

BASINS CAT, WEPPCAT, Stormwater CAT and CREAT: Scenario Analysis Tools for Assessing Streamflow and Water Quality Sensitivity to Climate Change

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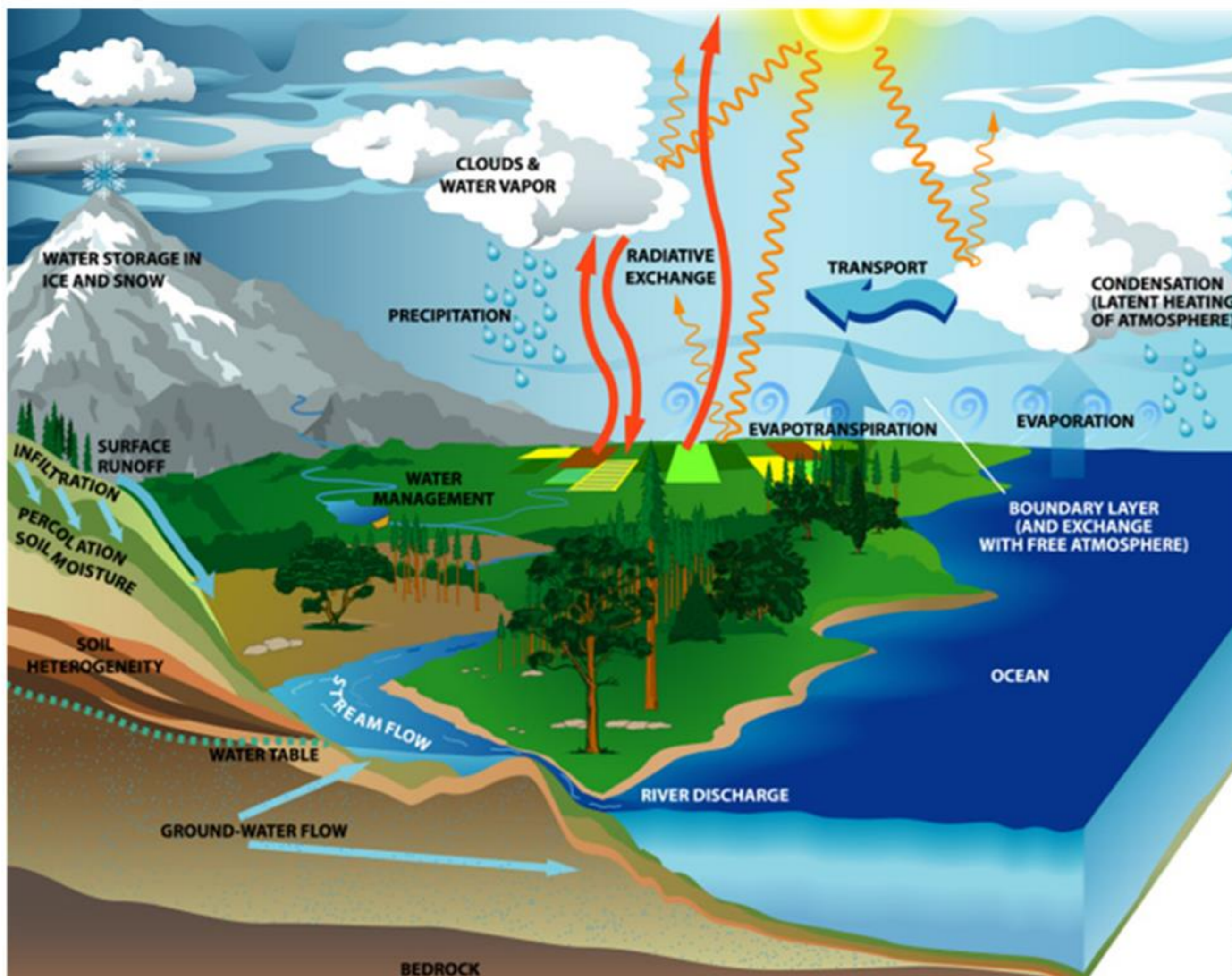
Paul Hummel, John Imhoff (Aqua Terra Consultants)

Mark Nearing, Dave Goodrich (USDA ARS)

Jason Berner, Curt Baranowski (EPA OW)

Climate Tools Café – May 7, 2013

Climate Change, Water, and Watersheds



Possible effects on water include:

- increased frequency of floods and droughts
- impacts on water quality
- impacts on aquatic ecosystems
- changes in infrastructure design and O&M



What can be done?

- Planning for climate change confounded by uncertainty; we currently have limited capabilities for *predicting* long term climate change at the spatial scales needed by water managers (particularly precipitation)
- Simulation models (e.g., climate, hydrology) are excellent tools for understanding system behavior; can be used to explore the implications of alternative actions, policies on future outcomes (scenario analysis)
- By exploring a range of future scenarios we can help determine how we might be vulnerable, and to develop management strategies for reducing risk

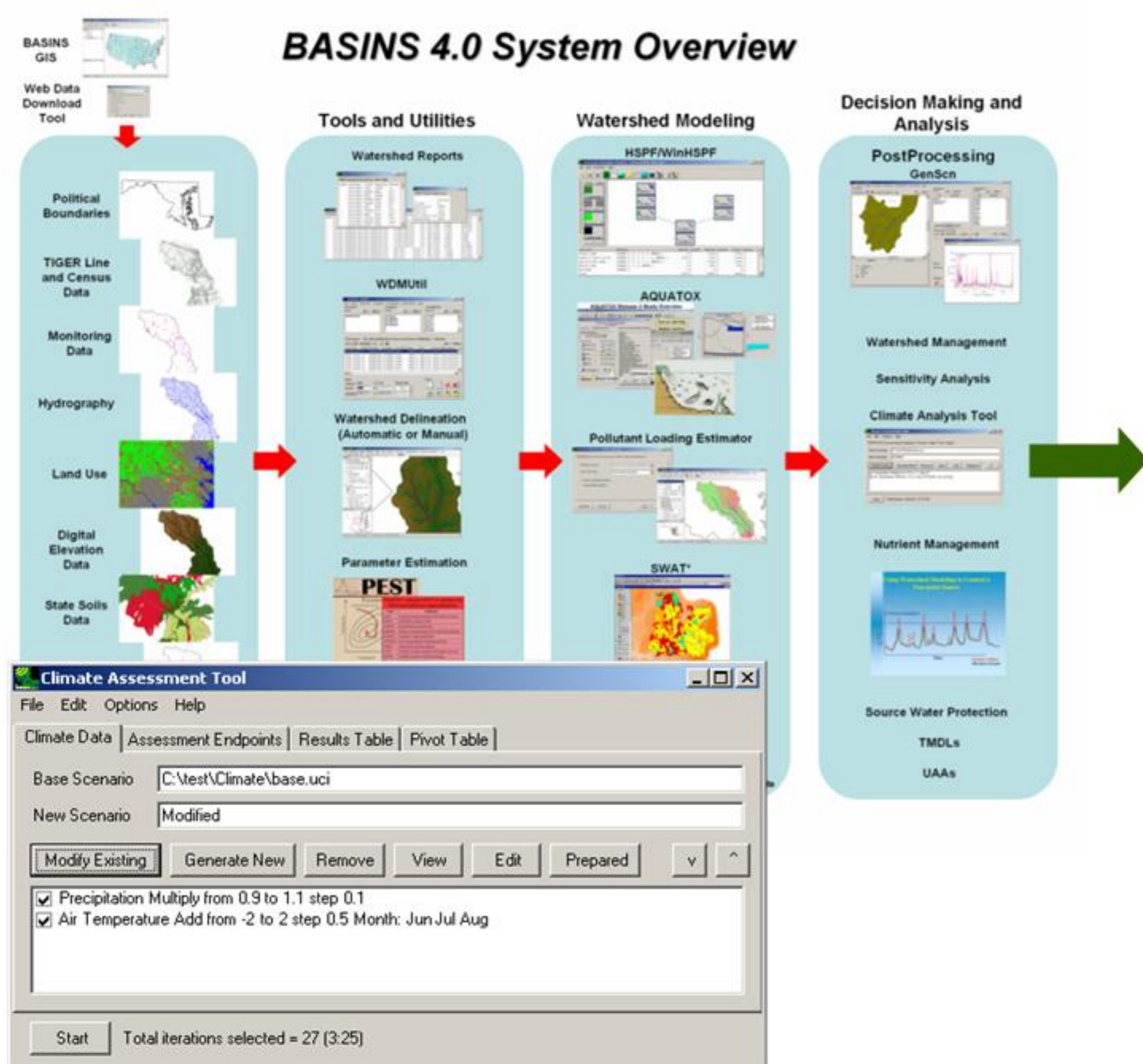
EPA Scenario and Risk Analysis Tools

EPA and partners have recently developed several tools useful for climate change scenario and risk analysis

- BASINS CAT and WEPPCAT (EPA/USDA)*
 - facilitate use of *existing* simulation models
- Climate Resilience and Awareness Tool– CREAT (EPA OW)
 - supports water utility adaptation planning
- Stormwater Calculator CAT (EPA ORD/OW)
 - screening assessment of GI effectiveness



BASINS Climate Assessment Tool (CAT)



- Implemented as a plug-in for BASINS 4.0
- Available for use with BASINS models
 - HSPF (2006)
 - SWAT, SWMM (~ June 2013)
- Provides capability to create and run new meteorological time series by modifying historical data (change factor method)
 - scenarios specified by user
- Supports sensitivity analysis, scenario planning; to address “what-if” questions about system response to climate change

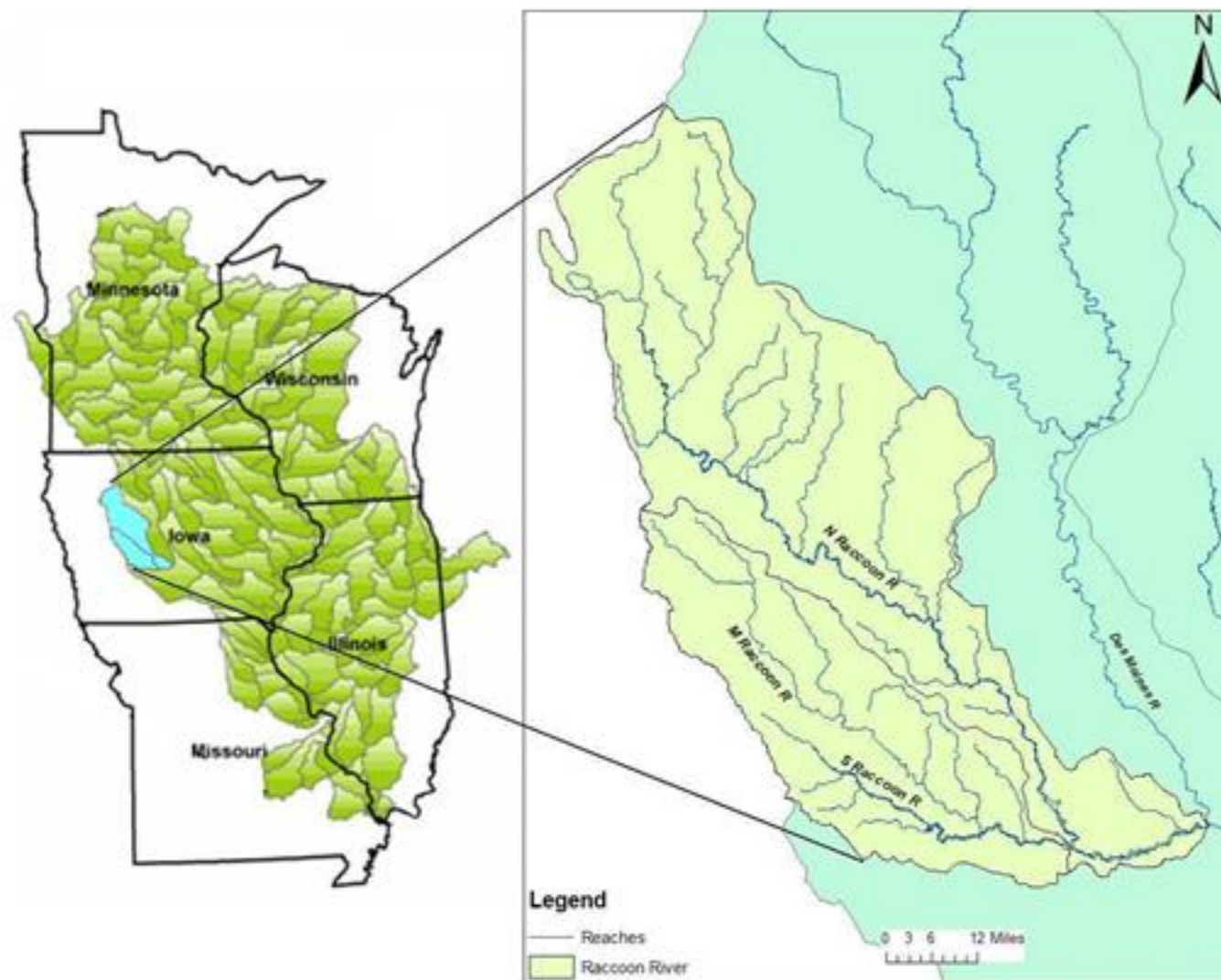
http://water.epa.gov/scitech/datait/models/basins/BASINS4_index.cfm

BASINS CAT Time Series Adjustments

Modifying historical precipitation records	<ul style="list-style-type: none"> • Apply a multiplier to each value within selected months in a multiyear record • Apply multiplier to each value within selected years in a multiyear record • Represent storm intensification by applying multiplier to values (events) only within a selected size class • Represent changes in event frequency by adding or removing storm events to observed historical precipitation time series
Modifying historical air temperatures	<ul style="list-style-type: none"> • Add or subtract from each value within selected months in a multiyear record • Add or subtract from each value within selected years in a multiyear record
Creating complex scenarios	<ul style="list-style-type: none"> • Combine multiple adjustments to precipitation and temperature time series to create complex scenarios
Calculating assessment endpoints	<ul style="list-style-type: none"> • Calculate summary values from model output time series (e.g., mean, 7Q10, 100-year flood)

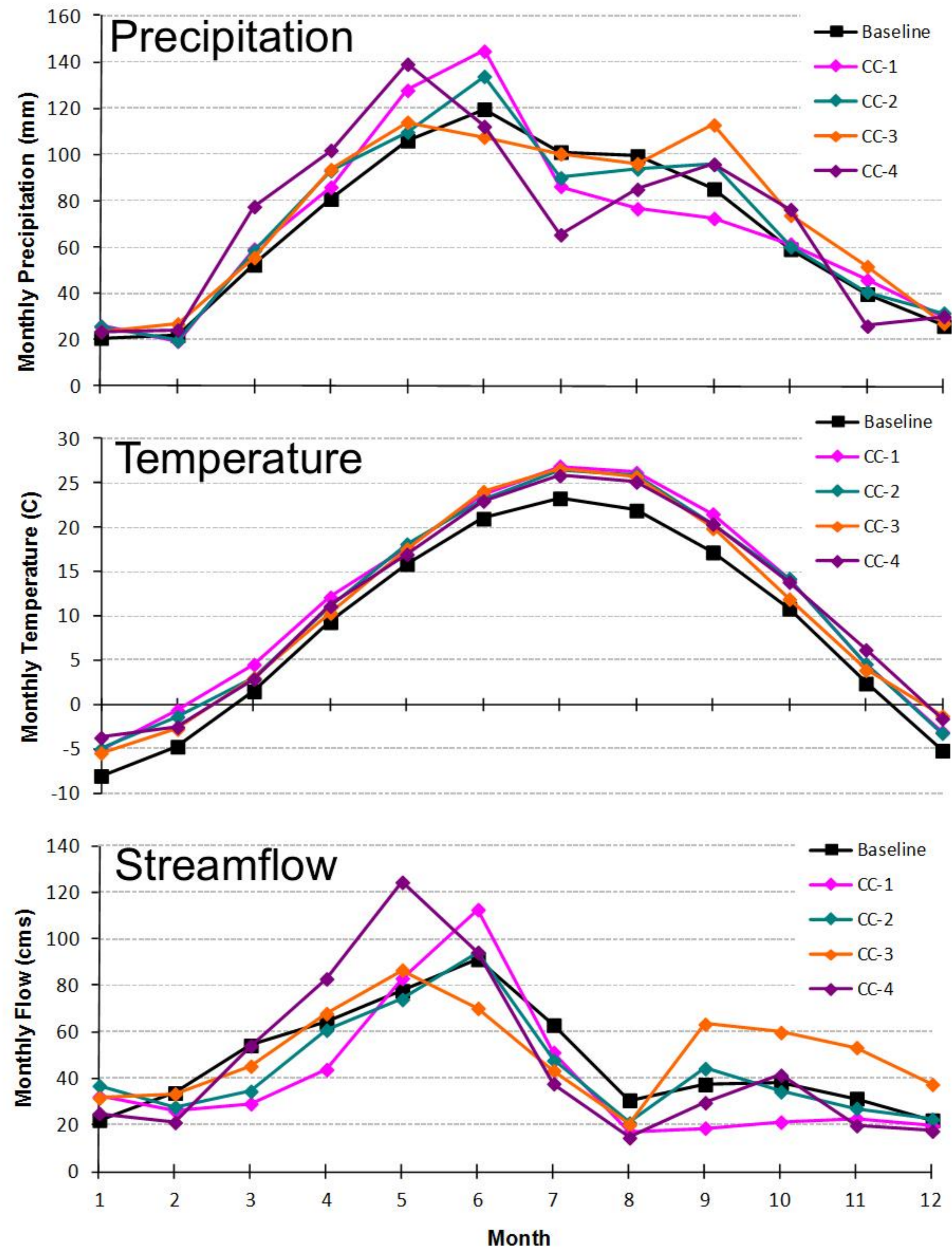
Example 1: Streamflow sensitivity to climate change in the Racoon river, Iowa, using the SWAT model

Raccoon R., Iowa



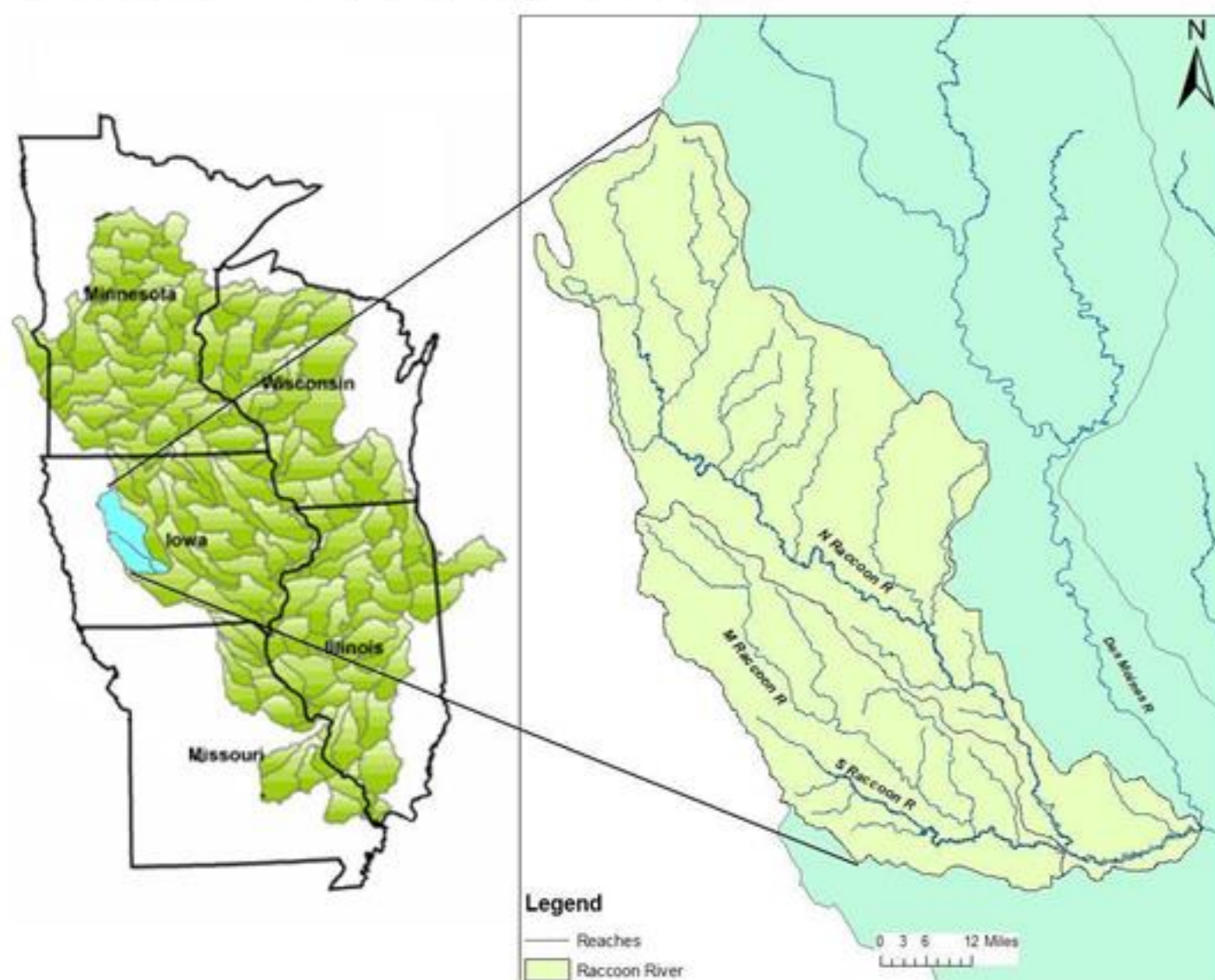
Climate change scenarios based on 4 dynamically downscaled model projections for period 2041-2070 from NCAR NARCCAP

Scenario	NARCCAP RCM/GCM model combinations used to develop climate change scenarios (RCM_GCM)
CC-1	Canadian Regional Climate Model nested in the Canadian Global Climate Model version 3
CC-2	National Center for Atmospheric Research (NCAR) Regional Climate Model version 3 nested in the Canadian Global Climate Model version 3
CC-3	NCAR Regional Climate Model version 3 nested in the Geophysical Fluid Dynamics Laboratory Climate Model version 2
CC-4	Weather Research and Forecasting Grell Model nested in the NCAR Community Climate Model version 3



Example 2: Streamflow sensitivity to climate change in the Racoon river, Iowa, using the SWAT model

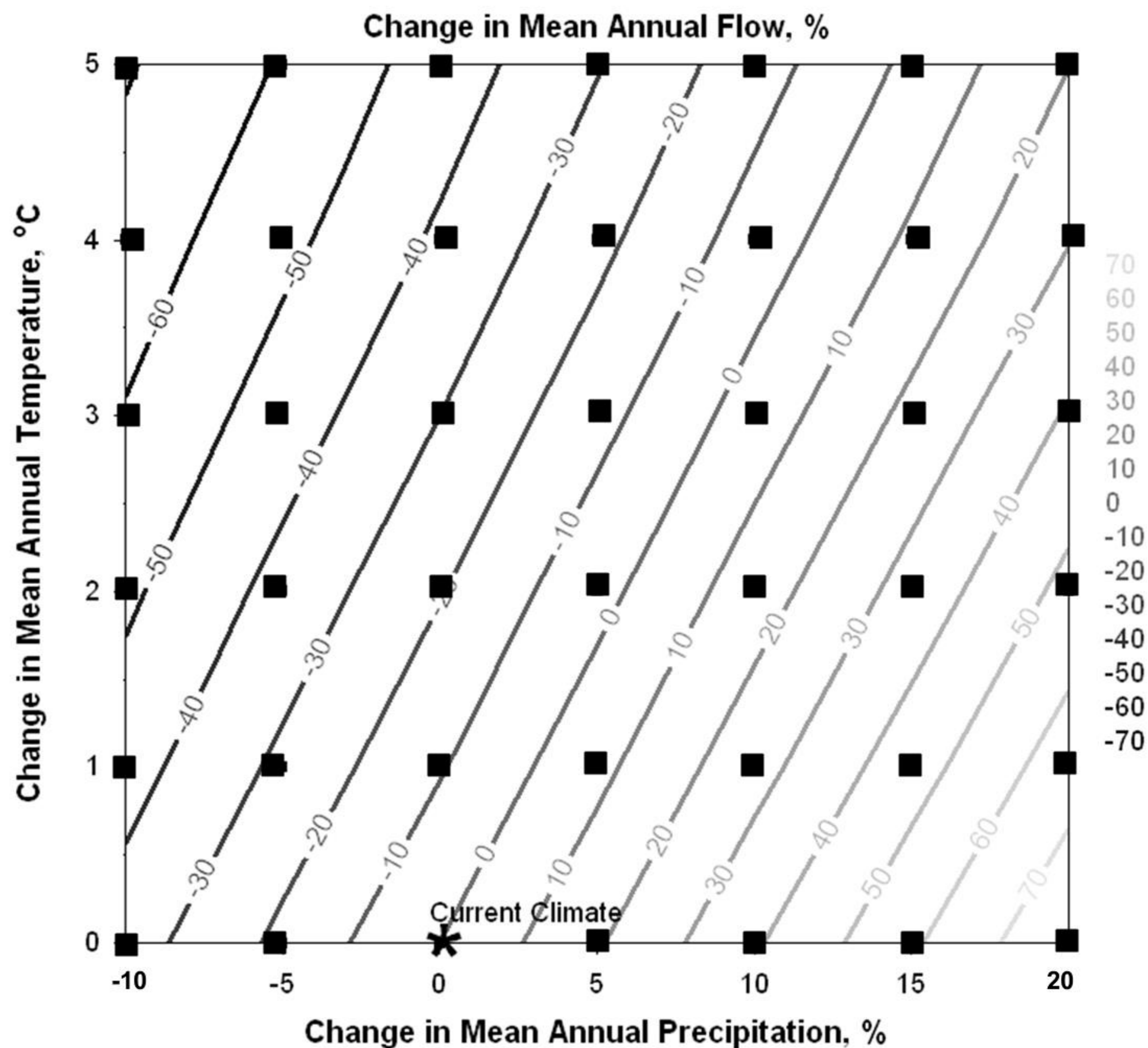
Raccoon R., Iowa



Climate change scenarios represent different combinations of temp and precip change within a user-specified range:

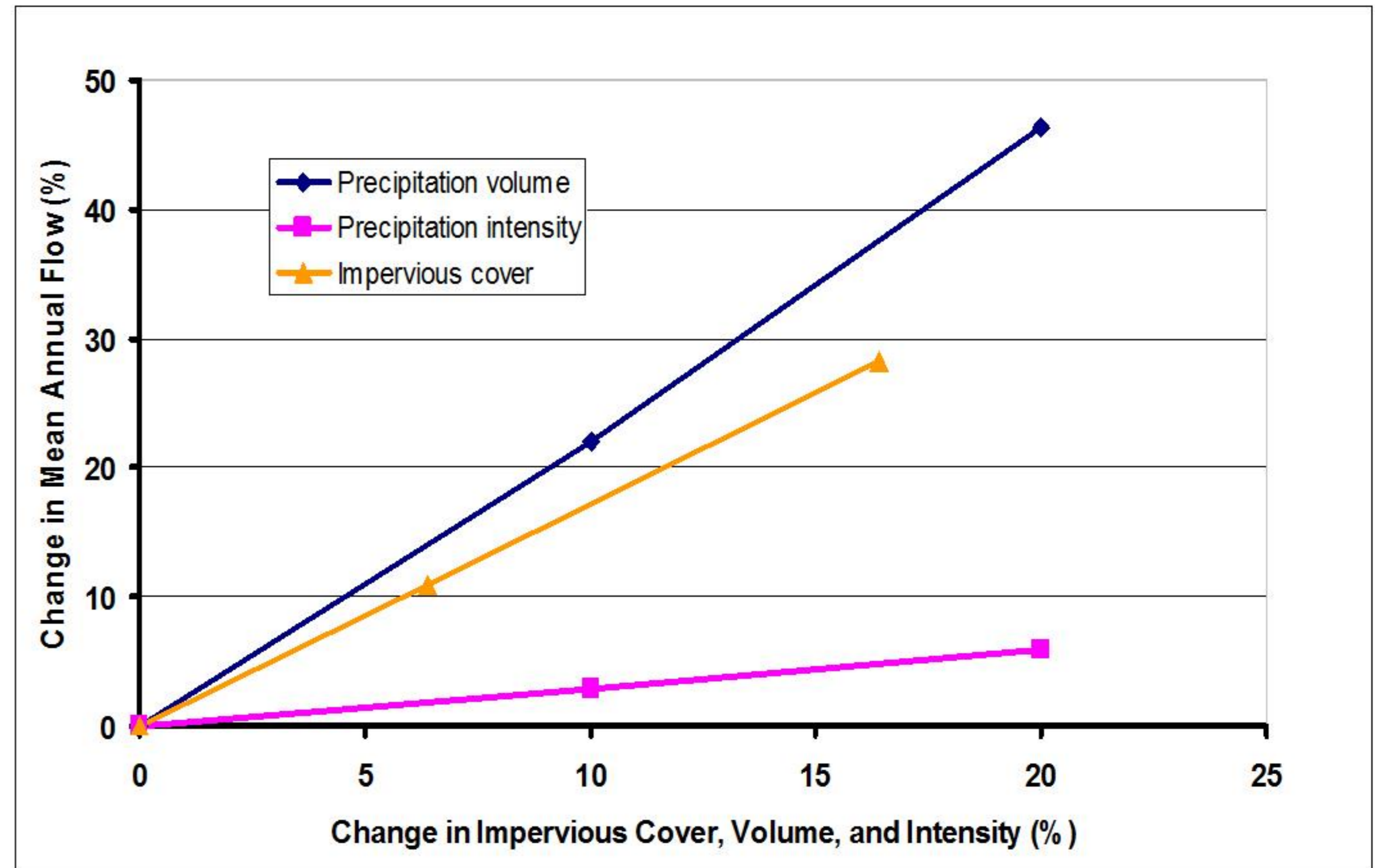
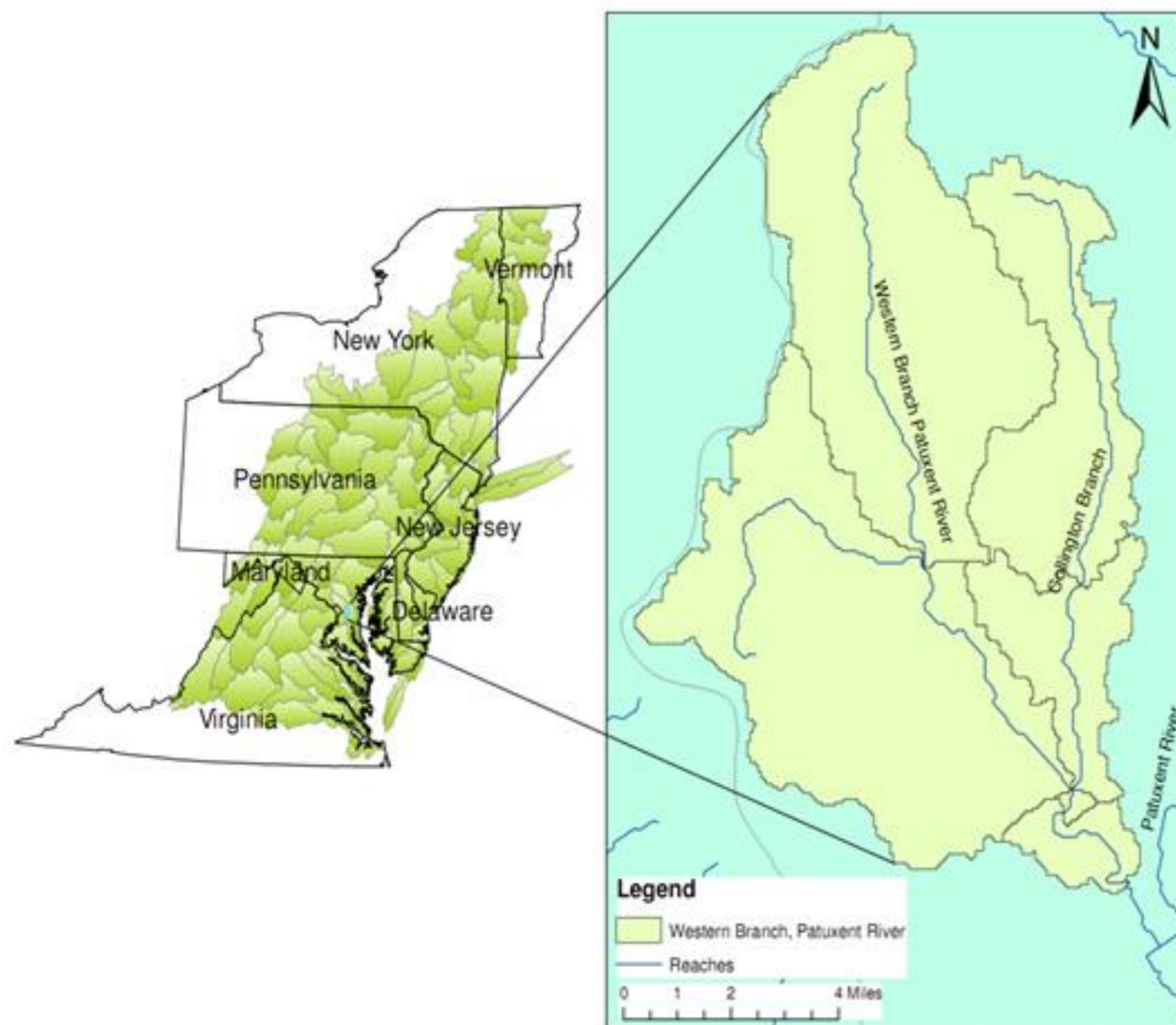
- Temp from 0 to +5°C by 1°C
- Precip from -10 to +20% by 5%

Total of 42 scenarios. Contours show simulated changes in streamflow



Example 3: Streamflow relative sensitivity to changes in precipitation and impervious cover in the W. Branch of the Patuxent River, MD, using HSPF

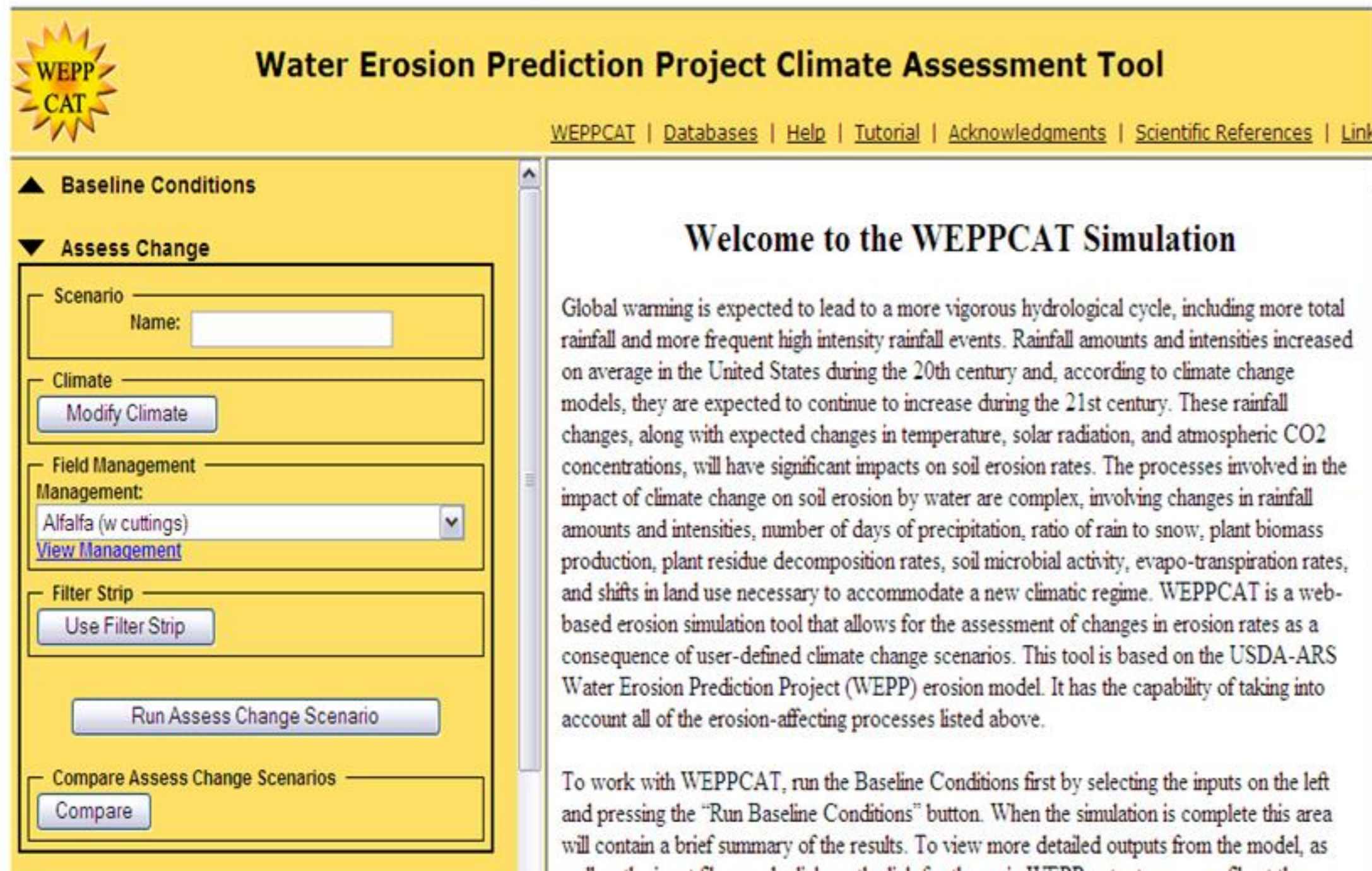
W.B. Patuxent R., MD



Climate change scenarios created by:

- increasing precipitation volume by 10 and 20%
- increasing proportion of annual precipitation occurring in large magnitude events by 10 and 20% (70th percentile and greater)
- also increased impervious cover from 8.6 (current) to 15 and 25 percent (done outside of BASINS CAT)

WEPP Climate Assessment Tool (WEPPCAT)



The screenshot shows the WEPPCAT web interface. The title bar reads "Water Erosion Prediction Project Climate Assessment Tool". Below the title bar is a navigation menu with links: WEPPCAT, Databases, Help, Tutorial, Acknowledgments, Scientific References, and Link. The main content area is divided into two columns. The left column contains a "Baseline Conditions" section with a "Scenario" dropdown menu (Name: [text box]), a "Climate" section with a "Modify Climate" button, a "Field Management" section with a "Management" dropdown menu (Alfalfa (w cuttings)) and a "View Management" link, a "Filter Strip" section with a "Use Filter Strip" button, and a "Run Assess Change Scenario" button. The right column contains a "Welcome to the WEPPCAT Simulation" section with a paragraph of text about global warming and its impact on soil erosion rates. Below this paragraph is a paragraph of text about how to work with WEPPCAT, including instructions on selecting inputs and running the simulation.

<http://typhoon.tucson.ars.ag.gov/weppcat/>

- Available online as stand-alone WEPP application for assessing sediment loss from agricultural fields
- Create and run new meteorological time series using the WEPP weather generator (Cligen)
- Support sensitivity analyses, scenario planning; addressing a wide range of “what-if” questions about system response to climate change
- Consider effects of agricultural BMPs

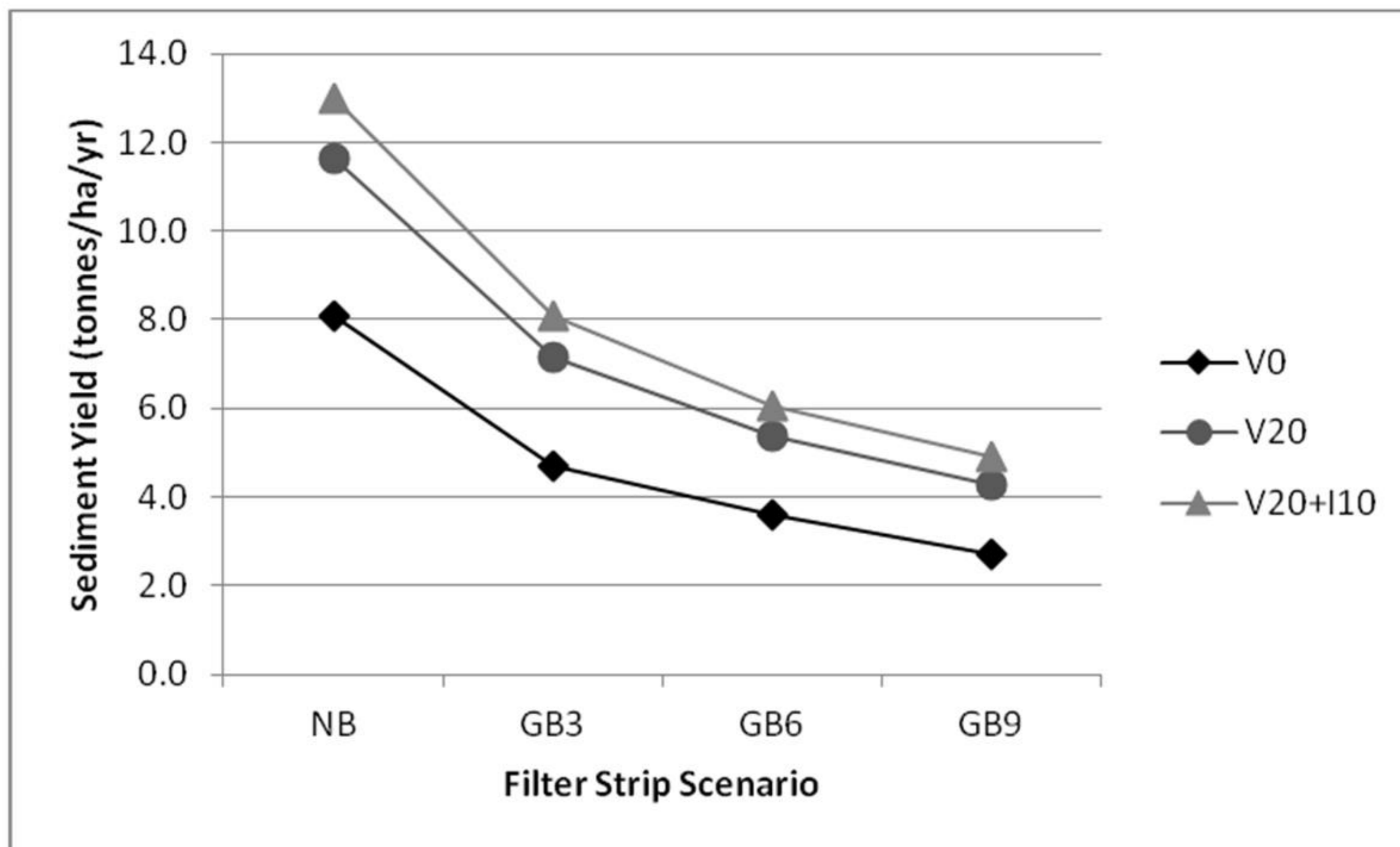
Example 1: Effectiveness of grass riparian filter strips for reducing sediment loads under a range of potential climate change in Blue Earth County, MN

Scenarios

Consider grass riparian buffer Strips 3, 6, and 9 meters wide

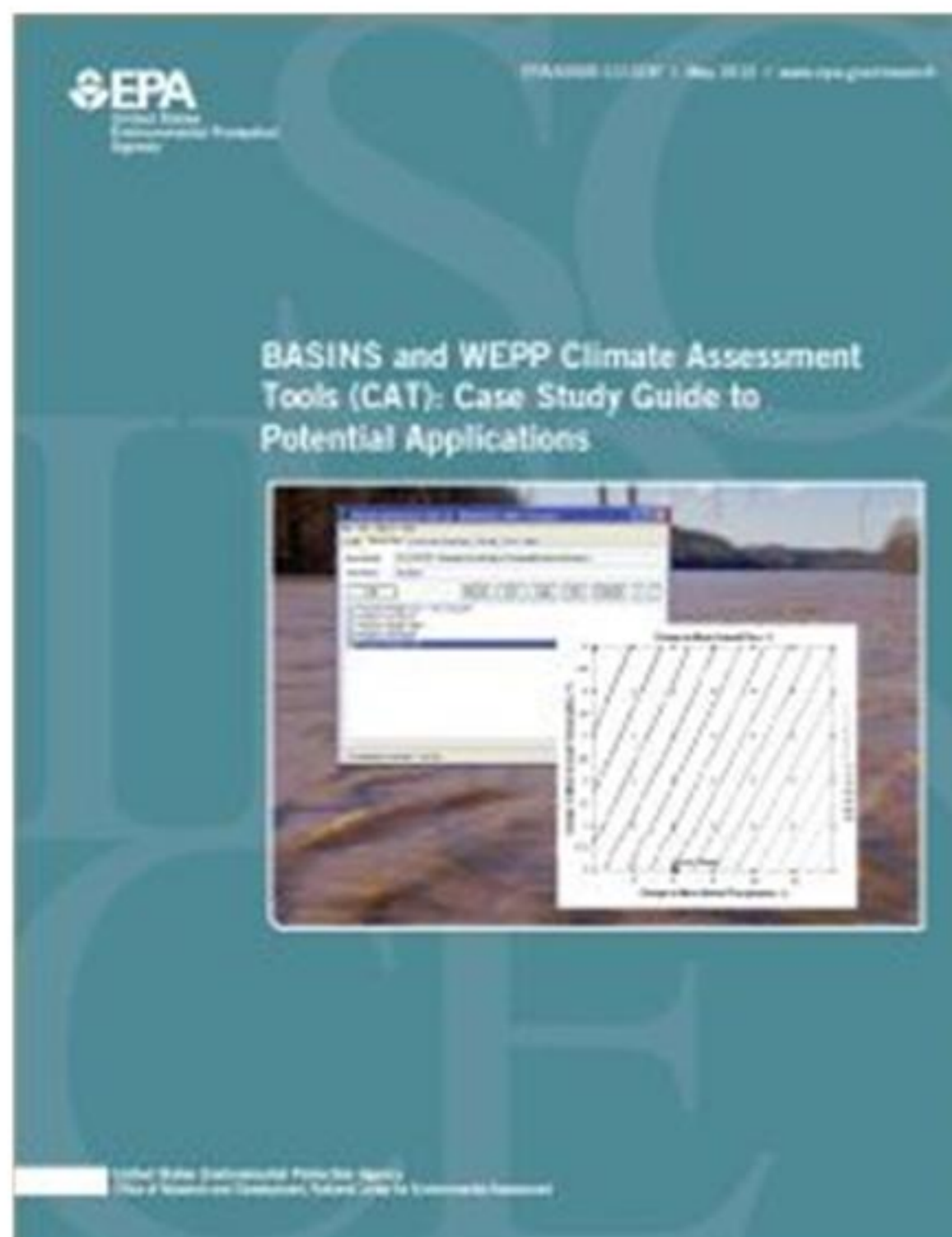
Climate change scenarios represent:

- baseline conditions (V0)
- precipitation volume increase of 20% (V20)
- precipitation volume increase of 20% and “intensity” increase of 10% (V20+I10)



Simulated sediment yield (tonnes/ha/yr) under corn fall mulch till with a 3, 6, and 9 meter grass riparian buffer under alternative climate change scenarios

BASINS/WEPP CAT report with illustrative case studies of potential applications available



“BASINS and WEPP Climate Assessment Tools: Case Study Guide to Potential Applications”

<http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=242952>

EPA's Climate Resilience and Awareness Tool (CREAT)

- Software tool for conducting **risk assessment** of potential climate change impacts at your utility
- Multiple climate scenarios provided to help **capture uncertainty** (hot/dry, mid-range, warm/wet; future periods 2035 and 2060)
- Assessments will help inform **adaptation planning**
- Results from CREAT help utilities compare potential **costs, risk reduction and energy implications** of different options



The CREAT Process

Setup



CREAT captures a variety of information about your utility, including size and ownership structure. You also specify other options used during analysis.

Threats



CREAT provides a set of descriptive narratives regarding climate change impact and potential threats associated with them. You can select the threats applicable to your utility and define custom ones.

Assets



CREAT provides a standardized list of assets. You can modify the asset inventory to reflect your specific facility.

Baseline Analysis



After establishing your initial facility setup, you can determine your current risk level associated with asset/threat combinations over the specified time periods.

Resilience Analysis



After conducting a baseline analysis, you can move forward and consider potential adaptations to your facility to lower the risk associated with specific asset/threat combinations.

Adaptation Planning



Use Adaptation Planning to review your existing and potential adaptive measures, and to develop packages of adaptive measures that you may consider for implementation over future time periods.

Results & Reports



Generate reports of the analysis results developed around your inventories of assets, threats, time periods, or various sorting of any analysis you have conducted.

CREAT – Availability and Training

- CREAT is available at EPA's Climate Ready Water Utilities' website: www.epa.gov/climateredyutilities
- Many training opportunities (webinars)
 - May 8th webinar, CREAT 101, will highlight CREAT and how it can help utilities build more resilient systems
 - May 22nd webinar will demonstrate use the Climate Ready Water Utilities' Workshop Planner and Adaptation Strategies Guide to develop adaptation plans
- To register for these webinars or view past webinars visit the Training tab at www.epa.gov/climateredyutilities.
- For additional information email CRWUhelp@epa.gov.

EPA Stormwater Calculator and CAT Tool

- ORD/OW developing a Stormwater Calculator Tool
 - based on the EPA's Stormwater Management Model and BASINS meteorological data
 - allows non-modelers to conduct screening level stormwater runoff analyses throughout US
 - can assist with the design or retrofit of LID/green infrastructure stormwater management technologies for CSO or MS4 communities
- Enhancements to the Stormwater Calculator will provide climate change assessment capabilities similar to BASINS CAT
 - analyses with user-defined climate change scenarios to address “what-if” type questions
 - analyses using pre-defined climate change scenarios (from CREAT):

EPA Stormwater Calculator Site Analysis

National Stormwater Calculator

Overview Location Soil Group Conductivity Slope Rainfall Evaporation Land Cover LID Controls Runoff Results

Site Name (Optional)
Yards Park

Search for an address or zip code:
10 Water St SE, Washington, DC

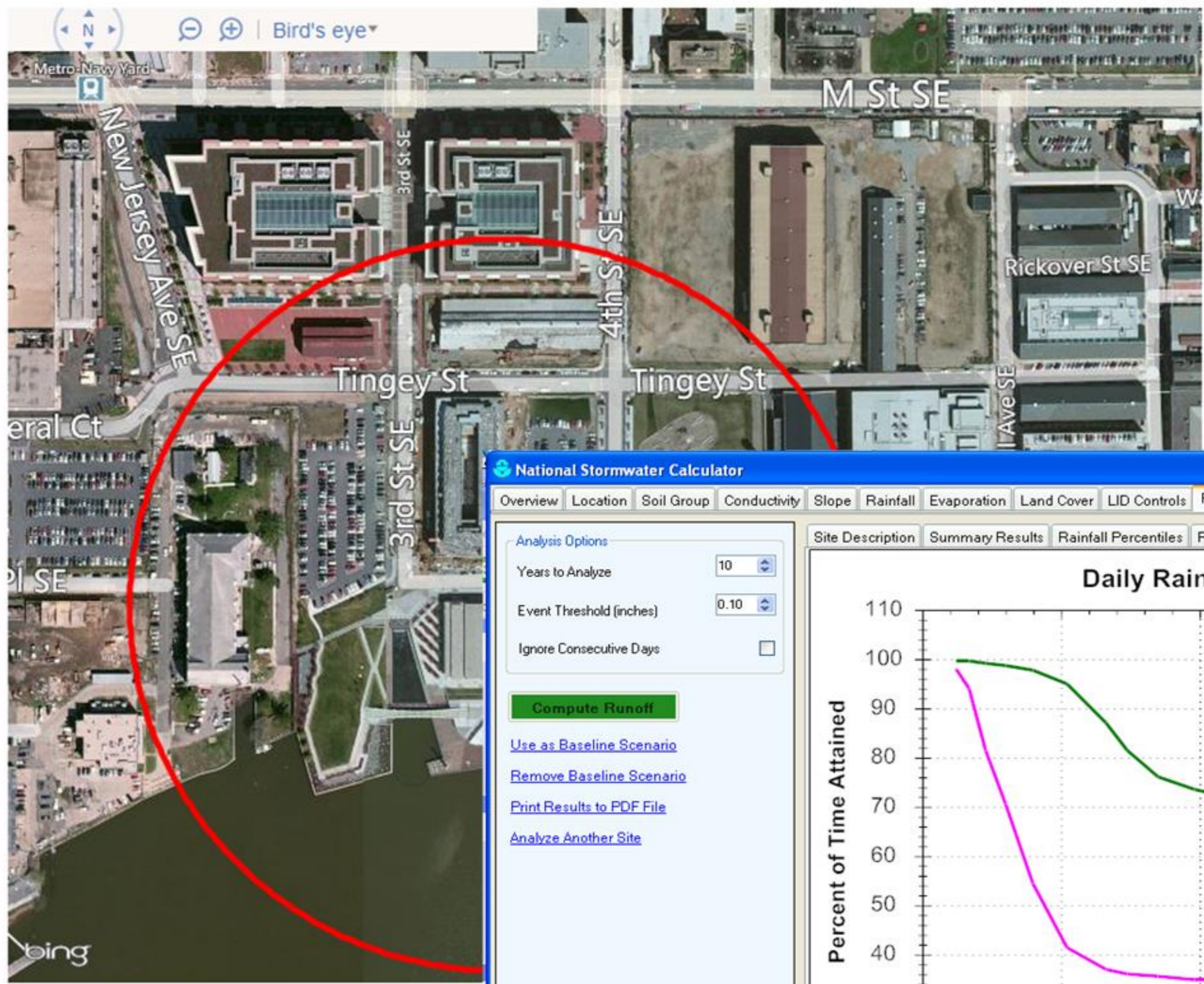
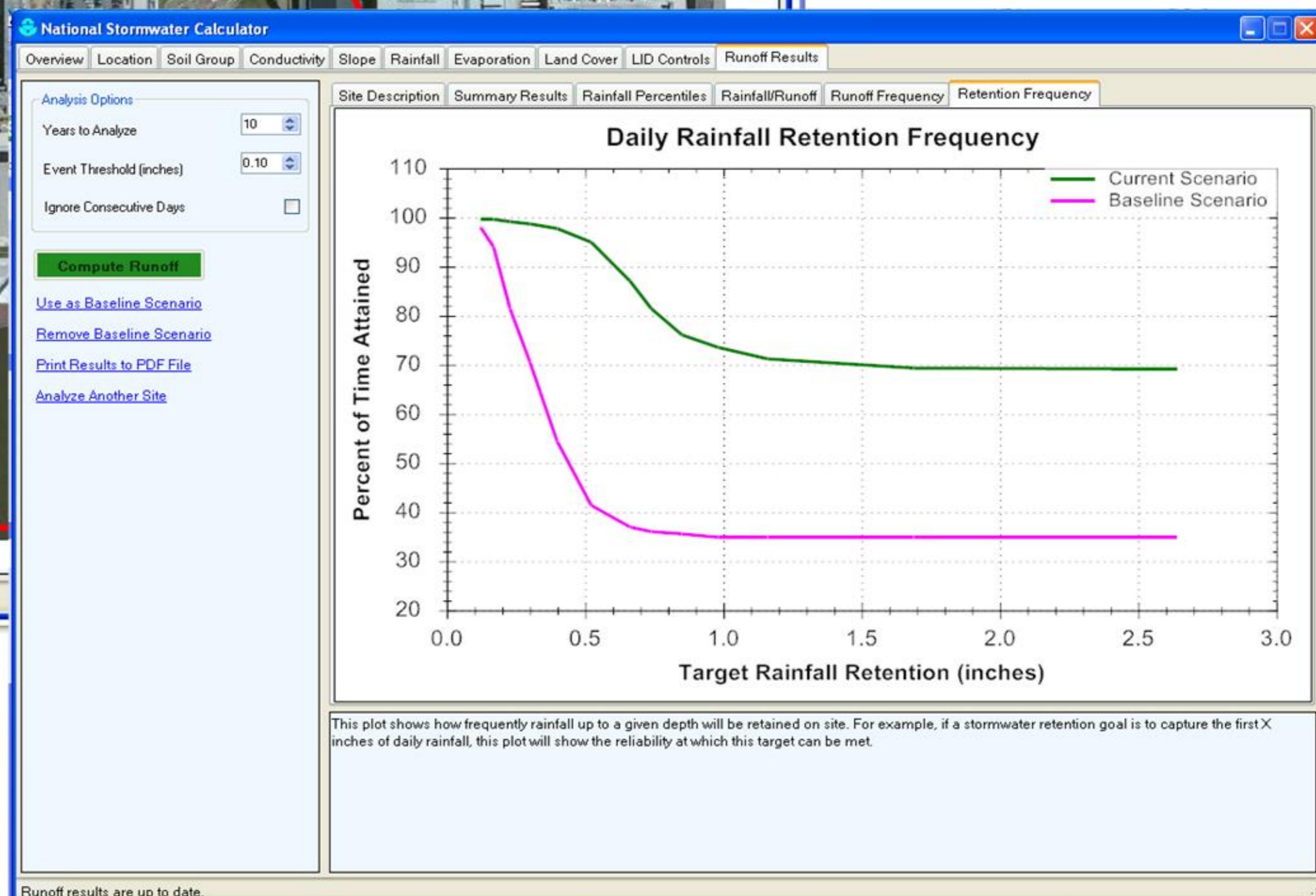
Site Location (Latitude, Longitude)
38.87365961492534, -77.001367882848

Site Area (acres - Optional)
40

[Open a previously saved site](#)

Use the navigation tools on the map to locate the site to be analyzed and then click on its location. You can also locate the site by providing its address or zip code.

Locate the site on the map.

EPA Stormwater Calculator CAT - Availability

- Release of Stormwater Calculator anticipated June, 2013.
Will be available at EPA ORD website:
<http://www.epa.gov/research/waterscience/water-models-data-tools.htm>
- Release of Stormwater Calculator CAT anticipated September, 2013 at website above
- For additional information contact Jason Berner (EPA Office of Water, Berner.jason@epa.gov, 202-564-9868) or Lewis Rossman (EPA ORD, Rossman.Lewis@epa.gov, 513-569-7603)

Closing comments

- Faced with uncertainty, models and tools like those described here can be used to learn about potential vulnerabilities, and to guide development of management strategies for reducing risk
 - e.g., identify response options that are robust across a range of plausible future climatic conditions; minimize regret rather than optimize for a most likely future

Thanks!

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