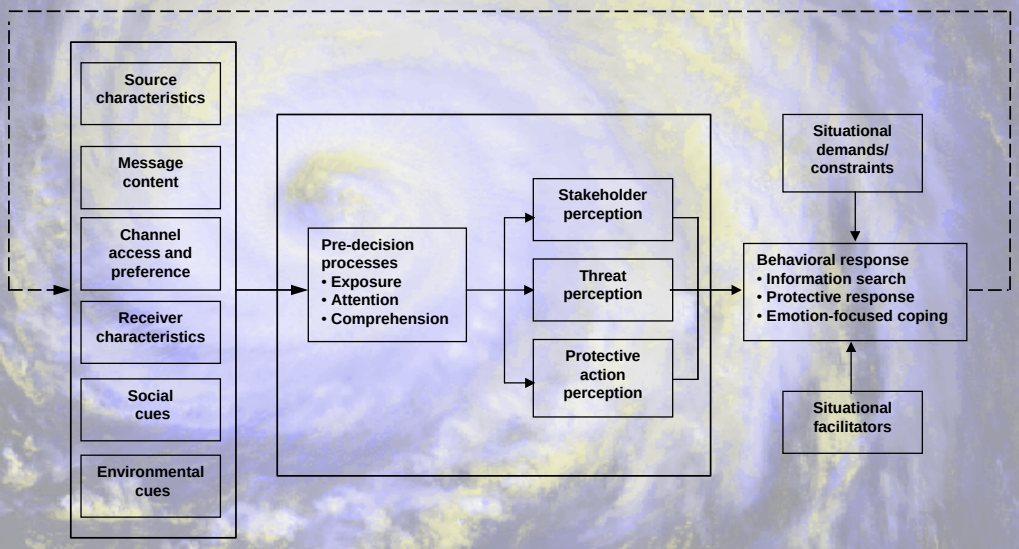
Outline

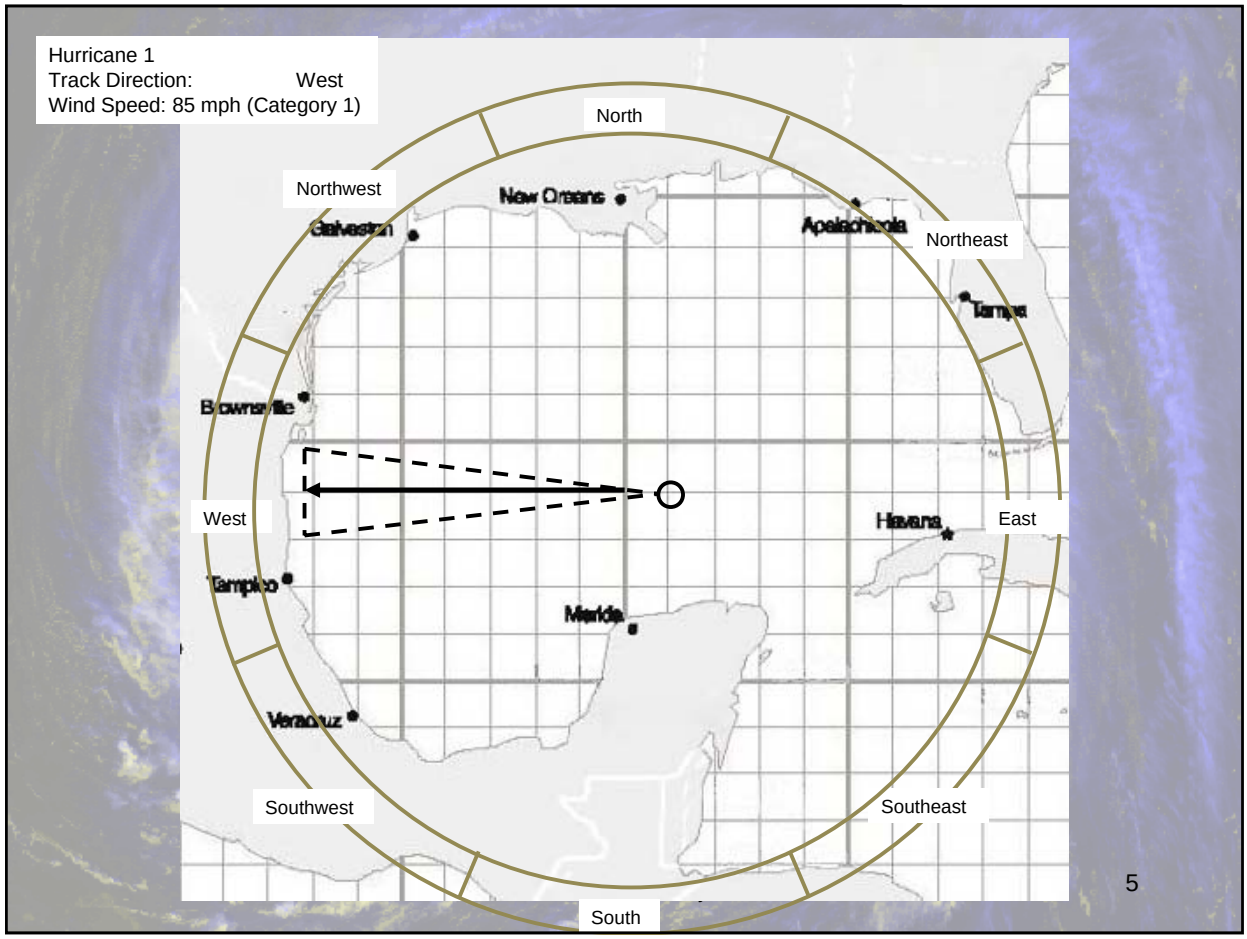
- This presentation will address the effects of different information displays on people's information seeking, probability judgments, and protective action decisions.
- We have conducted a number of relevant studies on hurricane evacuation but time constraints limit this presentation to three topics.
  - > An overview of the Protective Action Decision Model,
  - > The Hurricane Track Experiment, and
  - > The *DynaSearch* Hurricane Tracking Experiment

Protective Action Decision Model



Hurricane Track Experiment

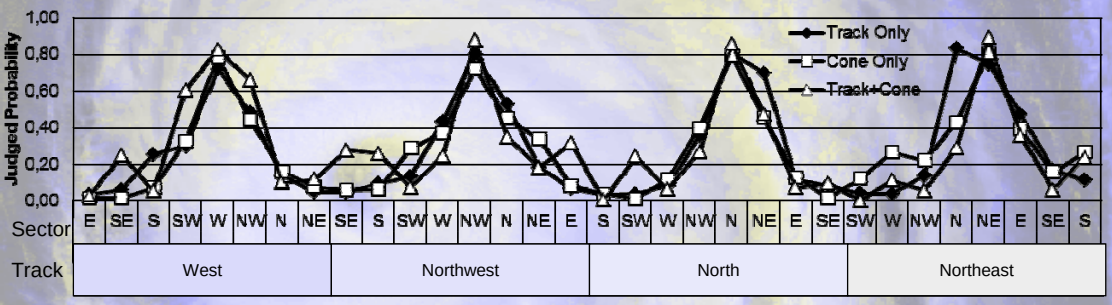
- Hurricane behavior cannot be predicted with perfect accuracy, so people need to have information about forecast uncertainty—especially *track forecast* uncertainty.
- How well do people assess track uncertainty when they receive a--
  - > Forecast track only,
  - > Uncertainty cone ("confidence interval") only, or
  - > Forecast track plus uncertainty cone?


Hurricane 1
Track Direction: West
Wind Speed: 85 mph (Category 1)
North
Northwest
Northeast
West
East
Southwest
Southeast
South
New Orleans
Galveston
Tampa
Brownsville
Havana
Tampico
Merida
Veracruz

Hurricane Track Experiment

- Participants began by reading the *Local Official's Guide to Hurricane Evacuation Decisions* and taking the *Hurricane Knowledge Test*.
- They judged strike probabilities (p_s) for eight sectors corresponding to the cardinal and ordinal compass directions.
- p_s judgments were collected for eight hurricanes created from two factors
  - > Two hurricane intensities (CAT1 and CAT4), and
  - > Four track directions (West, Northwest, North, and Northeast).

Category 1 Hurricanes

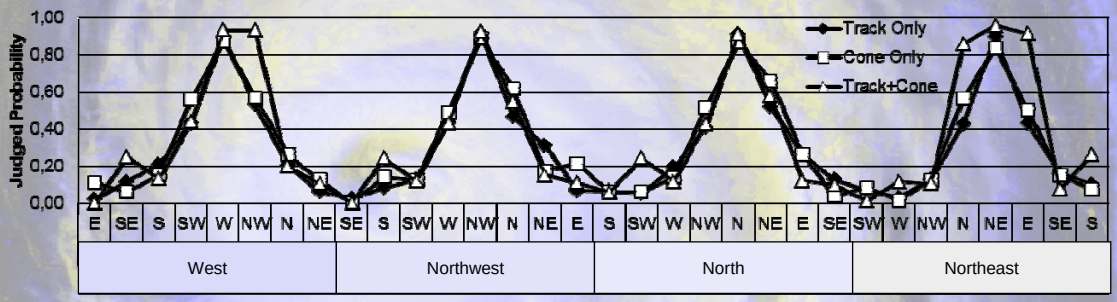


- The probability judgments were highest for the sector in which the hurricane was headed and decreased relatively symmetrically in the sectors on either side.
- The probability judgments were extremely low in the direction opposite to the hurricane heading.
- There were trivial differences among the the track information conditions.

Conclusions

- p_s judgments were *qualitatively* reasonable (i.e., decreased over distance from likely landfall).
  - > However, this does not necessarily mean they were *quantitatively* accurate.
- There were no differences among track information conditions (track only, uncertainty cone only, track plus uncertainty cone).
  - > This suggests that people are not misinterpreting uncertainty cones.
  - > However, it is possible that participants used uncertainty cones only to identify a hurricane's direction and generated their p_s using a simple distance-decay heuristic.

Category 4 Hurricanes

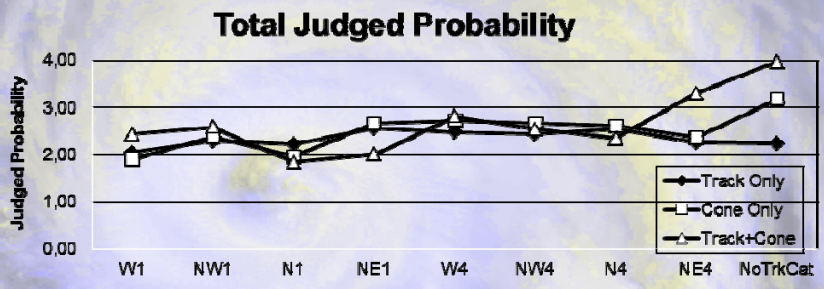


- The results for the Category 4 hurricanes followed the same pattern as those for the Category 1 but the sums of probabilities were higher for the more severe Category 4 hurricanes.

Conclusions

- The p_s distributions for the Category 4 hurricanes were similar to those for the Category 1 hurricanes.
- However, p_s judgments were higher for the Category 4 hurricane than for the Category 1 hurricane.
- This is consistent with other research finding that the severity of event consequences affects judgments of event probability.

Sum of Probability Judgments



- The eight sectors are mutually exclusive and exhaustive, so the total judged probability for each hurricane should equal 1.0
- However, this was not the case.

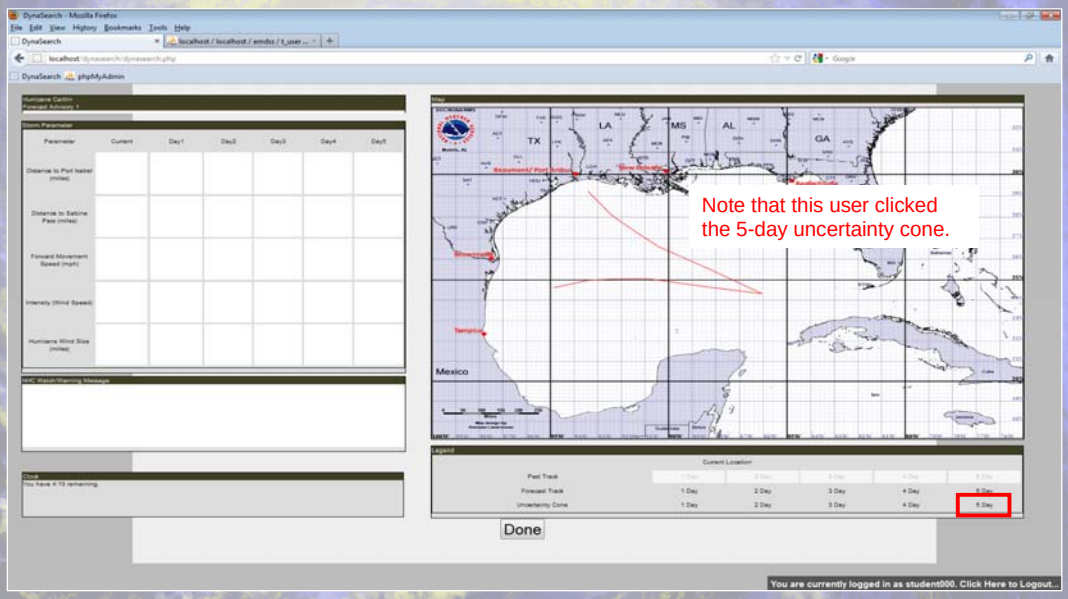
Conclusions

- The finding that the sum of p_s for a given hurricane exceeded 1.0 replicates previous findings that people do not process probabilities well.
- It appears that, when the number of categories (e.g., sectors) is greater than two,
  - > People are only able to treat the probability scale as a rating scale where the anchors are 0-1 rather than, for example, 1-10, and
  - > Don't have the working memory capacity to constrain the sum of the ratings to 1.0.

DynaSearch Computer Program

- We have developed a Web-based process tracing program for studying dynamic decisions—ones in which decisions are based on data that is updated over time.
  - > *DynaSearch* can display information in graphic (e.g., maps), numeric (tabular), and text formats.
  - > Display content is made visible by clicking/holding a cursor on the desired information element.
  - > *DynaSearch* is a useful alternative to eye-tracking methods for studying information search because it can be used to conduct Internet experiments.

DynaSearch Forecast Advisory Information Display



Hurricane Tracking Experiment

- Participants began by reading the *Local Official's Guide to Hurricane Evacuation Decisions* and taking the *Hurricane Knowledge Test*.
- They played the role of a Local Emergency Manager making protective action recommendations (PARs) for their coastal jurisdiction.
- They tracked four hurricanes that made landfall at different locations—Brownsville, Corpus Christi, Port Arthur, or New Orleans.

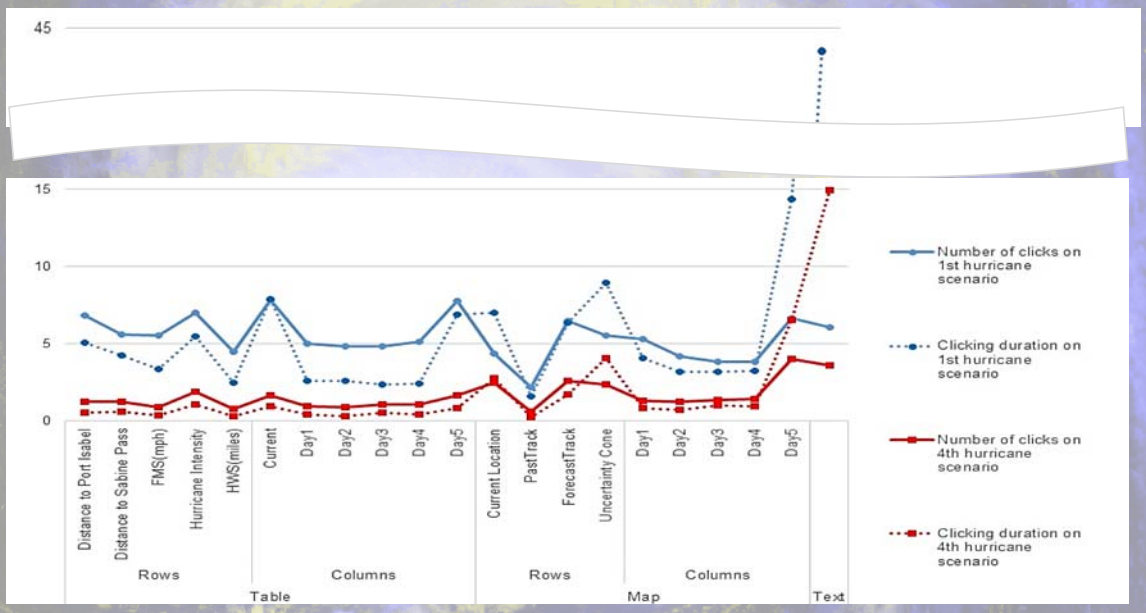
The Four Hurricane Tracks

Hurricane Tracking Experiment

- During each hurricane, participants viewed five different forecast advisories that were nominally one day apart but, in practice, were only a few minutes apart.
- Participants were randomly assigned to
  - > one of two counties (Cameron or Jefferson) and
  - > one of four hurricane sequences.

Texas Coastal Map

Mean Click Counts/Durations For Hurricane Scenarios 1 and 4.



Conclusions

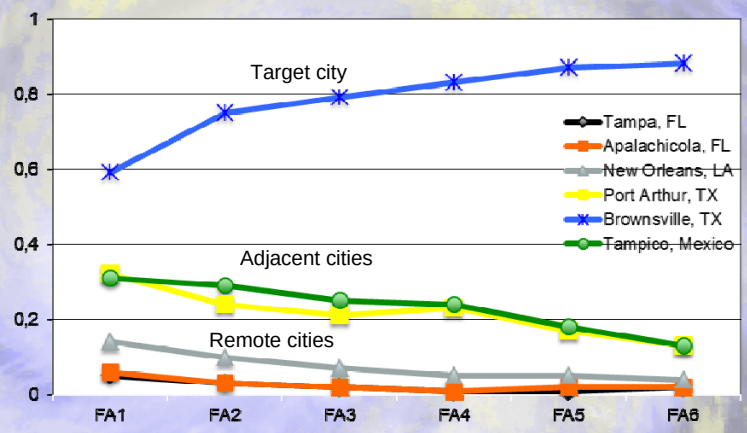
- Participants changed their parameter table and tracking map search strategies from the first to the fourth hurricane.
  - > This indicates that the *Official's Guide* was not a *sufficient* basis for decisions.
  - > Participants needed "hands on" practice in making processing the information.
- However, they continued to spend a *substantial* amount of time viewing the National Hurricane Center Watch/Warning message box.

Strike Probability Judgments

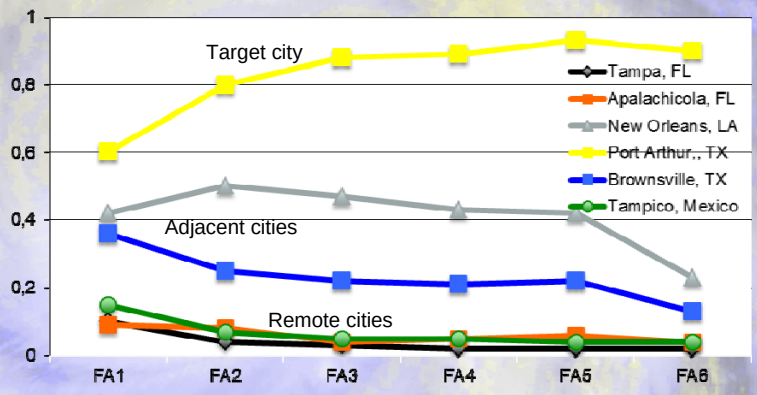
- After viewing the information search page for each forecast advisory, participants next provided p_s judgments for each of six cities located around the Gulf of Mexico
  - > Tampa, Apalachicola, New Orleans, Port Arthur, Corpus Christi, Brownsville, and Tampico.

The Six Reference Cities

Mean p_s for Hurricane A (Brownsville)



Mean p_s for Hurricane B (Port Arthur)



Conclusions

- p_s judgments were *qualitatively* reasonable (i.e., increased over time and decreased over distance from likely landfall)
  - > Once again, this does not necessarily mean they were *quantitatively* accurate.
- Consistent with findings from other studies, p_s judgments appear to have influenced PARs because the two measures were highly correlated (r = .40-.53).

Protective Action Recommendations

- After providing p_s judgments, each participant checked whether they would issue each one of 11 PARs:
  - (1) Activate the EOC,
  - …..
  - (11) Recommend immediate evacuation of the general population in Risk Area 5.

Evacuation Recommendations For Each Risk Area After Viewing FA5

Risk area	Percentage of participants who recommend evacuation	
	Hurricane A Cameron County	Hurricane B Jefferson County
1	78%	65%
2	70%	65%
3	55%	60%
4	33%	50%
5	28%	48%

Conclusions

- Participants' PARs were *generally* appropriate
  - > They increased more over time for hurricanes approaching their jurisdiction than for hurricanes approaching the other jurisdiction.
- However, participants *substantially under-responded* to the hurricane threats.
  - > This is an extremely important finding because the ultimate test of a forecast/warning system is to implement appropriate protective actions.

Conclusions

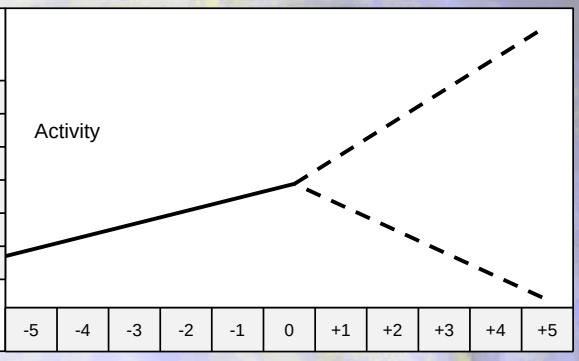
- This problem of under-response might be reduced or avoided by
  - > Revising the *Official's Guide* to make the response implications of strike probabilities clearer,
  - > Providing graphical displays that increase the salience of hurricane intensity,
  - > Providing graphical displays forecasting the risk areas that are likely to be affected if the hurricane strikes with its current intensity,
  - > Providing graphical displays that better convey when evacuations must be initiated to clear the probable impact area before arrival of storm conditions, or
  - > All of the above.

Application to Volcanic Activity Tracking

- *DynaSearch*—in conjunction with an equivalent to the *Official's Guide*—could also be useful in studying information search processes, threat perceptions, and PARs for volcanic activity.
- Volcanic activity could be characterized by the levels of different indicators over time.
- Graphic displays could show point forecasts and uncertainty bounds for different volcanic activity indicators over time.
- Participants' judgments of p_s and PARs could also be collected.

Sample *DynaSearch* Volcano Forecast Advisory Information Display

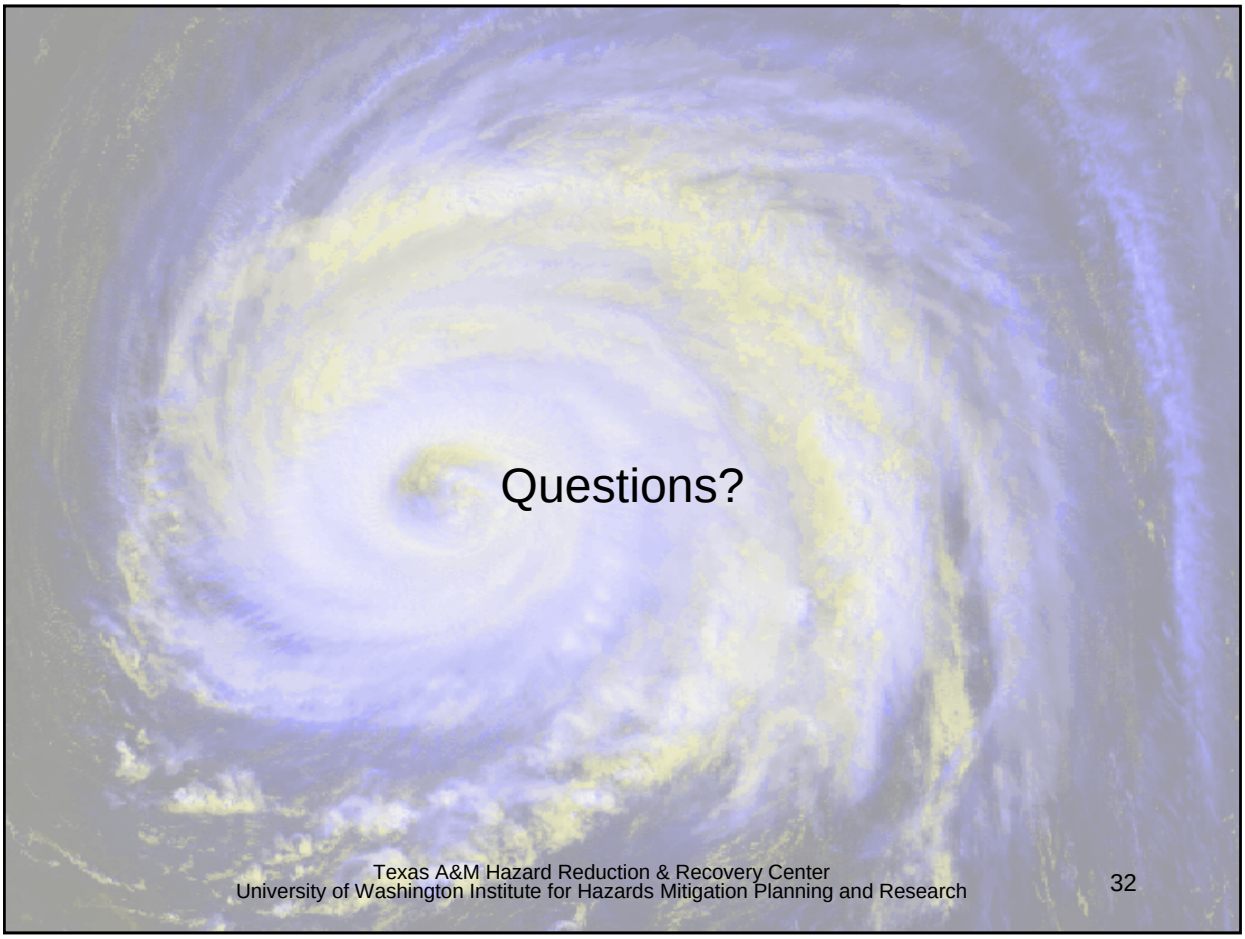
Volcano Parameter	Display
Debris flows	☐
Water temp/pressure	☐
Earthquakes	☐
Cone deformation	☐
Gas release	☑



Hazard Parameter	1 day	2 days	3 days	4 days	5 days
Debris flows					
Water temp/pressure					
Earthquakes					
Cone deformation					
Gas release					

Risk Area	Impact Probability
RA1	.25
RA2	.15
RA3	.10
RA4	.05
RA5	.01

Response	Status
Activate EOC	☑
Activate public shelters	☐
Close schools	☐
Activate sirens	☐
Evacuate risk area	☐


Questions?

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