Hydrologic Modeling of the English River Watershed

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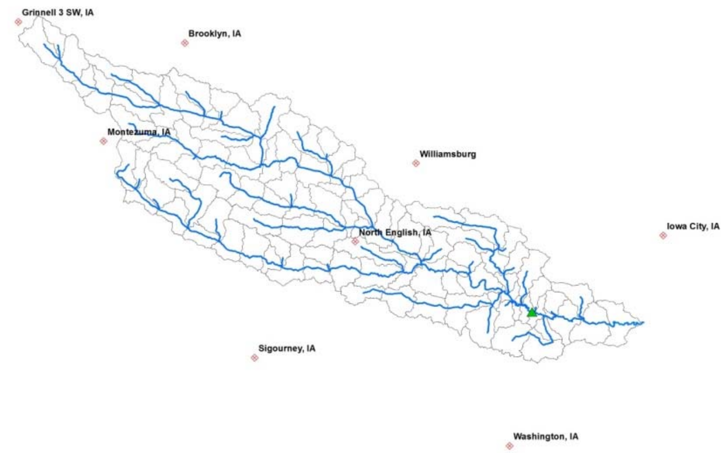
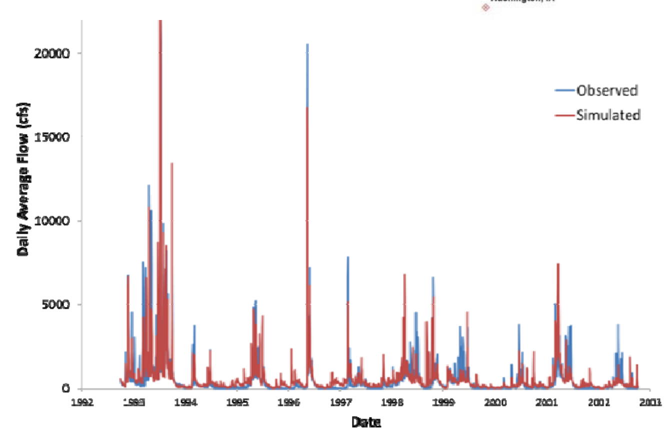
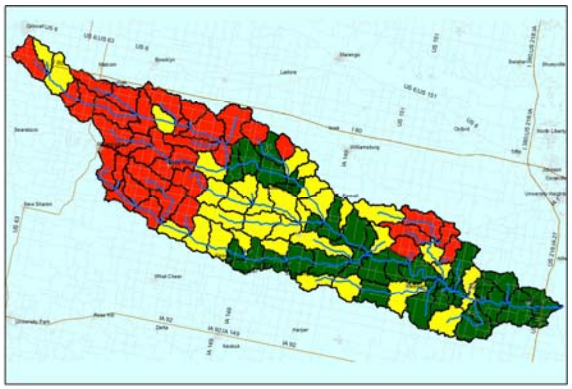




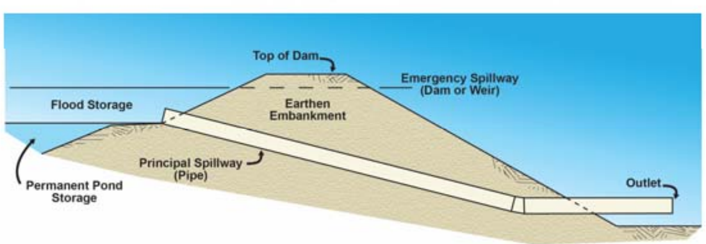
Iowa Flood Center

IIHR Hydroscience & Engineering

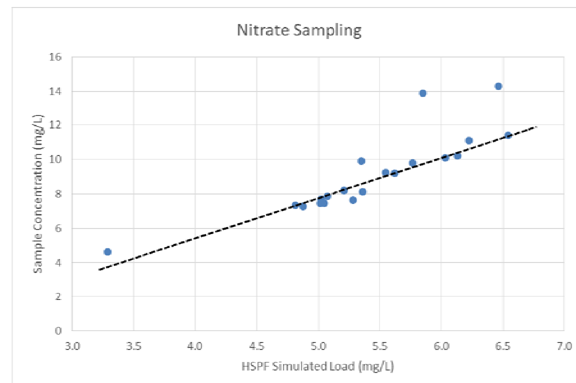
We will assess the water cycle and flooding from model predictions



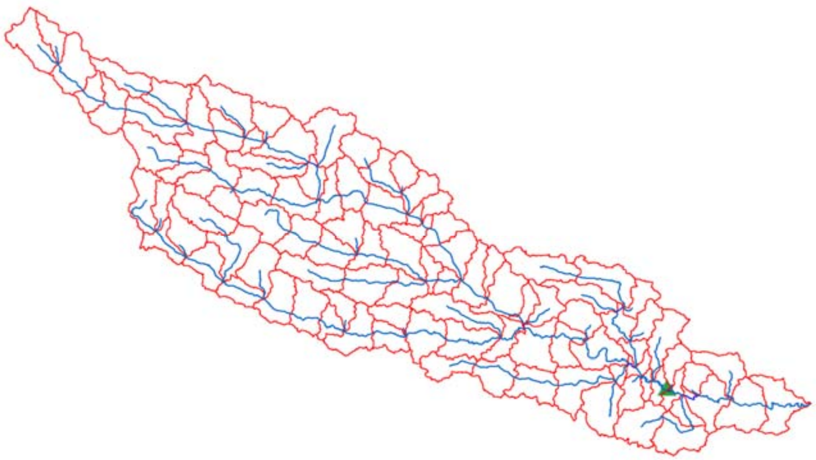
Identification of high runoff and high flood areas



Examples of hypothetical watershed scenarios



The use of model predictions in interpreting water quality sampling



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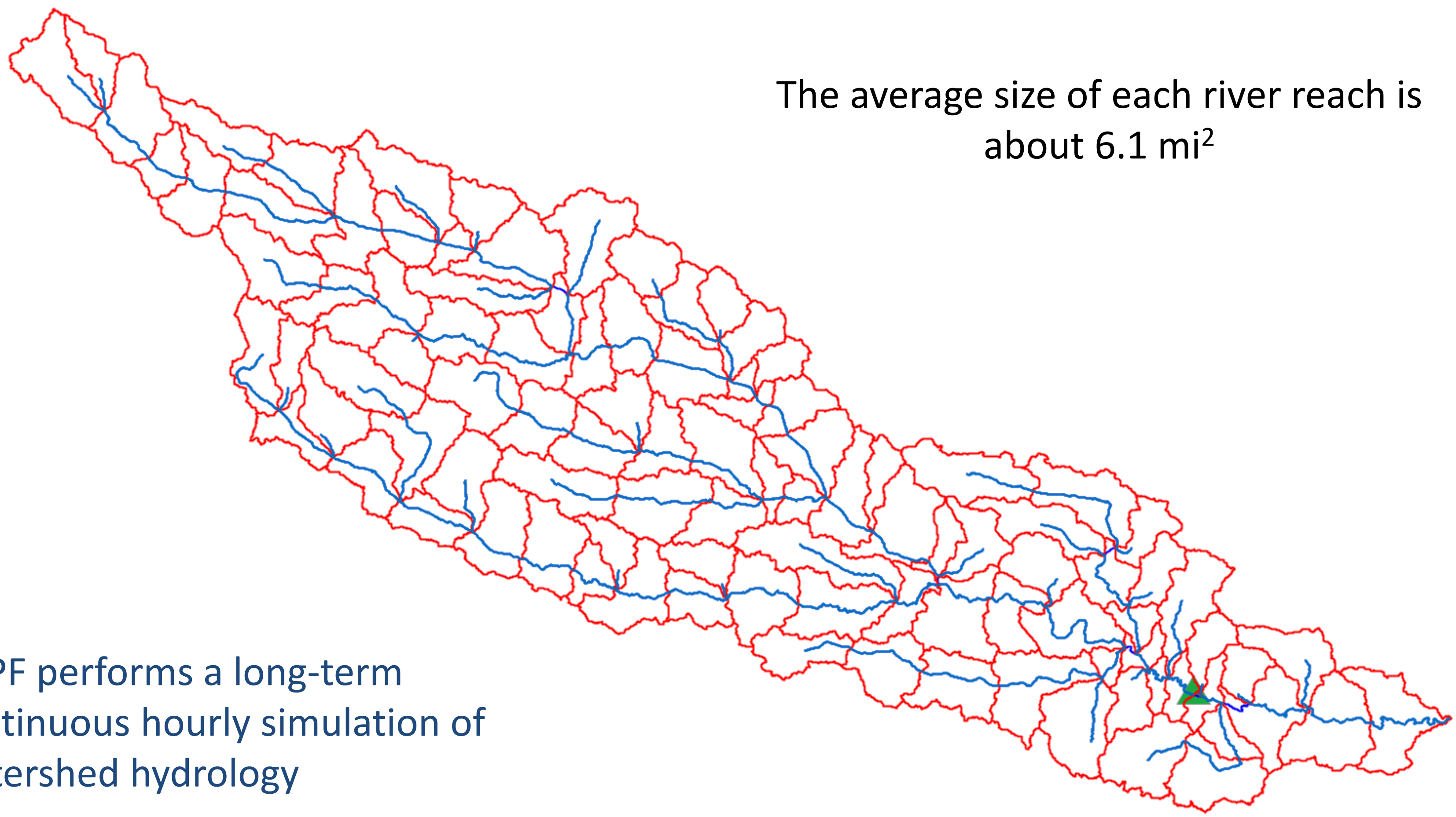
HSPF MODEL OF THE ENGLISH RIVER WATERSHED

The English River watershed is subdivided into 103 river reaches for flow prediction

Application to the English River Watershed



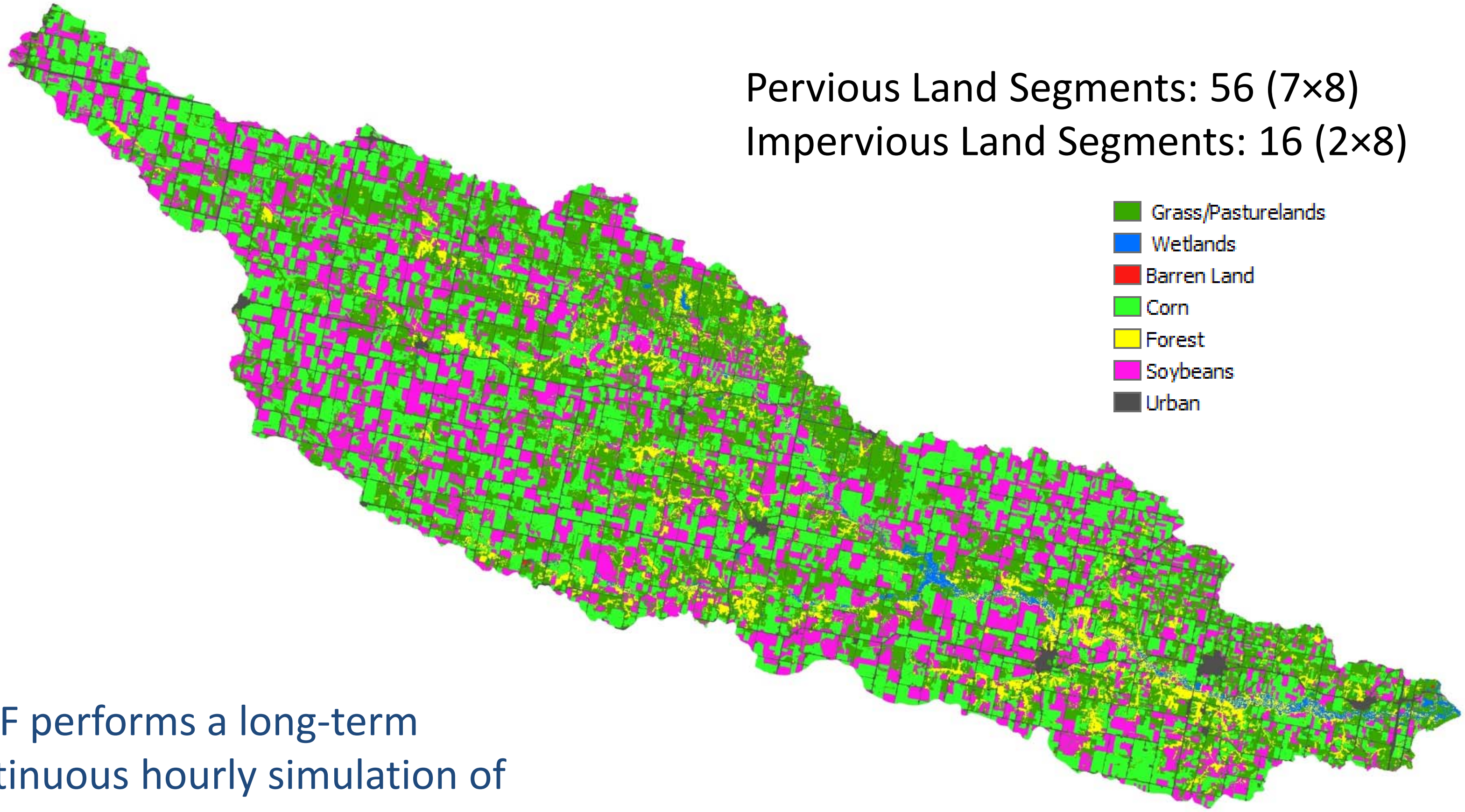
The average size of each river reach is about 6.1 mi^2

HSPF performs a long-term continuous hourly simulation of watershed hydrology

Subdivision into land segments is based on land use and weather inputs

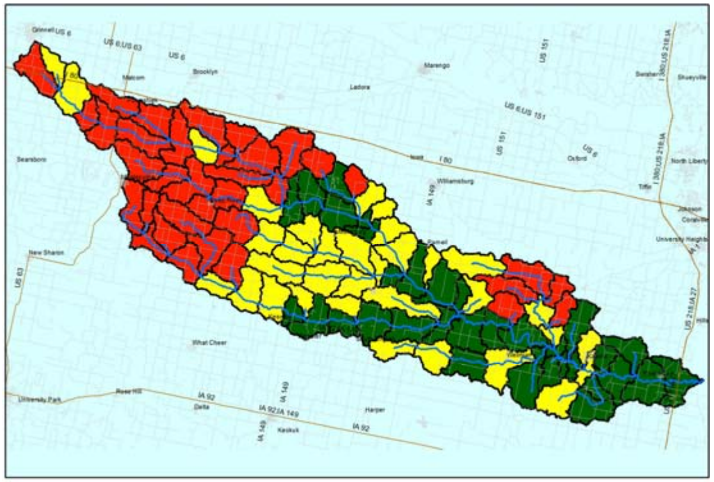
Application to the English River Watershed

Pervious Land Segments: 56 (7×8)
Impervious Land Segments: 16 (2×8)



HSPF performs a long-term continuous hourly simulation of watershed hydrology

2013 Land Use Information (Iowa Soybean Association)



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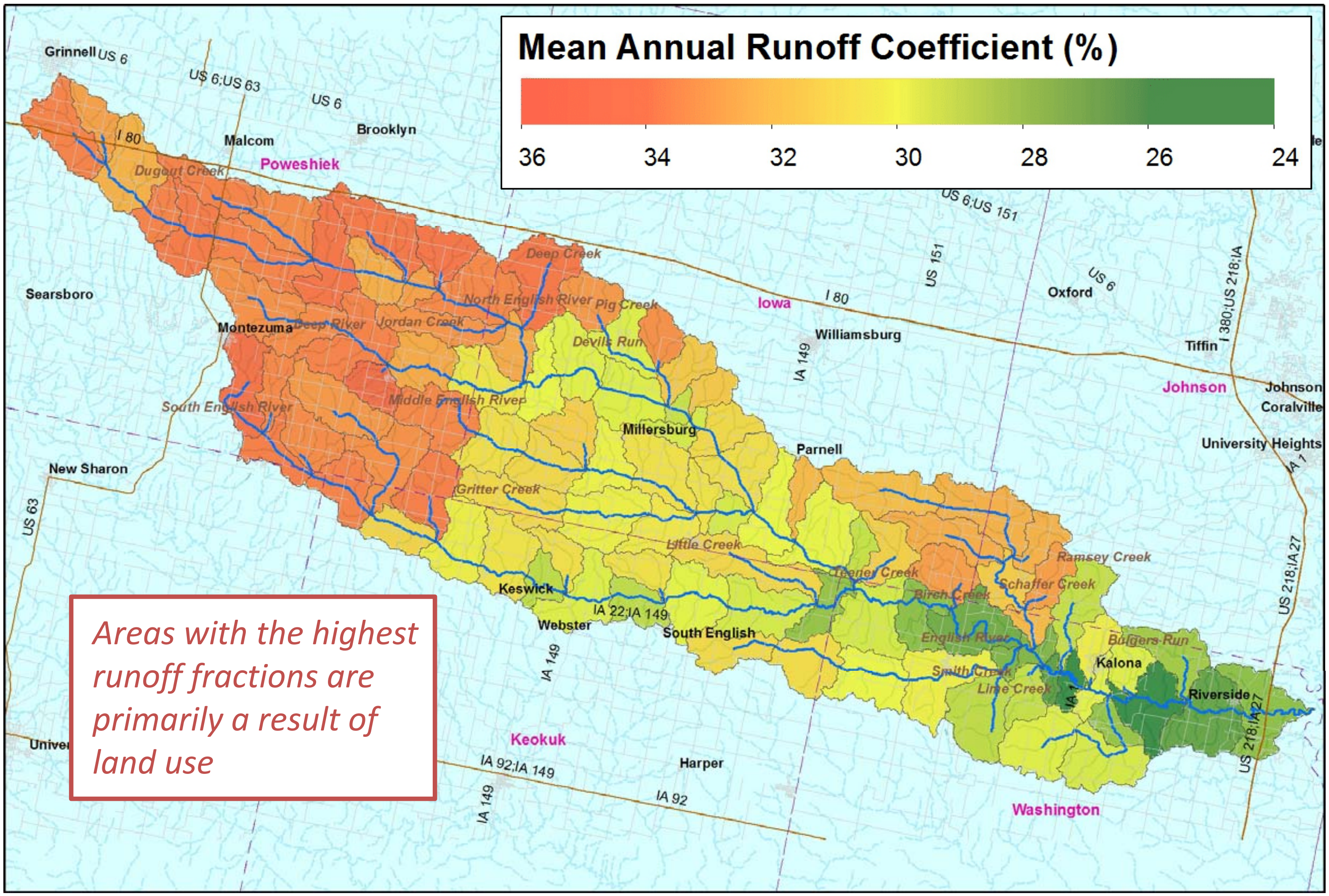
HIGH RUNOFF AND HIGH FLOOD AREAS

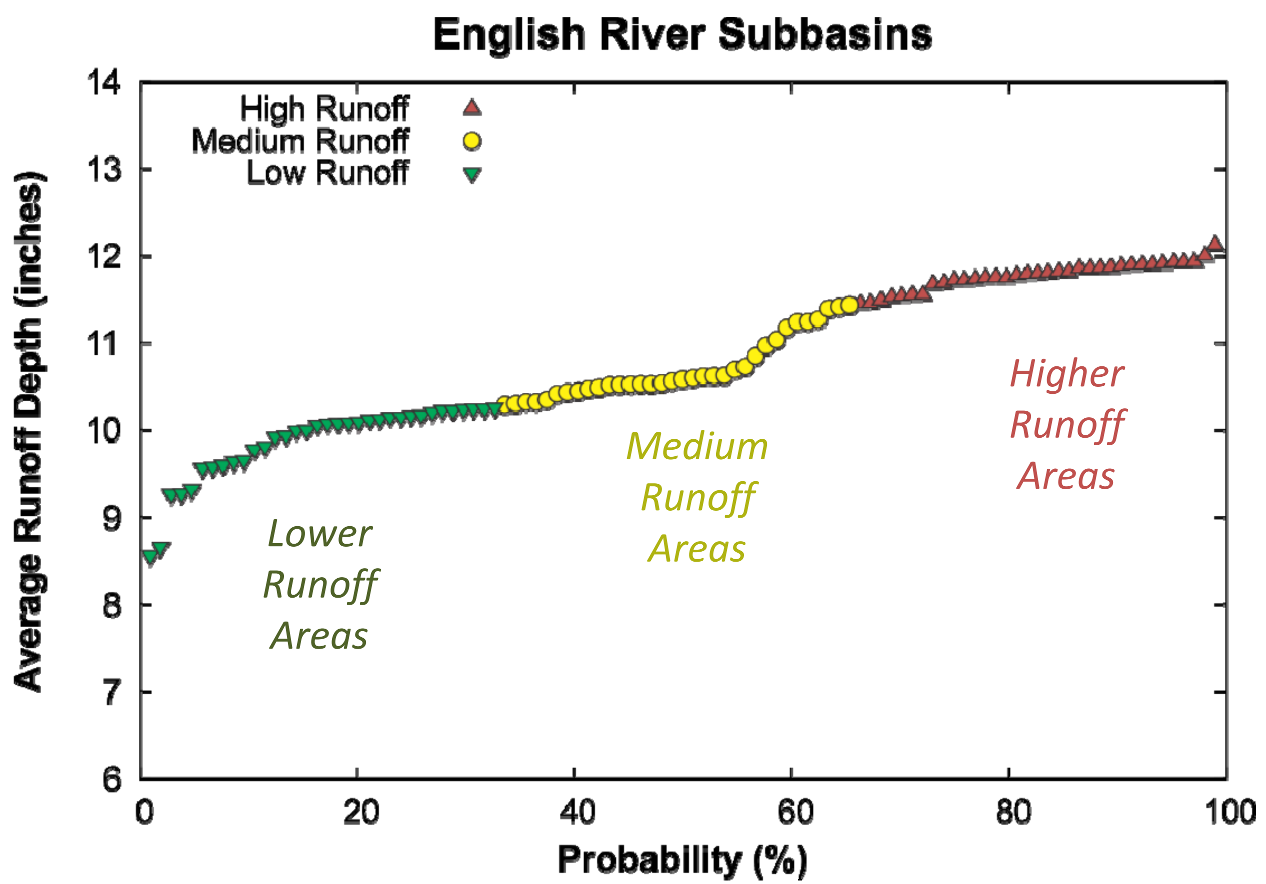
The fraction of precipitation that runs off varies across the English River watershed



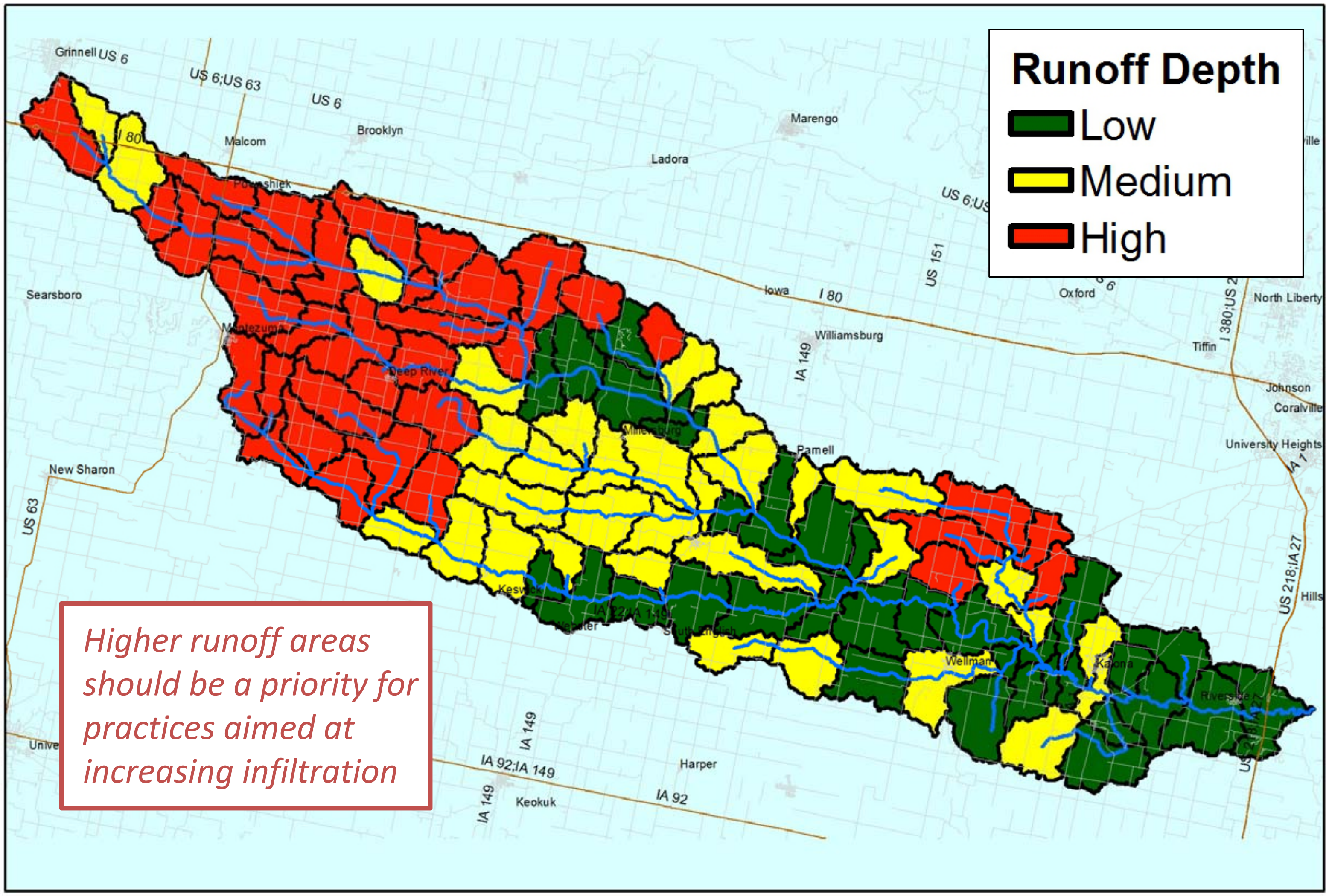
Areas with the highest runoff fractions are primarily a result of land use

Subbasins can be classified as low, medium, or high runoff areas

Average annual runoff depth from the 64-year simulation



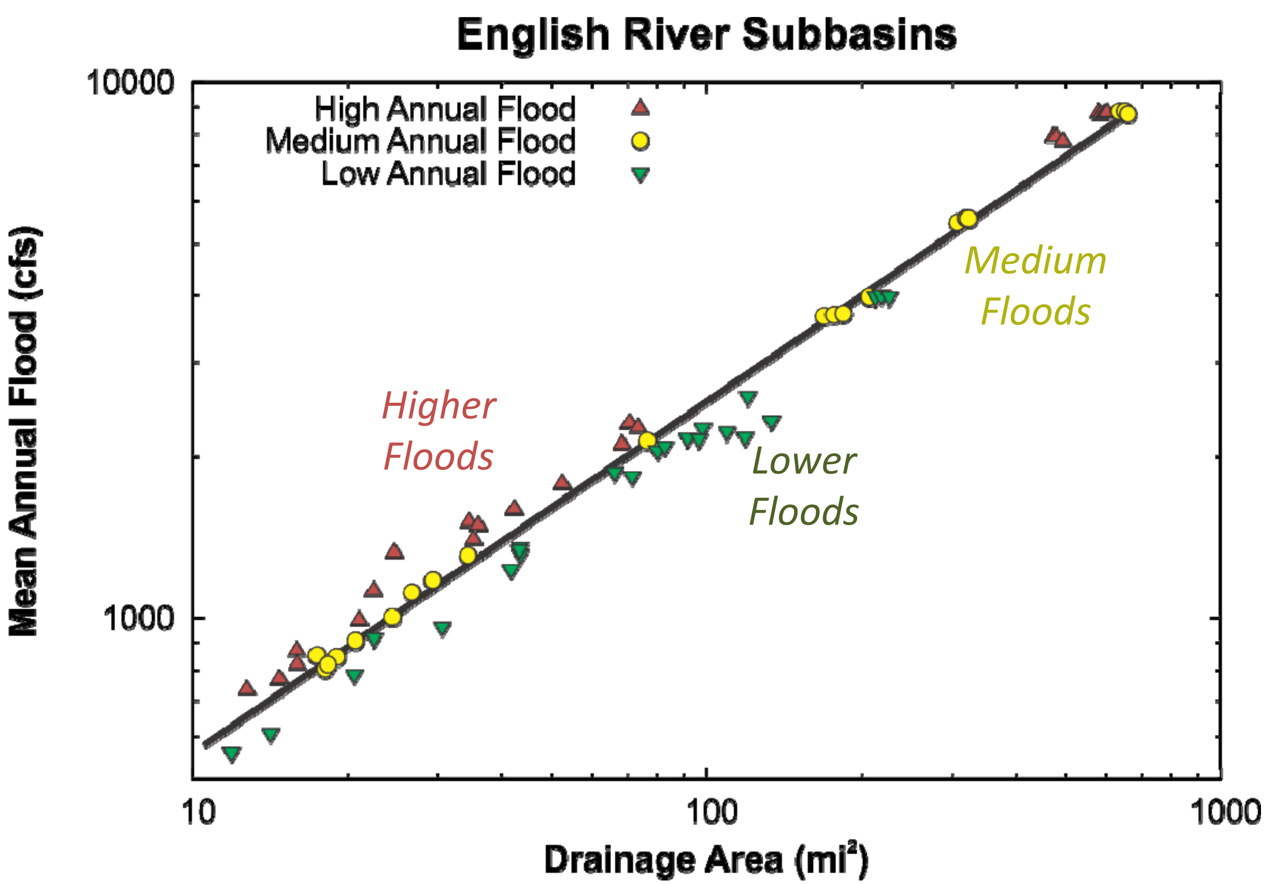
Subbasins can be classified as low, medium, or high runoff areas



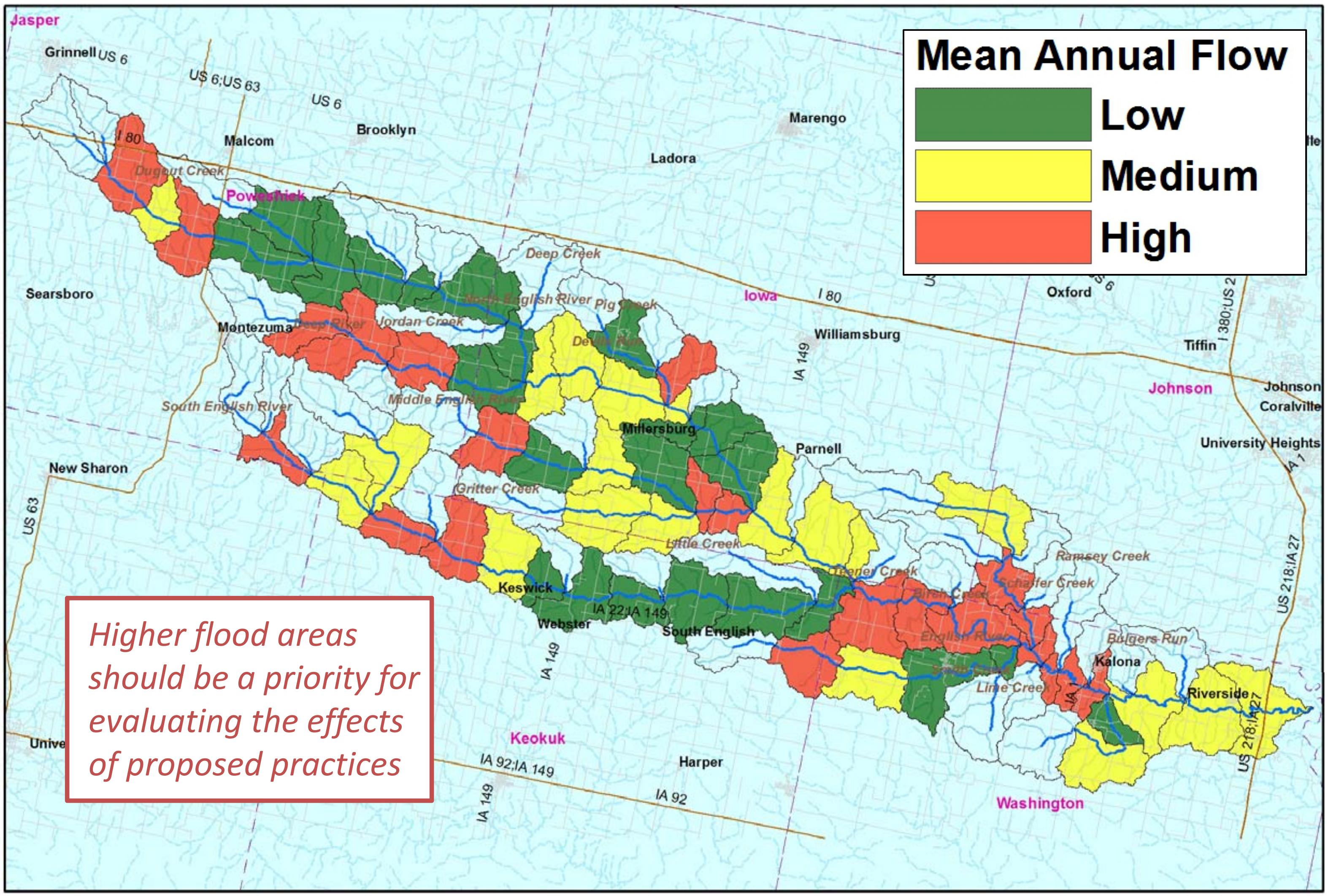
Higher runoff areas should be a priority for practices aimed at increasing infiltration

The mean annual flood tends to increase predictably with upstream drainage area

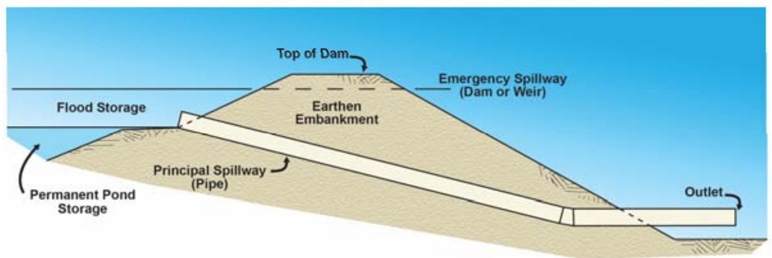
Mean annual flood from the 64-year simulation



Subbasin outlets can be classified as low, medium, or high flood areas



Higher flood areas should be a priority for evaluating the effects of proposed practices



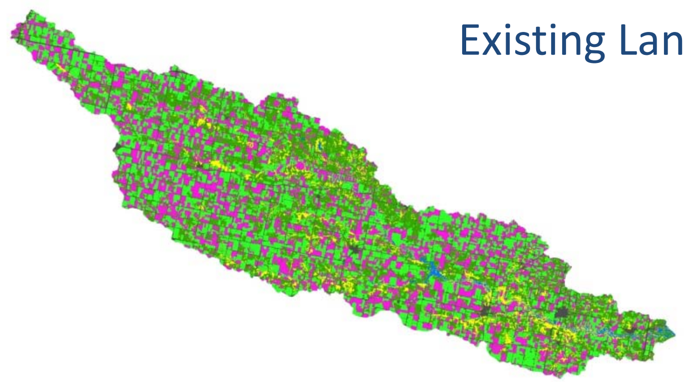
Hydrologic Modeling of the English River Watershed

IMPACTS OF HYPOTHETICAL ALTERNATIVE CONDITIONS

The hydrologic model can be used to explore alternative watershed conditions

Alternative Land Use in the English River Watershed

Pre-settlement
Tall-grass prairie
scenario



Existing Land Use

Scenario Land Use

Assume existing row crops are replaced with tall-grass prairie

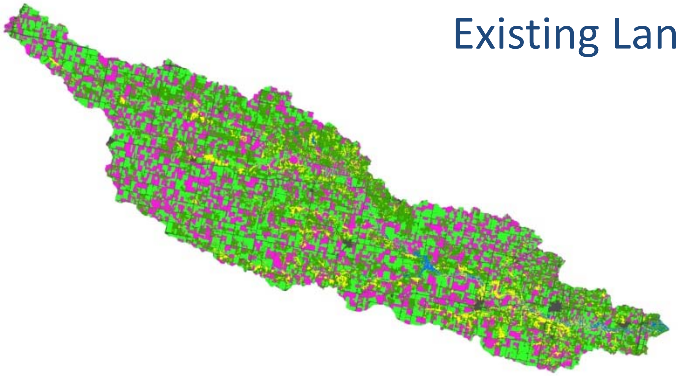
Deep rooted vegetations allow more water to infiltrate more quickly, and transpire more water

The hydrologic model can be used to explore improved agricultural hydrology

Alternative Land Use in the English River Watershed

Agricultural best management practices scenario

Existing Land Use



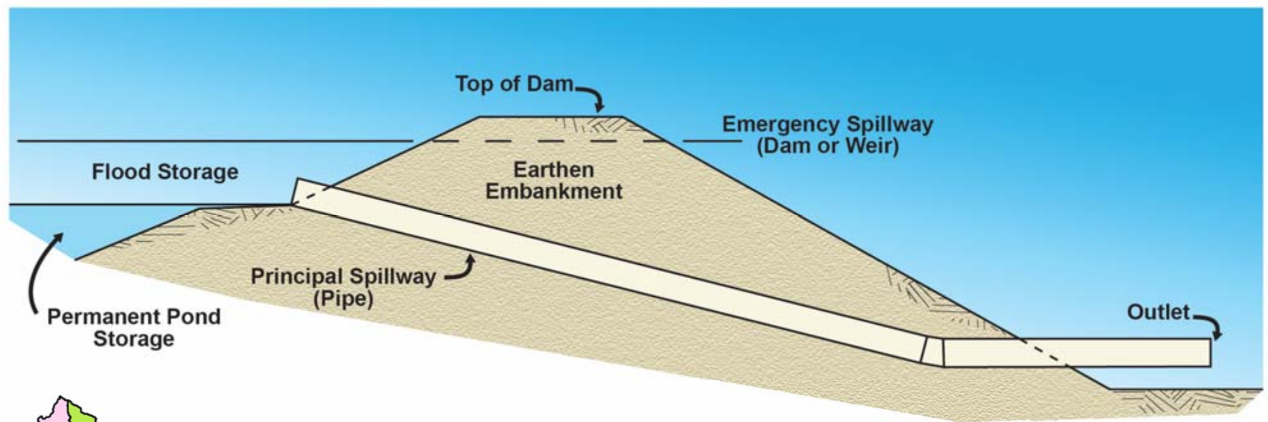
Scenario Land Use

Assume existing croplands have full implementation of conservation best management practices

Assume best runoff conditions for cropland areas

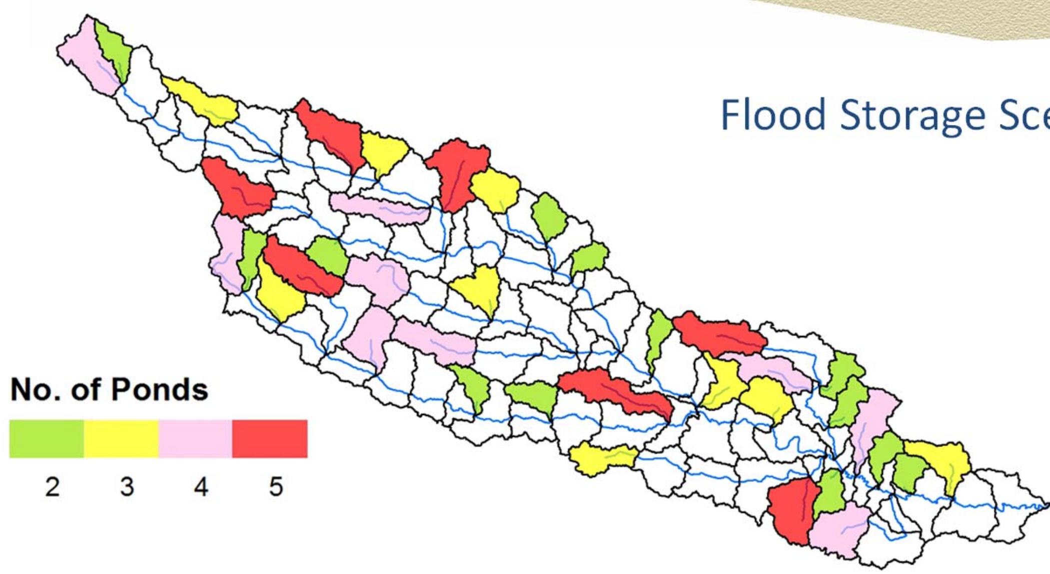
The hydrologic model can be used to explore flood management strategies

Flood Storage in the English River Watershed



Small (3-foot)
10.9 acre-feet
Medium (5-foot)
26.7 acre-feet
Large (7-foot)
48.2 acre-feet

Flood Storage Scenario



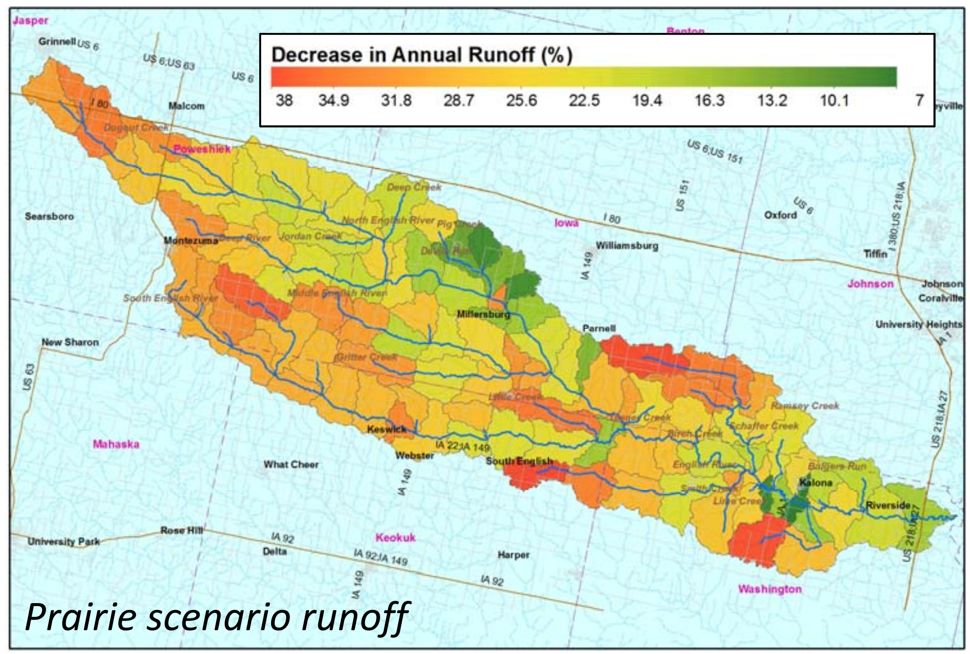
Assume that 124 prototype ponds are installed in headwater reaches (1 pond per 2 square miles)

Changes in the land surface can have a significant impact on runoff generation

Scenario effects on runoff

Tall-grass Prairie Scenario

The average annual runoff depth is 8.3 inches (a 27% reduction)



Prairie scenario runoff

Changes in the land surface can have a significant impact on runoff generation

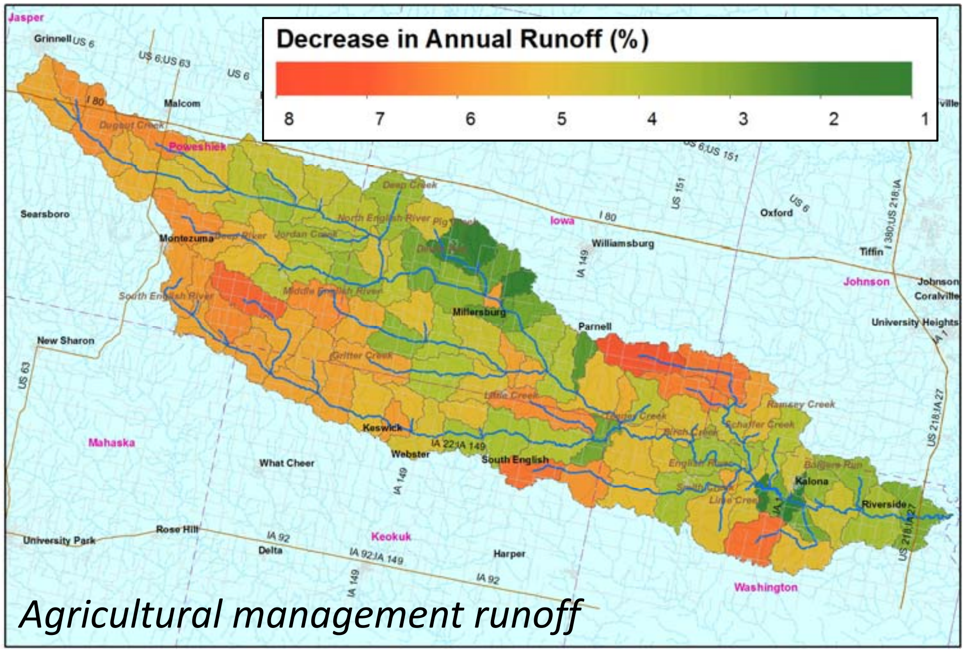
Scenario effects on runoff

Tall-grass Prairie Scenario

The average annual runoff depth is 8.3 inches (a 27% reduction)

Agricultural Management Scenario

The average annual runoff depth is 10.8 inches (a 5% reduction)



Agricultural management runoff

Changes in the land surface can have a significant impact on runoff generation

Scenario effects on runoff

Tall-grass Prairie Scenario

The average annual runoff depth is 8.3 inches (a 27% reduction)

Agricultural Management Scenario

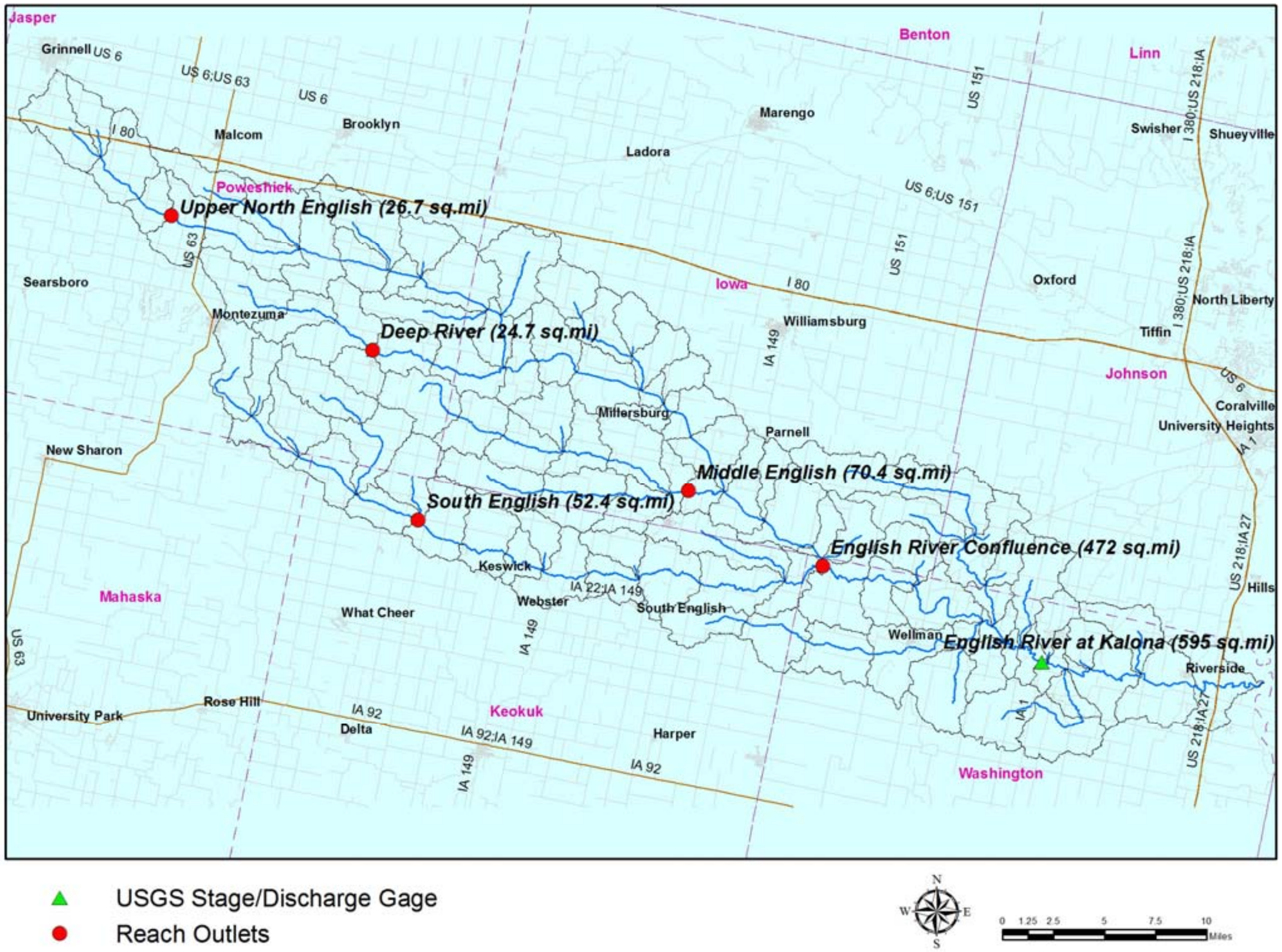
The average annual runoff depth is 10.8 inches (a 5% reduction)

Flood Pond Scenario

The average annual runoff depth is 11.3 inches (no reduction)

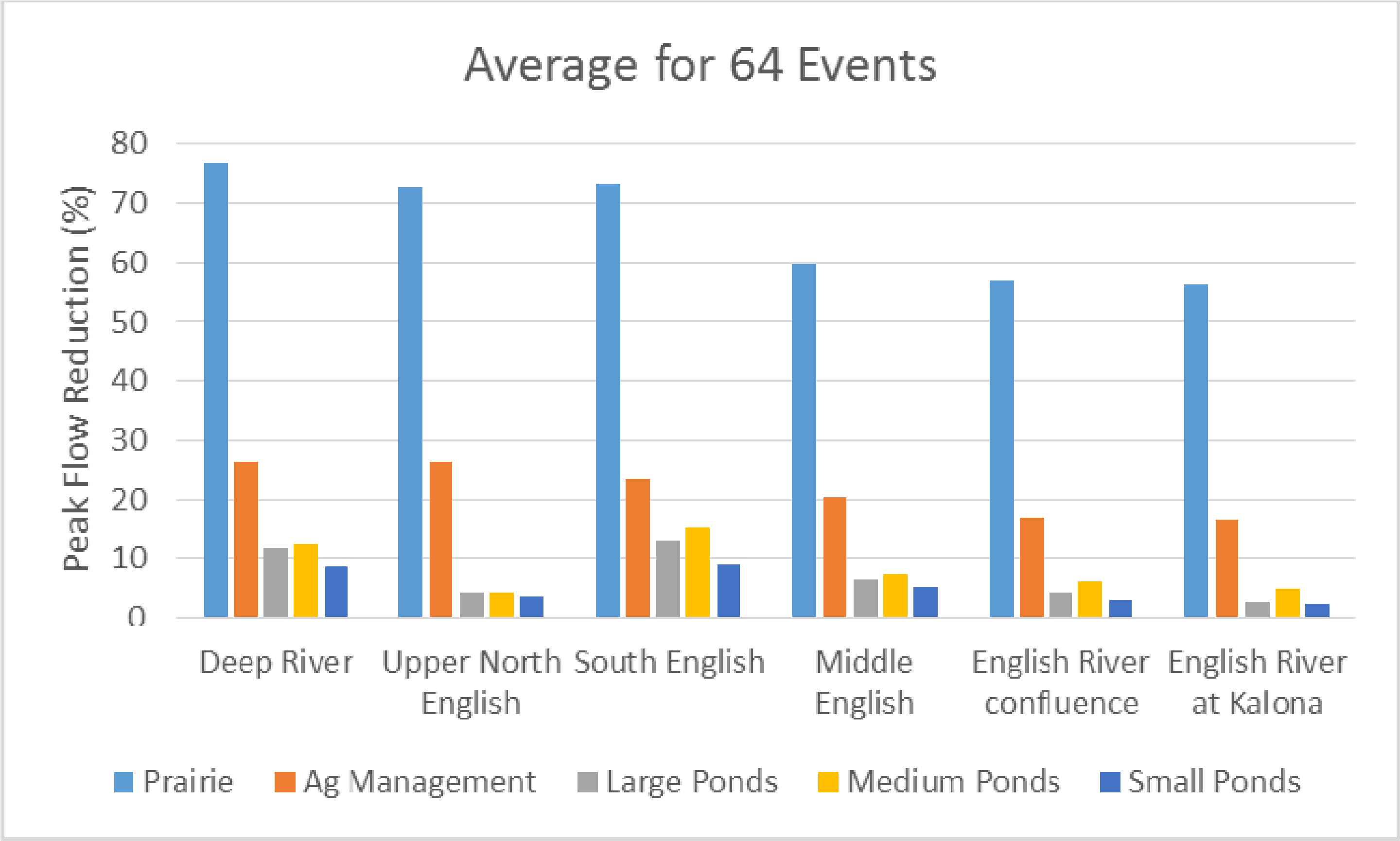
The decrease in peak flow for a flood event is called the *peak reduction effect*

Scenario effects on flooding



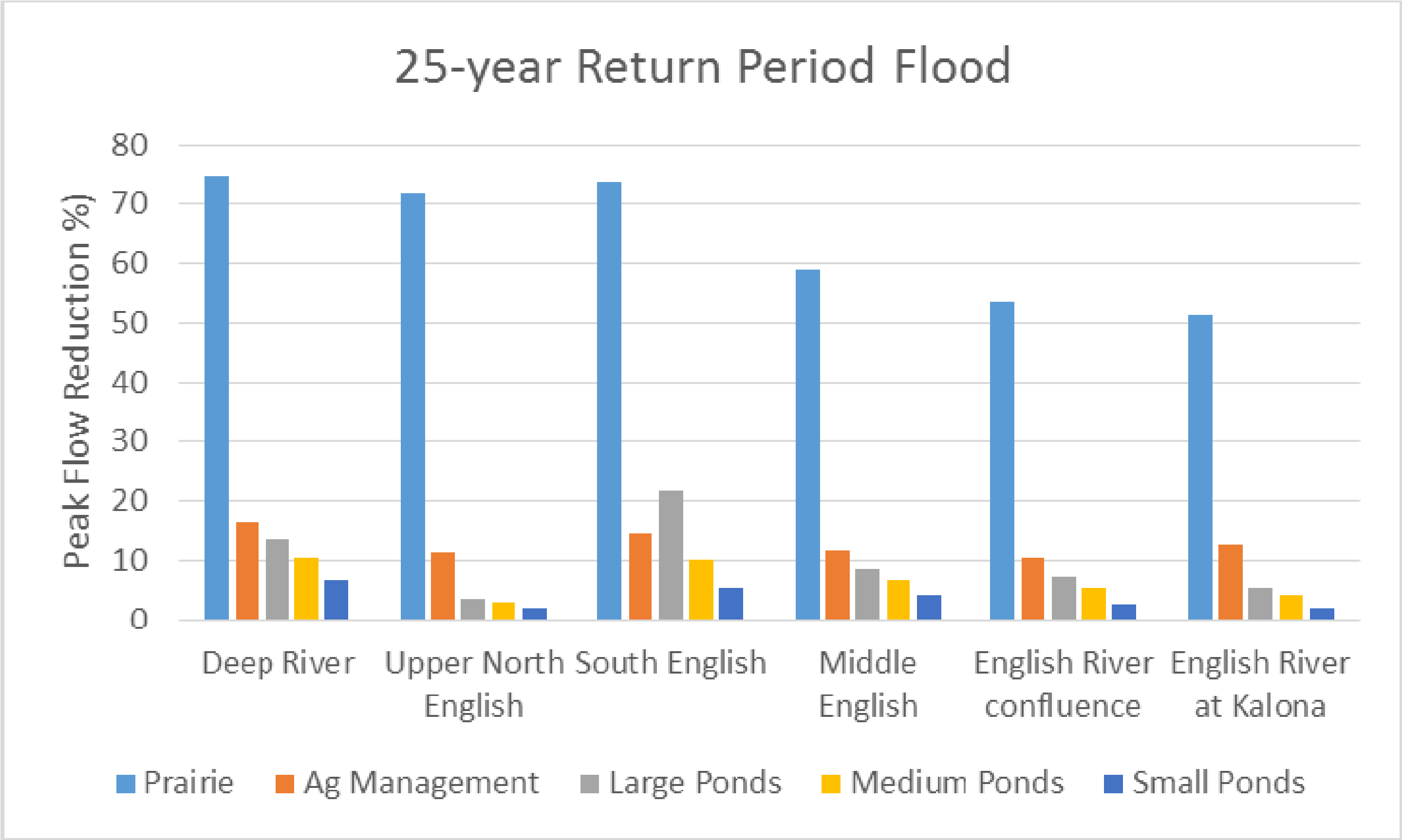
Flood peak reduction effect diminishes in the downstream direction

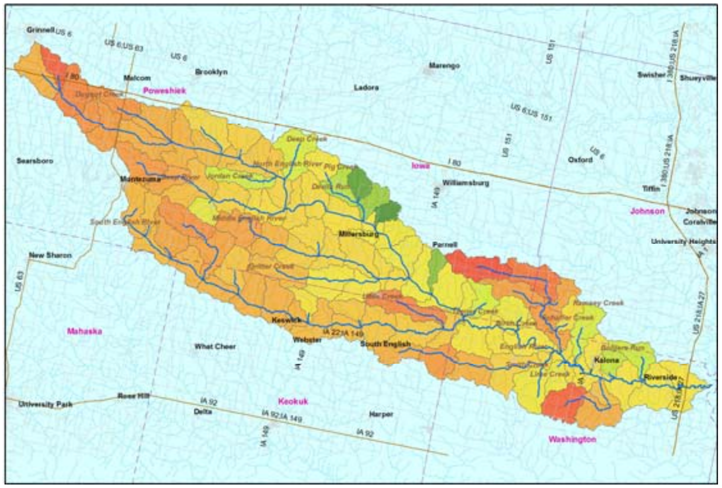
Scenario effects on flooding



Flood storage can be design to be most effective for large flood events

Scenario effects on flooding





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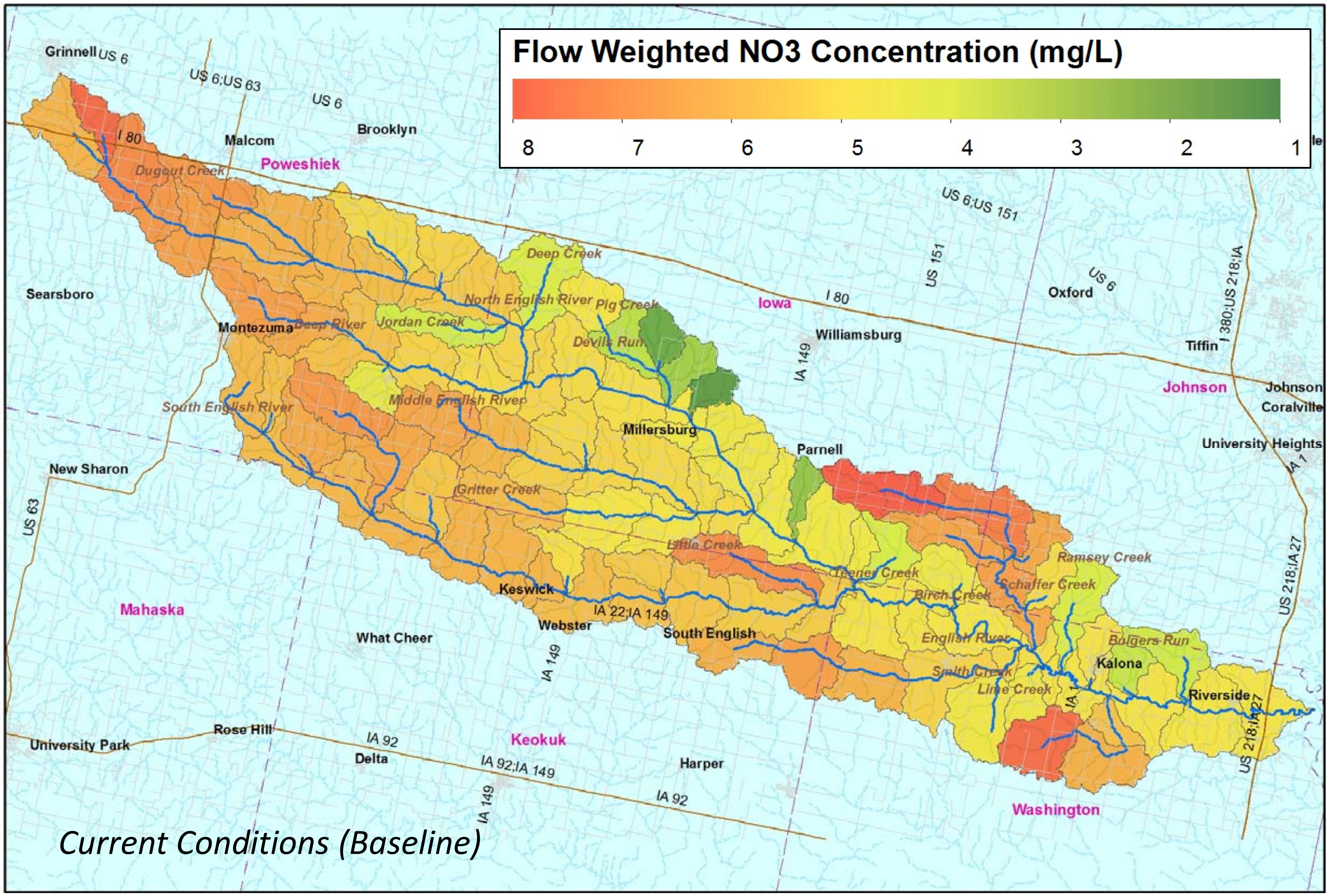
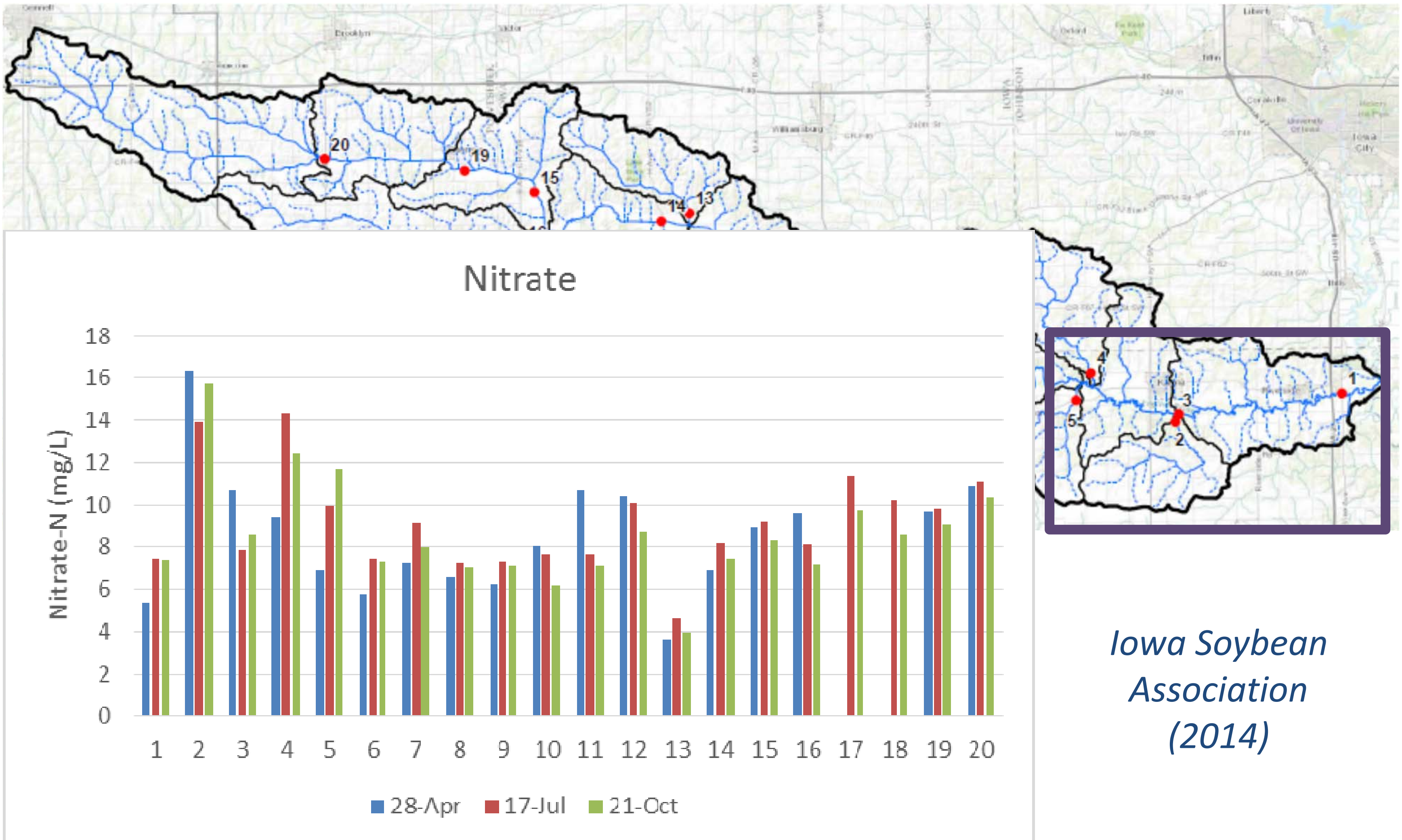
WATER QUALITY SIMULATION (NITRATE)

Nitrate load for the 64-year simulation varies with land use across the watershed



Current Conditions (Baseline)

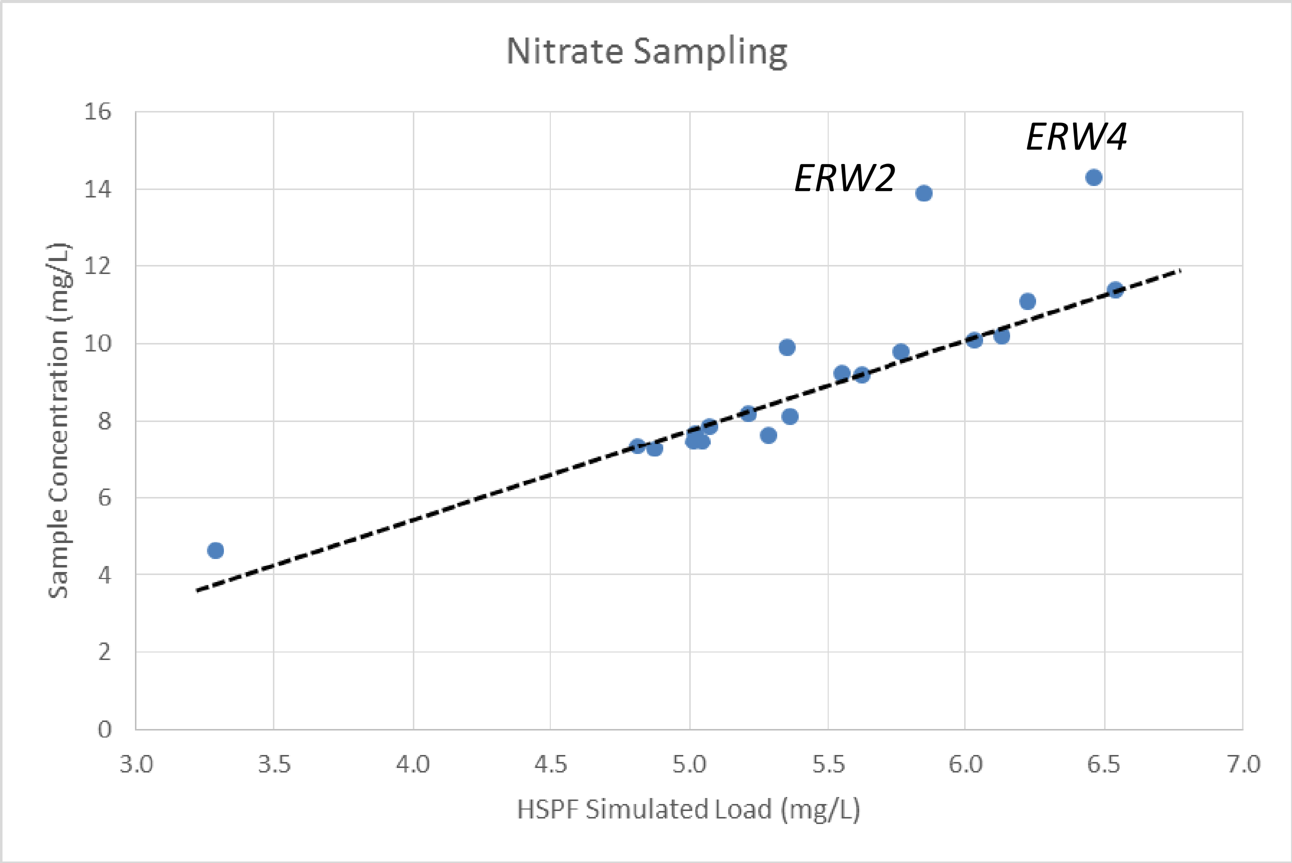
The water quality snapshot characterized Nitrate at 20 locations in the watershed



Iowa Soybean Association (2014)

Where load predictions are low (high), the snapshot saw low (high) concentrations

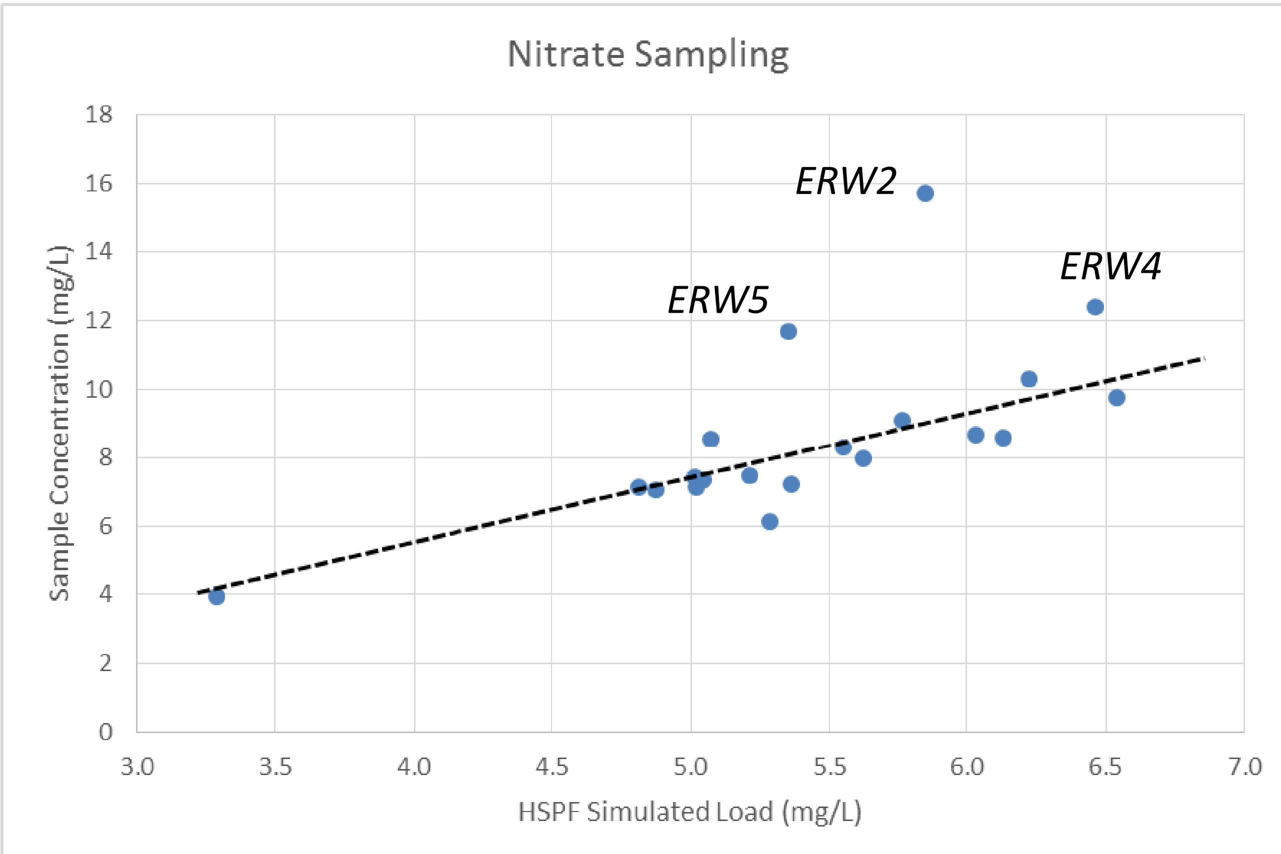
Nitrate Snapshot for 17 July 2014



Some sites are anomalously high compared to model predictions

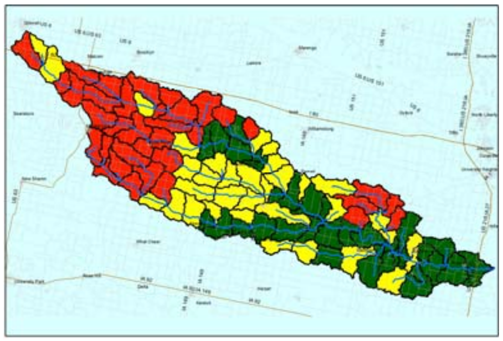
Where load predictions are low (high), the snapshot saw low (high) concentrations

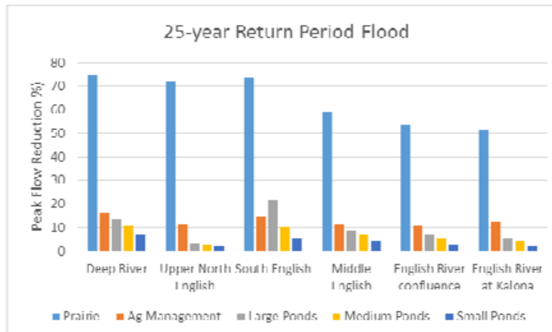
Nitrate Snapshot for 21 October 2014

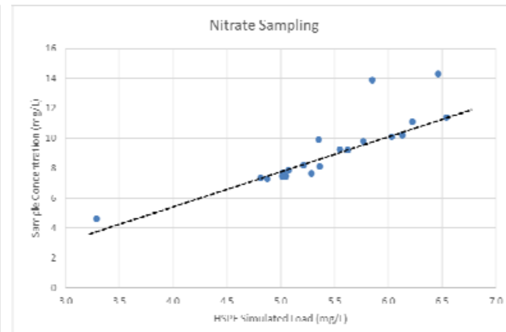


Some sites are anomalously high compared to model predictions

Model predictions provide a valuable context for interpreting measurements







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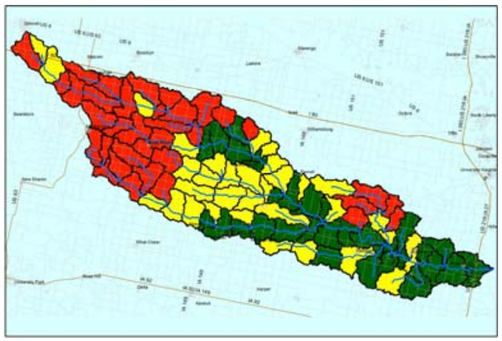
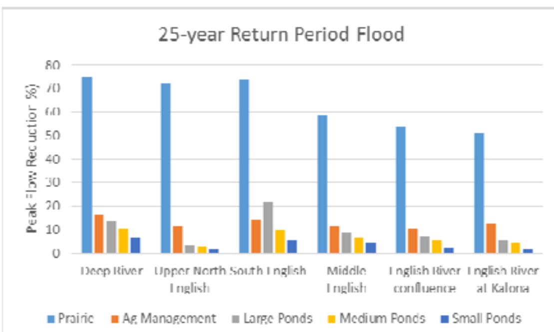
SUMMARY AND CONCLUSIONS

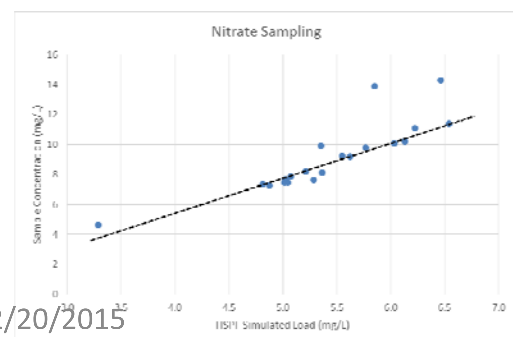
Modeling can help us assess the water cycle and water quality of the watershed



Model predictions were used to identify high runoff areas (a priority for practices) and high flood areas (a focus for assessing the impacts of practices).



Land use changes can have significant impacts on runoff and flooding. Flood storage can be targeted to reduce runoff effects for large floods.



Model predictions of water quality can help us make sense of field measurements.