USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Comparison of models to estimate land derived nitrogen loads

Focus categories: MOD, M&P, GW

Keywords: model, nitrogen loading, watershed, land use, estuary, groundwater

Duration: 04/1999 - 02/2001

Federal Funds: $25,000

Non-Federal Funds: $100,008

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Congressional district: 10 and 12

Critical problem addressed

Eutrophication of coastal waters, prompted by the increasing nitrogen load from watersheds, is arguably the principal and most pervasive anthropogenic alteration to coastal ecosystems everywhere. Therefore, managers, decision makers and stakeholders must have tools available that allow prediction of nitrogen loads from watersheds based on land use within the watershed and that allow evaluation of watershed management options to reduce nitrogen loads. The many existing nitrogen loading models differ bewilderingly in the nutrient sources they consider (atmospheric, fertilizer, wastewater, livestock, waterfowl), the form of nitrogen they deal with (nitrate, ammonium, dissolved organic nitrogen, particulate nitrogen), the loss terms included (soil, vegetation, vadose zone, aquifer), the detail of land use that they demand as inputs, the emphasis they place on different types of land covers, the sequence in which they consider the different fates of nutrients as the nutrients cascade toward receiving waters, and in the specific values used for many terms (for example, the annual contribution of nitrogen per person, the house occupancy, fertilizer dosages assumed, retention of fertilizer nitrogen in soils, and many other such values). At present, stakeholders and managers are often presented with nitrogen loads calculated by consultants or researchers, with too little perspective on exactly what the calculated loads refer to (nitrate? total nitrogen? loads from wastewater or total loads? for impervious surfaces only or for all land covers?), without model verification to assess uncertainties of the method, and without justification as to why the model used was selected.

Based on our preliminary comparisons, the various methods provide widely varying estimates of nitrogen loads differing from several fold to an order of magnitude. To our knowledge, there has been little effort to verify the estimates of the proposed models

versus actual measured values for loads. This seems a minimal requirement for a management tool that will prompt many important decisions. We propose here to compare estimates of nitrogen loads from selected models with measured nitrogen loads, to provide information to decision makers about the type of prediction each model makes, and about the uncertainty of the loads predicted by models. The models to be tested were developed for and are applicable to New England watersheds overlying coarse grained sediments including Cape Cod, southeastern Massachusetts, Rhode Island, Long Island, and New Jersey.

Expected benefits

The activities we propose to carry out will produce results of immediate use to stakeholders and managers who need to understand the tools used to estimate nutrient loads, and decide which they might prefer to apply or have applied to their specific site. The results of this study will: First, allow anyone to assess in a concrete, easily perceived fashion, just what differences exist among the different approaches. Second, make it possible for users to actually apply the method they might prefer to the user's own site of interest. Third, make available a graphical and statistical critical analysis of the relative accuracy of each model. Fourth, allow users to evaluate how each model performs at different spatial scales.

The products of our work will therefore make it easier for researchers, stakeholders, and managers to critically evaluate technical information, as well as assist in selection of the model or protocol most suitable for the issue to be assessed. Once the model has been selected and verified, model output can be used to compare the relative magnitudes and fates of contributions from atmospheric, fertilizer, and wastewater nitrogen to estuaries. The model can also be used as a simulation tool to evaluate the potential of various management options to reduce the nitrogen load, or to tell managers the consequences of various development scenarios; for instance what would be the loads at buildout, or the effects on nitrogen loads to the receiving waters of different zoning restrictions on remaining parcels on a watershed.