# A Framework for Incorporating Climate Information into Impacts Management

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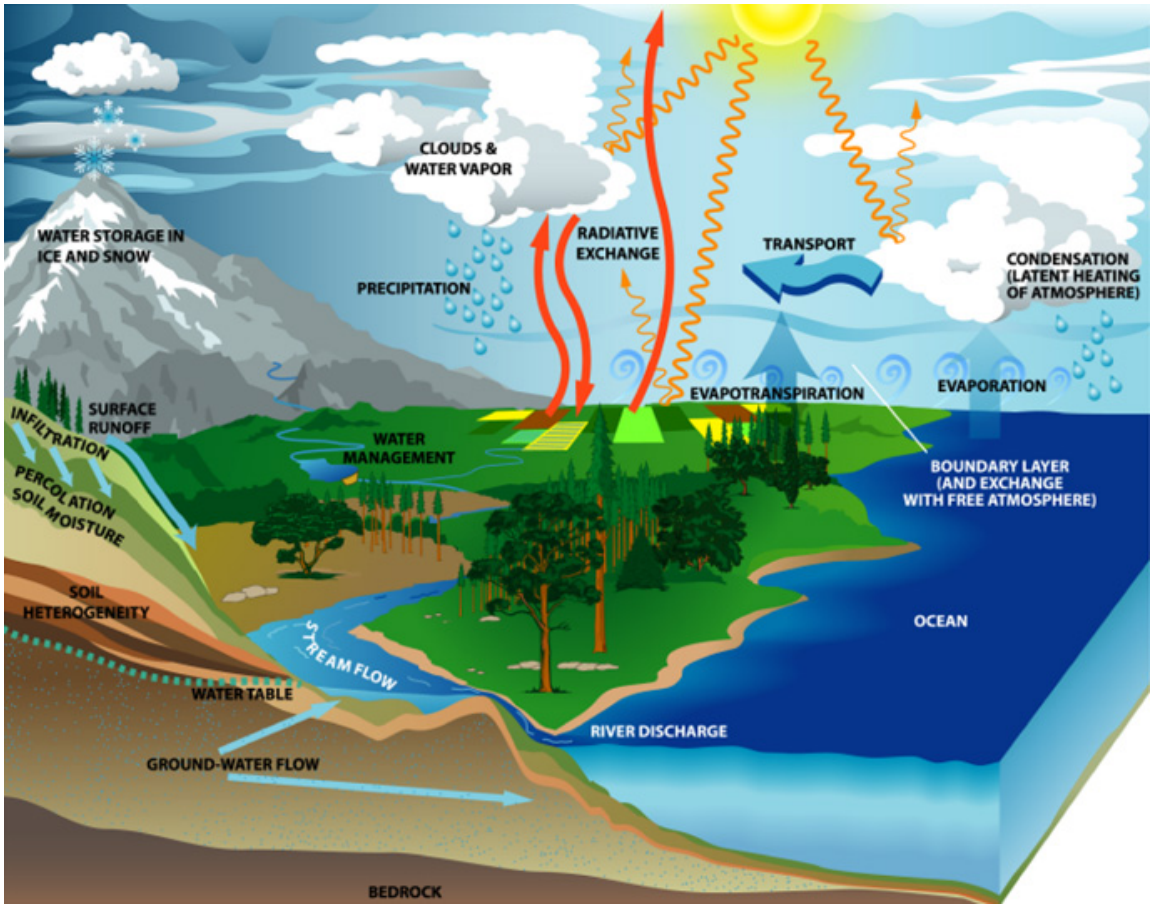
# Frame

- Watershed managers have an established process for doing their work.
- But climate change is emerging as a potentially confounding factor.
- There's a daunting amount of information out there about climate change. What to do with it?
- We can't predict the future with perfect accuracy, but that doesn't stop us, in general, from using information about the future to help make decisions.
- A systematic strategy for folding new information into existing processes can help open great opportunities for progress.

# Climate and water resources




*"How do I bridge the scale and process gaps between what the climate models can provide and my needs in a given watershed?"*

# Blueprint

- Bridging the gap between specific management endpoints (at specific scales) and the capabilities of climate science.

- Based on a healthy, iterative dialogue between scientists and stakeholders - a two-way flow of information about stakeholder needs and scientific capabilities.

- Steps:
  1. Establish decision context.
  2. Develop conceptual model.
  3. **Assess available data on climate drivers for building scenarios.**
  4. **Downscale climate drivers scenarios to local/regional scale.**
  5. **Assess available tools to capture process pathways between drivers and endpoints.**
  6. **Assess sensitivity of endpoints to the derived changes in climate drivers.**
  7. Loop back to previous steps.

# Step 1

## Establish decision context

Remember the dialogue! The decision context determines things like:

- The endpoints on which to focus
- The time horizon
- The acceptable levels of uncertainty in the endpoints required for effective decision support
- Is the decision to be based on forecasts of predicted impacts to arrive at an “optimal” solution for the most likely future? A “robust” solution over a wide range of futures?

# Step 2

## Develop conceptual model

What does the system look like?

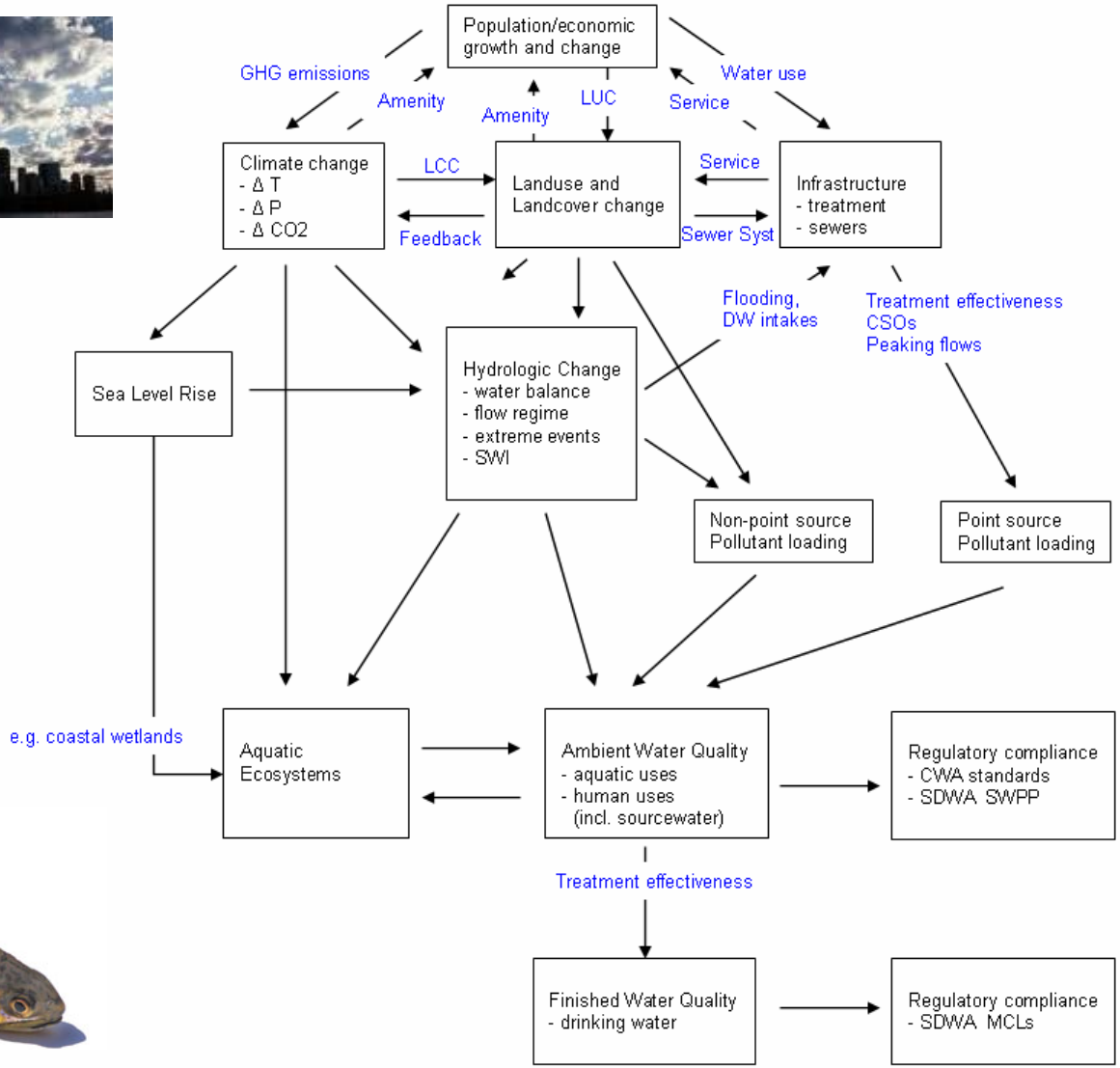
- the climate drivers
- other drivers
- the process pathways that link drivers and endpoints
- the relevant spatial and temporal scales

At what level is our current scientific understanding of the system?

Prioritize the major/minor sources of uncertainty likely to be associated with projections of the drivers at the relevant scales.

Do the current tools for making decisions about endpoints have "hooks" for weather and climate data?

# Conceptual Model Linking Stressors and Endpoints



# Reflections

Complex, 3-D, climate models are clearly valuable scientific tools:

- They allow us to explore nonlinearities, feedbacks, threshold effects when we link together lots of sub-systems.
- They encapsulate our current level of scientific understanding - they provide a useful snapshot of the state of the science.

But … we don't yet know how to use them effectively in impacts work. They are NOT by themselves decision support tools.

We need to spend as much time learning how to do this as we spend on model development.

Overselling of model usefulness – "loading dock."

# Step 3

## Assess available data on climate drivers for building scenarios

- The conceptual model tells us which are the climate drivers that are mostly likely to affect the endpoints.
- It also tells us the resolution at which we need these variables.
- What are the available sources of information from which to create future scenarios of drivers for the endpoints of interest?
  - Ranges from palaeoclimate data
  - Extrapolations of current trends
  - Future projections from sophisticated climate models
- Different analyses have needs for different levels of scenarios.
  - Example: CSOs vs. air quality

# Step 4

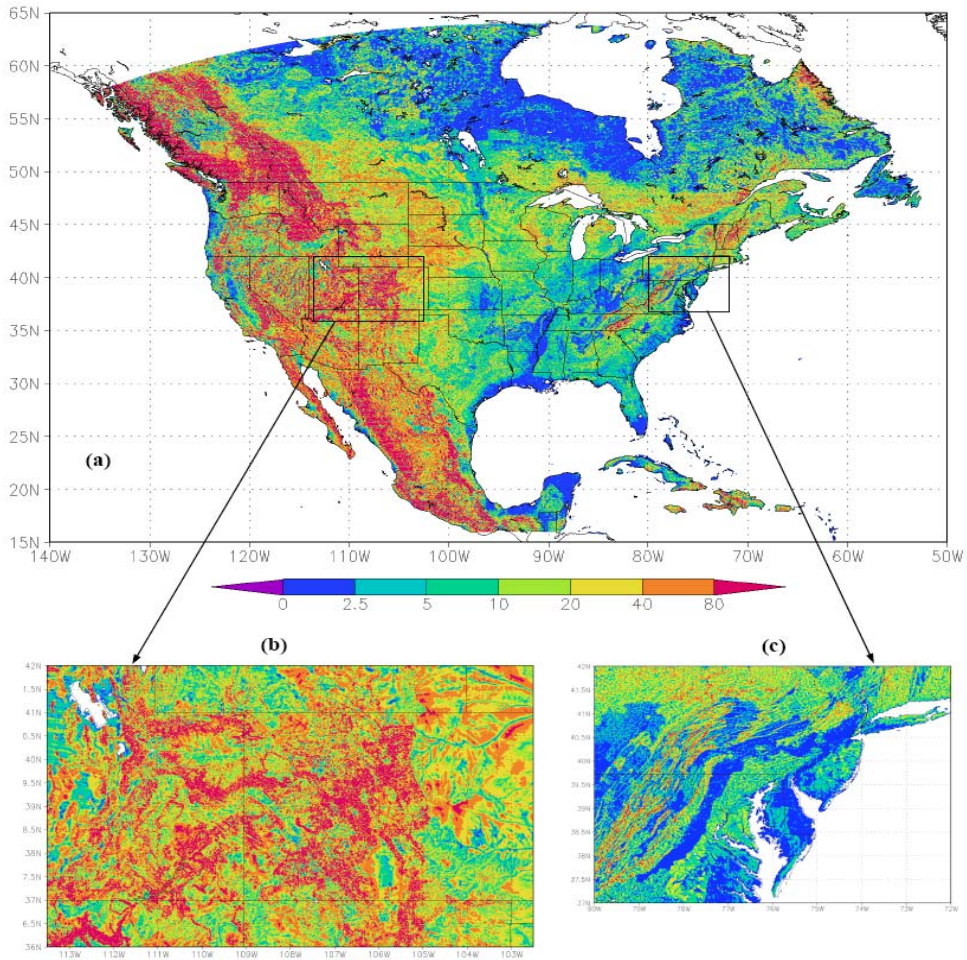
## Downscaling

*Are the climate variables to which the endpoints are sensitive available at the required spatial/temporal scales?*

*Dynamical, statistical …*

*Create new tools and methods.*

*Blend climate model output with other pieces of knowledge.*



# Step 5

## Assess available tools to capture process pathways

- Determine what process models and analysis techniques are available for investigating changes in the endpoints.
- If necessary, refine existing tools or build new ones to properly capture the links between the climate drivers and the endpoints.
  - Example: HSPF in BASINS
- The goal is to reproduce the conceptual model - the best we can do is an imperfect approximation, but that captures the key pathways.

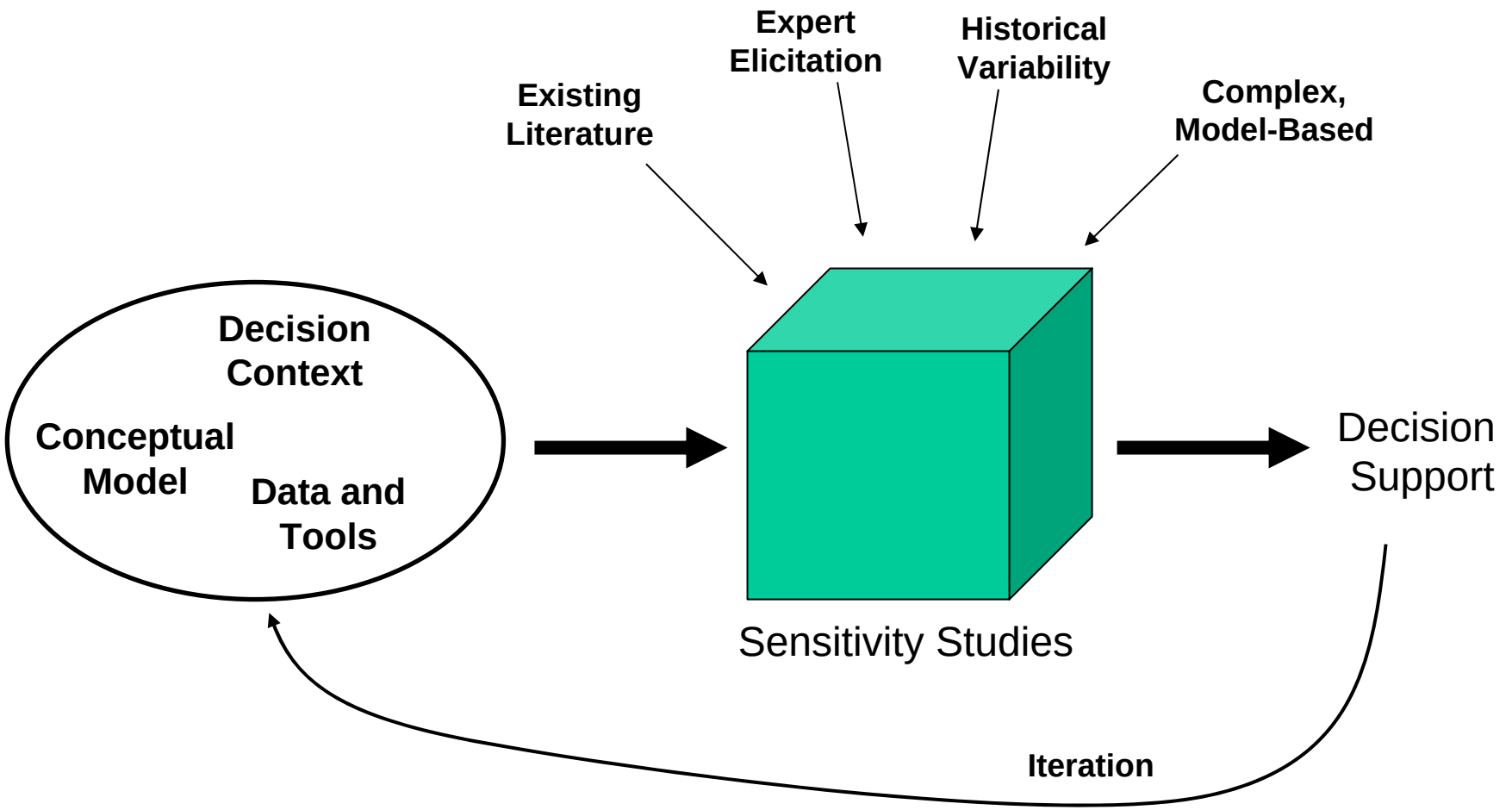
# Step 6

## Conduct sensitivity studies

- Assess endpoint sensitivity to the full range of plausible change, while identifying the key climate variables driving response.
- Establish the range of plausible impacts (high/low).
- These sensitivity analyses help winnow down the large amount of potentially relevant data to only what is needed to address the important stakeholder questions:
  - "Is the endpoint most sensitive to the total amount or the intensity of precipitation events?"
  - "Are there asymmetries in the system (e.g., large responses to decreases in rainfall but only small responses to increases)?"

# Step 6

## Conduct sensitivity studies



# Step 7

## Loop back …

- Is the information generated sufficient to support decisions?
- Does the conceptual model need to be refined?
- Are there new climate data needs?
- Does the decision context require the development of scenarios with greater likelihoods?
- Are there additional interesting questions to explore?

# Take-Home Messages

- ✓ The process is the product
- ✓ A healthy process creates opportunities
- ✓ Technical partnerships help bridge gaps between communities
- ✓ Putting the blueprint into practice …