Development and Use of Climate, Land-Use, and Hydrology Scenarios in EPA/NCEA's Global Change Research Program

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Abstract: EPA's Global Change Research Program is devoting a major effort to the development of national-scale, spatially explicit scenarios of future climate, land use, and hydrologic change in the United States. This work is designed to support assessments of climate change vulnerabilities that start with a focus on existing natural resource management goals. The goals of this effort are: (i) to allow us to make a national-scale assessment of the potential range of sensitivity of hydrologic and water quality endpoints to climate and land-use change; (ii) to provide a large-scale context for more detailed analyses in selected places; (iii) to help guide prioritization of work to the most vulnerable regions and systems; (iv) to help us synthesize place-based results to draw national-level conclusions; (v) to place a meaningful lower bound on model and methodological uncertainty our assessments. These scenarios are already being applied in a number of research and assessment projects.

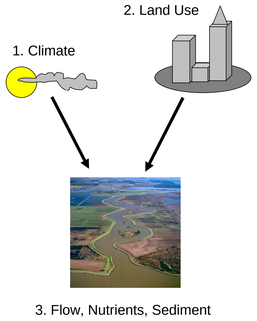
Key Issue: We need to manage uncertainty about future global change under a risk assessment paradigm, where we focus on key vulnerabilities, rather than under a "predict-then-act," paradigm, where we attempt to prepare for a single, most likely future.

To do so, we have developed a vulnerability-based framework, based on the following elements:

1. Understand the decision context of established management goals/endpoints and supporting sets of decisions to maintain these into future
2. Develop conceptual model of system – bottom up from endpoints back up to global change drivers
3. Develop range of plausible future scenarios
4. Assess vulnerability across this range (esp. thresholds)
5. Assess tradeoffs between or unintended consequences of different policy options
6. Identify robust solutions to build readiness

There is a critical, dual role in this framework for earth system models: (a) they help us improve our understanding of key system behaviors and interactions; (b) they allow us to create scenarios over a wide range of plausible futures

Since we need to use multiple scenarios to systematically explore the implications of a wide range of futures and assumptions and reveal where the greatest vulnerabilities may lie, we are developing scenario datasets as "foundational" elements of our 5-year assessment of the potential vulnerability of U.S. water quality, aquatic ecosystems, and urban communities to global change.



We also hope these datasets and approaches will be useful to other ORD programs (e.g., ESRP), Program Offices, Regions, and other institutions!

Office of Research and Development
National Center for Environmental Assessment, Global Change Research Program

1. Climate Change Scenarios

We are acquiring dynamically downscaled future climate change scenarios via a partnership with the North American Regional Climate Change Assessment Program (NARCCAP)
http://www.narccap.ucar.edu/

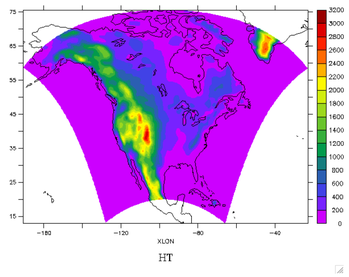
Key Facts:

6 international modeling teams participating

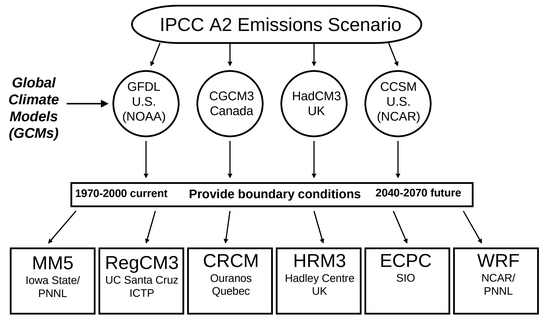
Future: 2040-2070
Historical: 1970-2000

Spatial grid: 50-km
Time freq: 3-hourly

Change in average amount, seasonality, intensity, extremes for T, P, winds, clouds, etc.

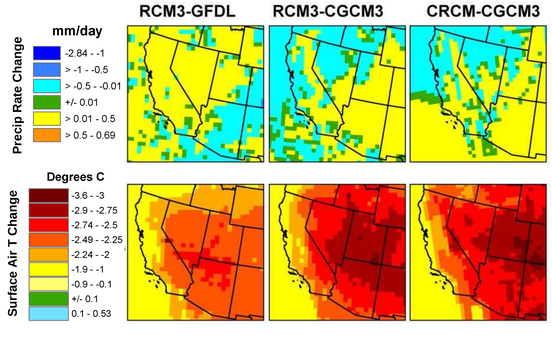


NARCCAP Simulation Strategy



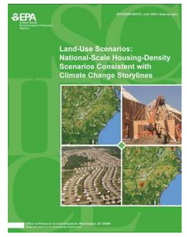
High-Resolution Regional Climate Models (RCMs) Over North America

Example: Climate Change in the U.S. Southwest 1970-2000 minus 2040-2070

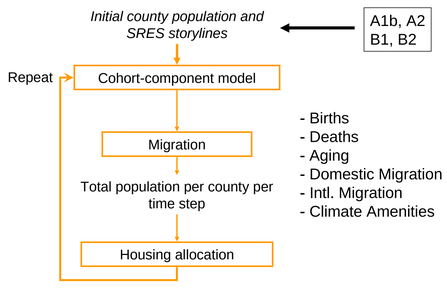


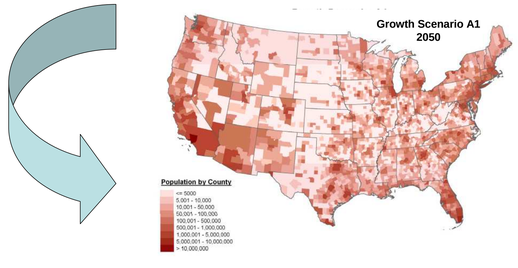
2. Land-Use Change Scenarios

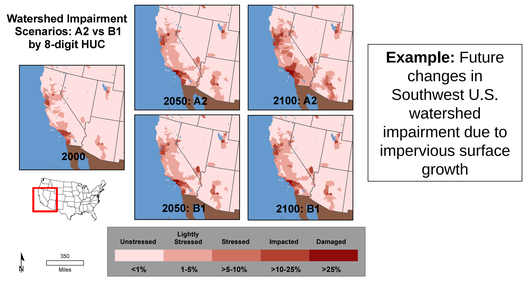
Goals:
- Create seamless scenarios of population, housing density, and impervious surface for the conterminous U.S. consistent with IPCC storylines
- Provide consistent benchmarks for local and regional land use studies
- Identify geographic areas where climate/land use interactions may exacerbate impacts or create adaptation opportunities
- Tool for custom use



Integrated Modeling Structure

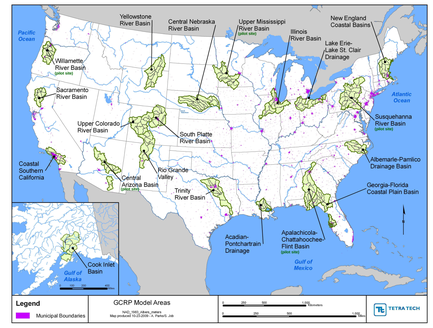






Example: Future changes in Southwest U.S. watershed impairment due to impervious surface growth

3. Hydrologic Change Scenarios



Watershed modeling in 20 U.S. watershed regions (~ 10 HUC8 each)
Focus on nutrients, sediment, streamflow
Daily data for 30-year historical and 30-year future periods

Phase I (5 watersheds for which team has most modeling experience):
- 2 models, HSPF and SWAT
- 6 NARCCAP climate change scenarios
- 2 ICLUS land-use change scenarios
- Sensitivity tests: downscaling, precipitation, and ET methodologies

Phase II (remaining 15 watersheds):
- HSPF only
- 6 NARCCAP climate change scenarios
- 2 ICLUS land-use change scenarios

Example: Simulated flow, nutrients, and sediments under multiple climate and land-use change futures for Southwest U.S.

Expected completion: Oct 2010