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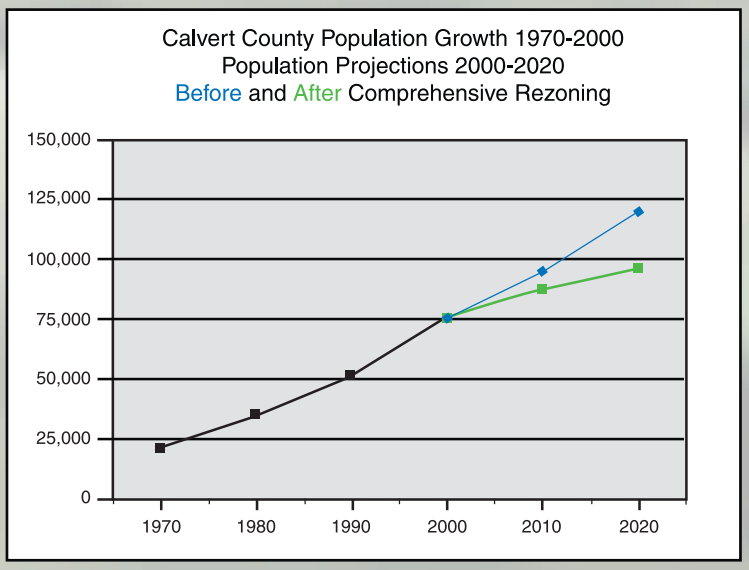
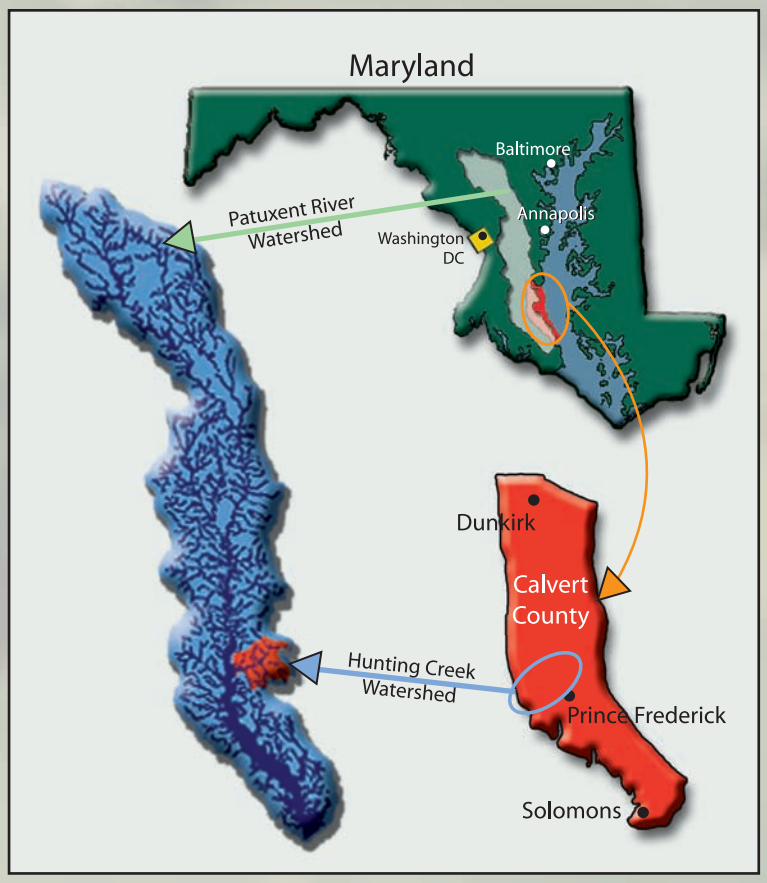
Calvert County, Maryland's Success in Controlling Sprawl

Rapid population growth and suburban development, and the resultant change in land use and land cover were affecting the Calvert County landscape.

The extent of the County's ability to build a strong economy, while protecting and maintaining its rural character, depends largely upon three factors – the amount of increase in population, the rate of new construction, and the location of future development sites. The County prepared a Comprehensive Plan which recommends a four-step implementation strategy to achieve maximum results: (1) reduce total build-out; (2) reduce the rate of residential growth; (3) preserve the County's prime farms, forests, historic resources and sensitive areas; and (4) direct all growth to appropriate locations. The County Commissioners were then faced with the decision of how and where to limit the location and amount of new construction. This increase in new construction and its location would also affect the amount of increase in point and non-point source pollution. Models of how a new comprehensive zoning plan would affect water quality in Calvert County were essential in designing ways to meet the environmental goals in the Comprehensive Plan.





The Institute for Ecological Economics (IEE) at the University of Maryland was awarded a Science to Achieve Results (STAR) Grant from the U.S. EPA, Office of Research and Development. The purpose of this grant was to develop an ecological, economic model to evaluate the driving forces and the ecological consequences of land-use change. The project goal was to create a dynamic, ecological, economically-linked model and make it available to resource managers for the effective management of ecosystems at the watershed scale. The approach designed by IEE estimates the impact of economic development on environmental conditions in a watershed. Various watershed data were combined to produce a spatially-explicit model. The IEE model was used to demonstrate how changes in zoning would affect water quality in Calvert County. The Hunting Creek watershed was used in the model as a representative area of the County.

For the Hunting Creek model, IEE compared nine different zoning alternatives (Figure 1) and their resulting water quality. The water quality was determined for each scenario in terms of the concentration of nitrogen (Figure 2).

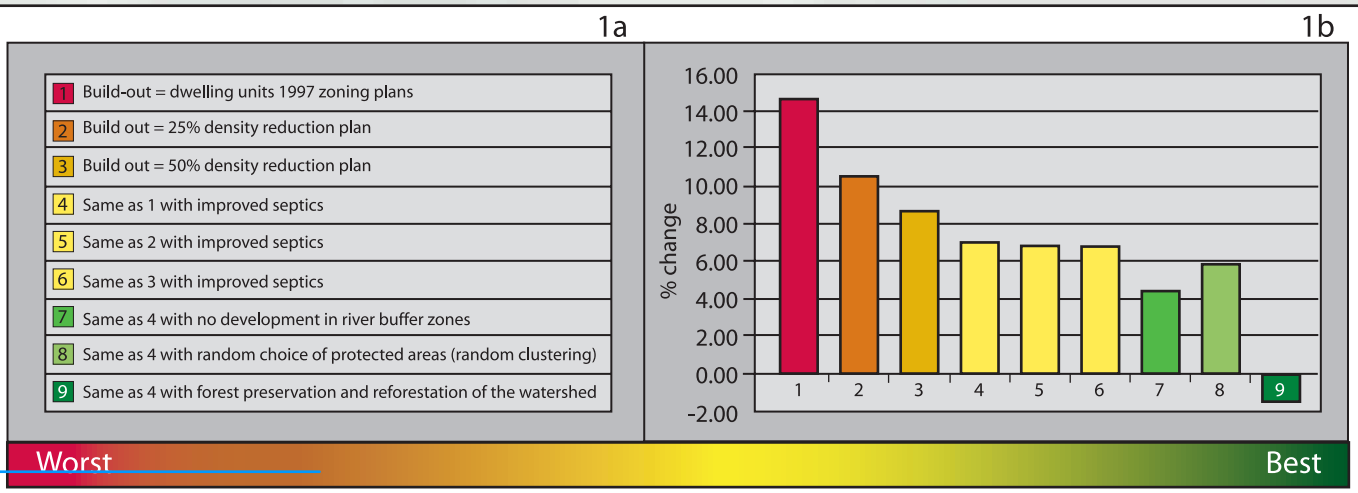


Figure 1. Percent change of annual average concentration of total Nitrogen (TN) in Hunting Creek in the scenarios relative to the concentration under existing development/zoning plan (1997).

There are five major sources of nitrogen in the watershed:

1) **Fertilizers**, applied in both agricultural and residential settings, account for **approximately 38%** of the nitrogen. This estimate is based on an expected yield for particular soils, assuming crops are rotated and the soils receive a determined amount of fertilizer to produce an expected crop yield.

2) **Atmospheric deposition**, although mostly generated outside of the County, accounts for **over 35%** of the nitrogen loading and is related to development in the airshed (a much larger area than the watershed).

3) **Septic tanks** contribute **over 5%** of the total nitrogen load and can be calculated from the number of residents within the study area. Though small, this load may have a disproportionately large effect since the nitrogen from septic systems is currently released directly into the ground water and is not available for plant uptake.

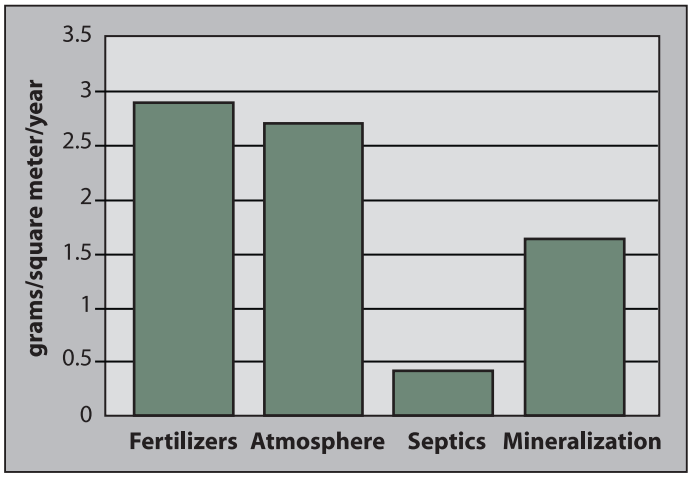


Figure 2. Total annual nitrogen loading in Hunting Creek watershed from the four sources used in the model (5th source was disregarded).

4) **Dead organic material** produces **over 21%** of the nitrogen. This is a significant amount, but since it is delivered directly into the root zone and rapidly recaptured by the vegetation, it is less important for the overall balance.

5) **Sewage treatment plants'** contribution to nitrogen loading in Calvert County was **considered negligible** because all sewage in this watershed undergoes tertiary treatment, and much of it is land applied.

The model integrated the effects of both the amount and location of human development and agricultural practices on water flow, plant productivity, and nutrients in the landscape. It estimated and analyzed how the County's comprehensive re-zoning scenarios would affect water quality and provided important information to County-elected officials and staff. The model showed how crucial ecological variables change in response to human activities and how these changes are distributed across the study area.

Calvert County provided GIS and development data and input for the model and selected the scenarios to be run. IEE ran the model, prepared the report, and presented it to the County Commissioners. By summer 2002, IEE plans to have a web interface that will allow stakeholders to run the model themselves and formulate their own scenarios.

Results:

The nitrogen content in the watershed is sensitive to the increase in the amount of dwelling units. The existing design of septic drainage fields effectively removes nitrogen from the active root zone and allows it to accumulate in the ground water that eventually finds its way into the river system (Figure 3). Scenarios 4-6 in Figure 1a employ septic systems that discharge in the near-surface vegetative layer (Figure 3, Alternative Design). In these scenarios, the nitrogen from the septic systems is considerably lower, and there is little difference among zoning strategies 4, 5, and 6. However, preservation of an extended river buffer zone (200 m) further diminishes the amount of nutrients entering the estuary (Scenario 7). If a similar totally-preserved area is chosen randomly, the gain is significantly less (Scenario 8). Furthermore, if the maximum build-out is assumed, but on a totally-forested watershed (Scenario 9), the pollution of the estuary relative to the current conditions can actually decrease, even for the maximum projected population growth in the watershed. It is hardly possible to implement Scenario 9; however, it is important to stress that environmental and management practices associated with development may be more important than the actual amount of build-out.

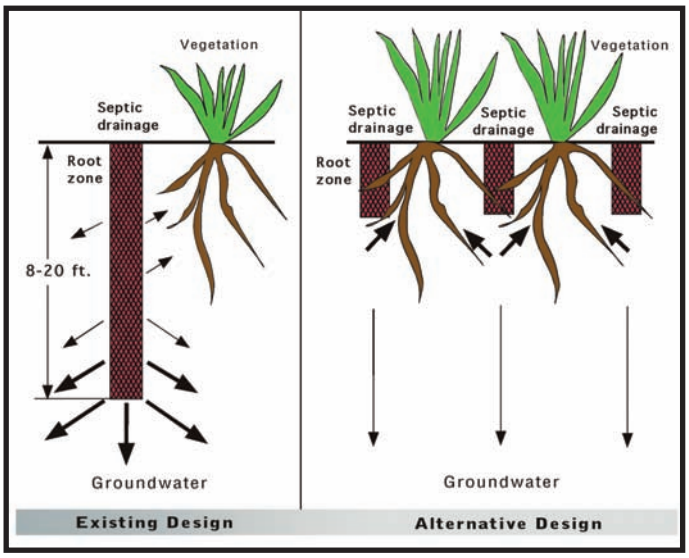


Figure 3. Comparison of existing and alternative septic system designs. Additional nitrogen removal for septic systems in watersheds that contribute heavily to the nitrogen load is under consideration in Calvert County.

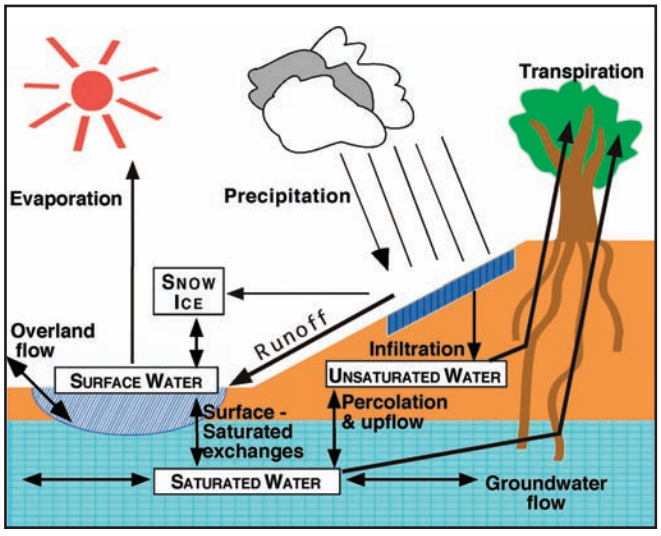


Figure 4. Hydrologic cycle used in the model.

Conclusions:

- Atmospheric deposition is a prime source of nitrogen loading that should not be overlooked. Additional research is needed to identify the contribution of local vs. distant sources of atmospheric deposition.
- Spatial distribution of the development is extremely important for water quality in the estuary. By avoiding land use change in the river buffers (~200 m), most of the development in the watershed can be compensated for, even under maximum build-out.
- Even more important are the particular land use practices: grow trees, not lawns.
- Most important are the management practices. Nitrogen removing septic tanks can remove 60% of the nitrogen from septic effluent and when combined with redesigned septic fields that deliver the effluent to the root zone (which increases nitrogen retention by the plants) rather than to the groundwater, these systems can be extremely effective.

Recommendations to Calvert County:

- Consider alternative designs of septic tanks and drainage fields to make better use of biological treatment and achieve greater nutrient removal (Figure 3, Alternative Design).
- Continue to prioritize and implement preservation/conservation efforts before further growth outstrips their positive effects.
- Minimize clearing, maximize reforestation and encourage reduced lawn areas.
- Support further analysis of the pathways of nutrients across the watershed.

Region 3
Philadelphia, PA 19103
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Patricia Bradley
bradley.patricia@epa.gov
410-305-2744

U.S. Environmental
Protection Agency
Mid-Atlantic Integrated Assessment
Environmental Science Center
701 Mapes Road
Ft. Meade, MD 20755
www.epa.gov/maia

Barbara Levinson
levinson.barbara@epa.gov
202-564-6911

U.S. Environmental Protection Agency
National Center for Environmental Research
(8723R)
Washington, DC 20460
www.epa.gov/ncer

David C. Brownlee
brownldc@co.cal.md.us
410-535-1600 ext. 338

Calvert County
Department of Planning and Zoning
150 Main Street
Prince Frederick, MD 20678
www.co.cal.md.us

Robert Costanza
costza@cbl.umces.edu
410-326-7213

Alexey Voinov
voinov@cbl.umces.edu
410-326-7207

University of Maryland
Institute for Ecological Economics
Center for Environmental Science
Chesapeake Biological Lab
PO Box 38
Solomons, MD 20688
iee.umces.edu
iee.umces.edu/PLM/HUNT

Based on the recommendations to the County by IEE and the reduction in the cost of future school and road construction, the Board of County Commissioners adopted a zoning ordinance that provides for a major reduction in future density and that directs the location of future growth. The Commissioners feel that these measures will improve the environment and help to maintain the general quality of life in Calvert County as described in the Comprehensive Plan's implementation strategy. Also, consistent with the Comprehensive Plan, the County is exploring the use of nitrogen-removing septic systems.

The spatial landscape model, funded by this STAR Grant and developed by IEE, is very flexible. It can be used to analyze the impacts of a specific development or regulatory policy. The model can be scaled down to represent small watersheds (Hunting Creek) or up to represent major drainage basins (Chesapeake Bay). The parameters used in the model can be adjusted to reflect the particular goals of the project. Numerous scenarios can be run through the model and the results compared, as was done with Hunting Creek. Or, decision-makers can formulate a goal that they want the system to reach and then have the model sort the parameters and pattern combinations to reach that goal. This is an especially important tool when many processes and factors with numerous constraints must be accounted for to reach an optimal decision. The kind of solutions required determines the complexity of the model. That, and the amount of available data determine the speed and expense of applying and using this modeling approach. However, if difficult and numerous questions must be answered, the complexity is appropriate and the model is more economical than other solutions.

The results of this grant and other STAR grants are available on the NCER website. This research may further assist other organizations in basing their decision-making on sound science.

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