The role of monitoring data in model development

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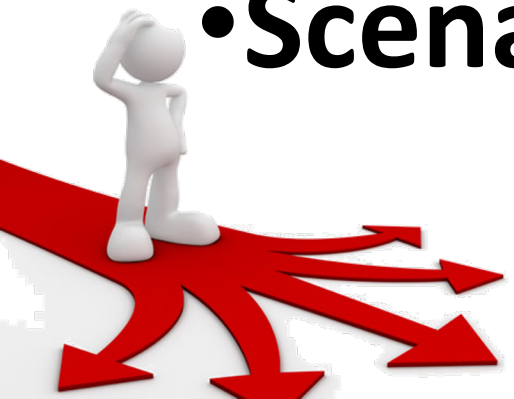
STAC Workshop on Local Monitoring

3/7/23

Types of Models

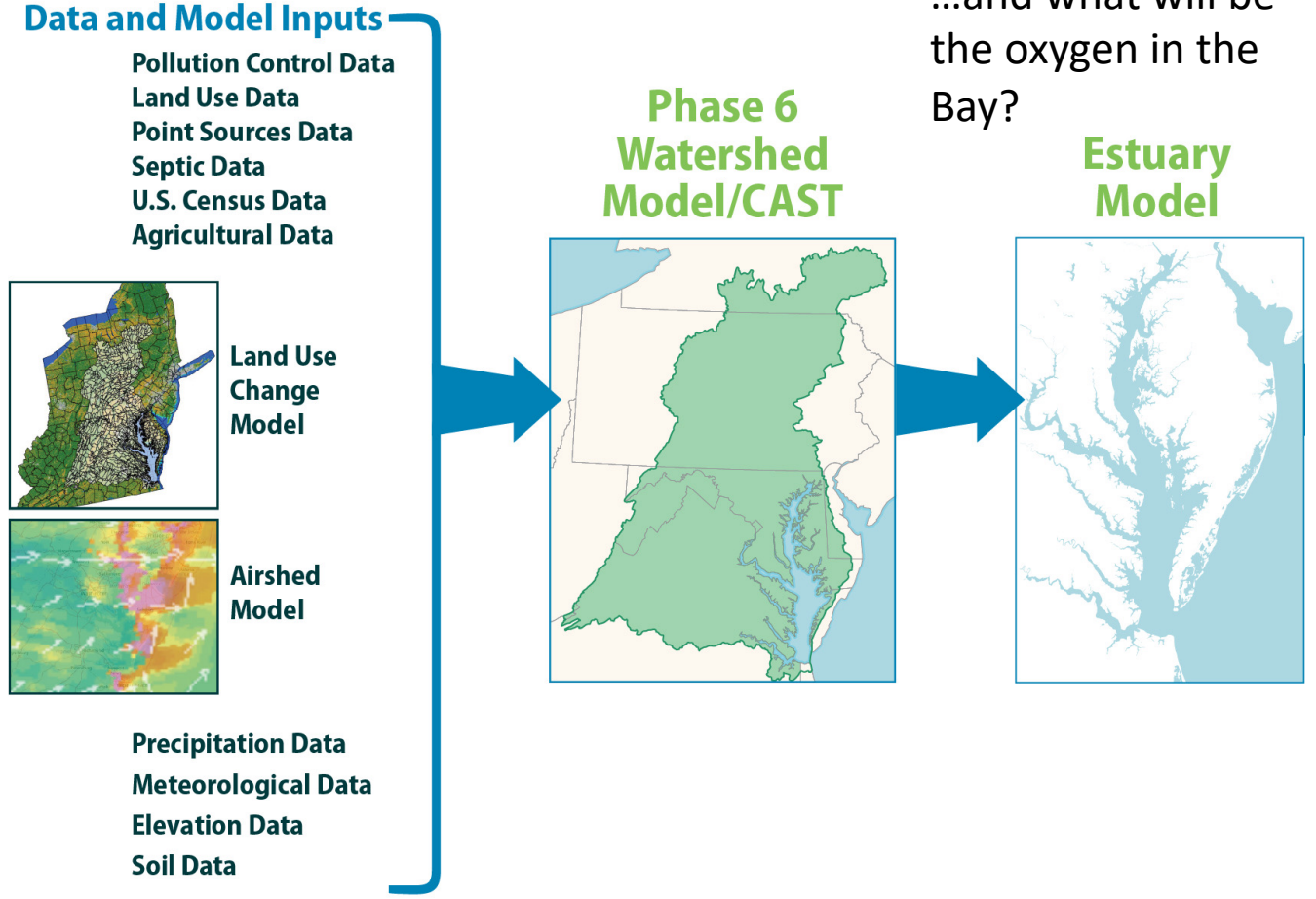
- Prediction
  - Temporal
  - Spatial
- Research
- **Scenarios** ✓



If we change what we do on the landscape…

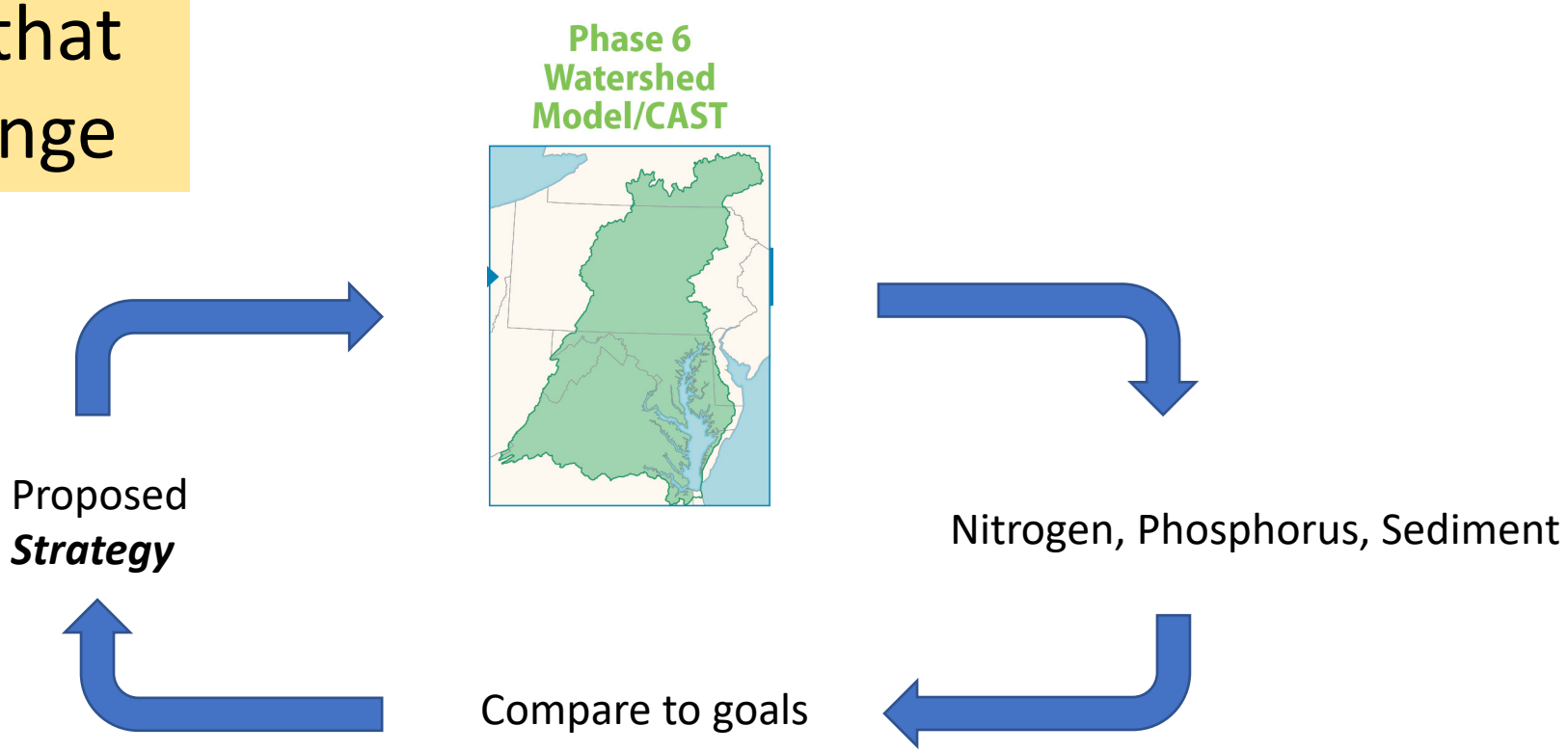
…how will that change nitrogen, phosphorus, and sediment?

…and what will be the oxygen in the Bay?



General Use Case of CAST

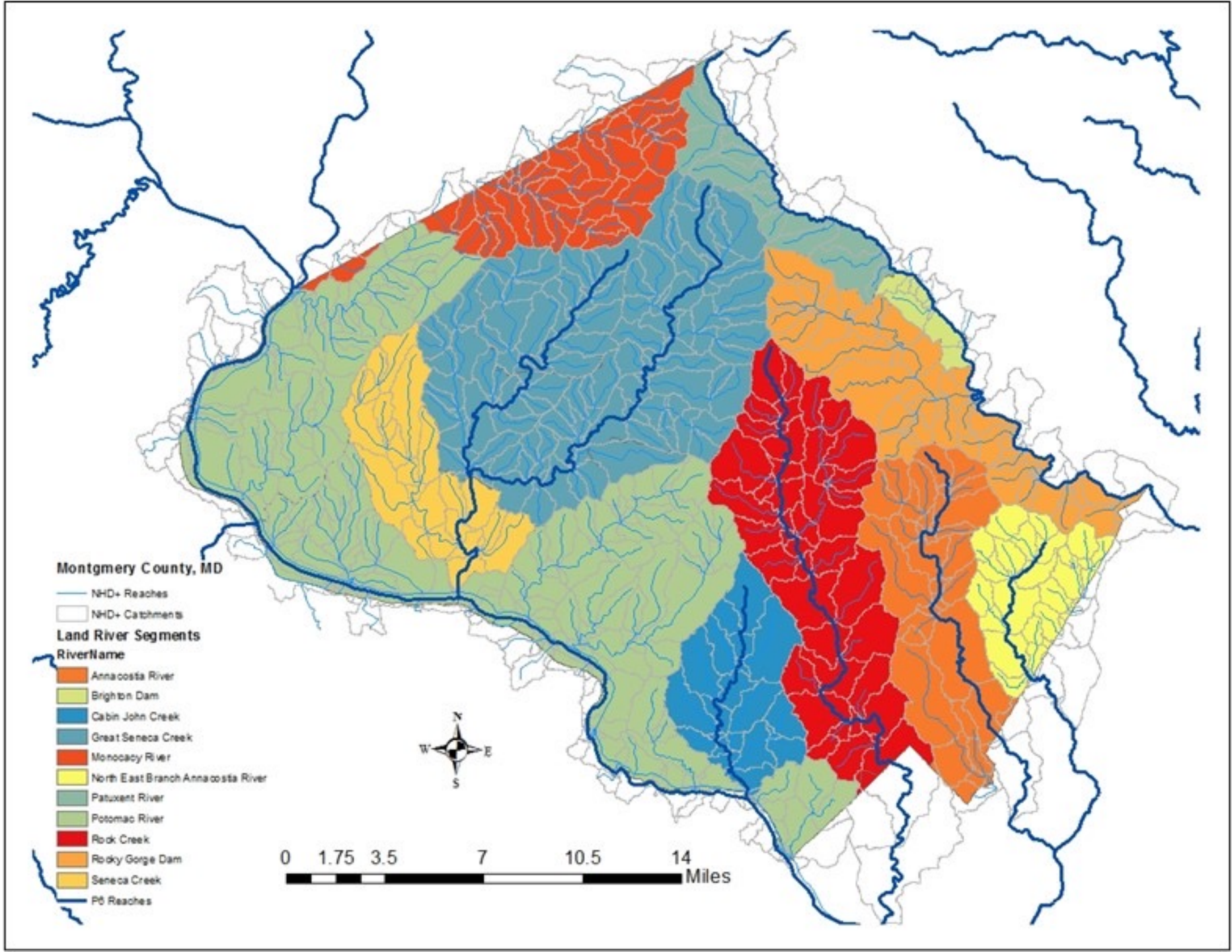
Organization that can make change



CAST Scale

- Land segment
- Land-river segment
- NHD catchment

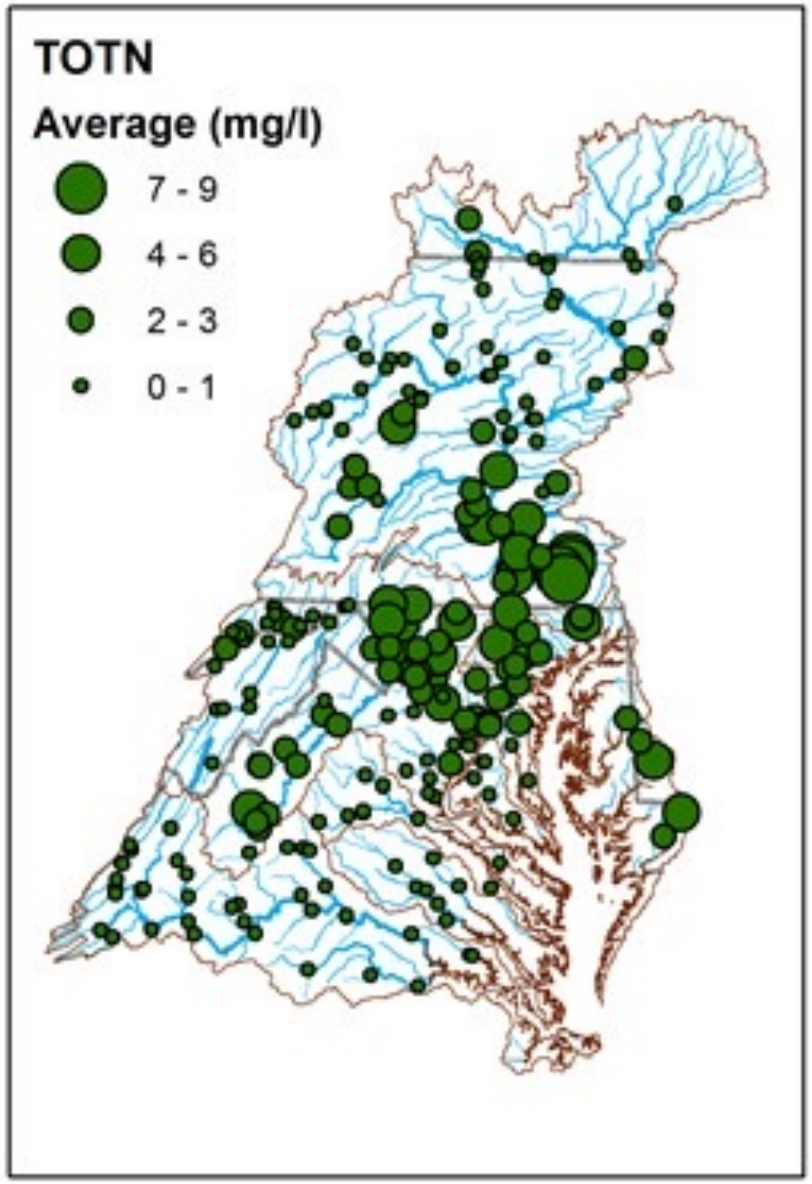
- Some development at NHD scale
- Final management model undetermined scale

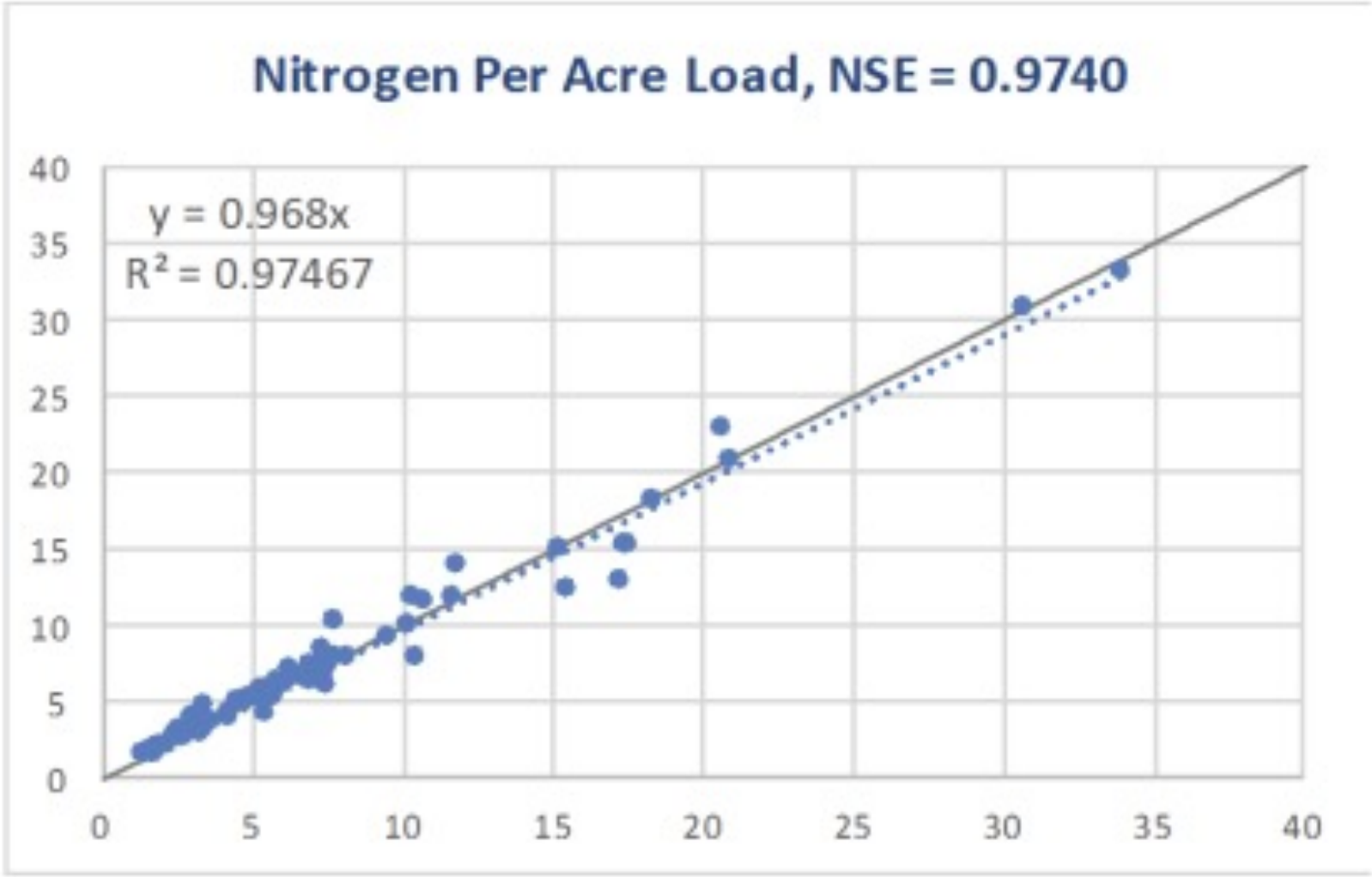


Three uses of monitoring data in the CBP watershed model

- Calibration
- Comparison with trends
- Knowledge generation

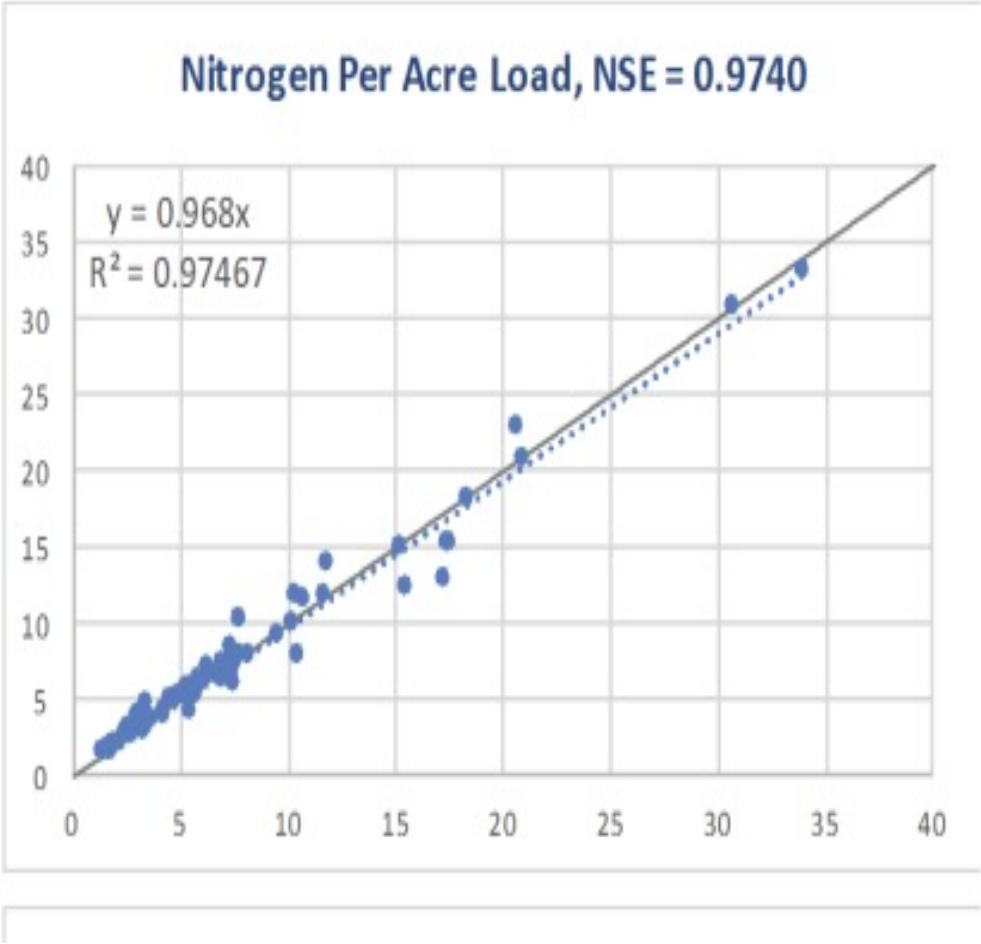
Calibration –



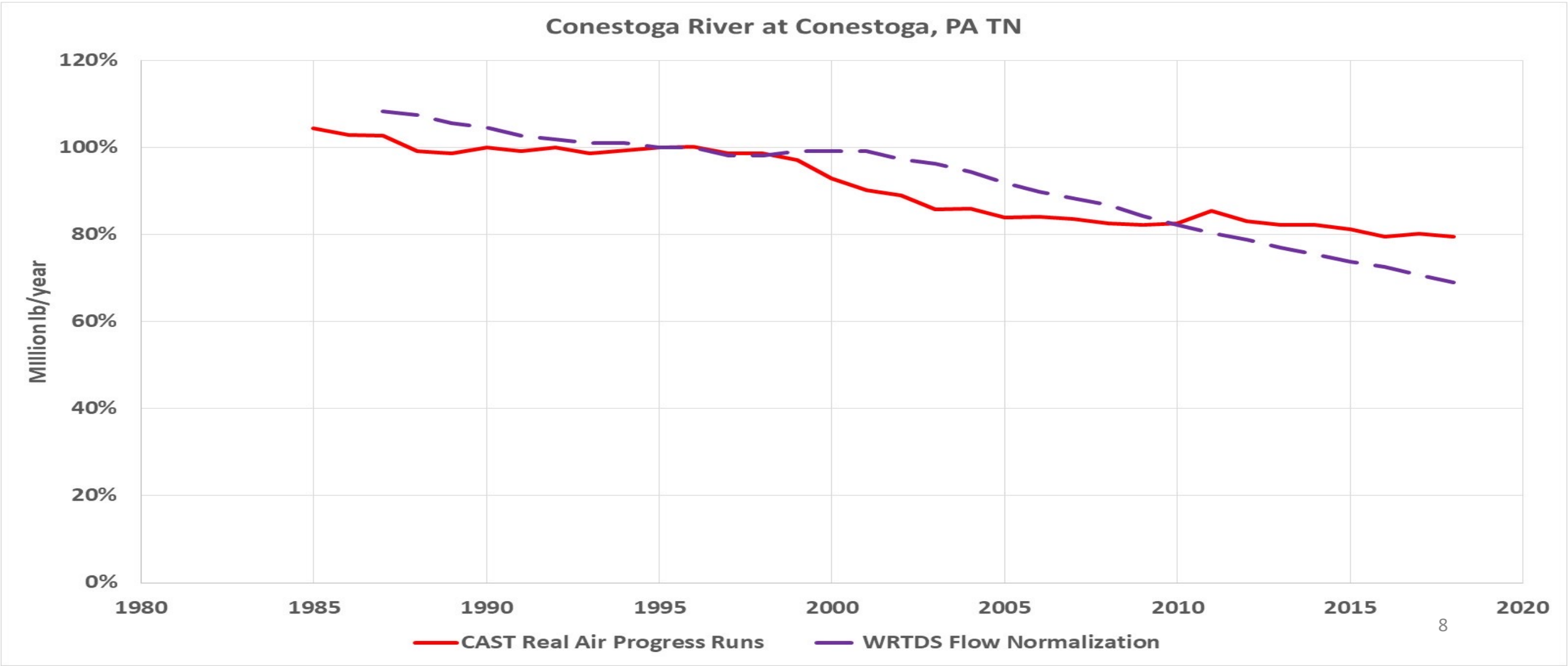


Calibration –

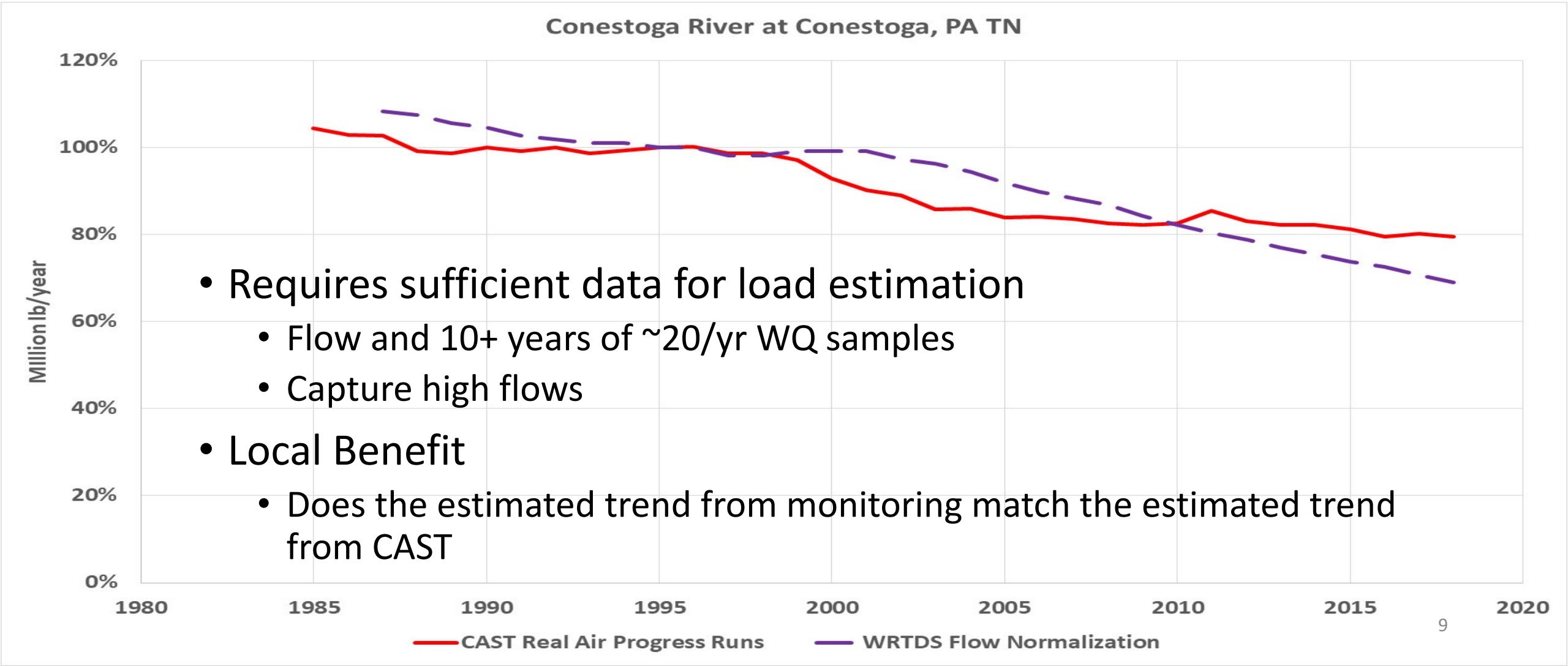
- Requires sufficient data for load estimation
  - Flow and 5+ years of ~20/yr WQ samples
  - Capture high flows
- Not necessarily a local benefit
  - Improves the overall model
  - Improves similar areas the most



Comparison with trends



Comparison with trends



- Requires sufficient data for load estimation
  - Flow and 10+ years of ~20/yr WQ samples
  - Capture high flows
- Local Benefit
  - Does the estimated trend from monitoring match the estimated trend from CAST

Chesapeake Bay TMDL Indicator

https://zhangqian0324.shinyapps.io/CBNTN_TMDL_Indicator/

Chesapeake Bay TMDL Indicator (Non-Tidal Network Stations)

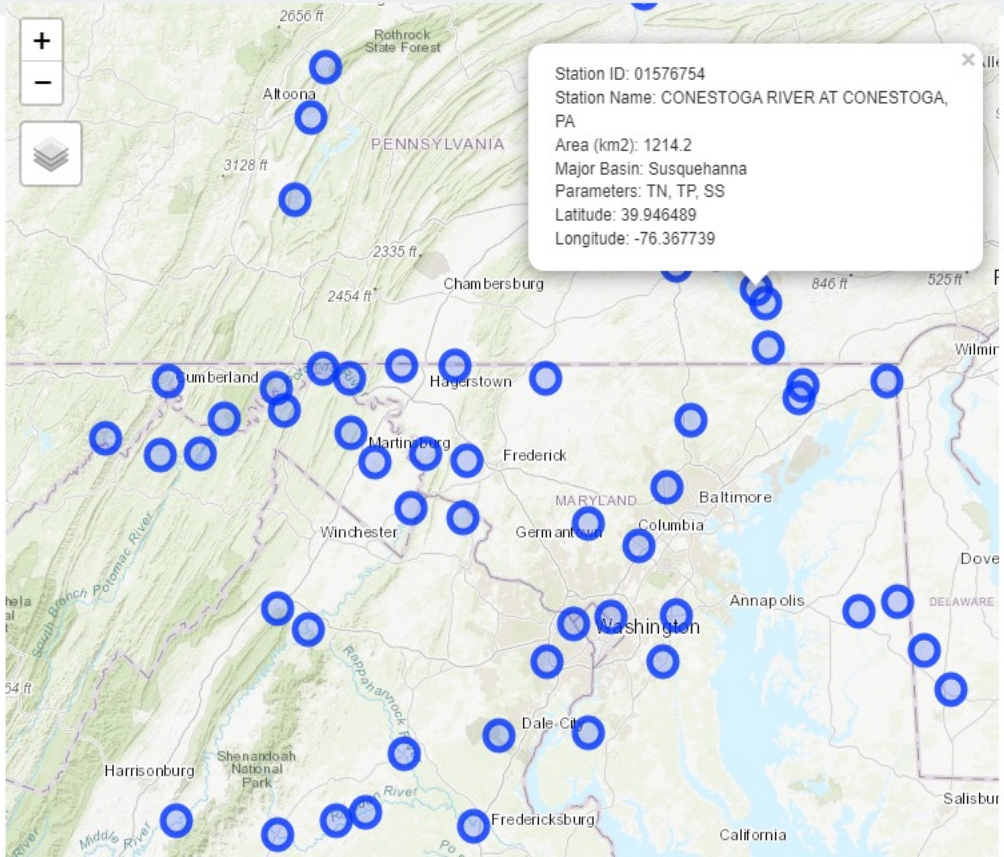
This R Shiny APP is designed for visualizing the monitored load trend and CAST-estimated load trend for the Non-Tidal Network (NTN) stations in the Chesapeake Bay watershed.
Last updated: 2023-03-03 by Qian Zhang (qzhang@chesapeakebay.net).

Step 1: Select the water-quality parameter:

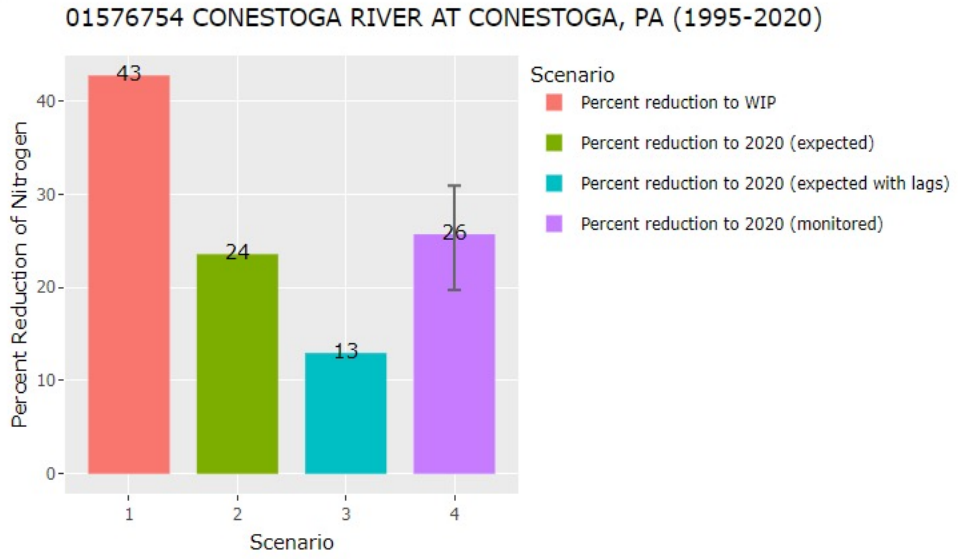
Nitrogen

Step 2: Select the monitoring station by clicking either Map or Table:

Map | Table



Timeseries | Barplot 1 | Barplot 2 | Table | Download | About



https://zhangqian0324.shinyapps.io/CBNTN_TMDL_Indicator/

Three uses of monitoring data in the CBP watershed model

- Calibration
- Comparison with trends
- **Knowledge generation**

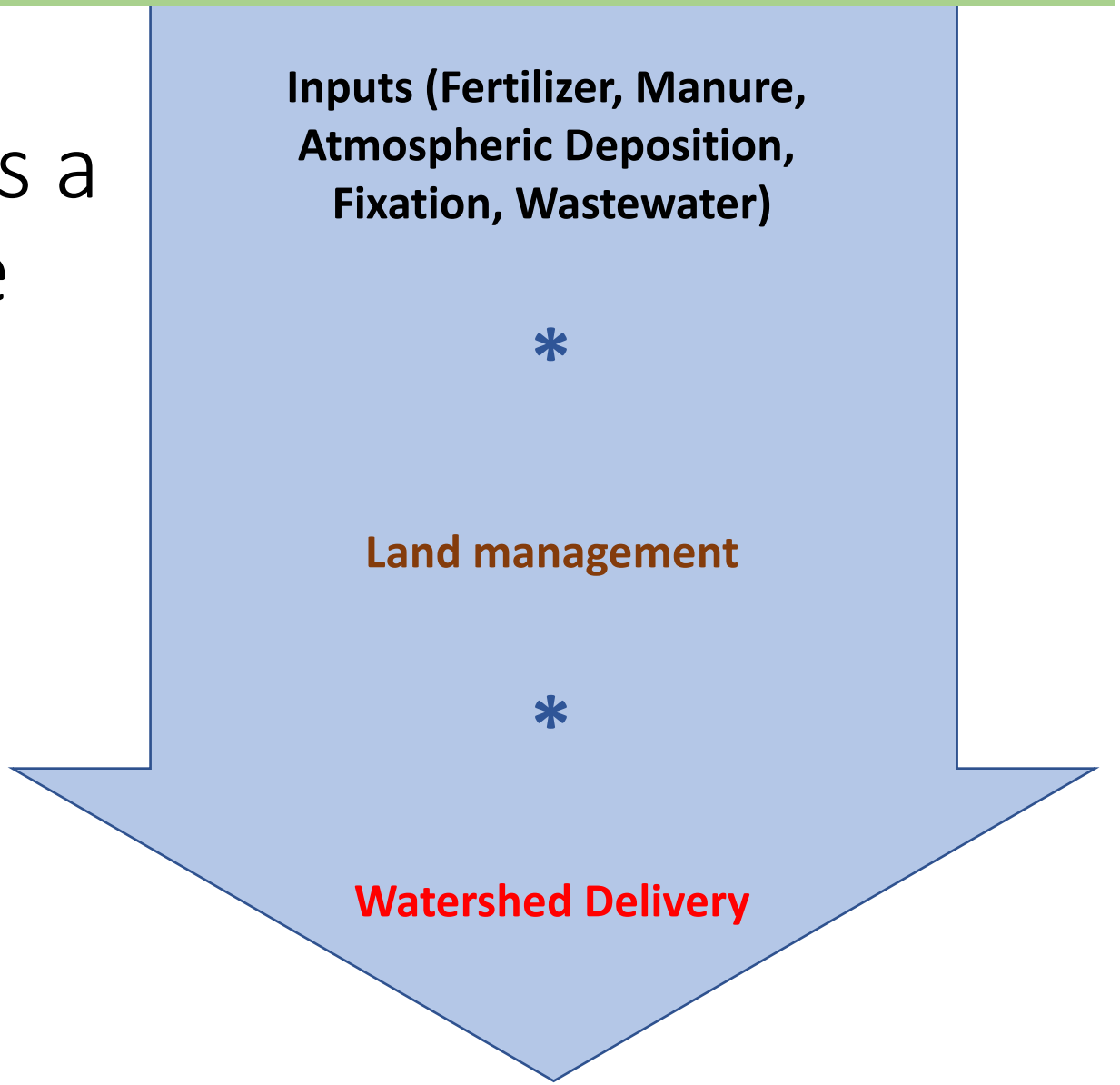
Research Model ⇔ Management Model

- Statistical Research Model
  - What can you learn from observations
- Process Research Model
  - What can you learn from aggregating processes

- Management model
  - Given everything that you've learned, what are the likely effects of potential anthropogenic changes.

CAST Structure

CAST is a simple model



Load by land-river segment and land use

CAST is a simple model

CAST Structure

Inputs (Fertilizer, Manure, Atmospheric Deposition, Fixation, Wastewater)

*

Land management

*

Watershed Delivery

Load by land-river segment and land use

CAST Structure

Average Load

+

△ Inputs * Sensitivity

*

BMPs

*

Acres

*

Land to Water

*

River Delivery

Load by land-river segment and land use

CAST

Average Load

+

△ Inputs * Sensitivity

*****

BMPs

*****

Acres

*****

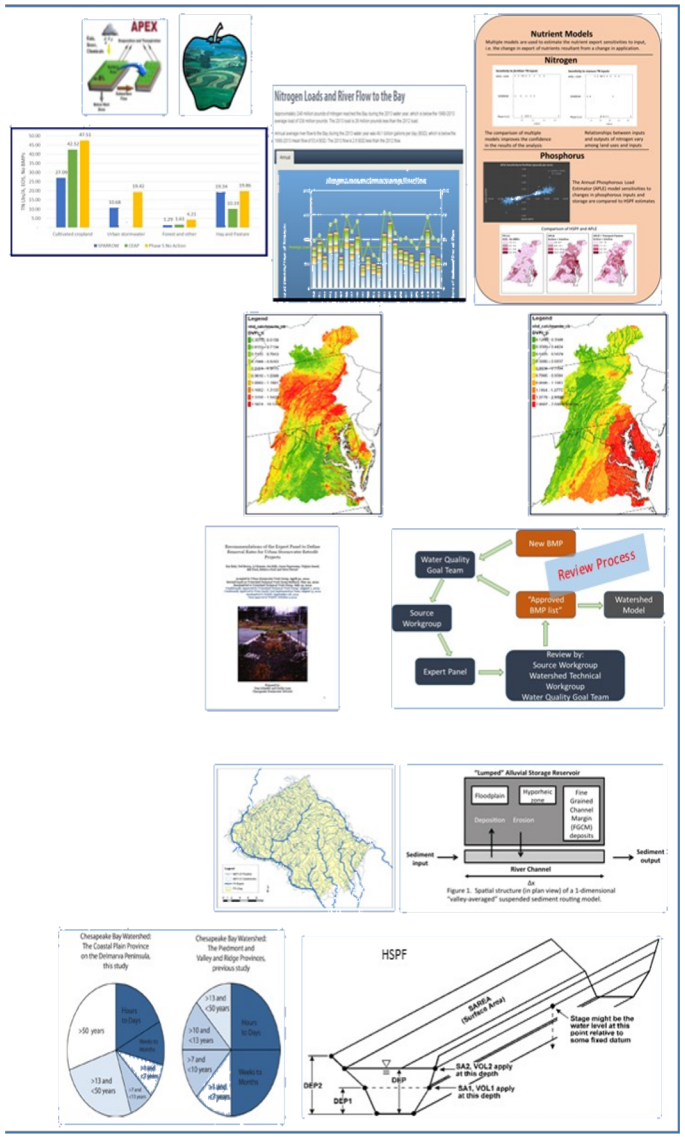
Land to Water

*****

River Delivery

Load by land-river segment and land use

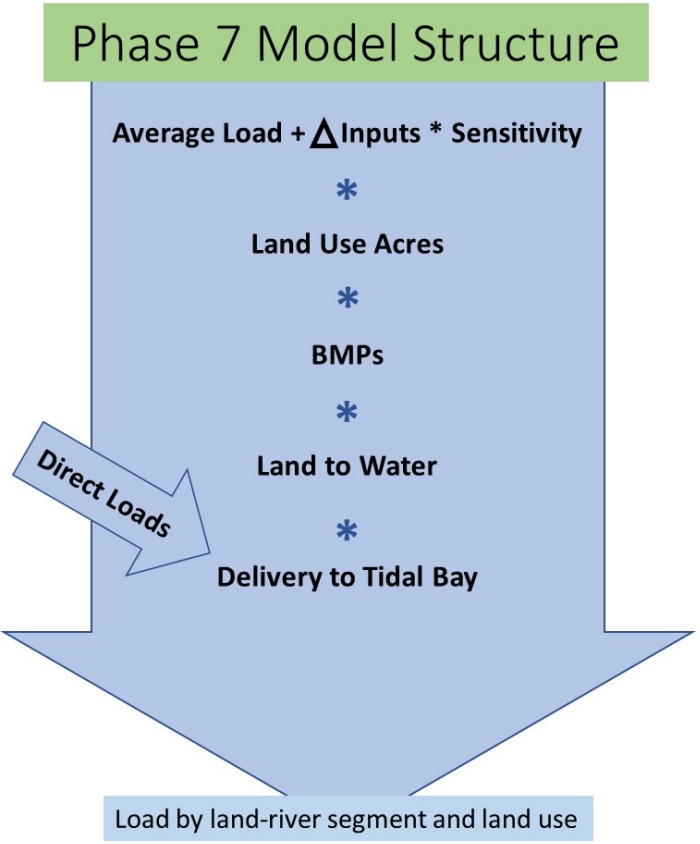
Knowledge Generation



The CBP watershed model has three parts

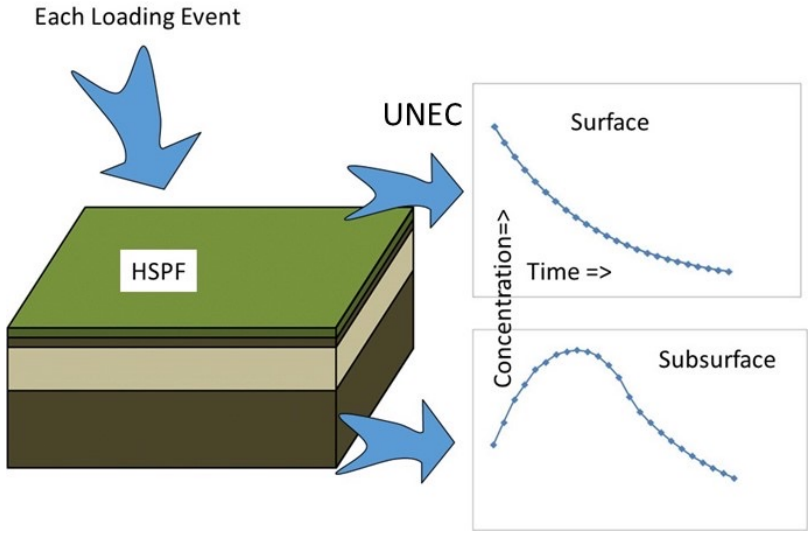
CAST

Management Model



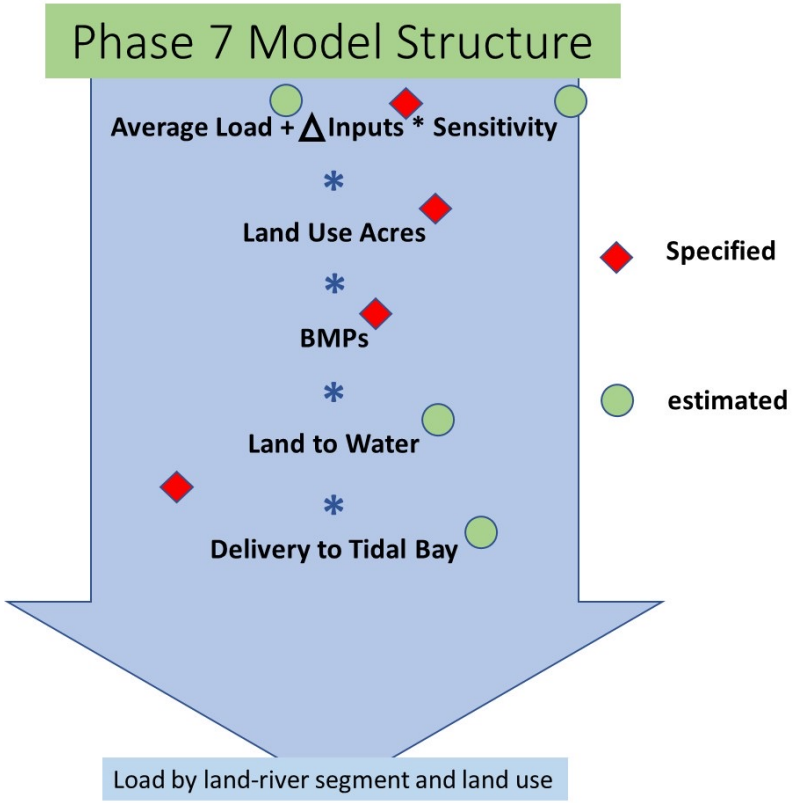
CAST-DM

Dynamic Model



CalCAST

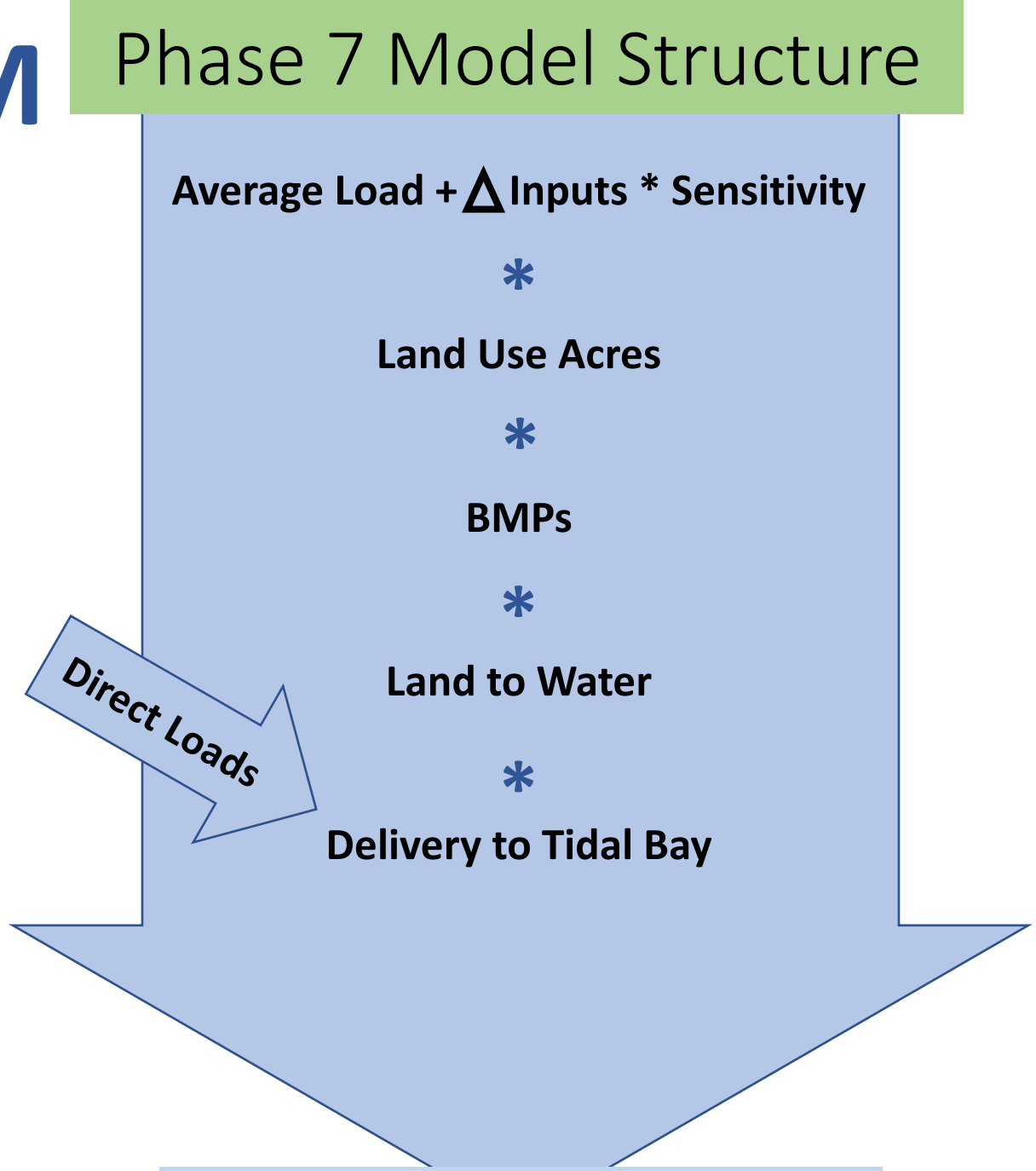
Statistical Model



Cast/CalCast/DM

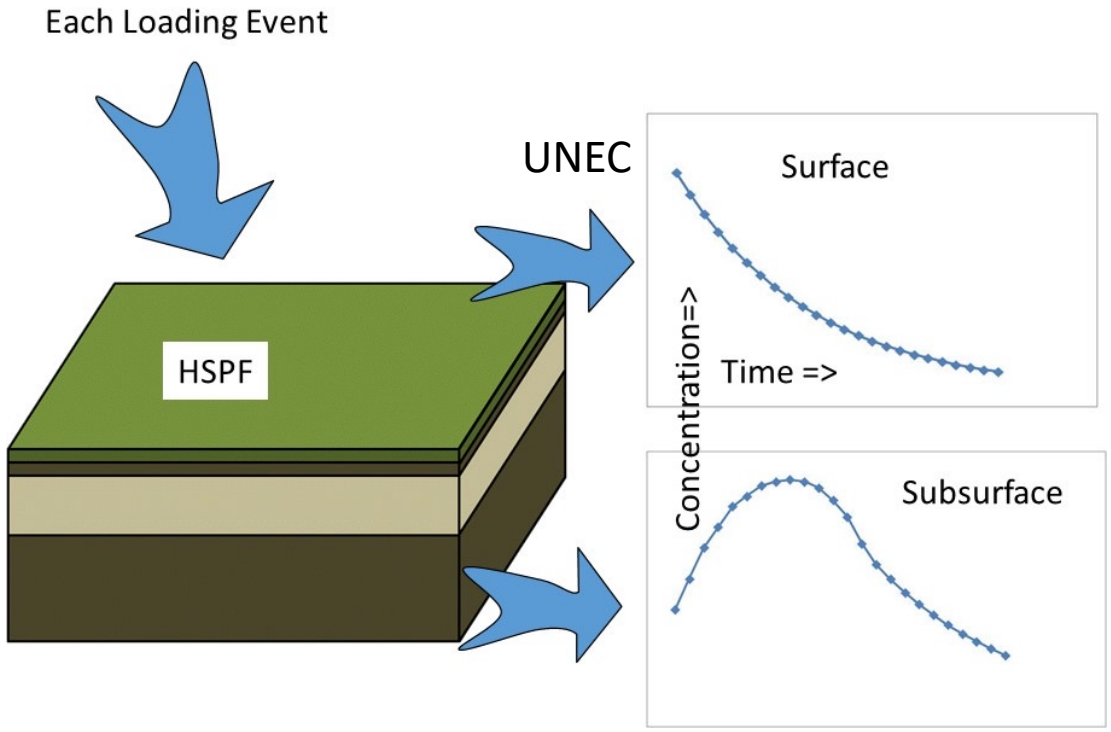
Phase 7
CAST

Deterministic
Scenario Tool:
1 set of loads for 1
set of inputs



Cast/CalCast/DM

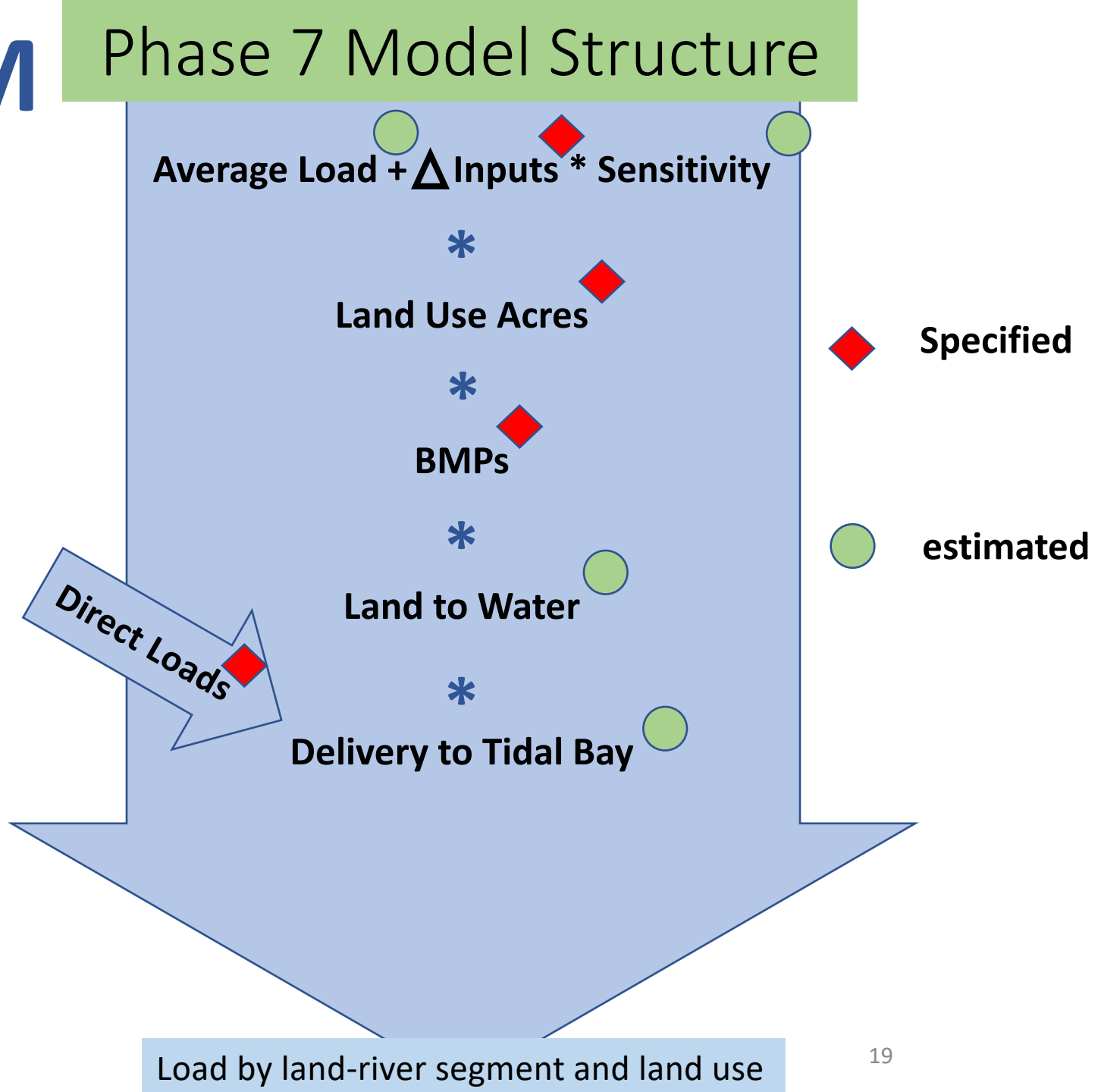
- Phase 7 Dynamic Model
- Tool for
  - loading estuarine models
  - Comparing against observations
  - Other potential collaborative projects



Cast/CalCast/DM

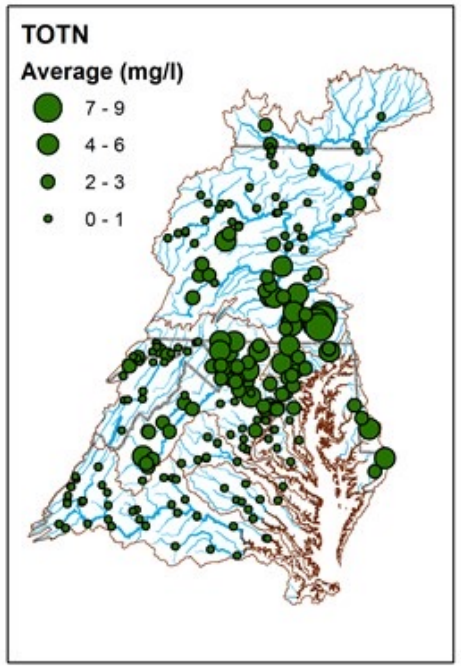
Phase 7
CalCAST

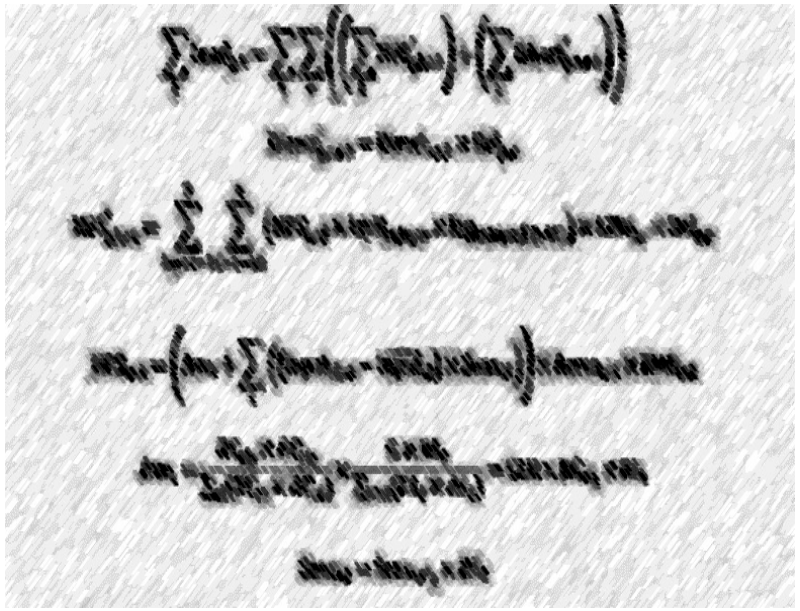
Tool for finding parameters that best match observations



CalCAST is a Bayesian Sparrow-like model

Loads + **Equations** + **Prior information about parameters**





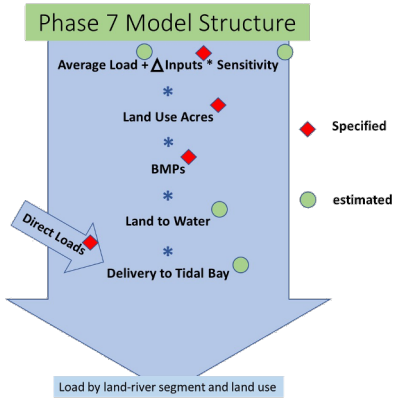
Pasture loads average 44% of crop loads

Turf Grass average 50% of Roads

Septic loads depend on distance to streams

A pound of manure applications causes about half the load increase as a pound of fertilizer

= **Estimates of parameters For CAST**

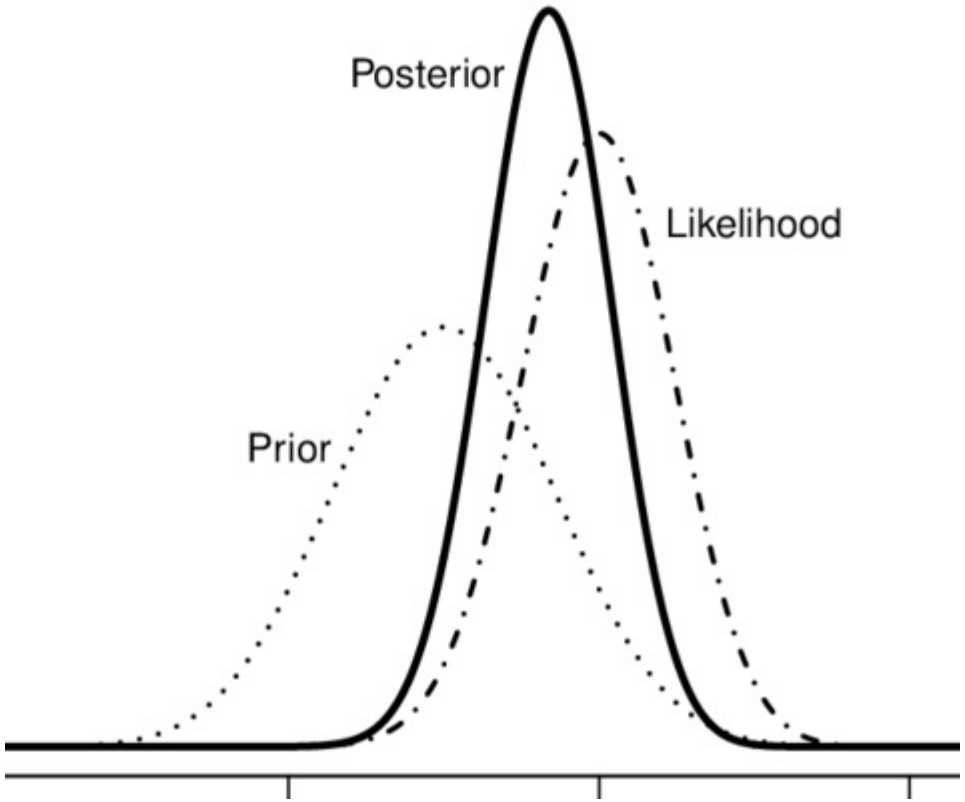


Types of prior information

Model Structure

- At one point in CBP history, we didn't know that atmospheric deposition was a load

Model Parameters



Prior information from Local Monitoring

- New Load sources
  - Waterproofing treatments?
  - Dogs and geese?
  - Tidal flooding?
- New relative loads
  - Is turfgrass really half of roads?
  - What's the uncertainty?
- Stormflow / baseflow split
  - How do flows and concentrations vary for different land uses
- Lag effects
- Really anything that creates ***generalizable knowledge***

Why are we telling you all this?

- Get into breakout groups and figure out:
  - How knowledge from local monitoring can be used to inform CAST
  - How we can monitor better to generate knowledge
- Breakout groups
  - Input from everyone
  - Wide-ranging conversation
  - Narrow down to top 3-4 actionable recommendations