

The use of SHAVE and NWS flash flood reports for impact characterization and prediction

Martin Calianno

[illegible]

Work carried out during my Master of Sc. Thesis, in collaboration with:

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(LTHE) Grenoble, France



Jonathan J. Gourley

(NSSL) Norman, USA



The context: US flash flood reports datasets

In the US, two different datasets are collecting reports of observed flash flood events:



Two datasets:
1°) **NWS**
2°) **SHAVE**

[illegible]

The context: US flash flood reports datasets



1° National Weather Service (NWS) Flash flood reports

> Collected by **trained spotters**

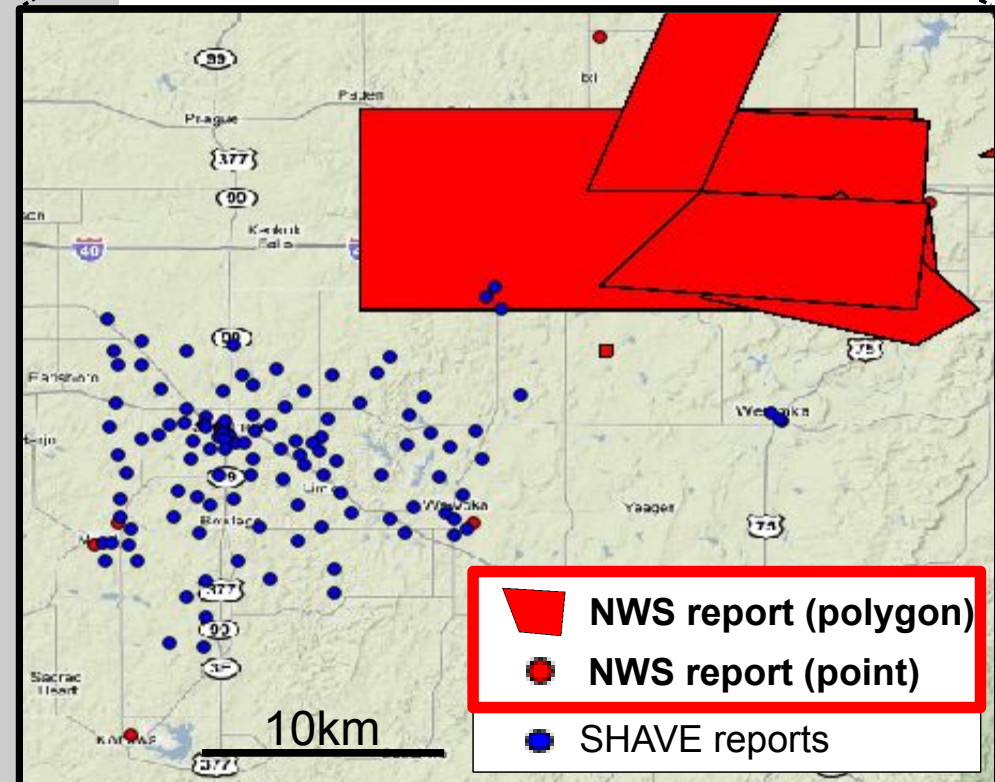
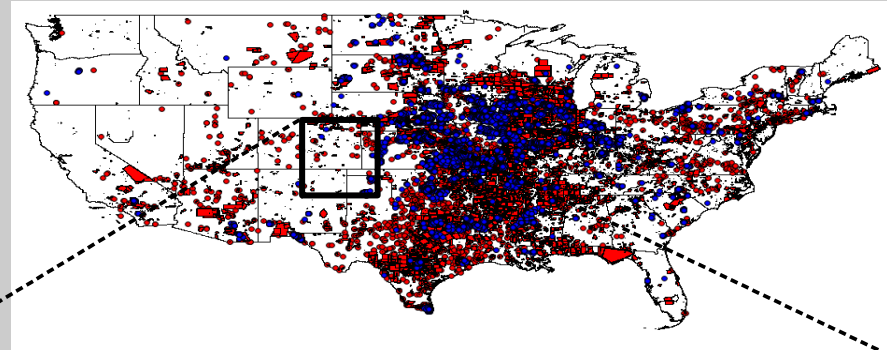
(Weather Forecast Offices)

- > Digitized as: - **Points** (2006 - 2007)
- **Polygons** (2008 – now)

> n=15 999 reports, over the whole US

Metadata:

- Event start/end
- Fatalities/Injuries
- Damages (\$)
- Textual comments about : * meteorological event
* flood event



The context: US flash flood reports datasets

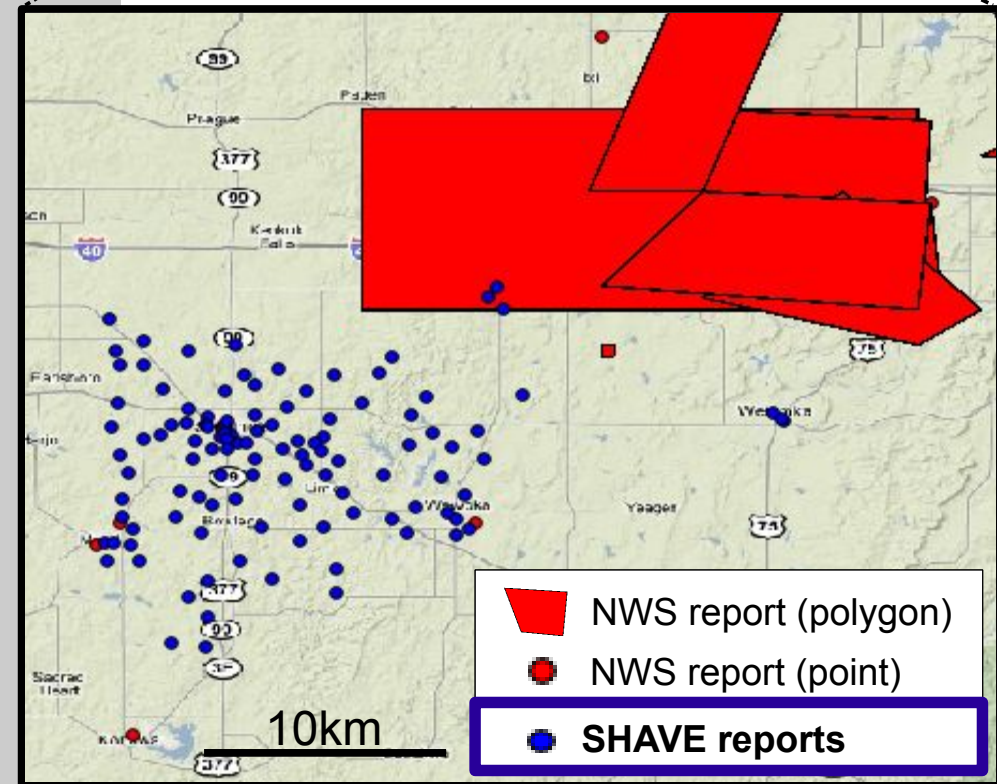
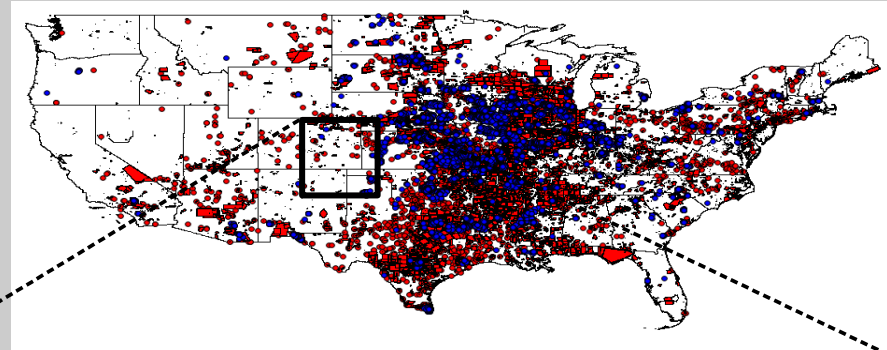


2°) Severe Hazards Analysis and Verification Experiment (SHAVE)

- > Observations based on a near real-time **public survey** (phone calls)
- > Digitized as **Points** (2008-10): n=9366
- > Contains **null reports** (observed non-events)

Metadata (questions asked to the public) :

- YES/NO flooding
- Event start/end
- Water movement / depth / extent
- Flood frequency
- Known evacuation, rescue



Goal of this work

These datasets are designed for the **evaluation** of **flash flood forecasting tools**.

=> But only on a **YES/NO** event basis.

Though, there is enough metadata in these datasets to further portray flash floods and especially, their **societal impacts**.

Goal of this work

These datasets are designed for the **evaluation** of **flash flood forecasting tools**.

=> But only on a **YES/NO** event basis.

Though, there is enough metadata in these datasets to further portray flash floods and especially, their **societal impacts**.

Goal of this work:

- Build an **impact classification** of these flash flood reports.

Then use these impact-enhanced datasets for:

- A **spatiotemporal analysis** of SHAVE reports, to:
 - * Validate the consistence of our impact classification.
 - * Explore the spatial characteristics of these impacts.
- An **example of application** of NWS reports, with the evaluation of the skill of forecasting models to predict these impacts.

Flash flood impacts classification



Fort Worth, TX, June 27, 2007.
AP photograph/Fort Worth Star-Telegram, Ron Jenkins

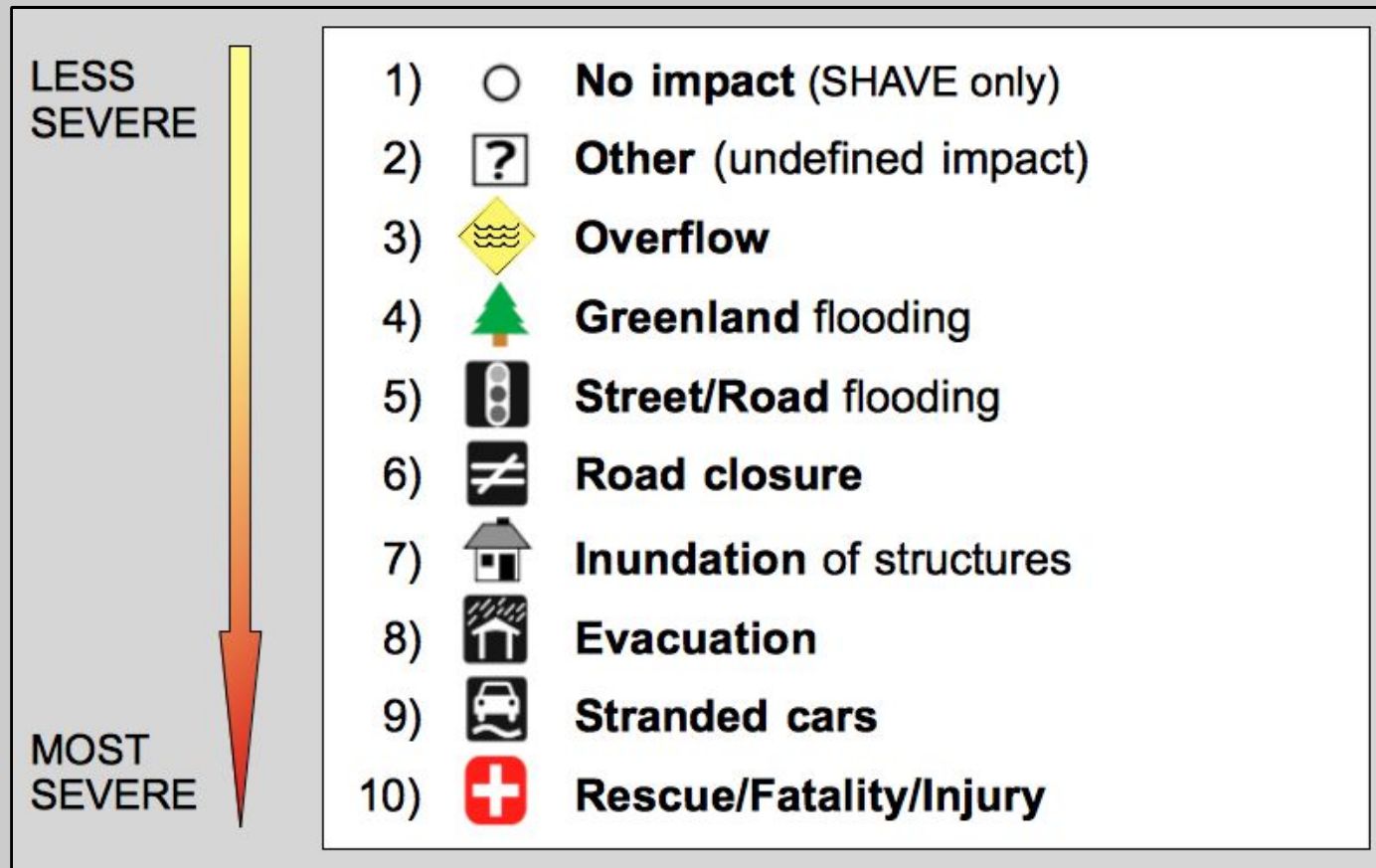
[illegible]

Impact classes

- 3)  **Overflow**
- 4)  **Greenland flooding**
- 5)  **Street/Road flooding**
- 6)  **Road closure**
- 7)  **Inundation of structures**
- 8)  **Evacuation**
- 9)  **Stranded cars**
- 10)  **Rescue/Fatality/Injury**

Flash flood impacts classification

Creation of an impact typology from NWS and SHAVE flash flood reports



Based on: => Metadata already included
=> Textual comments

Spatiotemporal analysis of SHAVE flash flood reports

GOAL 1°) Validate the consistence of our impact classification

SHAVE impacts

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- 4)  **Greenland flooding**
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CROSS TABULATION

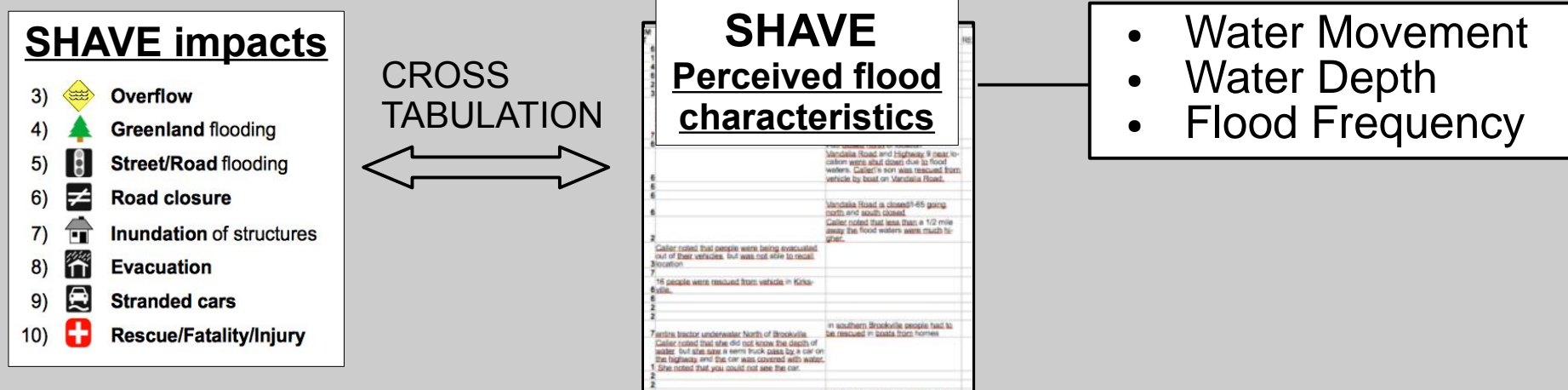
SHAVE

Perceived flood characteristics

- Water Movement
- Water Depth
- Flood Frequency

Spatiotemporal analysis of SHAVE flash flood reports

GOAL 1°) Validate the consistence of our impact classification



➡ Consistent results between impact classes & flood characteristics




That allowed to validate:

- impact classification
- severity ranking

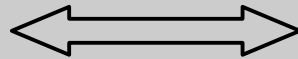
Spatiotemporal analysis of SHAVE flash flood reports

GOAL 2°) Explore the spatial characteristics of these impacts

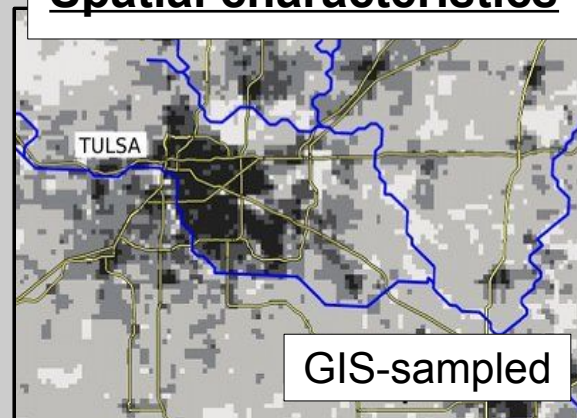
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TABULATION



SHAVE-independent Spatial characteristics

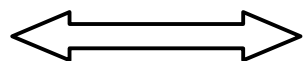


- Land Use
- Population Density
- Local Slope
- Drainage Area

Spatiotemporal analysis of SHAVE flash flood reports

GOAL 2°) Explore the spatial characteristics of these impacts

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IMPACTS
vs.
POPULATION DENSITY

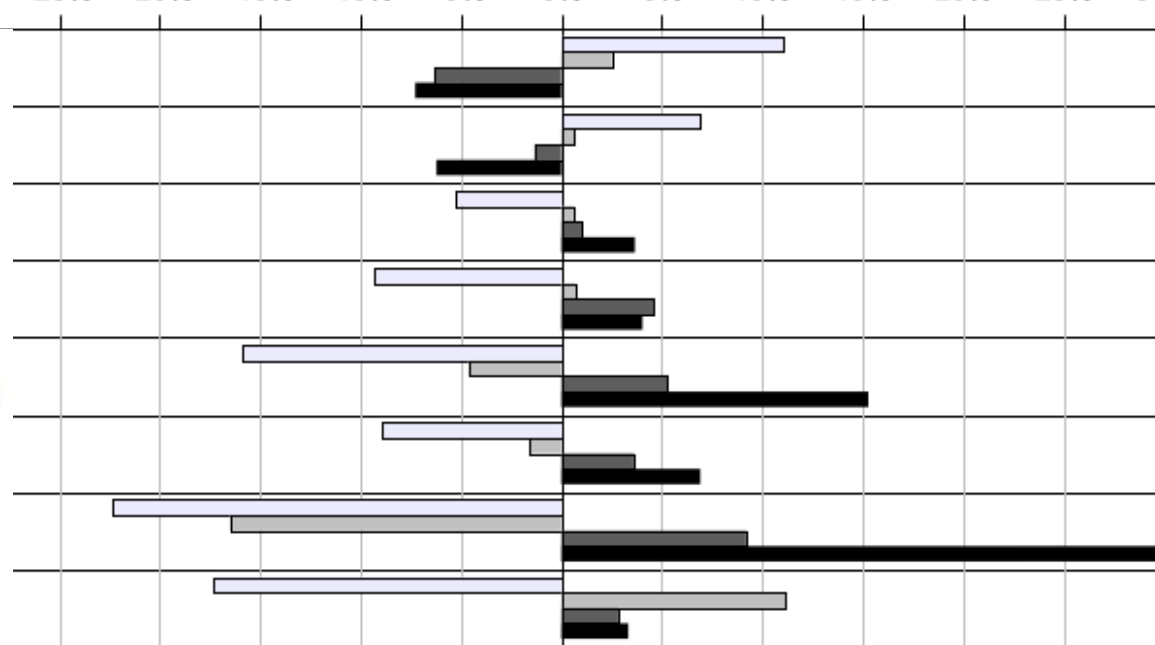
(inhab./km²)

POP.
DENSITY



□ ≤ 4 (n=1017)
▒]4-70] (n=866)
■]70-500] (n=339)
■ > 500 (n=326)

-30% -25% -20% -15% -10% -5% 0% 5% 10% 15% 20% 25% 30%



—

Deviation from average (%)

+

LESS
SEVERE



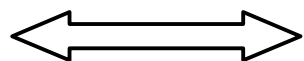
MOST
SEVERE

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Spatiotemporal analysis of SHAVE flash flood reports

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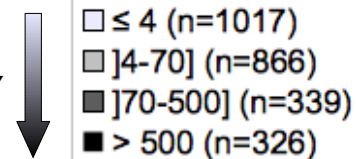
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IMPACTS
vs.
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(inhab./km²)

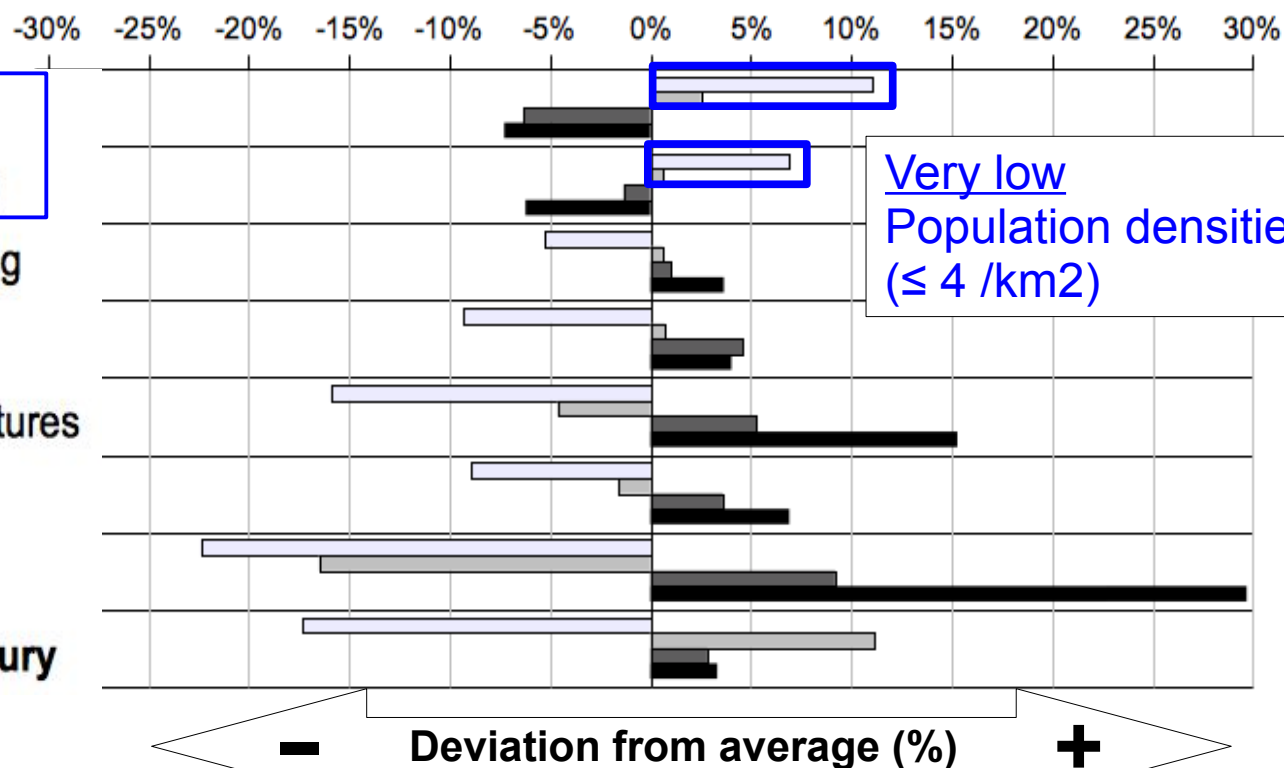
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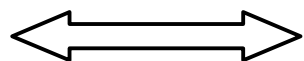
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Spatiotemporal analysis of SHAVE flash flood reports

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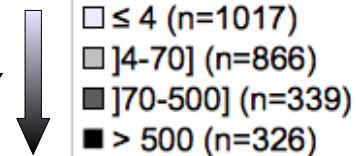
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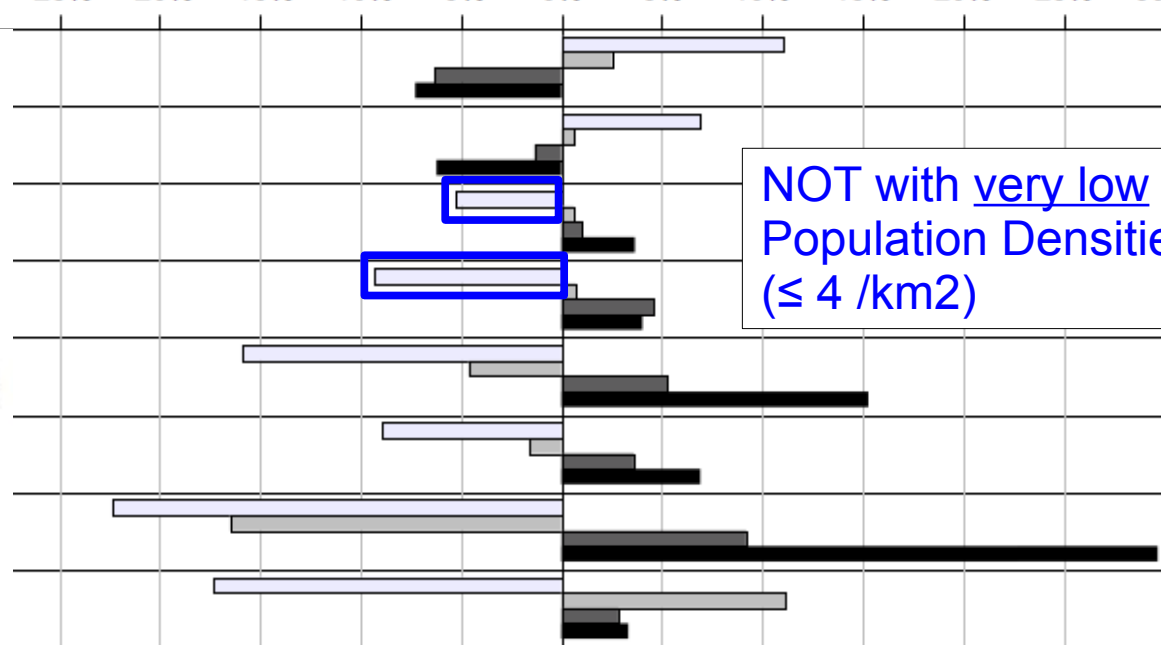
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POP.
DENSITY



-30% -25% -20% -15% -10% -5% 0% 5% 10% 15% 20% 25% 30%

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- 10) **Rescue/Fatality/Injury**
- MOST SEVERE



NOT with very low
Population Densities
(≤ 4 /km²)

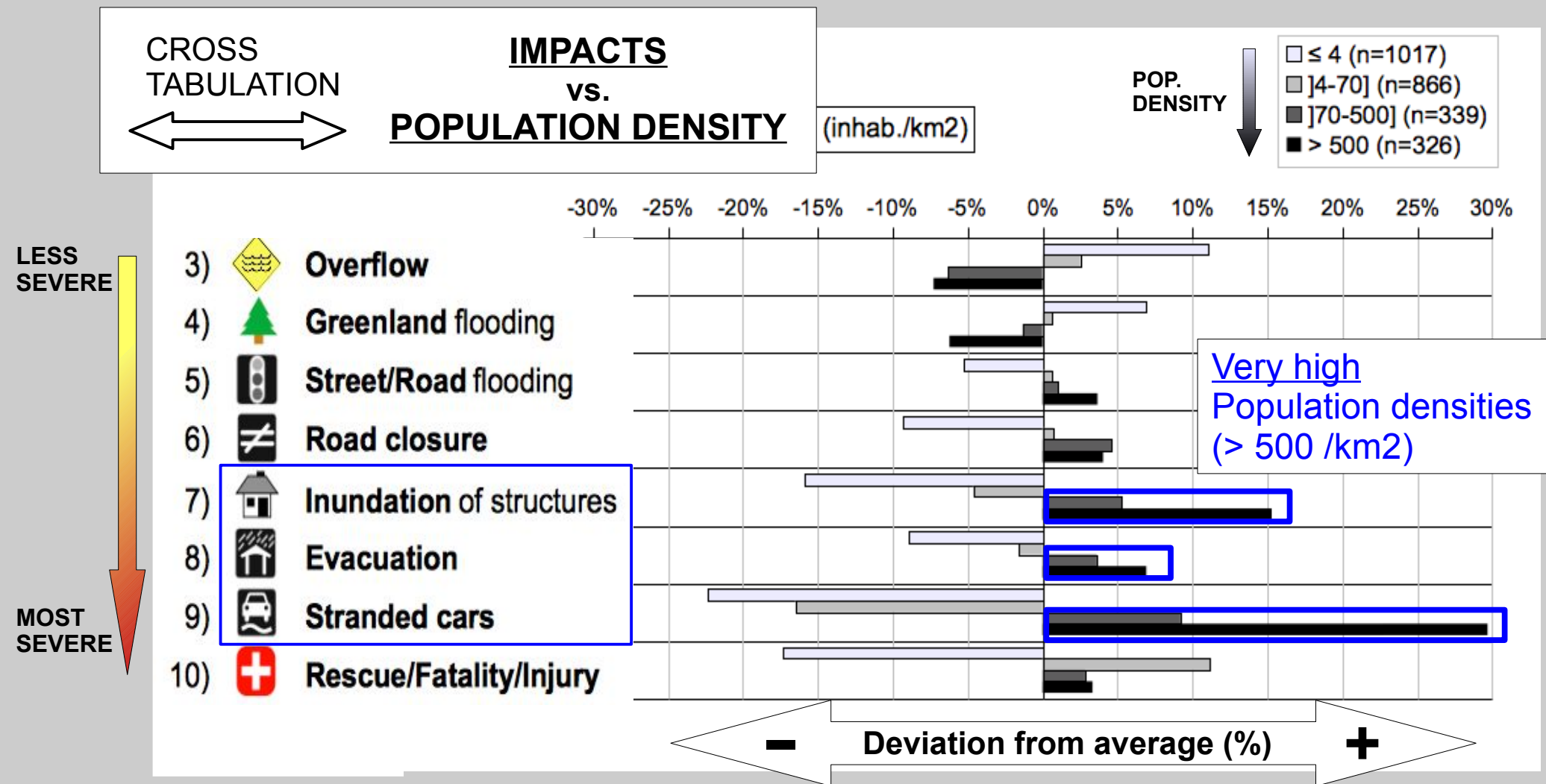
-

Deviation from average (%)

+

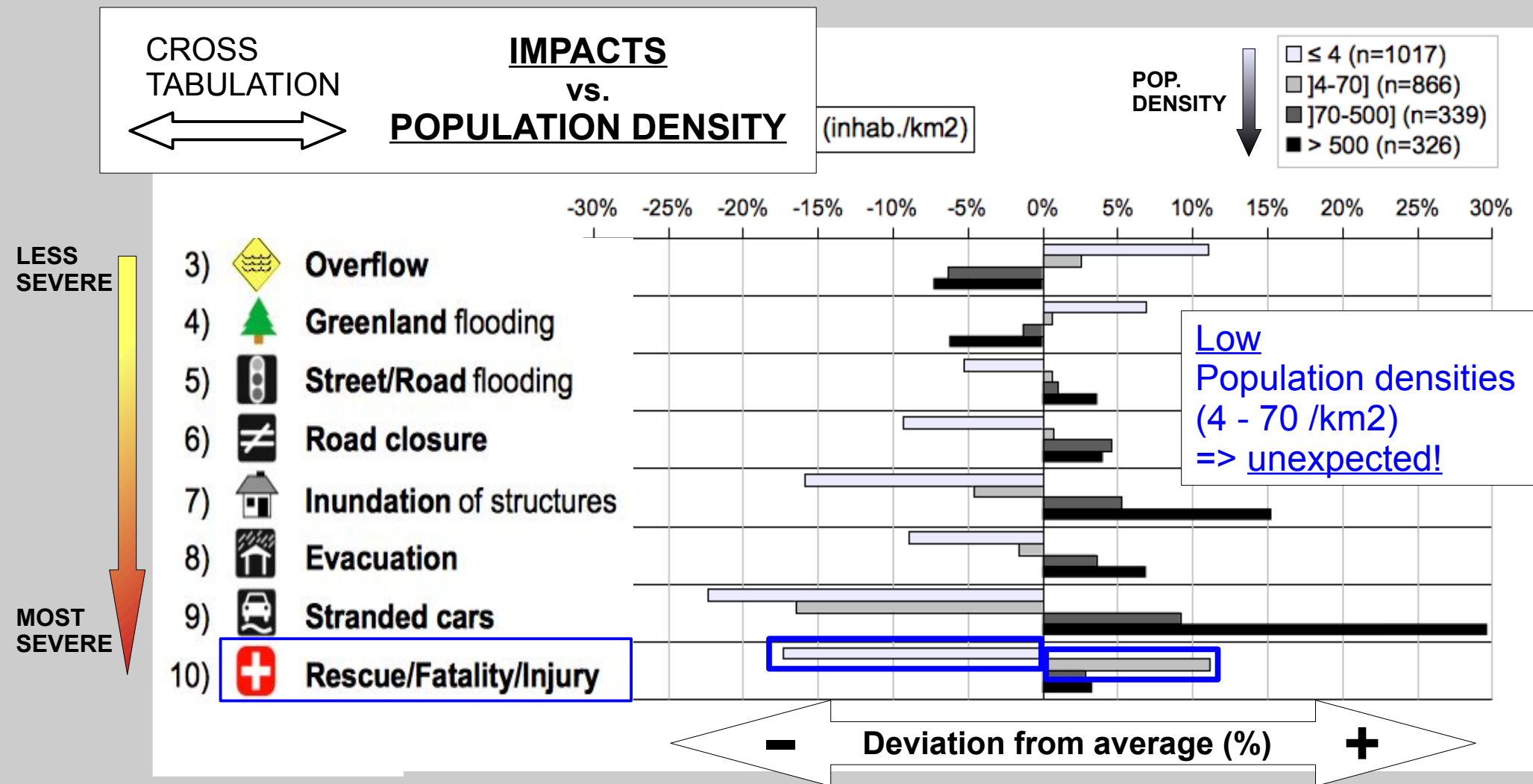
Spatiotemporal analysis of SHAVE flash flood reports

GOAL 2°) Explore the spatial characteristics of these impacts



Spatiotemporal analysis of SHAVE flash flood reports

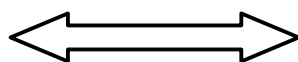
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Spatiotemporal analysis of SHAVE flash flood reports

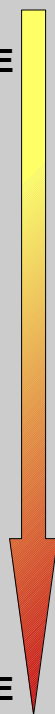
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IMPACTS
vs.
LAND USE

LESS
SEVERE



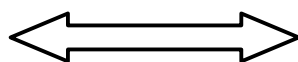
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Spatiotemporal analysis of SHAVE flash flood reports

GOAL 2°) Explore the spatial characteristics of these impacts

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IMPACTS
vs.
LAND USE

Most significant associations:

LESS
SEVERE

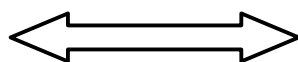
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- | | | | |
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Spatiotemporal analysis of SHAVE flash flood reports

GOAL 2°) Explore the spatial characteristics of these impacts

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IMPACTS
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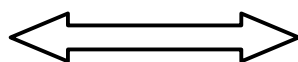
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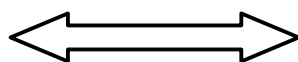
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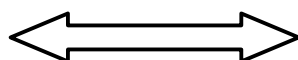
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| 6) | | Road closure | Developed – Low intensity |
| 7) | | Inundation of structures | (20-49% impervious surface) |
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Spatiotemporal analysis of SHAVE flash flood reports

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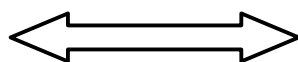
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Spatiotemporal analysis of SHAVE flash flood reports

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NATURAL

DEVELOPED

Spatiotemporal analysis of SHAVE flash flood reports

GOAL 2°) Explore the spatial characteristics of these impacts

- ↳ Impact severity ranking is dependent from:
- **Population Density**
 - **Land Use**
- As well as:
- **Drainage Area** (not shown here)

Spatiotemporal analysis of SHAVE flash flood reports

GOAL 2°) Explore the spatial characteristics of these impacts

What to conclude from this diagnosis of SHAVE spatial characteristics?

↳ Impact severity ranking is dependent from: - **Population Density**
- **Land Use**
As well as: - **Drainage Area** (not shown here)

↳ These **exposure** factors could be implemented for the prediction of flash flood impacts.

An example of application of NWS impact reports

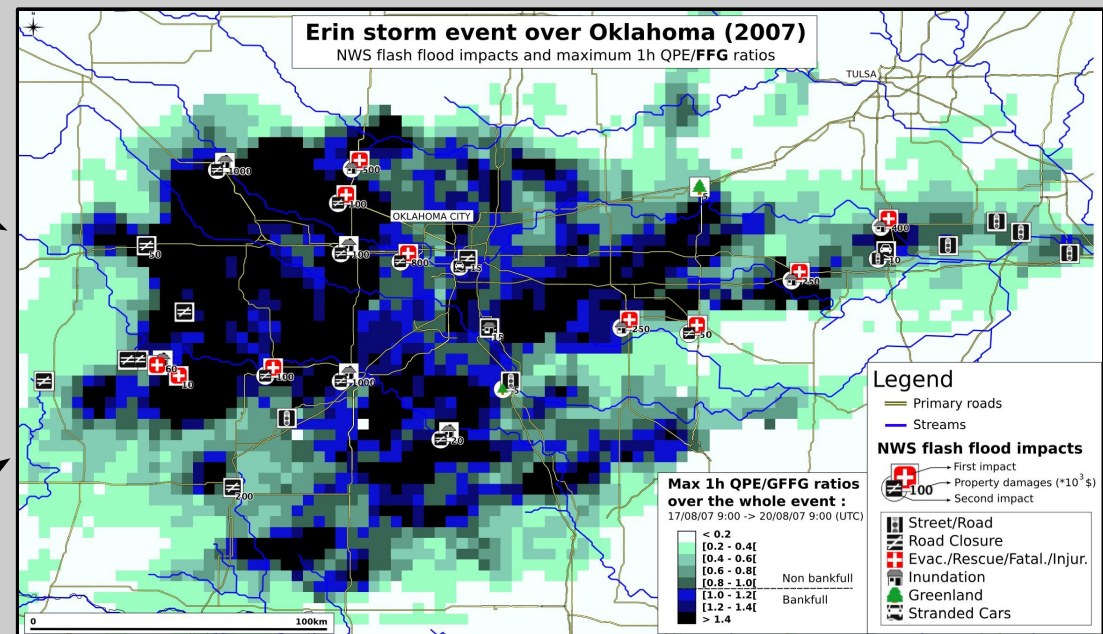
- Implementation of impacts for a **real flash flood case**, using **forecasting tools**.
- The goal: evaluate their **skill to predict these impacts**.

Flash Flood Forecasting tools

- 1°) FFG
- 2°) GFFG
- 3°) DHM-TF

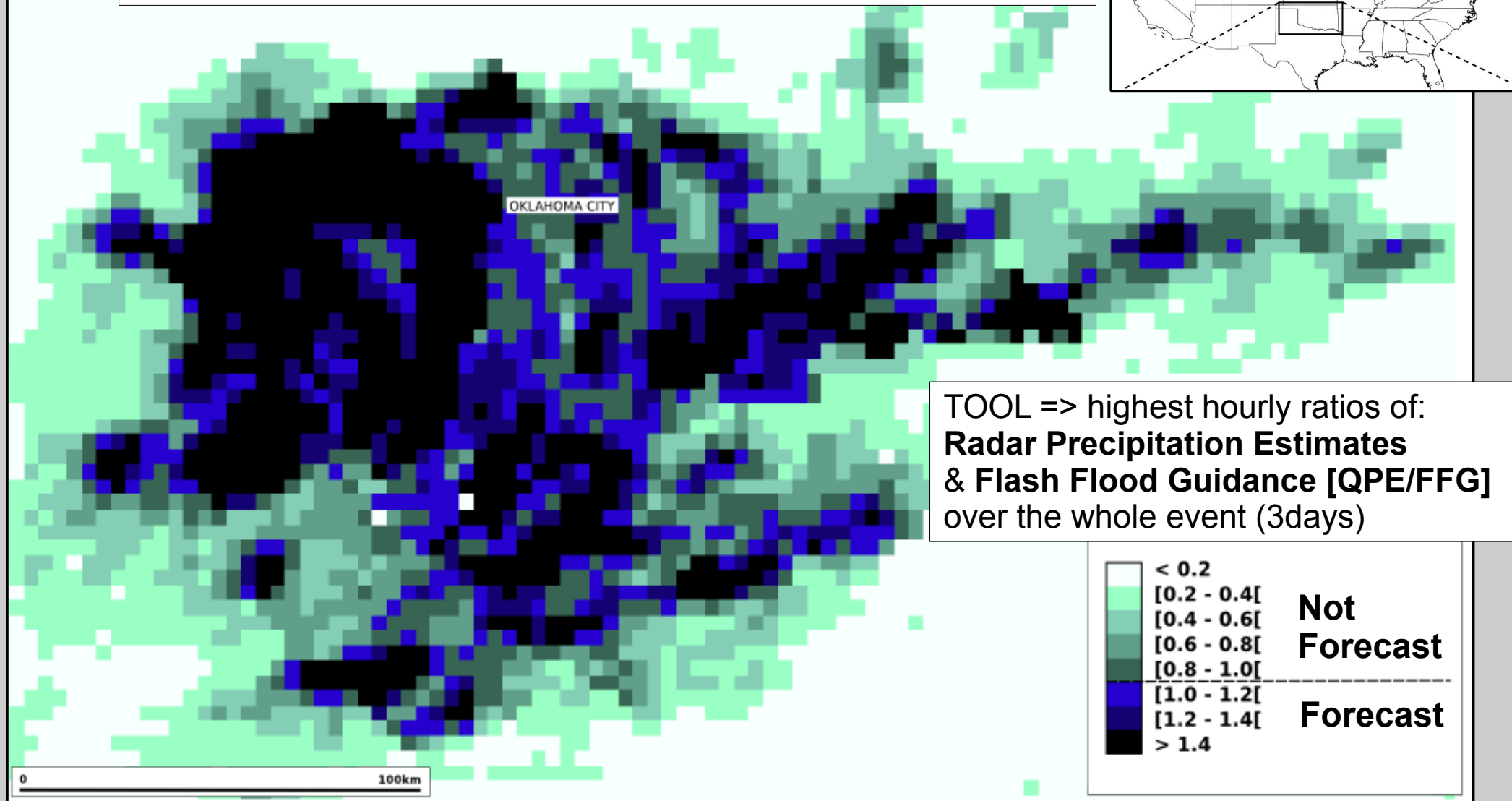
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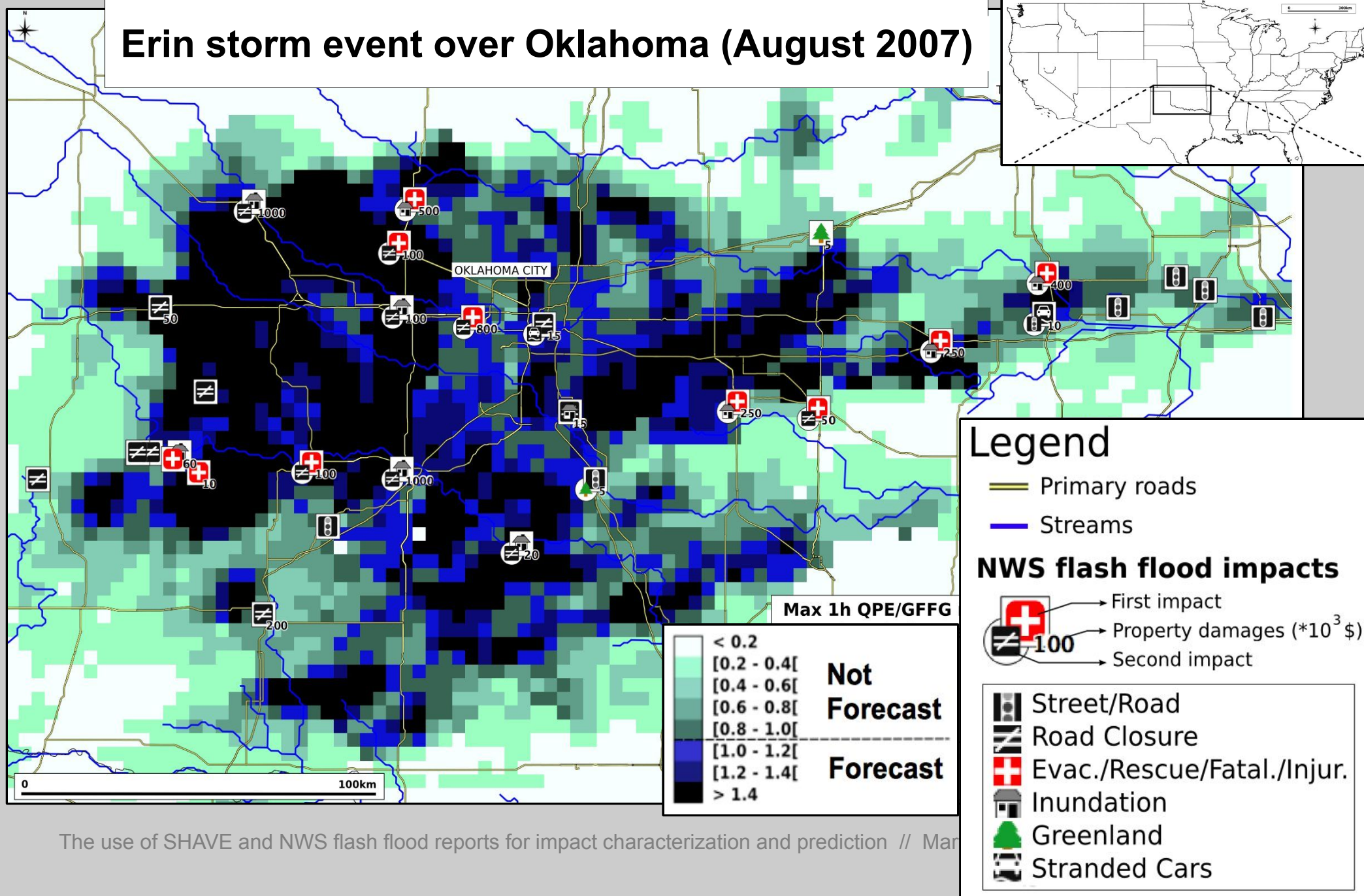
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Erin storm event over Oklahoma (August 2007)



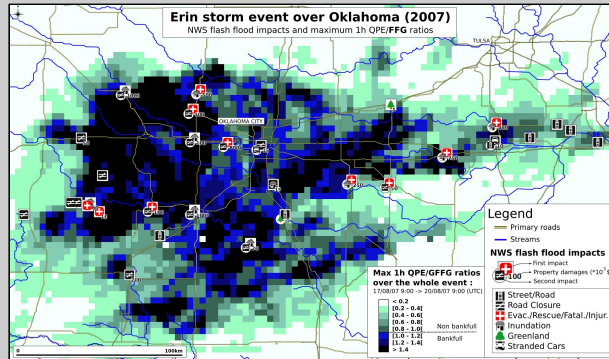
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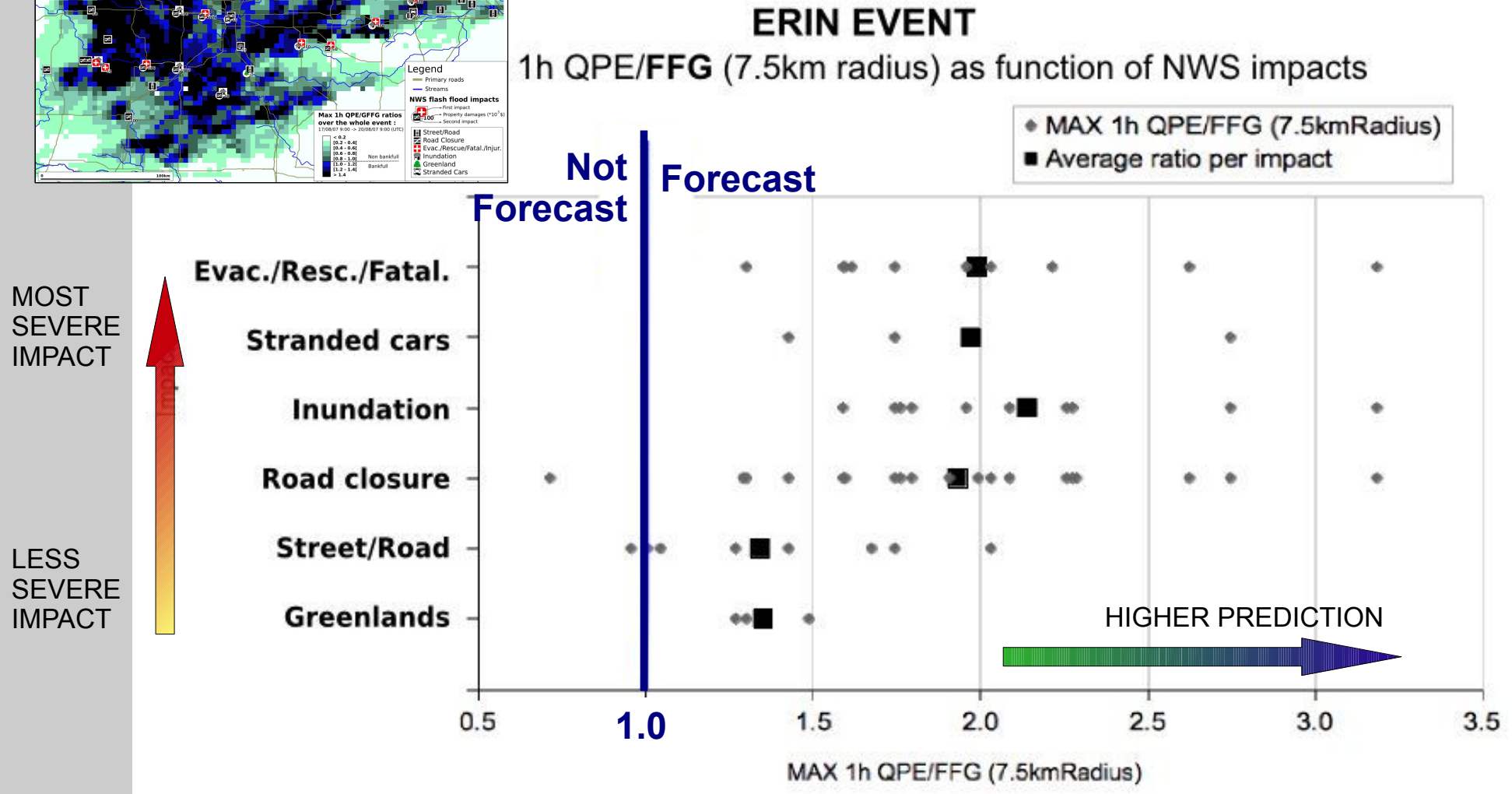


The use of SHAVE and NWS flash flood reports for impact characterization and prediction // Mar

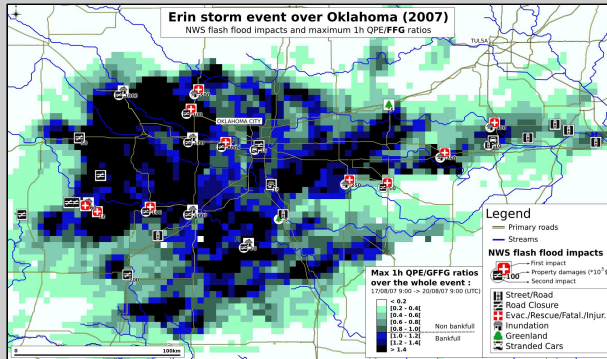
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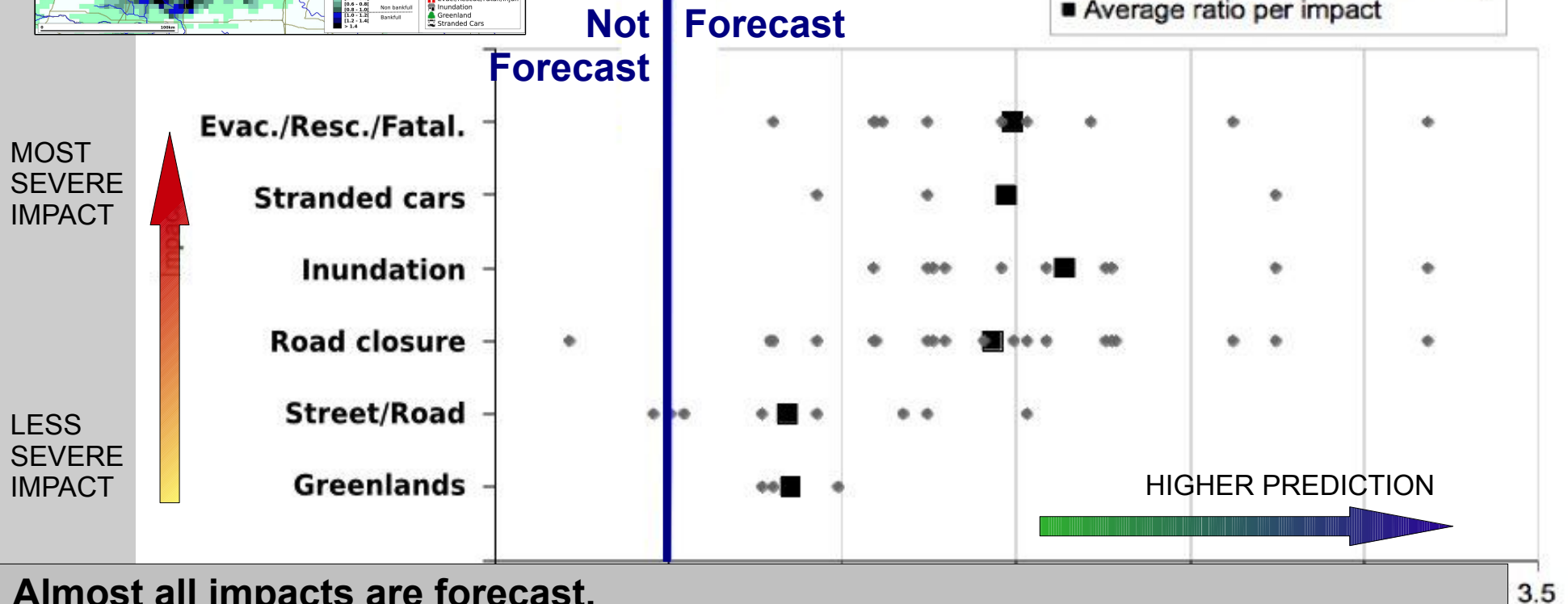
Tool values sampled for each impact report:



An example of application of NWS impact reports



ERIN EVENT 1h QPE/FFG (7.5km radius) as function of NWS impacts



Almost all impacts are forecast.

=> Confirms this case study was a big event

On average, most extreme impacts tends to higher values.

=> FFG has some capabilities to distinguish impact severity

But this is only one case => /\ small sample size & spread distributions

CONCLUSION

Considering the following definition of a flash flood impact, what has been covered by this work?

IMPACT

*A significant or major effect
(Source: Merriam Webster).*

=

EXPOSURE

*Potential “coincidence” (in space
& time) of people or property in
the path of the flood.*

&

HAZARD

*Probability that the flood event
(or its modeling...) reaches a
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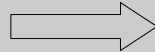
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**Impact classification of SHAVE
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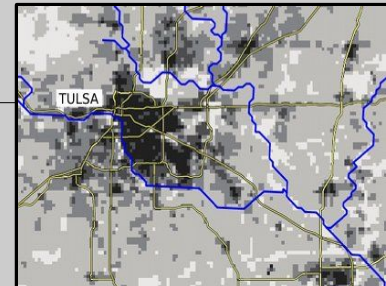
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A spatial analysis of these impacts to
identify **exposure** factors to flash floods,
potentially useful for impact forecasting:

- Population Density
- Land Use
- Drainage Area



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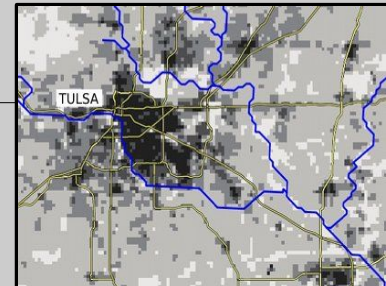
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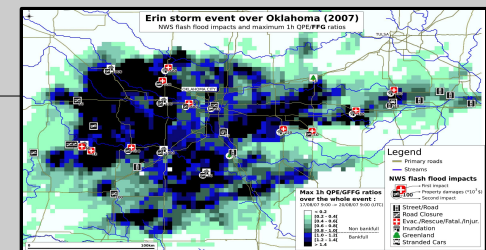
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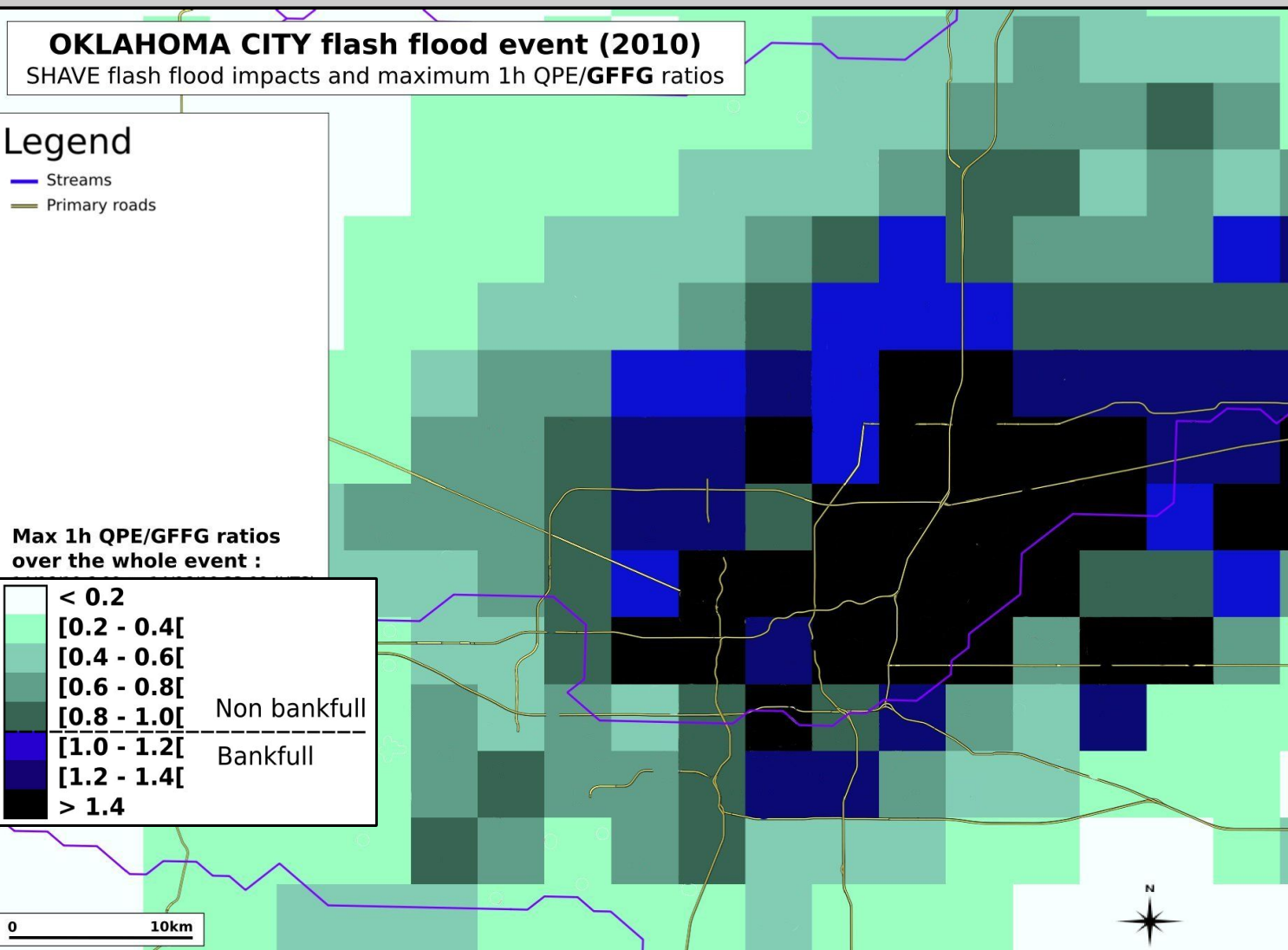
An example of application of these
impact-focused reports, to refine the
evaluation of **forecasting tools**.



Thank you for your attention...

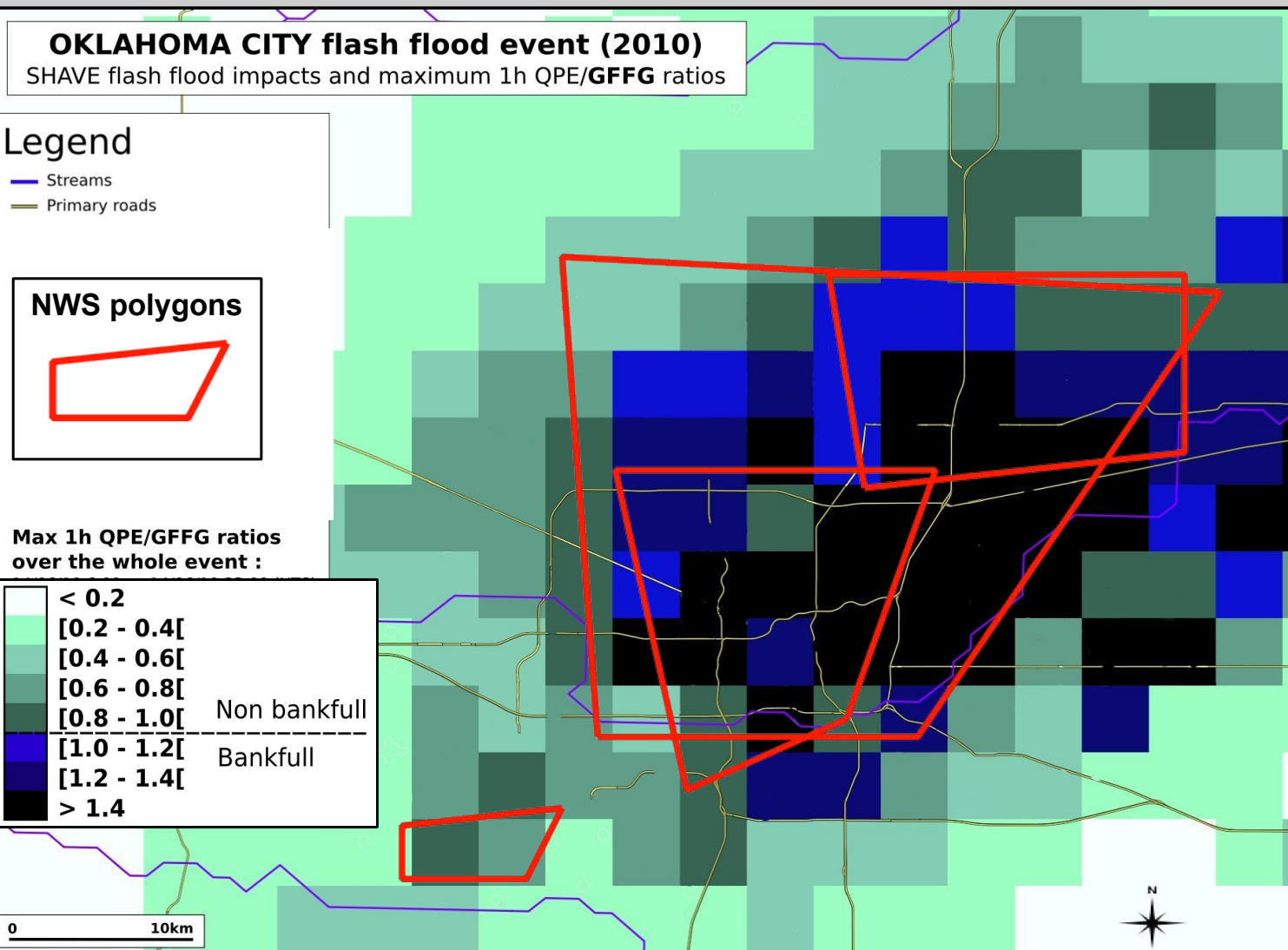


E. Assess the ability of NWS & SHAVE datasets to validate forecasts > the Oklahoma City flash flood event (2010)



**Gridded Flash Flood
Guidance (GFFG) tool**

E. Assess the ability of NWS & SHAVE datasets to validate forecasts > the Oklahoma City flash flood event (2010)

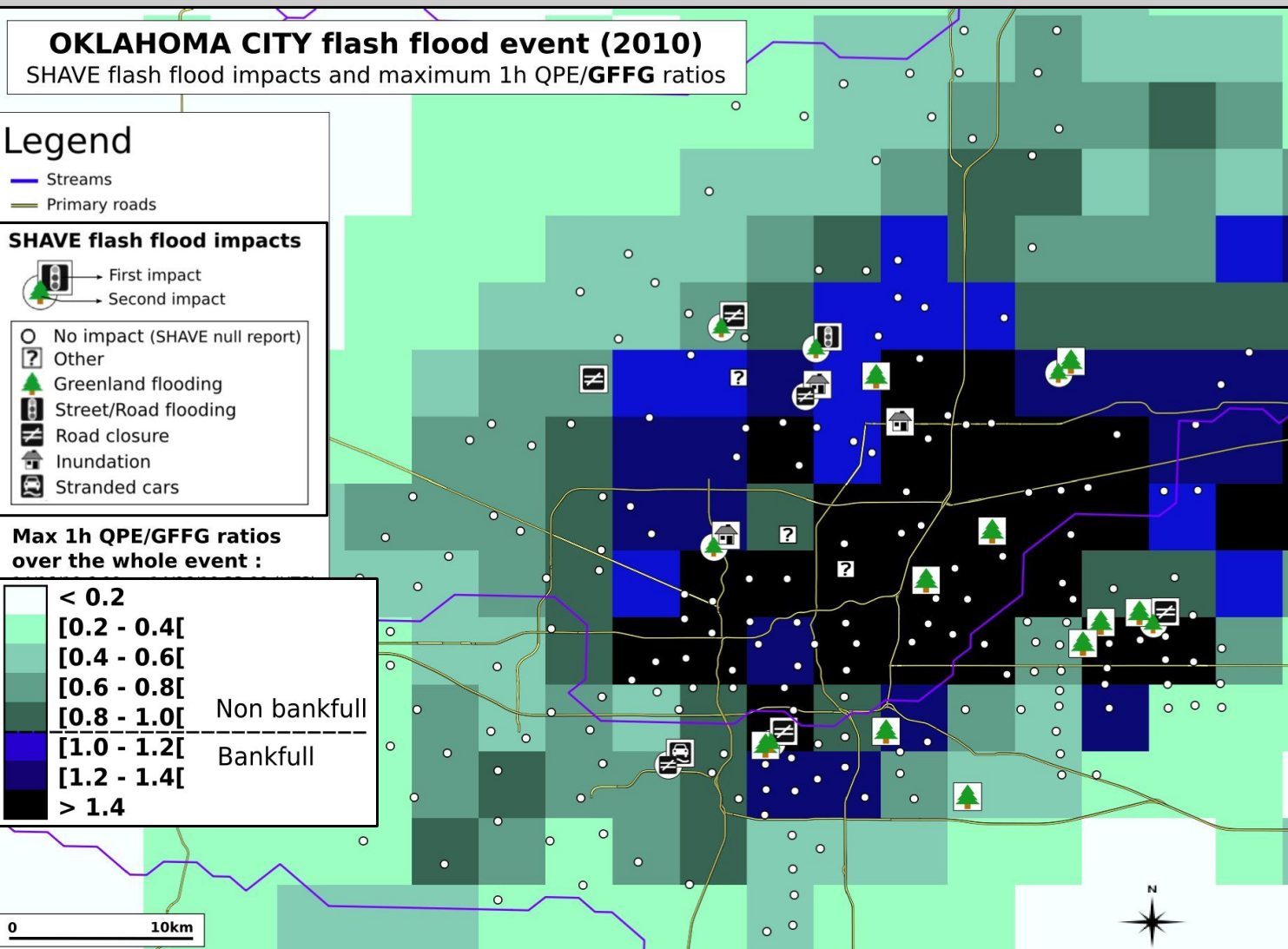


**Gridded Flash Flood
Guidance (GFFG) tool
+
NWS polygons**

- Poor spatial accuracy
- No null reports (no FA)

E. Assess the ability of NWS & SHAVE datasets to validate forecasts

> the Oklahoma City flash flood event (2010)



Gridded Flash Flood Guidance (GFFG) tool + SHAVE points

- Higher resolution
- Null reports > False Alarms

BUT:

- Point vs grid-cell mismatch
=> False Alarm assessment?
- Limit: people's perception
=> risk to miss impacts

CONCLUSION: improvements for the flash flood reporting methodology?

Remaining challenges for forecasting evaluation, in the particular case of flash flooding:

1°) Estimate the timing of sudden events

=> Accurate timing must be recorded (at hourly scale) to allow a temporal analysis.

2°) Delineate small scale and diffuse spatial patterns

As a public poll, SHAVE questionnaires should include information about interviewee's: age / gender / profession / level of education / income..., likely to influence people's perception and description.

SHAVE and NWS sampling strategies not enough hydrologically based.

For impacted patterns (e.g. flooded roads or habitats, overflow): precise hand-crafted polygons.

For punctual patterns (e.g. rescues, fatalities or evacuation): buffer polygons around the location.

>>> A single polygon layer could be used to delineate all kinds of patterns

3°) Measure false alarms

=> Using polygonal null reports should be more convenient to assess false alarms in the context of gridded forecasting models. The area of null reports included in forecast grid cells could then gives the metric needed for the assessment of a false alarms.

SHAVE reports 2008 > 2010

Flash Flood Impacts VS Drainage Area (max 300m) [km²]

