ELM-Developer Responses to Peer Review Panel Report

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1.1 Overview

The Everglades Landscape Model version 2.5 (ELM v2.5) was peer-reviewed by a Panel of independent experts from July 2006 through January 2007. The ELM web site (http://my.sfwmd.gov/elm) provides links to all model documentation (Fitz and Trimble 2006), the processes and discussions associated with the peer review project, and the Panel's draft and final reports.

In their Final Peer Review Panel Report (Mitsch et al. 2007), the Panel concluded that the ELM v2.5 is ready for applications, indicating that the current version is "*...robust and will produce a unique contribution, with an integrated ecosystem paradigm, to understand and predict potential outcomes of Everglades restoration projects...*". In addition, that report included a variety of recommendations that would lead to improvements of future versions of the model.

The Panel was asked to prioritize their recommendations into those that were "essential" to successful application of the ELM v2.5, and those that were "useful" towards refining the model, but of lesser priority. Prior to applications for future scenario evaluations, we must follow through with one Panel "essential" recommendation that involves a relatively straightforward refinement to some of the initial condition data. Regarding this and other Panel comments, we generally concurred with all of the recommendations made by the Panel; in some cases (such as the need to collect new data or to increase funding), we could not make immediate and specific commitments for action, pending collaborative agreements with other researchers and stakeholders.

In this summary of our responses to the Recommendations in the Peer Review Panel Report, we outline the model/documentation refinements that we made for ELM v2.5 during the Peer Review, and the model/documentation refinements that we plan to make for ELM v2.6 and higher. In this summary, we only quote the leading (underlined) sentence for each Recommendation from the Executive Summary of the Peer Review Panel Report; each recommendation is associated with further explanatory text in the Executive Summary and in the detailed sections of the Panel report. Appendix A of this response document includes a brief listing of (December 2006) responses to all of the Panel comments for which some input from the Developers appeared warranted, including comments which were not part of the "essential" or "useful" Recommendations sections written by the Panel.

1.2 Essential recommendations

There were five "essential" Recommendations made by the Panel, one of which was specific to refining the ELM v2.5 in preparation for any immediate applications of the model in future scenario evaluations.

1.2.1 Essential for immediate applications

1.2.1.1 Refine initial-condition data

Recommendation: "Great care should be devoted to the specification of initial conditions and to examination of their effect on model results."

Response: *We will use the recommended method for initializing the model variables in future scenario applications, and the sensitivity of the model will be further documented.*

An early request from the Panel was that we provide model output-responses to severe "perturbations" of phosphorus inputs to the model. Twenty- and 100- year simulations of such perturbations showed that the initial conditions of several spatially-distributed (map) variables (of soil phosphorus concentrations and macrophyte biomass) could affect some model results for a decade or two, depending on location and the initial values (ELM v2.5 Documentation Report, new Chapter 11, Nov 22, 2006 draft).

The Panel recommended that the initialization of those input variables be refined to better reflect the most likely starting conditions of soils and macrophytes. During the December 6-7 Workshop II, the Panel discussed several methods that could be employed, and concluded that future scenario simulations could be most simply initialized with the end-of-simulation values from the ELM v2.5 historical (1981-2000) run. Additional sensitivity analyses could be made to further understand the implications of these initial conditions, but were not deemed essential, given the existing analyses.

For any future-scenario application of ELM, we committed to initializing the ELM for future scenarios with those recommended inputs. In addition, in the near future we will report on the results of (existing and) new sensitivity runs that employ a range of initial input values, further characterizing their effects on the phosphorus Performance Measures used in evaluating the model results.

1.2.2 Other essential recommendations

The remaining "essential" recommendations did not affect the application of the current version (ELM v2.5), but were deemed an essential part of the comprehensive documentation and/or future model/data development.

1.2.2.1 Document non-linear ecosystem dynamics

Recommendation: "Behavior of the Everglades itself and ELM are highly non-linear and sometimes non-intuitive so that behavior of the model must be diagnosed, documented, and thoroughly understood."

Response: *Chapter 11 "Model Perturbations" was drafted (Nov 22, 2006) during the Peer Review period: after relatively minimal editing, this Chapter will be formally incorporated into the ELM documentation set, meeting the Panel's expectations.*

1.2.2.2 Expand investment in ELM

Recommendation: "The SFWMD should continue to invest in the development and application of the ELM."

Response: *We will further invest in this modeling effort, with specific mechanisms to be determined in the near future.*

1.2.2.3 Use temporally-aggregated performance measures

Recommendation: "Model evaluation is best done with aggregated seasonal response variables due to limited data available for surface water concentrations in many parts of the Everglades."

Response: *The value of such temporal aggregation was emphasized in the ELM documentation and during the review process; the ELM performance will continue to be evaluated with such an approach. Moreover, several new spatial aggregations were drafted, and will be formally added to the ELM documentation.*

1.2.2.4 Use model to prioritize field sampling

Recommendation: "Use the ELM to specify or prioritize sampling sites and variables to optimize testing and diagnostics. Continued use of additional key variables to diagnose model performance in addition to the present two Performance Measures is especially encouraged."

Response: *Results from ELM were used (by SFWMD and University of Florida researchers) to aid in designing a soil sampling network for the Comprehensive Everglades Restoration Plan, and we encourage collaboration with field researchers in other future efforts.*

1.3 Useful recommendations

The remainder of the recommendations were categorized under the "useful" designation, As such, appropriate follow-up by model Developers was deemed to add to the model's utility, but such actions were not essential prior to applying the current model version.

1.3.1.1 Improve phosphorus inflow estimates

Recommendation: "Improve TP concentration boundary conditions."

Response: *While we concur that improved historical boundary inflow estimates for phosphorus may lead to improvements in model calibration-validation performance, past efforts in data analyses have led to the current method as the "best available".*

The high prevalence of missing data for phosphorus concentrations in managed flows (of water control structures) leads to significant uncertainties in hind-casting phosphorus dynamics within the Everglades. Over the years, significant efforts have been made, by a variety of stakeholders and agency scientists, to develop the best methods to fill in missing data observations for use in estimating daily inflow phosphorus loads to the Everglades region. Modification of existing methods would require a consensus among numerous stakeholders on the best improvements; we would welcome any such collaborative effort.

1.3.1.2 Collect new data on phosphorus accumulation rates

Recommendation: "Collect phosphorus accumulation data and validate the model in areas other than Water Conservation Area 2A (WCA-2A)."

Response: *We will urge colleagues with such soil analysis resources to consider this very important recommendation, as any such additional data would benefit dynamic and conceptual models for understanding Everglades history.*

1.3.1.3 Collect new data on atmospheric phosphorus loads

Recommendation: "Atmospheric loadings should be separated into wet and dry components, and incorporation of spatial variability should be attempted."

Response: *We will urge colleagues with such atmospheric analysis resources to consider this recommendation, as any such additional data would benefit dynamic and conceptual models for understanding the spatial and temporal variability of "background" loading rates.*

1.3.1.4 Use broader literature on wetland models

Recommendation: "Wetland modeling literature outside of papers published on ELM itself should be evaluated and referenced for appropriate algorithms."

Response: *We will update the text and references in the Model Structure Chapter 5 to better represent the models that were evaluated during the ELM development and refinements. In the interim, see Fitz et al. (1996) and Fitz and Sklar (1999) for more of the literature references used in model development.*

1.3.1.5 Simplify habitat types

Recommendation: "The habitat division given in the model description should be simplified to a suite that can be simulated effectively."

Response: *We concur that the apparent complexity of the habitat parameterization of the ELM v2.5 application can and should be reduced. A reduced number of habitats will be used for future applications (e.g., ELM v2.6).*

See the Chapter 4 Addendum, (posted on ELM web site Nov 30 in the "Implementation: v2.5" subtab), showing that further habitat aggregation did not significantly reduce the actual parameter complexity of model, given the existing levels of parameter aggregation. Simulation results under a 10-habitat scenario were difficult to distinguish from the ELM v2.5, 28-habitat simulation. Research goals are to continue to summarize ecosystem processes in ca. 28 habitat types of the region.

1.3.1.6 Improve tidal boundary condition data

Recommendation: "The downstream tidal boundary condition (monthly average of astronomical tides) should be improved for two reasons."

Response: We *concur that the ELM v2.5 does not have tidal boundary conditions that are appropriate for predicting dynamics associated with fine/intermediate temporal scale interactions with estuarine regions. Other modeling projects have developed fine-scaled tidal observations for most of area needed, and we will acquire those data for applications involving estuarine interactions.*

For landscape evaluations at long temporal scales, the ELM v2.5 uses prototype (NOAA predicted) daily tidal data that were generated for the Regional Simulation Model (beta) development, which were then aggregated into monthly, annually-recurring means, replicating the method used in the regional South Florida Water Management Model (SFWMM).

1.3.1.7 Apply ELM in STAs

Recommendation: "Use the model to assess the effectiveness and spatial variability of phosphorus retention and spatial patterns in the STA (stormwater treatment area) wetlands that are being constructed to protect downstream Everglades."

Response: *We concur that the ELM design is such that its application in STAs could provide valuable information on their long-term dynamics. Lessons learned from such applications should also improve the ELM capabilities in general. A significant investment of effort in data synthesis would be involved with such an extension of the ELM, and such an extension may be feasible depending on the public/client needs.*

1.3.1.8 Compare performance to other models

Recommendation: "Model statistics such as bias and root-mean-square (RMS) error should be compared with other ecosystem models, in the Everglades and elsewhere."

Response: *Performance comparisons were made with the only other "water quality" model of the Everglades (ELM documentation Chapter 6, p 6-5). We will attempt to develop other comparisons, using literature suggestions provided by the Panel.*

1.3.1.9 Develop a formal uncertainty analysis

Recommendation: "A formalized uncertainty analysis should be developed that will place model predictions within a probabilistic framework that can be combined with other indicators of appropriate restoration scenarios."

Response: *We concur that it would be very informative if formal uncertainty analyses were developed for all models used in Everglades restoration. The ELM v2.5 code and data files were specifically designed for ensemble simulations to evaluate the influence of changes to model parameters and initial conditions.*

The design of a formal uncertainty analysis is a significant undertaking that should consider the restoration project(s) goals relative to the multitude of uncertainties in future projections of south Florida dynamics, and be an inclusive process for multiple models and data analyses. Thus, this effort should focus not on a single model, but also involve the other hydrologic and ecological models that are currently in use for CERP and other Everglades applications.

We anticipate that we can develop collaborations to develop simple ensembles of uncertainty runs for analyses using the recommended Generalized Likelihood Uncertainty Estimation method, employing a reduced parameter set obtained from the results from the current sensitivity analysis (Chapter 6 of ELM documentation).

1.3.1.10 Further evaluate performance along canals

Recommendation: "Evaluate the source of positive bias in TP concentrations under high TP values near canals."

Response: *Variability of observed data generally increases with increasing P concentration, and model bias generally increases in magnitude with P concentration. The regional scale application has a 1 km minimum path length due to grid scale, and a number of monitoring sites in the fine scale gradients are contained within the grid cells that directly exchange water with source canals (Model Performance Chapter 6, Figure 6.1b).*

See Model Performance Chapter 6 discussion, and the enhanced spatial summary document posted on ELM web site, Sep 21, 2006, in "Implementation: v2.5" subtab. We anticipate that we can further refine the spatial and temporal summaries of the model performance with the next documentation update.

1.3.1.11 Use volume/depth weighted statistics

Recommendation: "In addition to the arithmetically averaged TP concentrations, volume (or depth) weighted averages for wet and dry periods should be used to better compare TP water column mass during these times."

Response: *We concur that this is a useful approach, and reported depth-weighted statistics in the ELM v2.1 Calibration Report (2002). Their use had been questioned by stakeholders, and subsequently dropped for characterizing performance of ELM v2.5.*

See the improved model performance when considering depth-weighted vs. unweighted calibration statistics for surface water phosphorus concentration, in the ELM v2.1 Calibration Report on the ELM web site, in the "Documents: v2.1" subtab.

1.4 Literature cited

Fitz, H. C., E. B. DeBellevue, R. Costanza, R. Boumans, T. Maxwell, L. Wainger, and F. H. Sklar. 1996. Development of a general ecosystem model for a range of scales and ecosystems. Ecological Modelling **88**:263-295.

Fitz, H. C., and F. H. Sklar. 1999. Ecosystem analysis of phosphorus impacts and altered hydrology in the Everglades: a landscape modeling approach. Pages 585-620 *in* K. R. Reddy, G. A. O'Connor, and C. L. Schelske, editors. Phosphorus Biogeochemistry in Subtropical Ecosystems. Lewis Publishers, Boca Raton, FL.

Fitz, H. C., and B. Trimble. 2006. Documentation of the Everglades Landscape Model: ELM v2.5. South Florida Water Management District, West Palm Beach, FL http://my.sfwmd.gov/elm

Mitsch, W. J., L. E. Band, and C. F. Cerco. 2007. Everglades Landscape Model (ELM), Version 2.5: Peer Review Panel Report. Submitted January 3, 2007 to the South Florida Water Management District, West Palm Beach, FL. http://my.sfwmd.gov/elm (Peer Review: Comments tab).