Assessment of Watershed Vulnerability to Land Use and Climate Change

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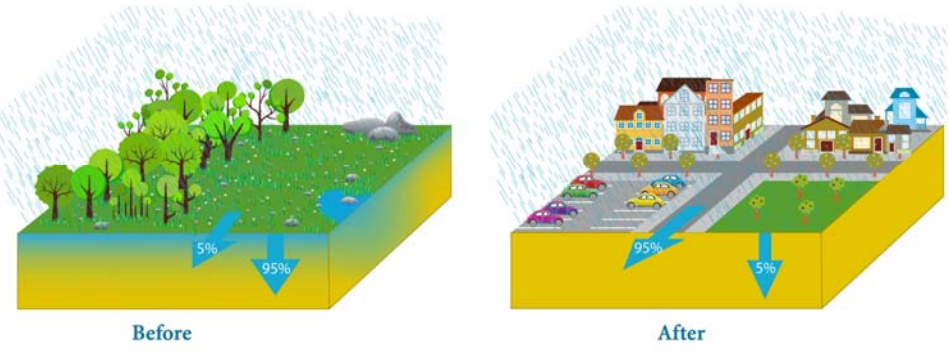
Surface Runoff Illustration



Research Questions

1. How might changing land use patterns by 2060 in the Yadkin-Pee Dee River basin affect streamflow?
2. How might climate change from 2050-2070 affect streamflow in the Yadkin-Pee Dee River basin?
3. Does one driver (land use or climate change) have a larger effect on streamflow?
4. Is there an interaction between drivers either by canceling or amplifying effects on streamflow?

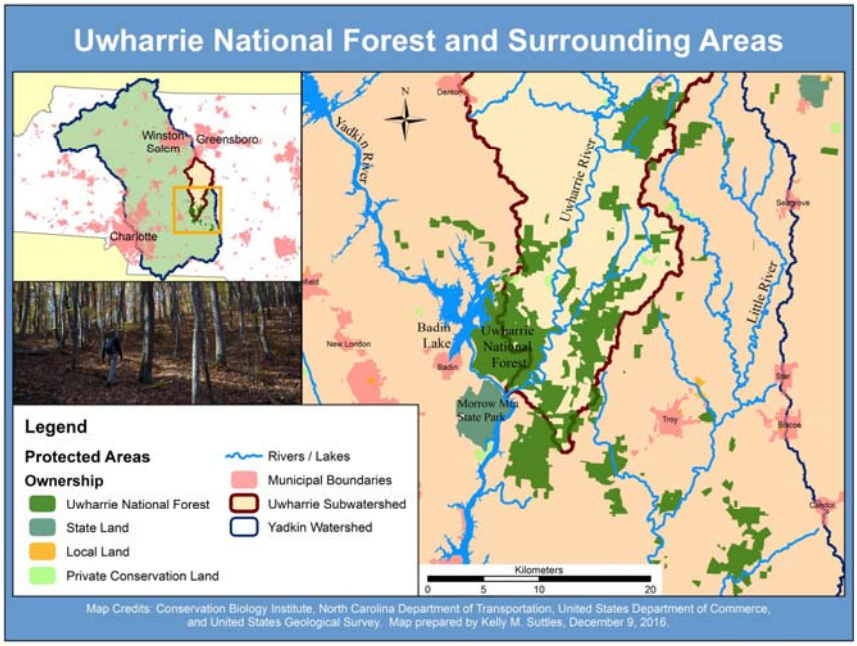
Yadkin River Watershed

Percent Urban	1992	2060 Avg
Muddy Creek	34	79
S. Yadkin River	0	30
Uwharrie River	0	18
Yadkin River	3	30

Percent Forest	1992	2060 Avg
Muddy Creek	45	17
S. Yadkin River	63	42
Uwharrie River	81	67
Yadkin River	69	50

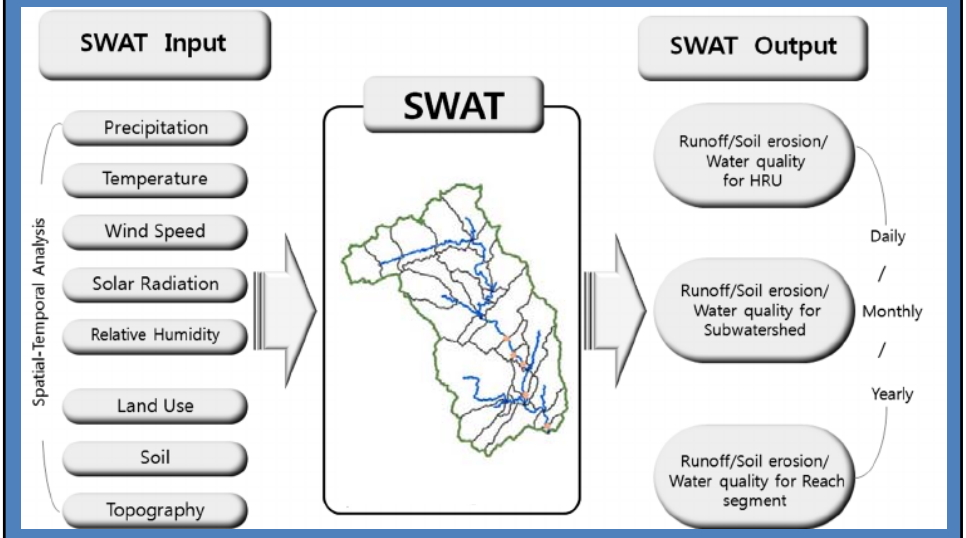
Map Credits: North Carolina Department of Transportation, United States Department of Commerce, and United States Geological Survey
Map prepared by Kelly M. Suttles
March 8, 2017

Uwharrie National Forest and Surrounding Areas



Map Credits: Conservation Biology Institute, North Carolina Department of Transportation, United States Department of Commerce, and United States Geological Survey. Map prepared by Kelly M. Suttles, December 9, 2016.

Soil and Water Assessment Tool



SWAT Model Input

2060 Land Use Cornerstone	Forest Loss 1992-2060	General Circulation Model (CMIP5)	Average Temp. Increase (C)	Average Annual Precip. Increase (mm)	Combined Scenario
A	-24%	MIROC5 RCP 8.5	3.2	146	A
B	-29%	CSIRO mk6 RCP 8.5	2.7	131	B
C	-23%	CSIRO mk6 RCP 4.5	2.4	219	C
D	-24%	Hadley GEM2 ES RCP 4.5	3.5	73	D

Methodology

Three Scenarios to Answer Questions

Land Use Only

2060 Projected LU
(A, B, C, D LU Models)

1982-2002
Baseline Climate

+

Climate Only

1992 Baseline LU

2050-2070
Projected Climate
(MIROC, CSIRO 8.5,
CSIRO 4.5, Hadley GCMs)

=

Combined

2060 Projected LU

2050-2070
Projected Climate

Climate and LU
pairings create
4 combinations:
A, B, C, D

Calibration and Validation

Calibration: 1982-1996
Validation: 1997-2008

Nash-Sutcliffe Efficiency
Coefficient Values:
0.71, 0.66, 0.59

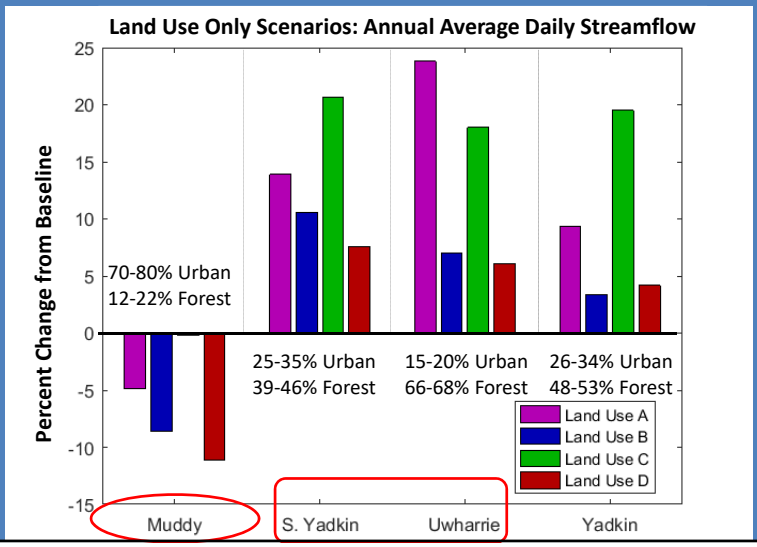
"IF WE HAD OBSERVATIONS
OF THE FUTURE,
WE OBVIOUSLY WOULD
TRUST THEM MORE THAN MODELS.
BUT UNFORTUNATELY
OBSERVATIONS OF THE FUTURE
ARE NOT AVAILABLE
AT THIS TIME."

Dr. Gavin Schmidt
NASA Goddard Institute for Space Studies

RESULTS

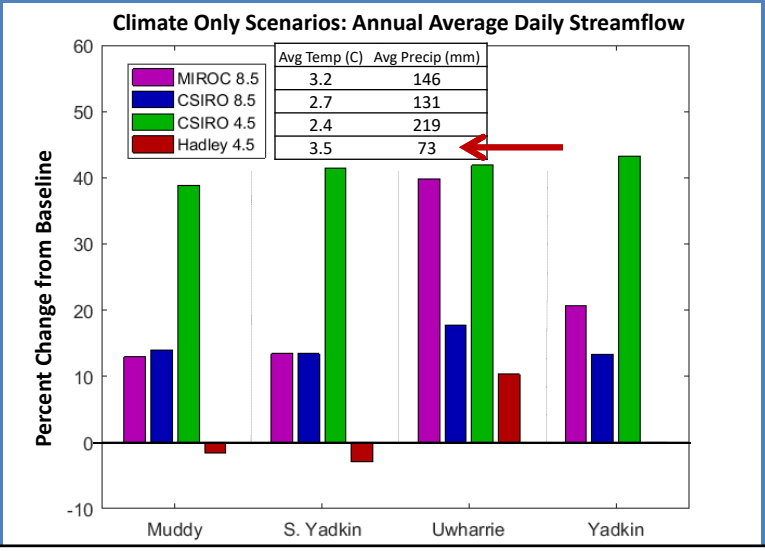
Land Use Only

Streamflow increased in less urban subbasins: 6-24%



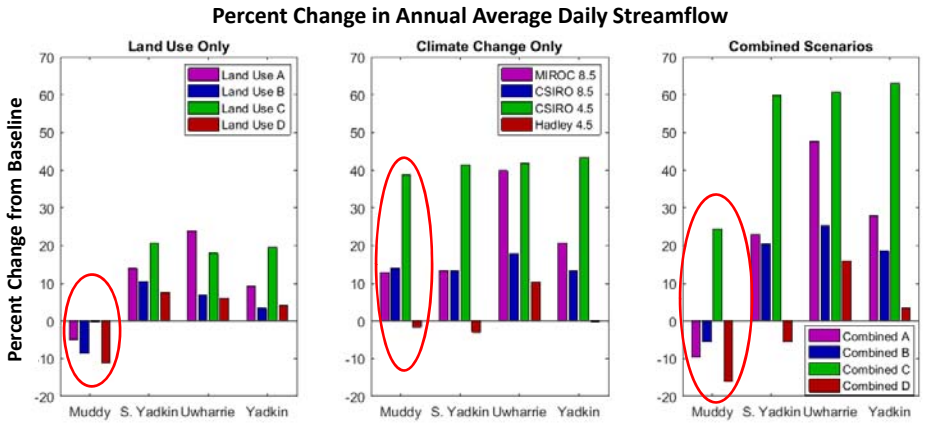
Climate Change Only

Streamflow increased for three models: 13-42%



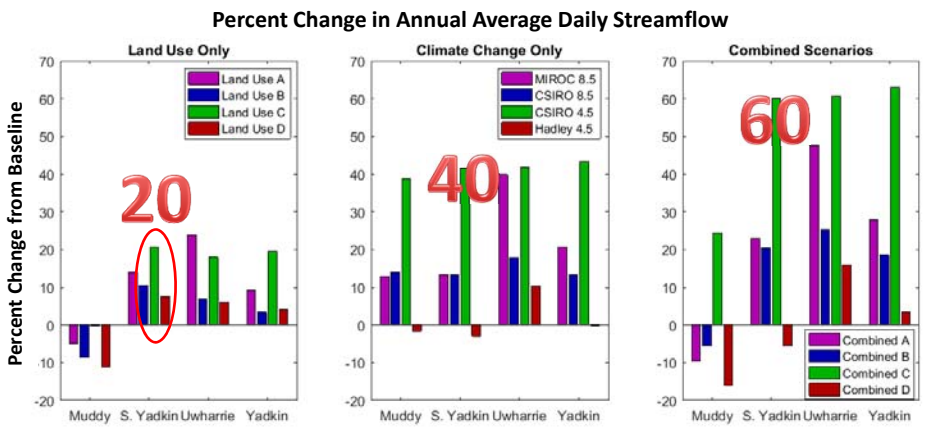
Climate Change Stronger Driver

Land Use Stronger in more Urbanized Areas

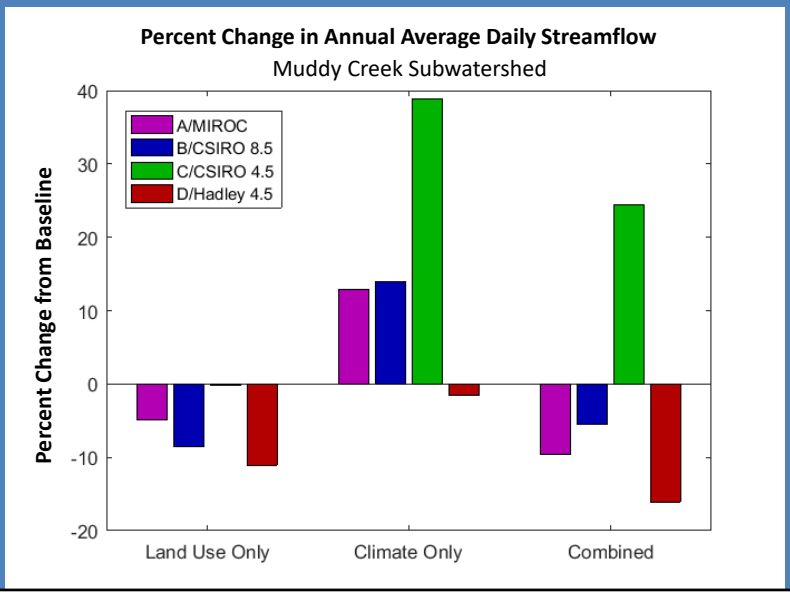


Results are Additive

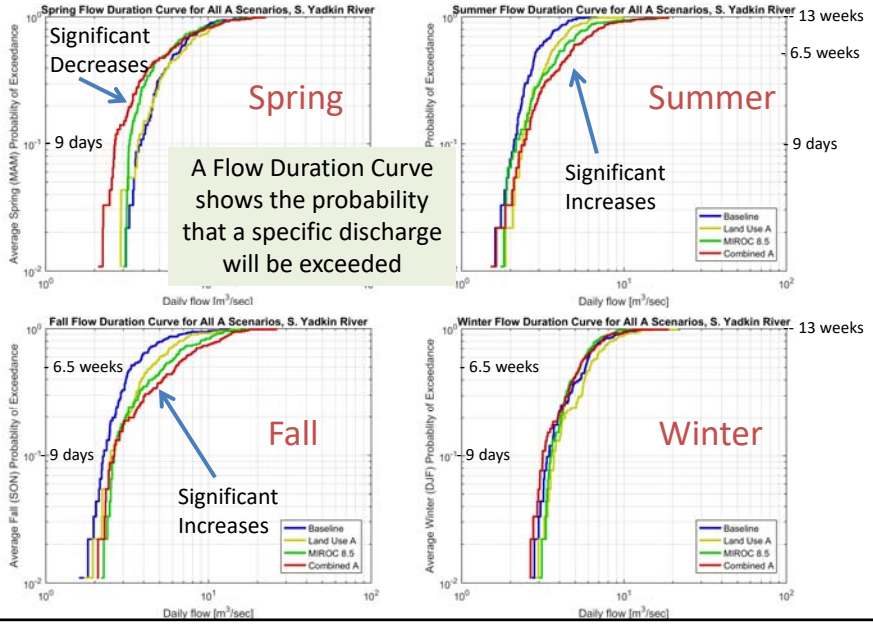
Land Use + Climate Change = Combined



Cancellation of Effects

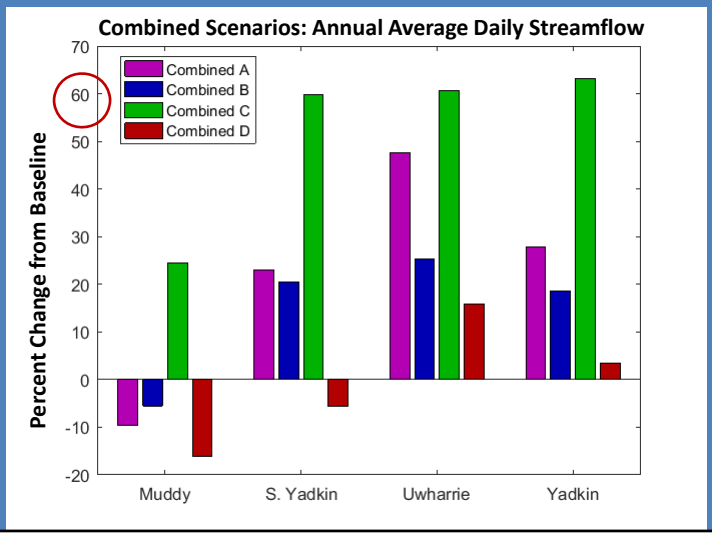


Seasonal Component

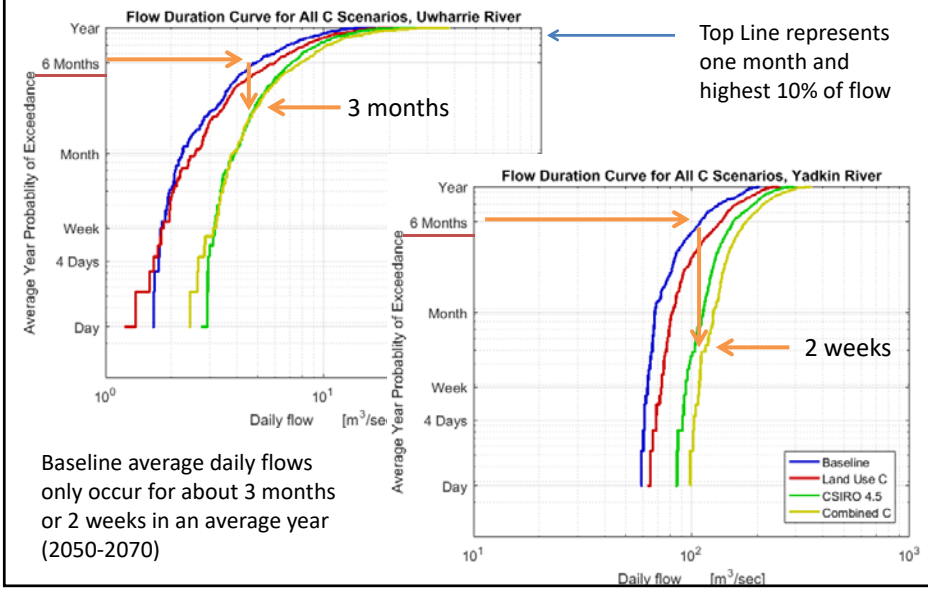


Combined Scenarios

Combined C and D scenarios are high and low range



Combined C Scenario



Baseline average daily flows only occur for about 3 months or 2 weeks in an average year (2050-2070)

Conclusions

- Land use change increases streamflow until reaching an urban threshold
- Climate change increases streamflow (in 3 out of 4 models)
- Climate change is the stronger driver; Land Use for more urbanized areas
- Results are additive
- Seasonal Pattern
- Plan for Risk

"For the strength of the Pack is the Wolf, and the strength of the Wolf is the Pack"
– Rudyard Kipling in The Jungle Book

Thank You

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