Cape Cod 3VS Model Update

November 6, 2013
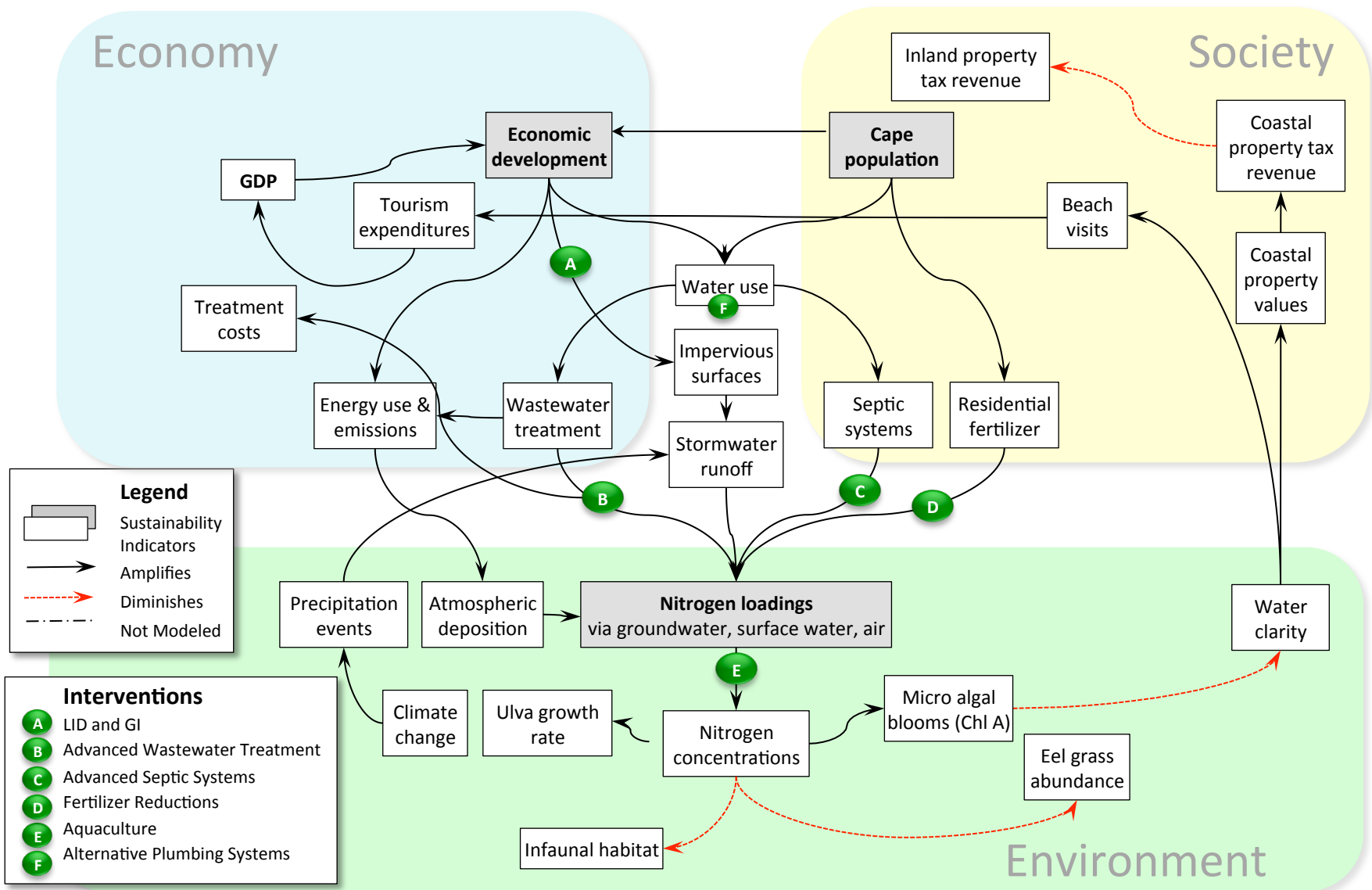
Local perspective

Land use

Land use model
(demographics)

Nutrients and Pollutants

Watershed MVP
Technology, (targets), cost of intervention

Environmental Impacts

Tourism Impacts
(number, consumption, property values)

3VS (core addition)

Economic Impacts
(Cape economic accounts)

Multipliers/SD
(direct, indirect and possibly induced impacts)
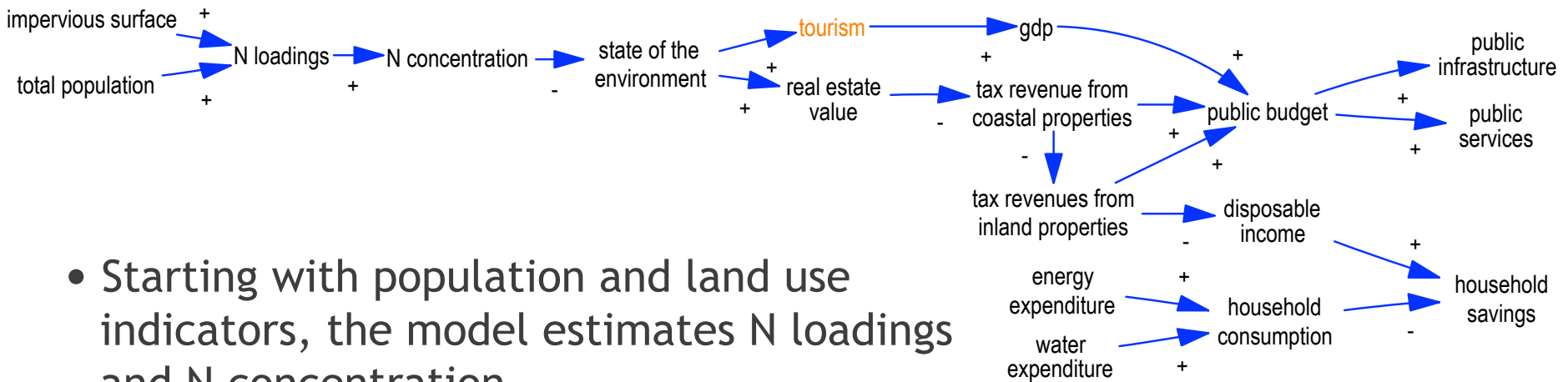
Macro perspective
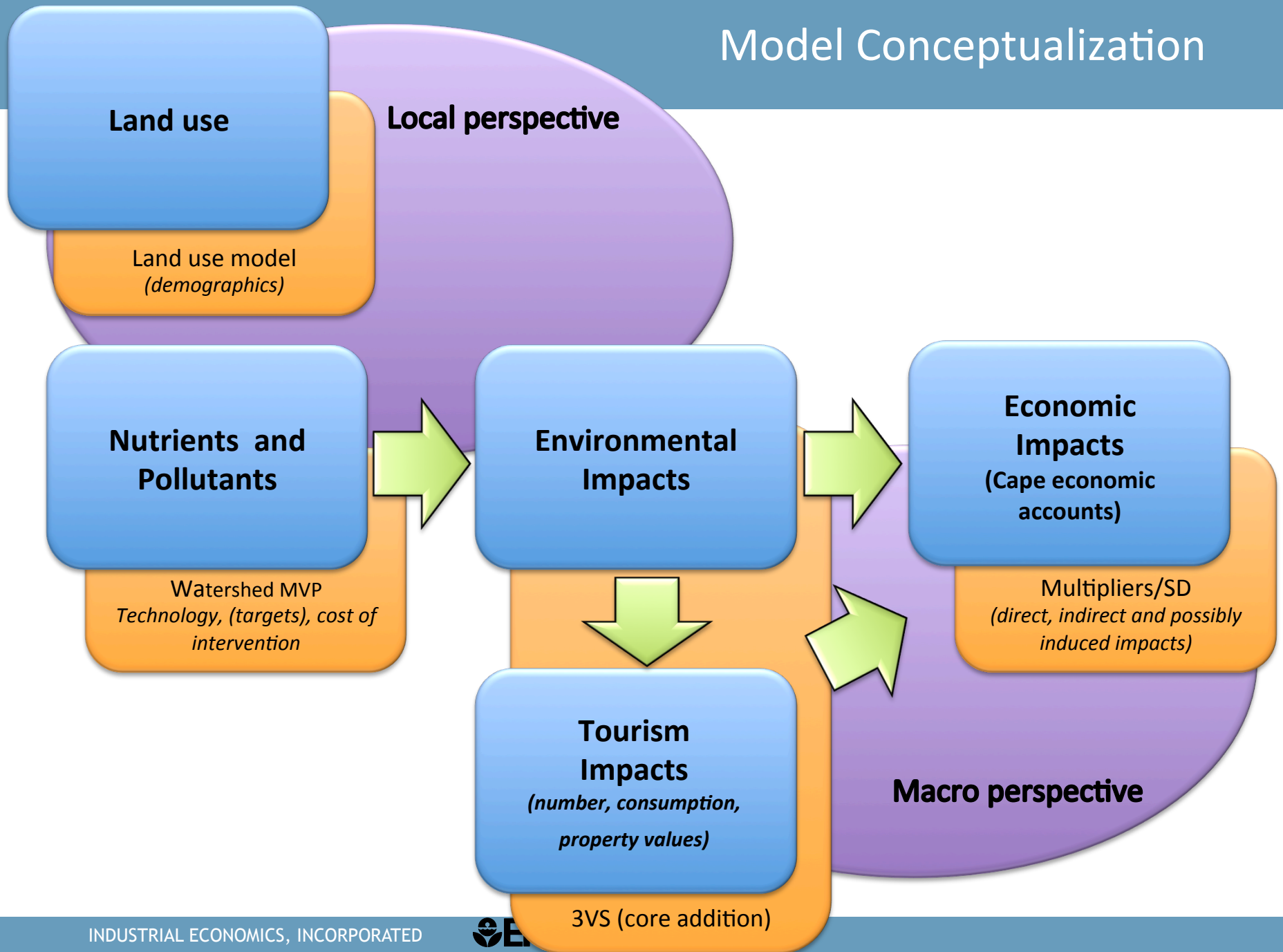
Prototype Model Review

- Phase 1 of the model will include:
  - No Action scenario with "Current" and "Buildout" Nitrogen loadings from Barnstable
  - Nitrogen concentrations by watershed
  - Environmental indicators, based on Narragansett Bay relationships and Massachusetts Estuaries Program (MEP) reports
  - Economic impacts, based on Narragansett Bay relationships and Cape Cod economic data
- Model features to be added in later versions include:
  - Policy intervention scenarios
  - Pathogen and phosphorus loadings
  - EPA ORD's work on alternate treatment systems and life-cycle analysis
  - Detailed cost and affordability data
  - Seasonality in economic and social indicators
  - Resilience of policy interventions to climate change

Cape Cod 3VS Schematic: Initial Model

Economy

Society

Environment

Legend

- Sustainability Indicators
- Amplifies
- Diminishes
- Not Modeled

Interventions

- A LID and GI
- B Advanced Wastewater Treatment
- C Advanced Septic Systems
- D Fertilizer Reductions
- E Aquaculture
- F Alternative Plumbing Systems

Inland property tax revenue

Coastal property tax revenue

Economic development

GDP

Tourism expenditures

Treatment costs

Cape population

Beach visits

Coastal property values

Water use

Impervious surfaces

Energy use & emissions

Wastewater treatment

Stormwater runoff

Septic systems

Residential fertilizer

Precipitation events

Atmospheric deposition

Nitrogen loadings via groundwater, surface water, air

Water clarity

Climate change

Ulva growth rate

Nitrogen concentrations

Micro algal blooms (Chl A)

Eel grass abundance

Infaunal habitat

Cape Cod 3VS Schematic: Planned Model

- Starting with population and land use indicators, the model estimates N loadings and N concentration.

- N concentration is assumed to be one of the main factors impacting the state of the environment.

- A deterioration of the environment is expected to reduce tourism arrival and expenditure, as well as the value of real estate.

- In this scenario, tax revenues from tourism-related activities would decline, requiring an increase in taxation from other sources (to be paid by residents).

- The macro economic impacts of this development include a reduction in disposable income, and possibly consumption and/or savings.

Model Data Sources

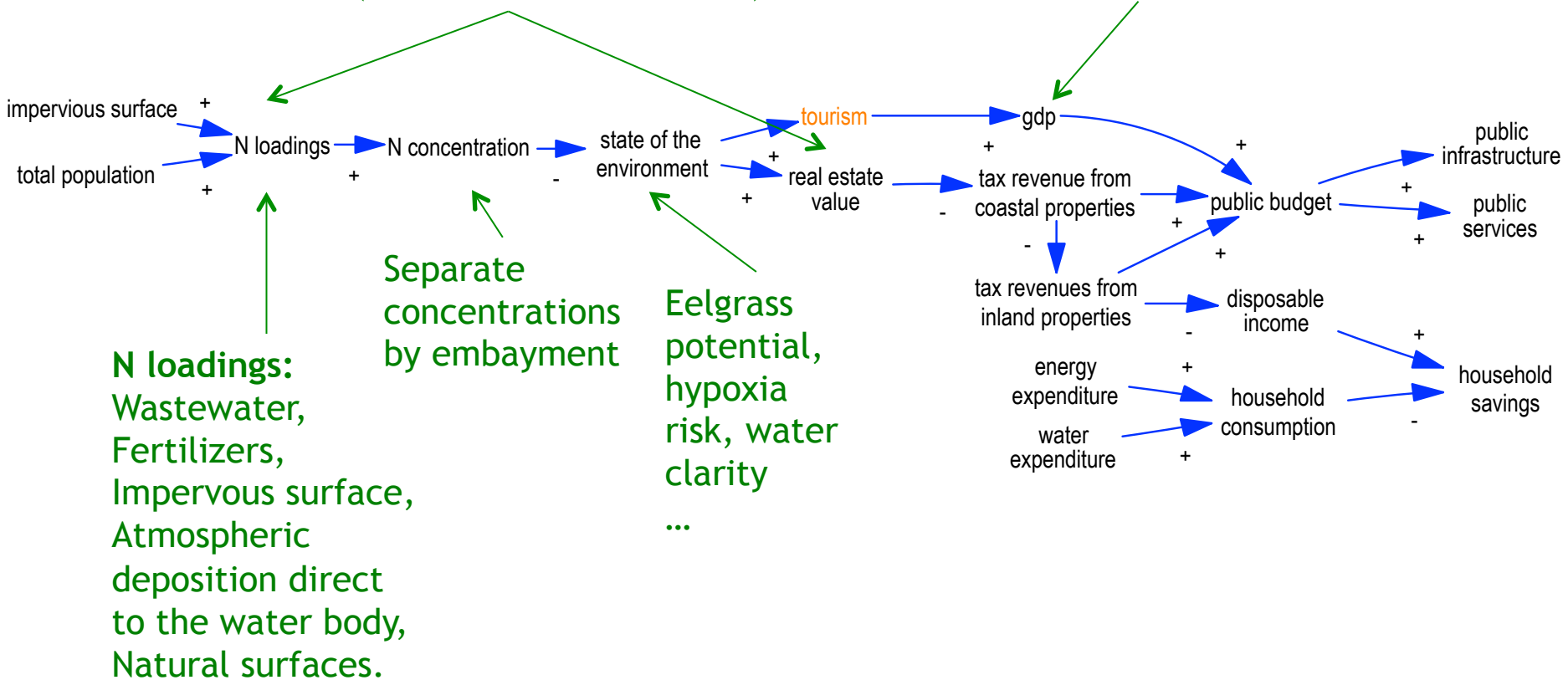Several data sources are used, and cross-checked for coherence.
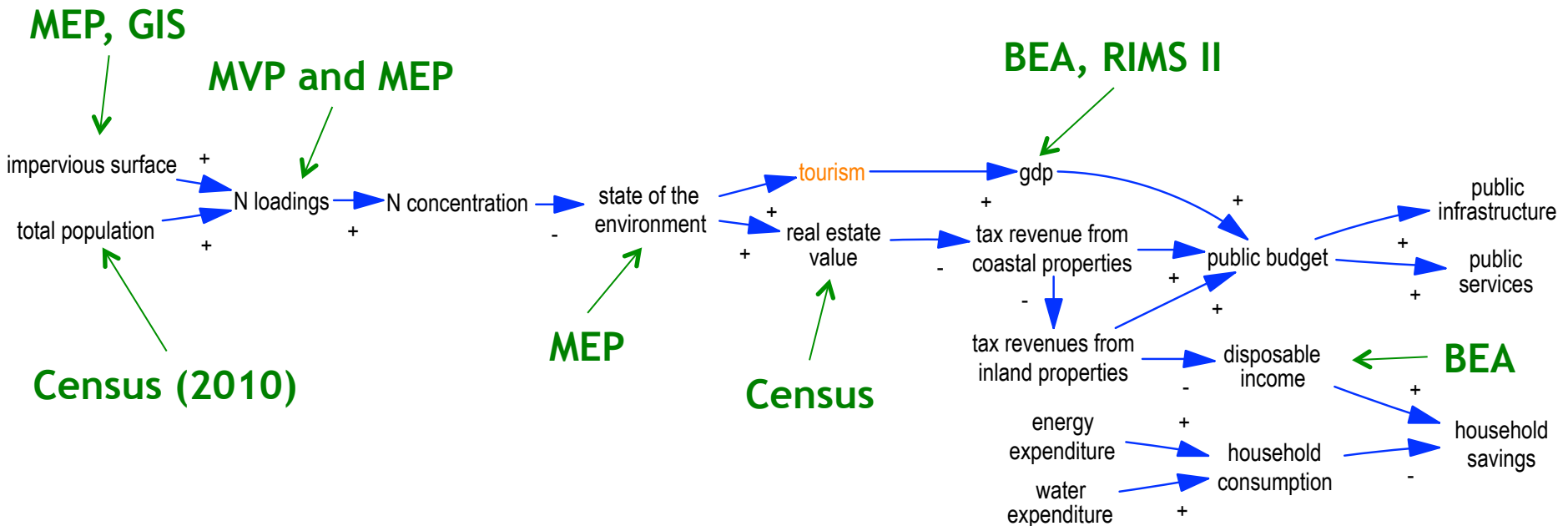
Model Disaggregation

Various layers of disaggregation are represented in the model.

Buildings: Commercial, Residential, Industrial, Other, Vacant (sewered and unsewered)

Economic sectors: Real estate, accommodation and food services, ...

N loadings: Wastewater, Fertilizers, Impervous surface, Atmospheric deposition direct to the water body, Natural surfaces.

Separate concentrations by embayment

Eelgrass potential, hypoxia risk, water clarity ...

Economic data

- Barnstable Town data are available for GDP, earning and employment for the period 2001 - 2011 (Source: BEA)
- Among others, the main sectors impacted by the state of the environment and tourism are:
  - Real estate and rental and leasing,
  - Arts, entertainment, and recreation
  - Accommodation and food services
  - Other services, except government
- The model can be calibrated to recreate historical trends endogenously.
- The use of RIMS II multipliers allow us to estimate the cross-sectoral impacts of changes in economic activity, either from investment or from an increase (or reduction) in tourism activity.
  - RIMS II provides both final-demand (output, employment, value added, and earnings) and direct-effect multipliers (earning and employment).

Nitrogen Loadings and Concentration Data

- MEP Reports allow us to relate N loadings from each watershed to changes in N concentrations by embayment
  - Linear equations approved by Brian Howse
  - Will calculate one equation per embayment (average concentrations)
- MVP has loadings data by town, watershed, and subwatershed.
  - Need to estimate factors for translating between MVP and MEP loadings data (including attenuation)
  - Can apportion loadings from one category (town) to another (watershed), based on current loadings
  - MVP scenario outputs must be summarized at the watershed or town level in order to be inputted into 3VS
- Three Bays MEP Report has estimates of unattenuated loadings for other source categories
  - Need to develop equations for estimating loadings endogenously (e.g., from population and imperviousness)

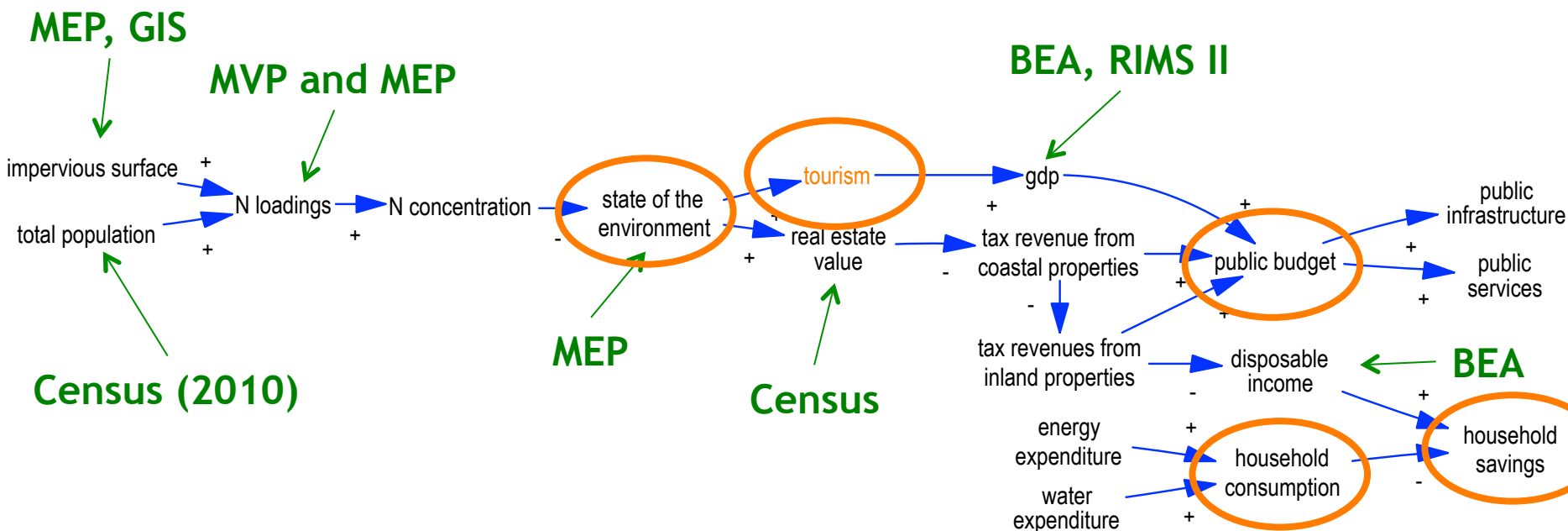# Nitrogen Loadings and Concentration: Conceptualization

Available data allow us to relate changes in nitrogen loadings to environmental impacts by embayment.
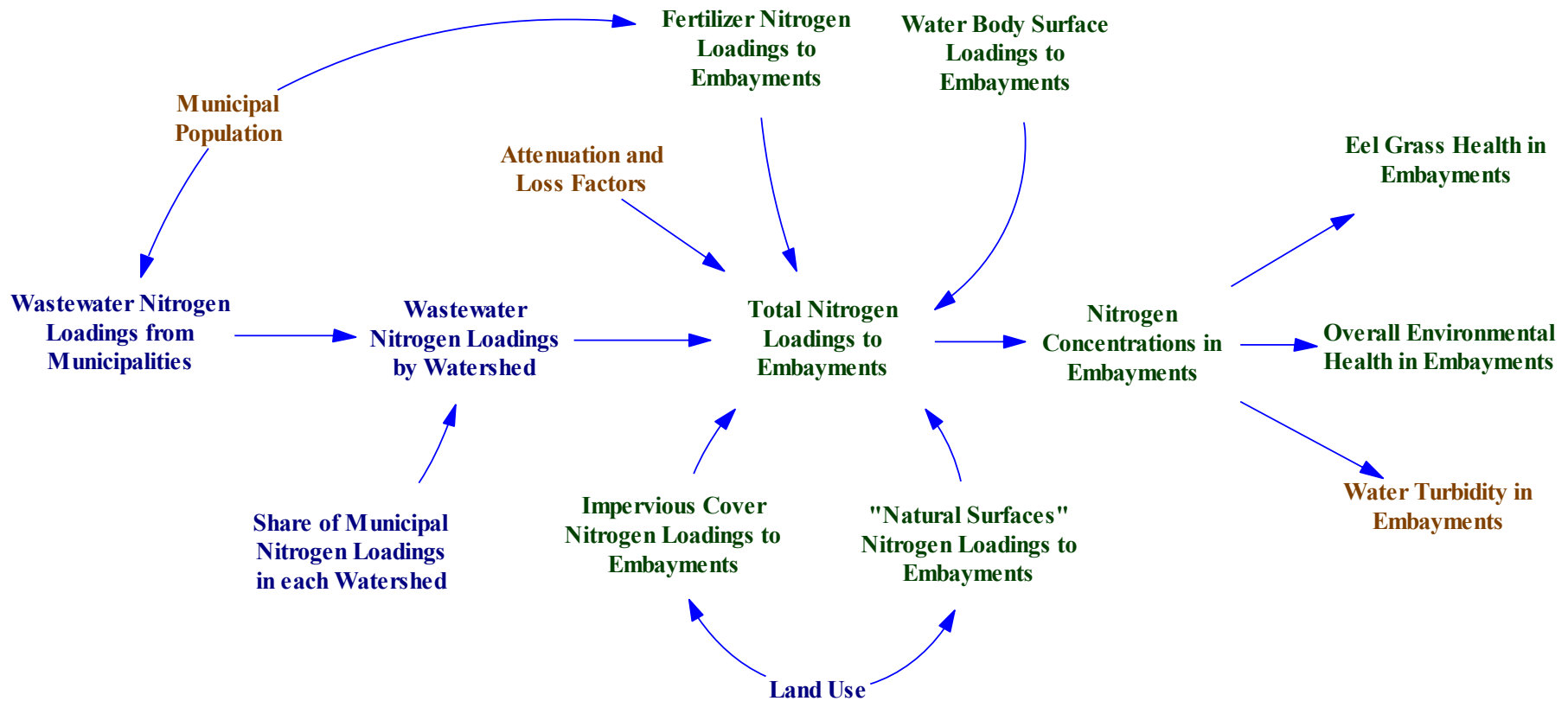
Data Sources: Watershed MVP, MEP Report for 3 Bays Watershed, Other Data Sources

Data gaps

Further research is needed to identify data sources for key variables and relationships.

Next Steps

- Coordination between CCC and modelers to define scope and scale of the 3VS model
  - Ongoing dialogue to ensure that model assumptions and generalizations are appropriate for intended purpose
  - Coordination regarding data gaps and uncertainties
- Modelers will synthesize local data and relationships from published literature/other modeling efforts
- Development of initial model prototype for Phase 1: No Action Alternative
- Identification of policy interventions to be evaluated in Phase 2