

Effect of adverse weather on roadway crash severity on county level

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Jonas blizzard in January 2016

- At least 13 people died in car accidents
 - In VA, by Jan 22, 2016, Friday night, police responded to 989 traffic crashes and 793 disabled cars
- Huge losses brought an old question
 - What is the effect of adverse weather on roadway accidents and their severities?
- Only a handful of research examined the weather effect on **accident severity**
- Even fewer of them were dedicated to such analysis on **county scale**

Outline

Objective

Data

Methodology

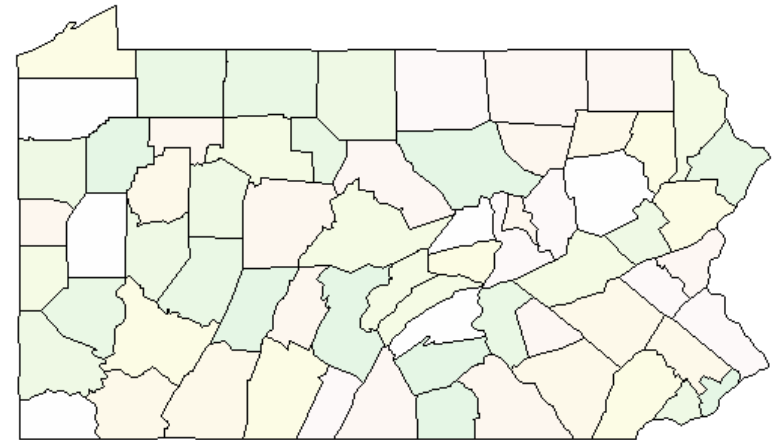
Conclusion

Objective and significance

- To estimate the likelihood of having a sever (fatal and major injury) crash in adverse weather in each county
- To test if a county has higher likelihood of sever crash in adverse weather comparing with the entire state
 - Inferior county

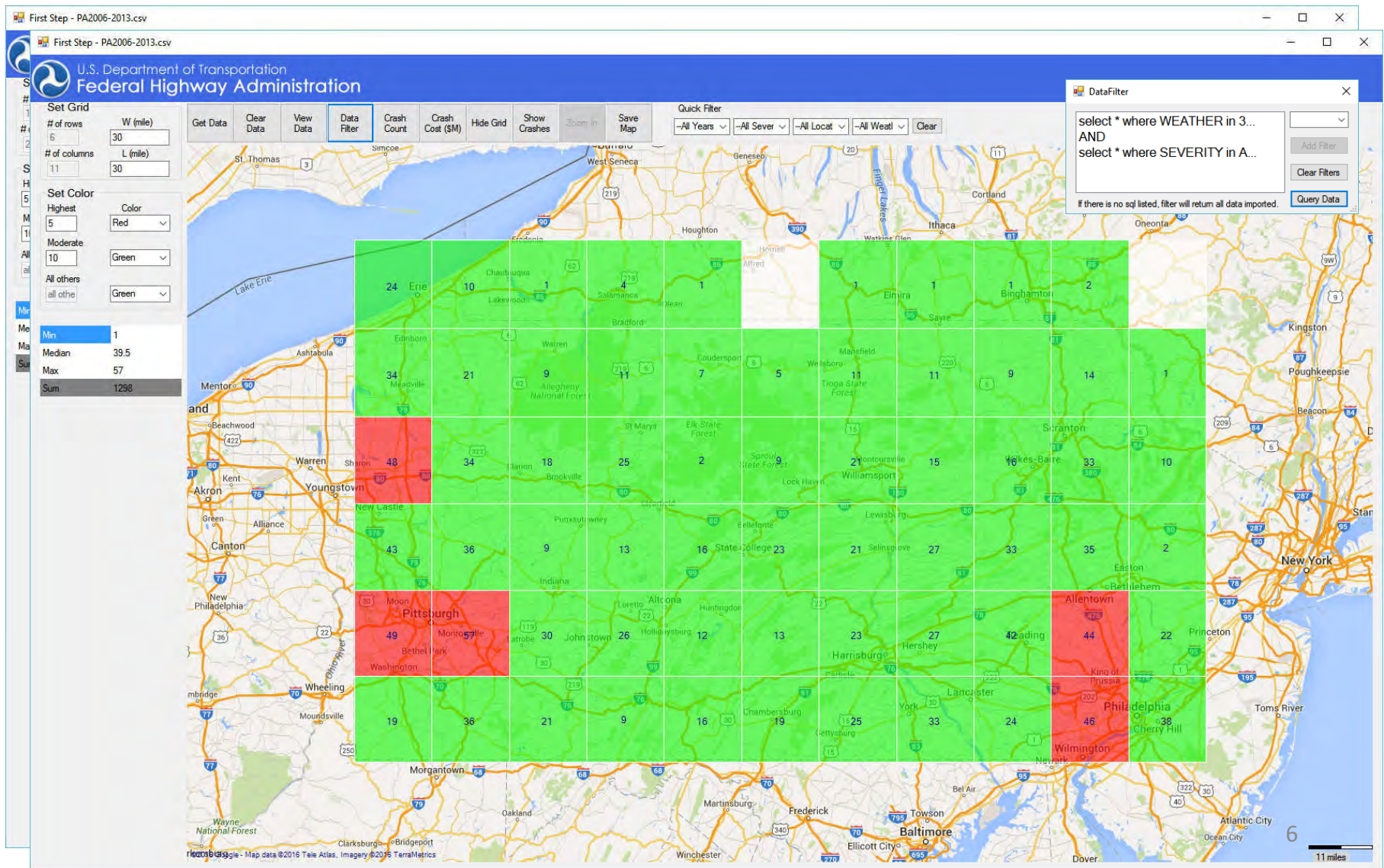
Study state and data

- Data source: Traffic accident record in **Pennsylvania** from SHRP2 (Systematic Highway Research Program Phase 2) dataset
 - Format: .xls and .csv
 - Data size: 957,742 crash records
 - Fatal – 9057
 - Major inj – 19107
 - Inj - 69962
- Key fields in the data



Key fields	Crash Time	Location	Severity	Weather
meanings	Year	GPS + geocode	Fatal - PDO	Rain, Snow, Sleet, Fog
values	2006~2013	67 counties	K, A, B, C, O	2, 3, 4, 5

Tool for data processing



Methodology

Calculate the
likelihood

Identify
inferior
counties

Visualization

Methodology – likelihood

- Calculate the likelihood of having a sever crash in certain adverse weather condition for **each county**
 - Count the occurrences of sever crashes, group by year, by county, and by weather type, denoted by
$$sc(Y, C, W)$$
where Y: year, from 2006 to 2013, C:county code (1-67), W:weather code (2-5)
 - Calculate the likelihood
$$L(Y, C, W) = sc(Y, C, W) / total(Y, C, W)$$
- Following the same procedure, calculate the likelihood for the **entire state** for each year

Methodology – likelihood

- E.g., $sc(2006, Lancaster, rain)$ is the # of sever crashes occurred in Lancaster in 2006 in rain, it is 16
- And $total(2006, Lancaster, rain)$ is 607
- Thus the likelihood $L(2006, Lancaster, rain) = \frac{16}{607} =$
0.0264
- Similarly, $L(2006, Lancaster, snow) = \frac{2}{96} =$ **0.0208**
 - Considering the low occurrences of sc in snow, sleet and fog, sc in these three types of weather were combined

Methodology – likelihood results

Year	Statewide	Adams	Allegheny	Armstrong	Beaver	Bedford	Berks
2006	0.029	0.043	0.023	0.075	0.031	0.054	0.014
2007	0.029	0.062	0.020	0.107	0.049	0.027	0.020
2008	0.025	0.069	0.018	0.063	0.054	0.035	0.030
2009	0.023	0.031	0.012	0.039	0.029	0.039	0.021
2010	0.024	0.021	0.019	0.102	0.009	0.051	0.017
2011	0.023	0.023	0.009	0.106	0.031	0.036	0.013
2012	0.024	0.048	0.028	0.038	0.009	0.029	0.023
2013	0.023	0.042	0.014	0.016	0.049	0.035	0.027
Mean	<i>0.025</i>	<i>0.042</i>	<i>0.018</i>	<i>0.068</i>	<i>0.033</i>	<i>0.038</i>	<i>0.021</i>
stdev	<i>0.003</i>	<i>0.017</i>	<i>0.006</i>	<i>0.035</i>	<i>0.017</i>	<i>0.010</i>	<i>0.006</i>

Methodology – inferior county

- To find out the inferior county (counties), ***t-test*** between the statewide likelihood and the county likelihood is employed

$$ttest(L(state), L(county))$$

- Hypothesis: same mean of the two series
- Confidence level: 0.95
- Inferior county identified
 - If the difference between the two input likelihood data is significant
 - And if the county has higher average likelihood, the county is identified as an inferior county

Methodology – result interpretation

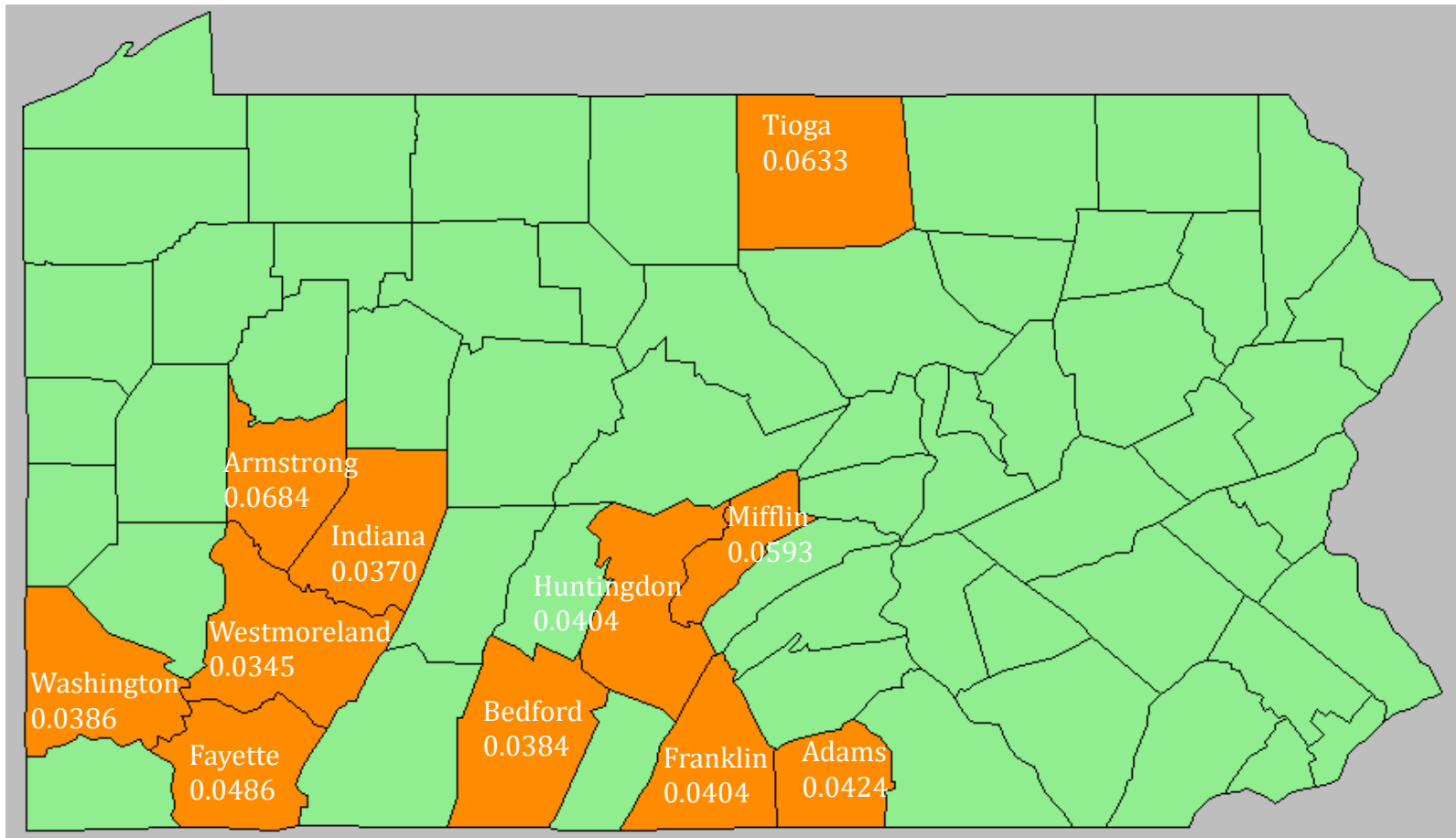
- P value is less than 0.05 -> significant
 - If the mean of likelihood for the county is higher than that for the state, this county is an inferior county

T-test result for Beaver county, rain	
t Stat	-1.23353
P value	0.118844
Statewide mean	0.025043
County mean	0.032708
It is NOT an inferior county	

T-test result for Adams county, rain	
t Stat	-2.82644
P value	0.00673
Statewide mean	0.025043
County mean	0.042417
It is an inferior county	

- Identified 12 inferior counties w.r.t. rain
- Identified 4 inferior counties w.r.t. snow, sleet and fog

Rain inferior counties

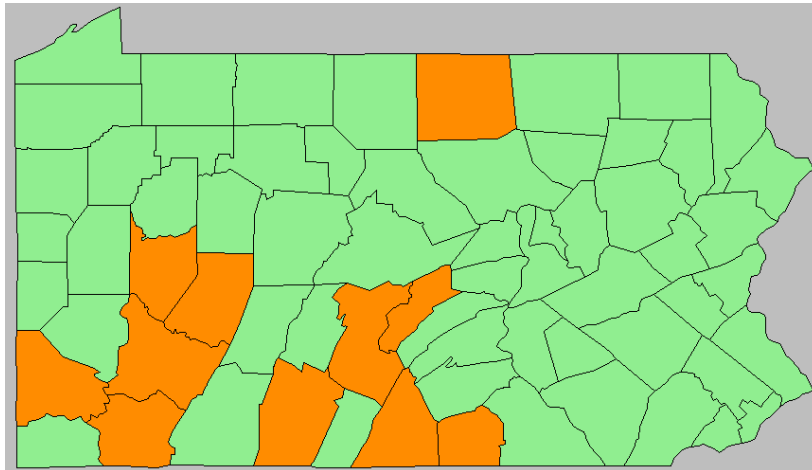


State average: 0.025

Inferior
county

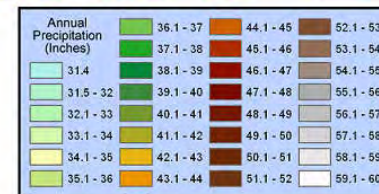
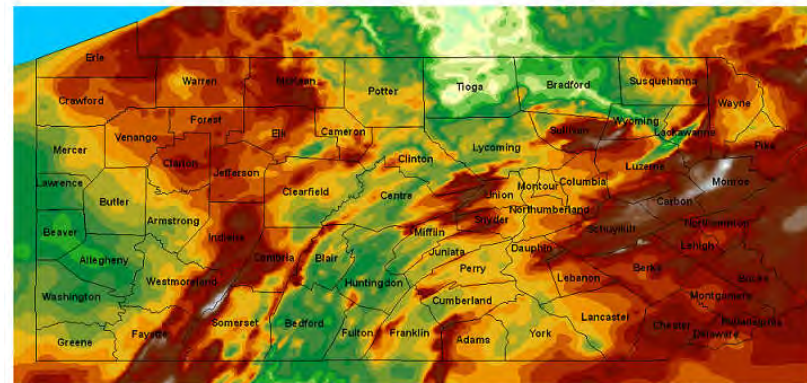
County name
Likelihood

Rain inferior counties



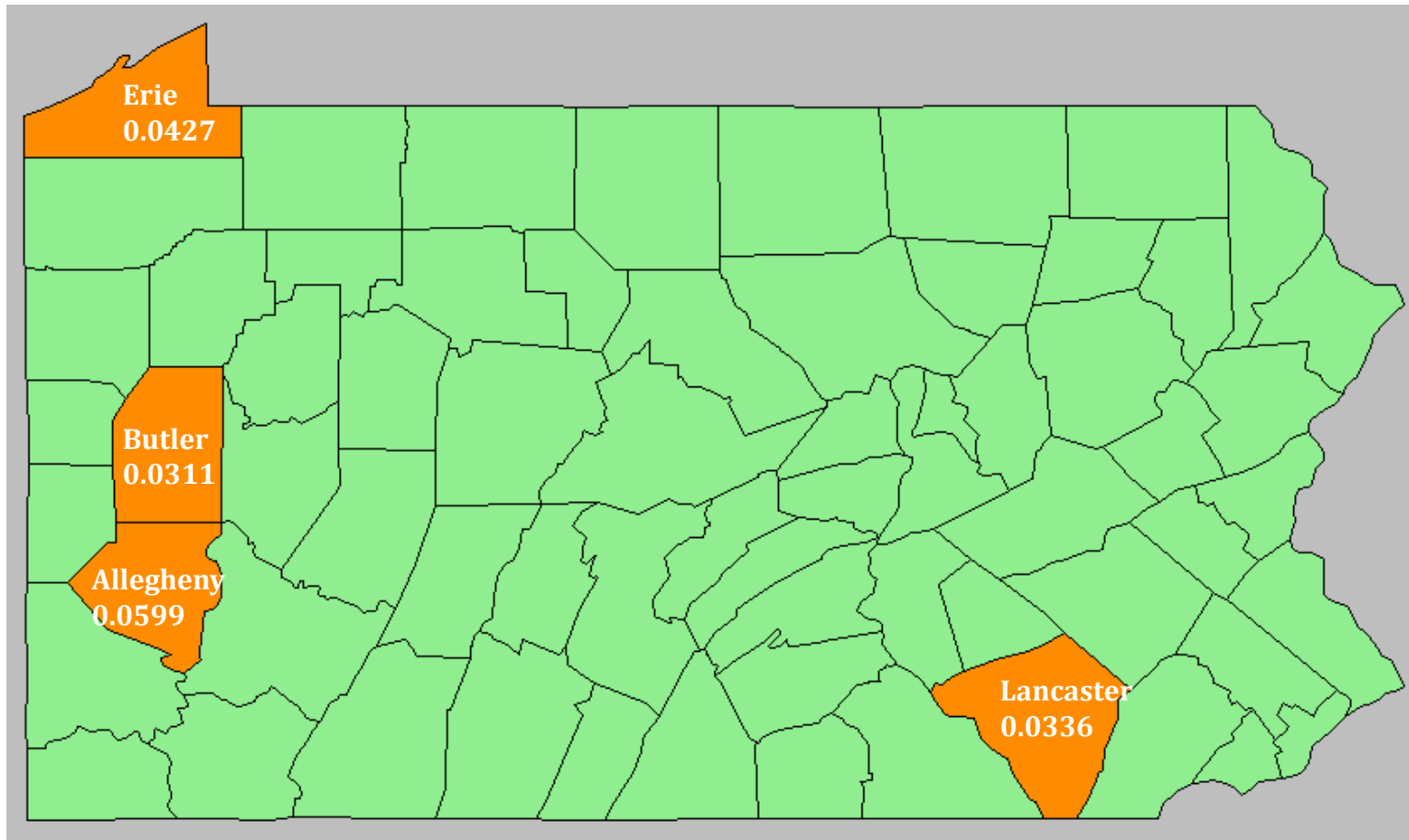
Inferior county County name
Likelihood

Pennsylvania
30 Year (1971-2000)
Mean Annual Precipitation (inches)



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Snow inferior counties

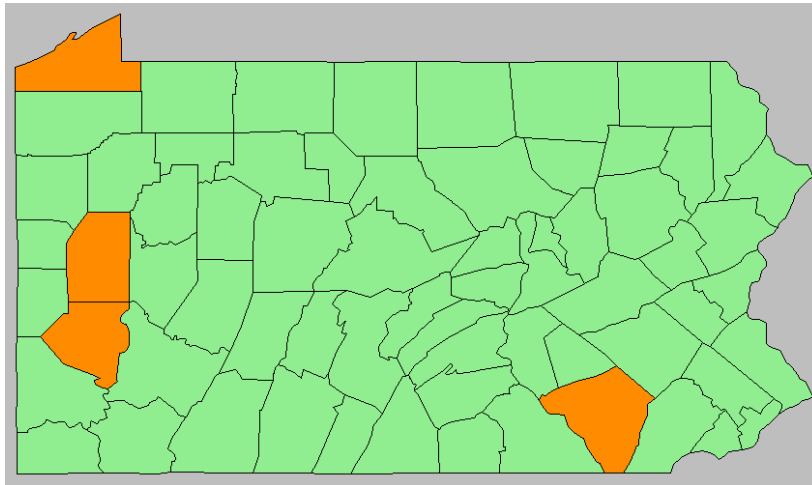


State average: 0.0205

Inferior
county

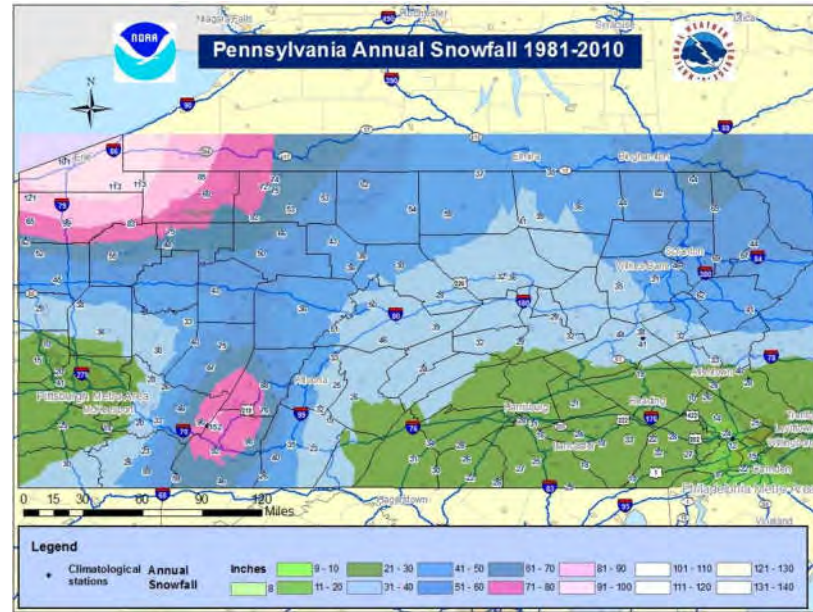
County name
Likelihood

Snow inferior counties



Inferior
county

County name
Likelihood



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Concluding remarks

Weather does have significant effect on crash severity

- The effect differs from county to county

Causes and counter measures

- By identifying the inferior counties, traffic engineers could determine causes for sever crashes and further carry out counter measures
- e.g., enforcement and education, redistribution of resources, and/or emergency respond team, etc.

Application in other industrial fields

- Resource configuration
- Emergency responding plan
- Insurance calculation
- ...

Thank you!
Questions and comments?

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