Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT)

Model Evaluation: Implementation and Application

Introduction

The National Consortium for Rural Geospatial Innovaitions (RGIS) is a U.S. Department of Agriculture (USDA-CSREES) supported group working to improve the accessibility of geospatial technologies to rural communities through technology transfer, pilot studies, educational efforts and other approaches. As new geospatial technologies and tools are developed and released RGIS seeks to evaluate them concerning their utility to resource managers and associated decision making processes. The National Oceanic and Atmospheric Administration (NOAA) have recently released a new water quality assessment model called Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT). RGIS-Pacific Northwest has developed a comprehensive set of criteria to evaluate N-SPECT regarding its ease of implementation, ability to generate reasonably accurate data estimates, and its utility to resource decision making processes at the watershed scale.

Model Overview

N-SPECT is described by its creators as being a complex yet user-friendly geographic information system (GIS) extension. Its purpose is focused on providing additional decision support for coastal managers and local decision makers by estimating the potential water-quality impacts from nonpoint source pollution and erosion. Users first enter information about their area (land cover, elevation, precipitation, and soil characteristics) to create the baseline information. A useful aspect of the model is its ability to conduct alternative land development scenario analysis, thus enabling the user to get information about potential changes in surface water runoff, nonpoint source pollution, and erosion.

Applicability

N-SPECT was initially developed as a decision support tool for coastal managers in Hawaii and has since been applied in coastal areas around the U.S., the Caribbean, Central America, and the South Pacific. It operates most effectively in medium-to-large watersheds having low-to-moderate topographic relief. Although N-SPECT was initially developed for coastal applications, it can also be applied to non-coastal watersheds where land managers may want to estimate potential increases in surface water pollution entering local stream systems. The tool provides the following data output:

- Accumulated runoff, pollutant, and sediment load grids (event scale; annual)
- Pollutant and sediment concentration grids
- Pollutant assessment grid, which compares the resulting concentrations in receiving water to user-specified water quality standards
- Alternative land use scenario analysis

N-SPECT has been designed as an extension program to ESRI's ArcGIS 8.3 and 9.x and can be freely downloaded from its host webpage:

(http://www.csc.noaa.gov/crs/cwq/nspect.html)

Evaluation Criteria

The N-SPECT program has been evaluated based on a series of questions that relate to the programs installations, implementation, and applicability to resource decision support. For each question a score is provided on a scale between 1 and 5, and a written discussion is provided explaining the allocated score.

Scoring Strategy

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

N-SPECT Evaluation

1. **Is the model readily available and accessible from a financial perspective?**

   Rating: 3

   Somewhat: N-SPECT can easily be downloaded off the internet at no charge. However, it has been developed as an extension program to ArcGIS to be operable, and also requires Spatial Analyst (extension program of ArcGIS) to complete scenario comparison analysis as described in the user manuals. Both ArcGIS and Spatial Analyst could represent a financial barrier to implementation by local government offices and land resource decision making bodies that have limited budgets.

2. **Does it use readily available data or does it require site-specific measured data?**

   Rating: 3

   Yes and No. To initially get N-SPECT operational for a specific region, the model can use readily available geospatial datasets. The sources for these datasets are provided on the homepage via web-links. However, the technical guide advises that users should develop site specific pollutant coefficients. This requires stream flow data, measurement station geographic coordinates, pollutant measurements that should be recorded within the same time period as the stream flow measurements, and the application of a Fortran program that derives the pollutant coefficient values. The stream flow data and pollutant measurements may not be available for specific watersheds. Furthermore, the Fortran program that utilizes this information is not publicly available at this point in time. The user is left to use pollutant coefficient

estimates developed on a national scale, for a limited set of pollutants. The estimated pollutant coefficient values are available in a table within an appendix located at the end of the Technical User Guide. Little reference is given to point new users to this important resource. It would be helpful if an additional copy of this table was provided on the N-SPECT homepage within the 'Resources' section. This would enable users to easily find the pollutant coefficient values and get the model operational.

3. **Has the model been extensively tested under a variety of conditions and its accuracy proven?**

   Rating: 4

   Yes, the models incorporated within the N-SPECT model have been applied throughout the U.S. over a significant period of time. For example, the N-SPECT model incorporates the USDA-SCS's curve number approach to estimate runoff volumes. The erosion estimates are generated by applying the RUSLE method. As mentioned previously, the pollutant concentration and accumulation method incorporated within N-SPECT is dependent upon having access to the Fortran program that enables users to develop site-specific pollution coefficients. Without access to this program it is impossible to develop tailored coefficient values as described by the user manual. It should be noted that pollution concentrations and accumulated volumes/masses that are gnerated by N-SPECT are rough estimates at best and should only be used as a directional indicator, not a quantitative absolute value. This issue is discussed on page 30 of the 'Tutorial' document that can be downloaded from the N-SPECT homepage.

4. **Does it require calibration and does it rely on large amounts of parameterization?**

   Rating: 4

   The model doesn't require calibration for conducting general assessments. For instance, users may simply want to get an indicator of whether runoff volumes might increase/decrease based on a specified land use change scenario. The model can provide a rough directional indicator. However, if a comprehensive set of pollution and stream flow data are available, the model could be calibrated and validated to demonstrate its level of accuracy. Such testing would provide resource managers with additional confidence in the prediction capabilities of the model, thus improving its utility to the decision-making process.

   The parameters required to get the model running can for the most part be extracted from the input datasets that are freely available. As mentioned, the main weakness of the model lies in the inaccessibility to the Fortran program that allows users to

develop site specific pollution coefficients. These coefficient values are critical to the estimation of reasonable pollution values for a specific local region.

5. **Is the model linked loosely, closely, or tightly with the GIS on which it may depend for parameter development?**

   Rating: 5

   Yes, N-SPECT has been tightly coupled as an extension to ESRI's ArcGIS 8.3 or 9.x. The extension is easily incorporated as an additional menu item in the ArcGIS interface. The extension utilizes existing geospatial tools and scripts (e.g. watershed delineation) to extract various physical parameters to populate the curve number and RUSLE models. A helpful addition to the watershed delineation script would be the ability to 'burn' stream layers into DEMs, thus enabling the user to generate hydrologically correct characterizations of the stream network. The script to accomplish the 'burning' process is available via the ArcHydro Tools extension.

6. **What is the level of knowledge required for model operation and does the model have good user documentation available?**

   Rating: 4

   The user must be comfortable operating the ArcGIS program and managing associated input datasets. Furthermore, users must have a working knowledge of Spatial Analyst, an extension program of ArcGIS. To improve upon the functionality and usability of N-SPECT, it would be useful to incorporate the functions borrowed from Spatial Analyst, and have these directly embedded as a menu items within the N-SPECT tool bar. This would increase the ease of use of the program as users could be clearly led through the analysis process via menu items and dialogs. As it currently stands, novice GIS users may find it daunting to have to switch into Spatial Analyst to conduct the final analysis that sometimes involves scenario comparisons. Having said this, N-SPECT documentation is excellent and clearly outlines how users can conduct and interpret the output data generated by the model. There are two user manuals and two sets of tutorials describing: the model's structure; the assumptions of each approach incorporated in the model; the limitations regarding conclusions that can be drawn from the output data; and clear text and visual directions concerning the implementation of the program.

7. **What is the model's ease of use? For instance, have user interfaces been created to guide users through the application of the model?**

   Rating: 4

   Assuming the user has a good working knowledge of ArcGIS, N-SPECT is relatively straight forward to use. The input datasets are readily available and listed pollutant

cofficients contained within the user's guide allow the modeler to complete basic analysis quickly. The unavailable Fortran program that is described for developing site-specific pollution coefficients appears cumbersome and convoluted. It appears to be a separate program that requires the user to reformat data inputs using Excel. Hopefully once this program is fully functional it will be tightly incorporated within the N-SEPCT menu of tools.

Note: The learning curve will be steep and may initially be overwhelming if the user does not have a good understanding of ArcGIS/Spatial Analyst.

Summary

To summarize the evaluation of the N-SPECT model, it should be judged upon how well it achieves the objectives it was designed for. The technical manual states that N-SPECT was designed to allow users to examine relationships between land cover, nonpoint source pollution, and erosion. Its stated utility is to aid resource managers in understanding and predicting the impacts of management decisions on water quality. This program is very useful for providing general directional estimates of runoff volumes, erosion quantities, and limited pollution quantities and concentrations. However, if resource managers are interested in generating estimates that can be calibrated and validated, and whose accuracy can be assessed, a more comprehensive watershed program may be desirable. Although it should be stated that models which are more comprehensive often require increased amounts of parameterization. Developing site-specific datasets can be costly, and implementing more complex models will require staffs that have increasingly specialized modeling backgrounds. This is one of the strengths of N-SPECT, due to its incorporation of simplistic models (e.g. Curve Number, RUSLE) it is easily parameterized. It is feasible that staff GIS technicians and analysts could parameterize the model without much difficulty. Furthermore, due to the wide application of the approaches included within N-SPECT its application can be transferred to most locations within the U.S. The model was originally designed to be applied to coastal environments, yet it also has utility for anticipating the water quality impacts of proposed land use changes within land-locked basins. However, models such as SWAT, KINEROS may be more suitable in these locations.