Scenario Optimization Tool for CAST

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- The vision of “scenario optimization”
- Development
- Medium-term products
- Next steps and looking ahead

- **The vision of “scenario optimization”**
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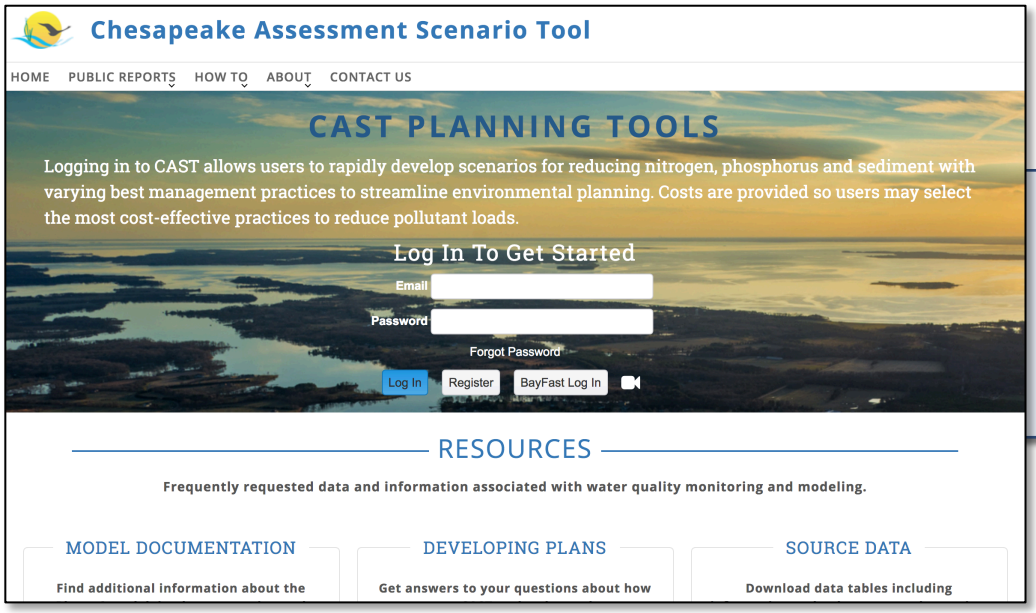
The Vision of "Scenario Optimization"



Target Loads

Low cost

Chesapeake Assessment Scenario Tool (CAST) estimates nitrogen, phosphorous, and sediment load impacts and the financial costs of implementing best management practices (BMPs).

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The Vision of "Scenario Optimization"

Build a module into the system that provides guidance:

Analyze the space of potential management scenarios and identify low-cost BMP implementation options

Optimization Model Description

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(Secondary) Maximize co-benefits

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- Number of acres (or other unit) of each BMP in each land-use category and land river segment (continuous)
- Tons of manure transported

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Basic Constraints:

- Scale/region of scenario (and/or agencies)
- Nitrogen and Phosphorous simulated load reductions ≥ reduction targets
- BMP'd acres ≤ available acres (by segment and land-use)
  - BMP'd roads ≤ available miles
  - BMP'd shorelines ≤ available miles
  - BMP'd animals ≤ available animal counts

Other Constraints:

- BMP constraints, for example:
  - agricultural land retirement ≤ *X* acres
  - cover crop oats ≥ *X* % of agricultural acres
- Land use restrictions for certain BMPs
- Capital limitations for certain sectors?

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Development

OptSandbox

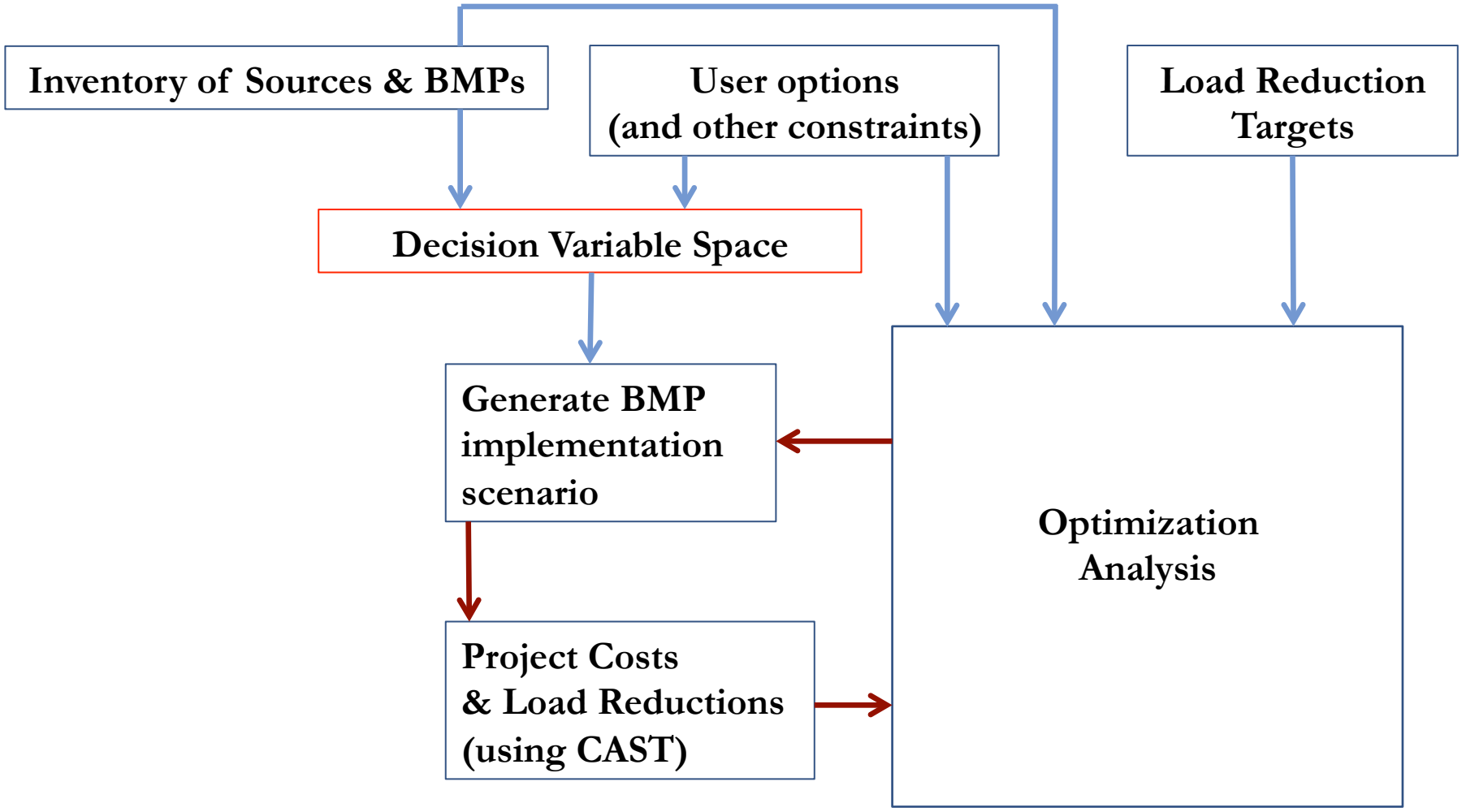
(tool to investigate space of possible scenarios and topology of solutions)

v0.1

- Preliminary scenario generation logic – **decision variable space**
- Preliminary graphical interface design

Cloned on CBP cloud server

A decision variable space is generated



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Metadata

- Base Year, Base Condition, Wastewater data
- Cost Profile
- Geography

Variable groups to modify ([*Source*, *BMP*] amounts that the optimization is allowed to tweak)

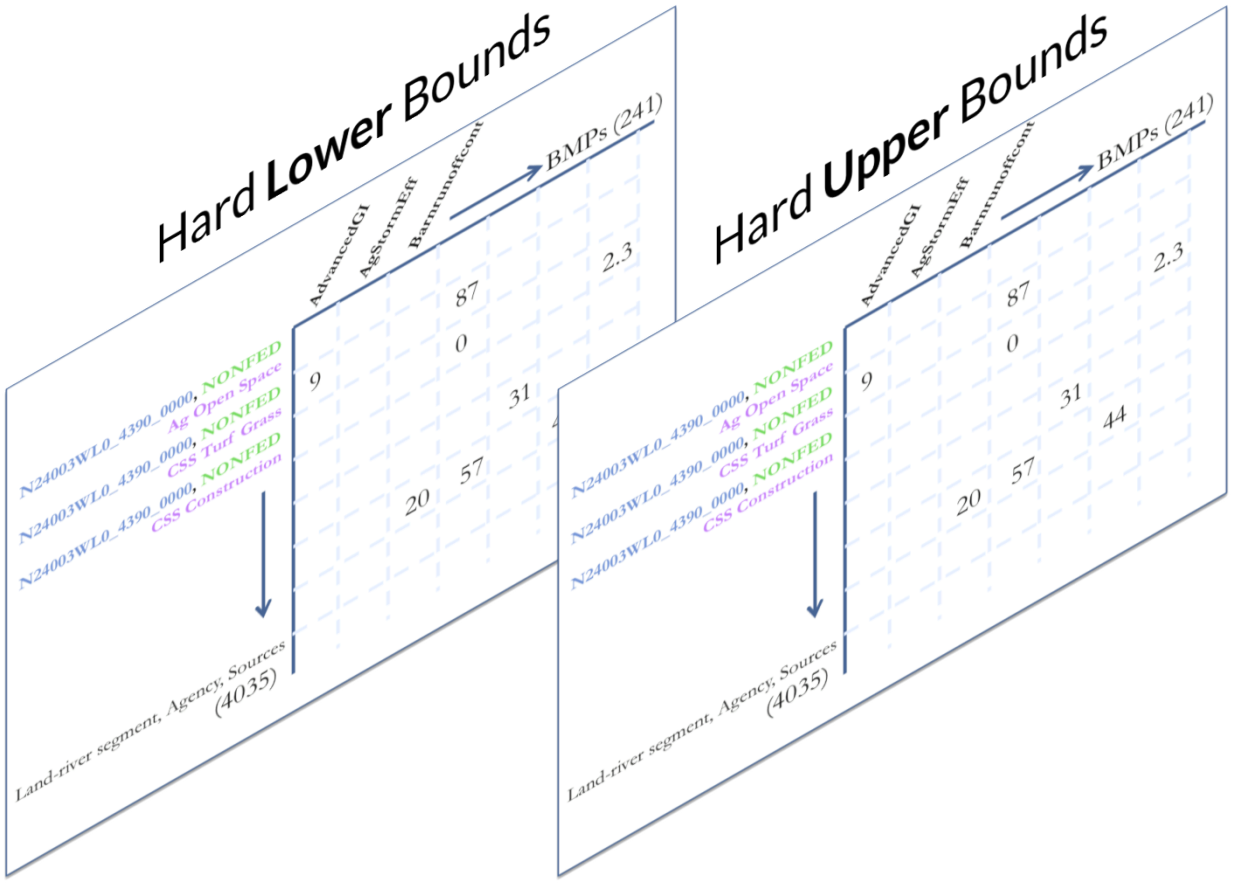
- Agencies
- Sectors

Constraints for variables

Scenarios Generated from this decision space

A decision variable space is generated

For Land, Animal, and Manure



- **20% sparse when including all land river segments, agencies, sources, BMPs**
- **~200,000 knobs to turn for Anne Arundel County**
- **Basic constraints determine hard upper and lower bounds**

Development: Where do things stand?

Fast CAST:

- PyCast (python) is likely to be transformed into CoreCast (C#)

OptSandbox:

- v0.1 (querying/parsing from Excel Sheets)

- v0.2 (querying/parsing from flattened tables of SQL Server data)

Estimated dates:
~ One month for transition to SQL Server data
~ Fall for development team transforming Cast to FastCAST

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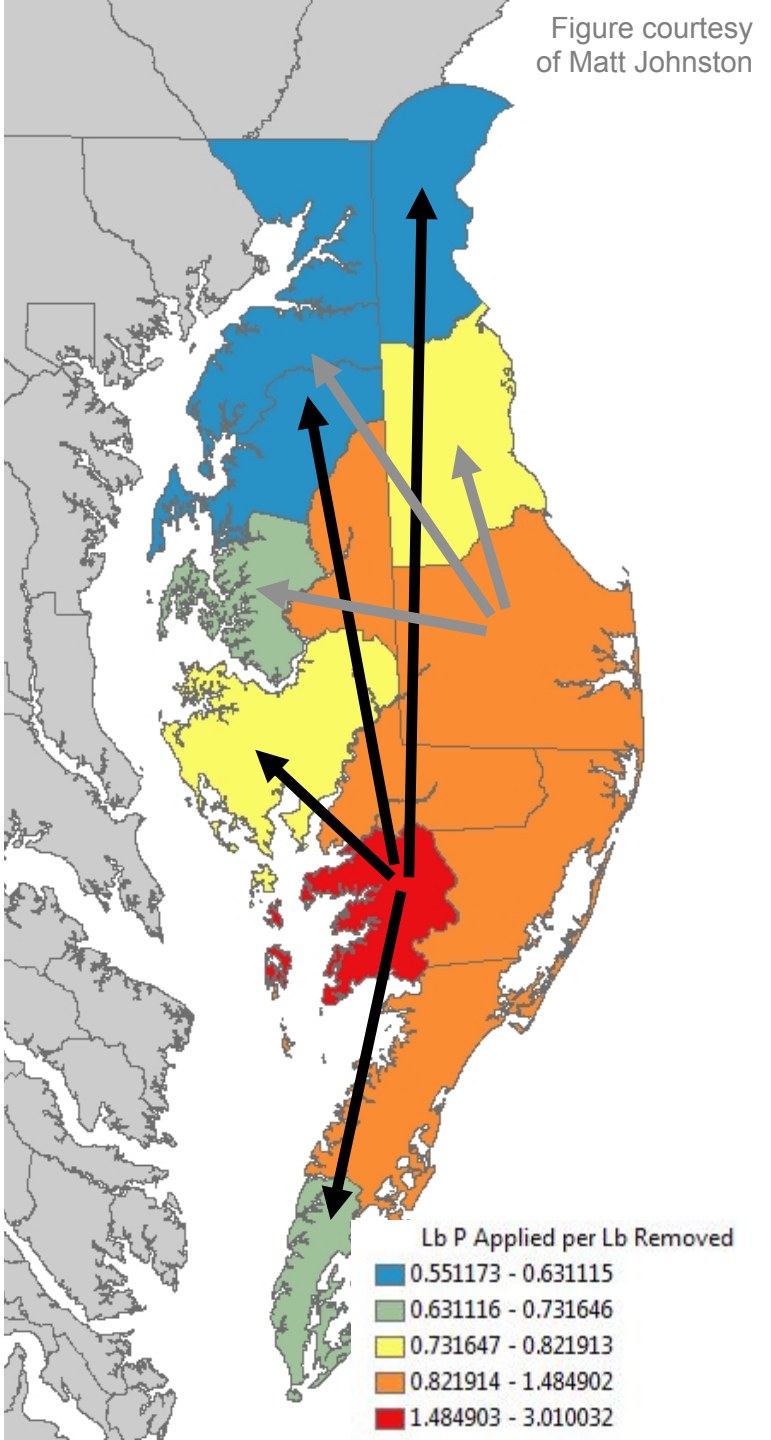
Medium-term product concept 1of2

Manure Transport Optimization

Assuming manure can be moved across the Delmarva, what is the least costly (best environmental) outcome for manure redistribution?

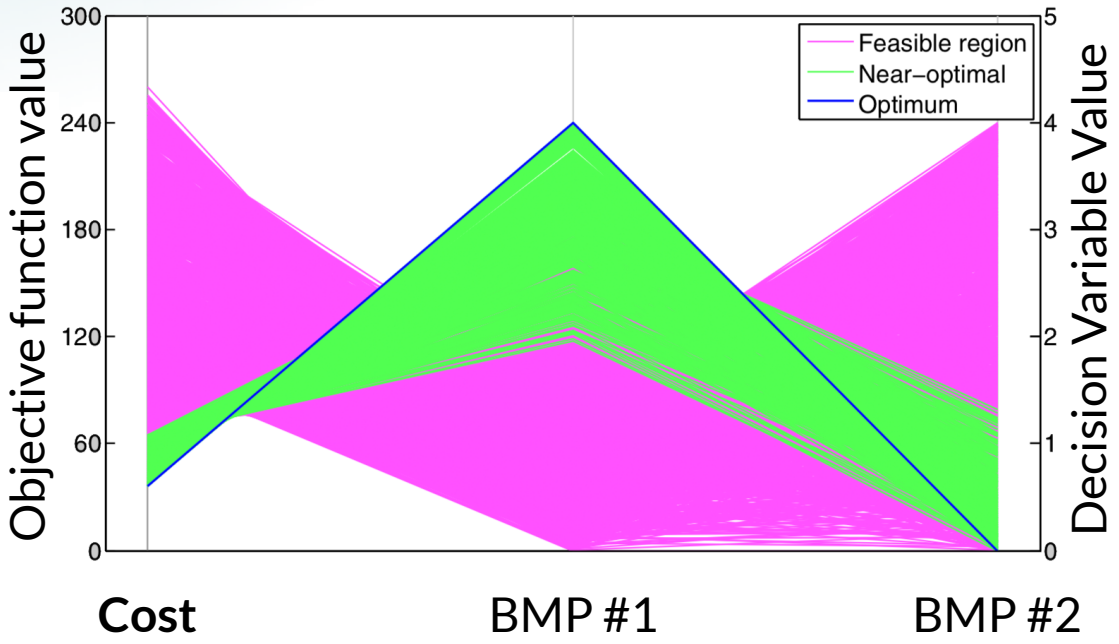
For Example

County From	County To	Amount
Caroline	Cecil	41
Caroline	Wicomico	30
Dorchester	Cecil	90
Dorchester	Talbot	8
Sussex	New Castle	76
…	…	…



Medium-term product concept 2of2

Scenario Generator, Explorer, Comparer



An objective and batch sampling of the solution space could provide automatic comparisons with scenarios of interest

Figure modified from Rosenberg, 2015

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- SQL server data queries to generate decision variable space
- Offline batch scenario analyses
- Manure transport analyses
- Response to STAC workshop

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Looking ahead

- Data flow
  - Cloud architecture
  - Modular access to CAST procedures allowing for multi-step optimization
- Algorithm testing
  - Hybrid Pop.-based & Nonlinear Prog.
  - Machine learning approaches
- Co-benefits, Alternatives

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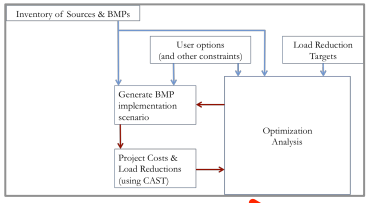
Sandbox



Identifying Alternatives

Cost Tradeoffs

Baseline Optimization Prototype

Co-benefits

Local Targets

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- **Include all land river segments, agencies, sources, BMPs**
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