Appendix D – Task Force Papers
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Planning Models Improvement Program

D-1 What's a Planning Model?

What is a model?

A model, in simple terms, is an abstraction or simplification of reality. Models are created to help understand and/or predict something that is unknown. Models provide a rationale for making decisions with less than complete and perfect knowledge. Models typically consist of a set of the most critical components of the system to be understood. Models can be general, precise or realistic, but, by definition, they cannot be all three. Models can be so complex that they require advanced degrees to comprehend and use or they can be as simple as a spreadsheet created in Excel or some other standard format. Models are created to help make rational judgments about an unknown future.

What a model is and what it will do is a function of the builder, the data used, what the model will be used for, and the level of commitment of the model user. The classic term used to describe the weaknesses of models is: garbage in = garbage out. Too often, the "garbage out" product is seen as a fault of the model, rather than the deficiencies of the user or the inadequacies of the input data. Thus, models are often viewed as objects of dislike and even fear (they contain math). Non-users describe models as unintelligible black boxes to be avoided and even a useless waste of time and money. Advocates, on the other hand, recognize that without models, logic, rationale, and a desire for replicable results are not achievable. There are lessons to be learned from these disparaging remarks about models, such as: garbage in does equal garbage out; user knowledge and commitment are REQUIRED for successful applications; models are a simplification of reality (they are NOT exact science, they are NOT 100 percent accurate, and they are BETTER than a coin toss.) The "black box syndrome" tells us that models need to be transparent.

What is Planning?

Before defining a planning model, perhaps we should define Planning. Planning is a way of looking at possible futures that should reflect the norms and goals of society. Planning should help society decide upon a desirable future. Ultimately, planning should define pathways to achieve that future.

What is a planning model?

Planning models are a subset of models. The difference between a planning model and a model comes down to the uses of the model. Planning models are used by planners to help them better understand the problems they are attempting to address and to make decisions about the future use of resources. Planning models provide a systematic approach to problem solving. A good planning model would be a model that is easily understood, widely accepted and used to the point that different groups using the same models and input data and having the same level of commitment to an outcome, would derive the same or very similar conclusions. Planning models simulate future conditions, both with and without proposed projects. They project consequences of actions and help to place a priority on actions and data needs. They combine knowledge from different sources into new knowledge and help to identify missing information. Planning models often address demographics of people, places and resources, and they consider the economic consequences of actions. Planning models attempt to characterize the future by selecting key variables and making educated assumptions about those variables. These models attempt to represent the outcomes of human behavior and actions over time. Thus, it shouldn't be surprising that results of models do not always predict what actually happens over time. Models can also be a tool for teaching, learning, communicating information and ideas and consensus building among team members and others involved in the planning process. Some models are standardized and used by hundreds of analysts on a regular basis, while others may be developed for a specific task and be discarded afterward.

The concept of "planning models" relates more specifically to applications within the Corps of Engineers. Planning models are defined as any model that planners use to address water resource management issues and to support decision-making. Corps planners rely on models from many technical disciplines to support their work: hydrology and hydraulics, structural engineering, biology, ecology, economics, public involvement, and many others. In some cases planners apply the models themselves, while in many other cases specialists from other disciplines (or parts of the organization) perform the modeling and provide the results to the planners.

In addition to models, planners utilize any number of other helpful aids that fall under the broad category of "analytic tools." Like models, these tools are used in planning analysis that supports decision-making. These tools may help with routine mathematical computations, such as computing interest rates, converting Metric units to English units, or standardizing elevation observations across datum. The line that divides analytic tools from models may not always be distinct, but they are mentioned for the purpose of inclusion to assure that all of the important aids to planners are considered in this effort.

What are the benefits of models?

Models add a sense of logic or rationale to problem solving and decision-making. Some of the benefits of modeling have been expressed by New York District and are captured here. Models provide an explicit expression of our assumptions and understanding of an entire system. They help a planning team to focus on issues that may or may not be address in the absence of a model. In essence, models help the planning team to expand their thoughts on a problem. Models help to organize the information concerning the components of a system. They help to reduce the complexity of the problem by focusing on the critical elements. Models describe explicitly the linkages among sources of stress in a system, thus helping to further understand the influence of critical elements. This later function becomes more important when addressing the less well understood aspects of cause and effect relationships in ecological systems. Better understanding of these relationships help to provide a template for generating environmental impact matrices.

General Typology

This section presents a typology of models to better describe the universe of models applicable to the Planning Models Improvement Program. The typology has been adapted from Morrison et al (1992) who developed a useful typology for ecological output and wildlife-habitat models, one that is often used in the literature as a means of describing the general attributes of models under consideration for use in environmental benefits realized from ecosystem restoration measures. As shown in Figure 1, this typology is organized according to model type, form, complexity, and common purpose within two broad categories, empirical and theoretical, which are briefly reviewed in turn below.

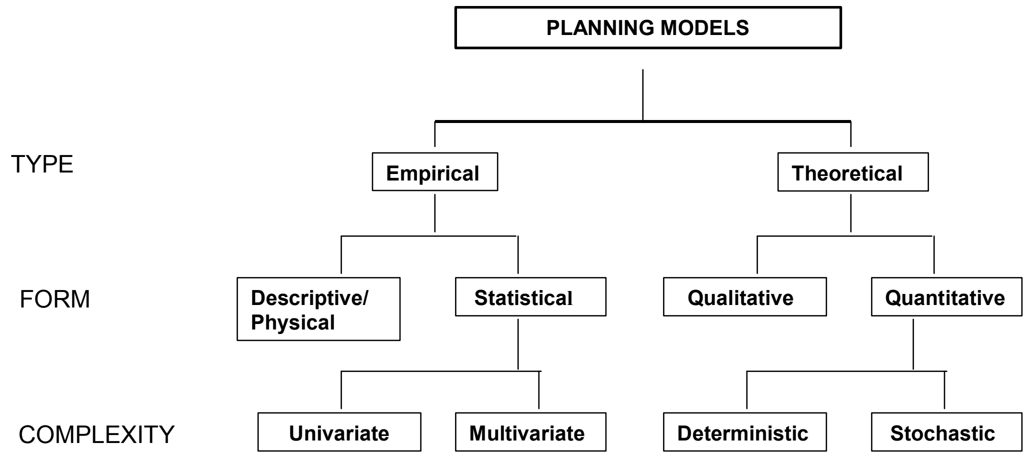

Figure 1. A model typology potentially useful for planning models based on the Morrison et al. (1992) typology for wildlife-habitat model typology.

Empirical models

Empirical models are developed directly from individual field observations (data) from which generalizations are made about pertinent relationships. The logic is inductive--developing general patterns of behavior from individual observations. A specific model structure is developed from the information drawn from case studies and samples of field conditions. Empirical models may be descriptive or statistical.

Descriptive models

Descriptive models are either physical models or word descriptions. Physical models may be smaller scale representations developed with or without the aid of photographs, text, architectural drawings, schematics and other description. Generic descriptive models are commonly used in natural resources management. Stream, wetland and various vegetation classifications are examples of generic descriptive models that have been used to guide habitat development in situations where mathematical precision is not needed.

Statistical models

Statistical models start with samples taken from a "statistical universe" of all possible samples for the variable of interest. From these samples a quantitative model of variable distribution is integrated inductively. The model describes the form of the relationship and the fraction of the sample distribution that is explained by the modeled relationship. While statistical models describe relationships they do not necessarily describe cause and effect. Statistical models are desired over theoretical models when there is an existing understanding of cause-and-effect mechanisms and high demand for predictive precision at a specific location (Grant et al 2000). The more that conditions extend beyond the location and conditions sampled, the less confidence there is in the predicted result. Even so, statistical models often are used to predict effects under conditions different from those for which the models were developed.

Statistical models can be **univariate,** defining relationships between two variables, or **multivariate,** defining relationships between one dependent variable and several independent variables.

Theoretical models

Theoretical models are developed from the general "fit" of behavior to some theoretical form. The logic is basically deductive; i.e., predicting specific outcomes from observed or anticipated actions into assumed general patterns of response. The coefficients used in the general model form are often calibrated to more precisely fit site-specific interactions observed in local conditions. Theoretical model forms provide a general structure for characterizing properties that appear to be held in common in many different field situations. The models may be either mathematical (quantitative) or non-mathematical (qualitative).

Qualitative theoretical models

Qualitative theoretical models start with a concept of structural and functional cause-and-effect relationships integrated deductively from real-world observation. These differ from models describing a case-study situation by integrating a general model of structure and function from elements held in common in many case studies. Such models often pull together sequences of cause-and-effect relationships forming compartments or components. Qualitative theoretical models are conceptual and diagrammatic, often presented as material, energy and information flow diagrams when modeling ecosystems. The generic attributes of the model are applied to the specific conditions under study using local environmental conditions to calibrate the model.

Quantitative theoretical models

Quantitative theoretical models fit mathematical equations to qualitative theoretical models of cause and effect relationships. Numerical outputs are calculated from input variables using a mathematical equation for the each relationship. In complex models of ecosystems, for example, chains of equations produce outputs that serve as inputs for other equations. Quantitative models can produce static, time-independent results or time-explicit, dynamic results by introducing a time-step component sequence. Similarly, such models can be made spatially dynamic through a combination of spatial and temporal components. In contrast to statistical modelers, theoretical modelers typically seek to generalize fixed-input relationships across a wide range of conditions.

Quantitative models include **deterministic models** that produce exactly the same results with each execution under the same initial conditions and inputs; they incorporate no uncertainty in output. Under the same model configuration and input conditions the outputs are identical. However, algorithm coefficients often can be varied within a range of values representing statistical confidence to assess the sensitivity of model outcomes to uncertainty in the input information. Alternatively, a range, confidence interval, or other measure of variation may be generated with a mean or median result. However, the output, including any variance measure, is always the same given the same model condition and input.

Quantitative models also include **stochastic models** that add complexity to outputs by including uncertainty of result in model performance. This is accomplished by incorporating statistical measures of variance and Monte Carlo or other random process for selecting model elements from the statistical distribution. Stochastic models include one or more variable elements causing the results from repeating the same model run to vary according to the distributions of sample variation entered for each parameter in the model. Multiple model runs produce a probability distribution for model outputs. While stochastic model elements often are inductively derived from samples, they are not invariably so. For example, an underlying theoretical distribution can be fitted between the extremes of an observed range of values.

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D-2 Frameworks for Organizing Models

Introduction

All models used in Corps water resources planning studies and projects are used in at least one component part of each of seven broad categories. A matrix structure was selected to organize these models and to set the framework in two dimensions. The matrix rows are the list of all applicable models and the columns are the individual components of each of the seven categories. The individual components could also be considered model attributes. The seven categories include the following: 1) business programs or communities of specialized expertise (also known as project purposes); 2) Planning technical capabilities, functional areas of expertise, or communities of practice; 3) six steps of the planning process; 4) civil works planning phases; 5) civil works planning scale; 6) geographic applicability; and 7) model types. The components of the seven categories are described in the following sections.

Description of Model Categories

Corps Business Programs

Corps Business Programs: The Corps business programs are also known as project purposes or more recently referred to as communities of specialized expertise. The components of this category include studies and projects for this Administration's high budget priority mission areas and other Corps water resources mission areas of navigation, urban flood damage reduction, aquatic ecosystem restoration, hurricane and storm damage reduction, water supply, hydroelectric power, recreation and multi-purpose projects. Some of these major components can be further subdivided as indicated in the list below.[1]

1. Navigation
    a. Ports and harbors
    b. Inland waterway system
    c. Dredging

2. Flood and coastal storm damage reduction

3. Ecosystem restoration

4. Water supply
    a. Municipal and industrial
    b. Agricultural

[1] IWR Report 98-R-3, "Civil Works Program," May 1998.

5. Hydroelectric power

6. Recreation

7. Multi-purpose

Planning Technical Capabilities

Planning technical capabilities are also known as functional areas of expertise, and more recently as communities of practice. These are the essential technical knowledge areas and skills that are at the heart of the Corps' ability to successfully conduct water resources planning and include plan formulation, environmental sciences, economic analyses, social sciences, public involvement, and interdisciplinary areas. Many models can be found in these areas.

Six Steps of the Planning Process

The Water Resources Council's Principles and Guidelines (P&G) state that "the Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements." This is the primary objective of the Federal water resources planning process. The Corps water resources planning process consists of a series of six steps that respond to the problems and opportunities associated with the Federal objective and specific state and local concerns and culminates in the selection of a recommended plan. The six steps and brief descriptions are presented below.

Step 1. Specify problems and opportunities. The problems and opportunities are framed in terms of the Federal objective and specific state and local concerns.

Step 2. Inventory and forecast conditions. The inventory and forecast step quantifies and qualifies the planning resources important to the identified water resources problems and opportunities, now and in the future in the absence of a plan.

Step 3. Formulate alternative plans. Various alternative plans are formulated in a systematic manner to ensure that all reasonable alternatives are evaluated.

Step 4. Evaluate effects of alternative plans. The evaluation of effects is a comparison of the with-project plan and the without-project plan conditions for each alternative.

Step 5. Compare alternative plans. The differences of the alternative plans are compared.

Step 6. Select recommended plan. The culmination of the planning process is the selection of a recommended plan or decision to take no action.

Planning phases

There are three planning phases in civil works that are significant in this effort for model improvement. The phases are the reconnaissance phase, feasibility phase and the post-authorization phase.

1. Reconnaissance Phase. In the reconnaissance phase, the objectives are to: 1) determine if water resources problems warrant Federal participation in feasibility studies; 2) define the Federal interest; 3) complete a Section 905(b) Analysis; 4) prepare a project management plan (PMP); 5) assess the level of interest and support from the non-federal entities; and 6) negotiate and execute a Feasibility Cost Sharing Agreement (FCSA).

2. Feasibility Phase. The purpose of this phase is to fully define problems and opportunities, describe and evaluate alternative plans, and fully describe a recommended project.

3. Post-Authorization Phase. The reconnaissance and feasibility phases are usually completed prior to a project being authorized for construction. The post-authorization phase covers studies required after a project has been authorized for construction.

Planning Scales

Planning scale refers to the geographical scale of model applicability. The three scales for models are classified as site, local and watershed.

1. Site. Site models are typically for small projects under the Continuing Authorities Program.

2. Local. Local models are for specifically authorized studies, also known as "level C" studies in the "Principles and Standards for Planning Water and Related Land Resources" published by the Water Resources Council.

3. Watershed. Watershed models are typically General Investigations funded and cover a much larger area that is either basin wide (level B) or even larger (level A).

Geographic Applicability

Models can be applicable for a very specific region or nationally.

1. Regional. A regional model is usually developed for a given area and is not readily transportable to another location. It can often be referred to as a "homegrown" model and would have a location associated with it.

2. National. A national model is one that is developed for application anywhere in the nation.

Model Types

Model types can be classified as models used by planners (planning models), models that provide input to planning models (Model Type A) and models that receive input from planning models (Model Type B).

	Output	Input		Output	Input	
Model Type A	→	→	Planning Models	→	→	Model Type B

Summary

This section identifies the major categories of organizing models and suggests a two-dimensional framework of models, and categories and components. Other categories and components may be added as needed. Some categories or components could be eliminated if not required to describe the planning models being used.

D-3 Planning Model Problems

During the first Task Force meeting (15-17 April 2003) members brainstormed and discussed a variety of issues related to planning models, including: the definition of a planning model, criteria for a good model, frameworks for organizing models, whether or not models should be mandatory, peer review of models, and a model inventory. As a result of those discussions the Task Force identified a wide variety of modeling problems. These were grouped by causes that led to the problems, modeling-related problems (including inputs, models, users, results, and support), and the effects of the problems. Some of the specific problems identified by the Task Force follow a summary of recent critiques of Corps' modeling and analysis by others.

Critiques by Others

Many of the problems and conditions that have affected the state of Corps' planning models have been identified and documented in recent reports by interests outside the Corps. For example:

In 2001, the National Research Council completed its review of the Corps' Upper Mississippi River – Illinois Waterway inland navigation study. The Council praised the Corps' theoretical spatial equilibrium model, noting that, "This system model represents a major advance over previous economics models used by the Corps to forecast barge traffic". The Council went on to criticize the Corps' ESSENCE model for not using the more important concepts of the spatial equilibrium model, and warned that, "The problem lies not in the theoretical motivation behind these models but in their implementation and data used as input". (NRC 2001).

In the Water Resources Development Act of 2000, the Congress requested the National Academy of Sciences to "make recommendations relating to the independent peer review of [Corps'] feasibility reports". In response, the Academy included a recommendation that "reviews [of Corps' reports] should be conducted to identify, explain, and comment upon assumptions that underlie economic, engineering, and environmental analyses, as well as to evaluate the soundness of models and planning methods" (NRC 2002).

A General Accounting Office report to the Congress on the Corps' navigation channel deepening project for the Delaware River found that "the Corps' analysis of project benefits contained or was based on miscalculations, invalid assumptions, and outdated information…While the Corps has established procedures to ensure that its benefit-cost analyses are fundamentally sound and properly prepared, in this case at least, the process was ineffective in identifying significant errors and analytical problems" (GAO 2002).

In addressing the Corps senior leaders in August 2002, Mr. James T.B. Trip, General Counsel of Environmental Defense, challenged the Corps to "use nationally respected economic models to restore credibility to Corps economic analyses" (Tripp 2002).

A critical review of the Florida Keys Carrying Capacity Study by the National Research Council praised the "pioneering effort" in developing a Carrying Capacity Analysis Model (CCAM), but concluded that, "Endeavors such as the CCAM tend to obscure significant scientific uncertainty and project an unrealistic understanding of complicated environmental issues. What is needed and what the committee would like to express in this review are expert opinion, common sense, and stakeholder consensus" (NRC 2002).

Causes of Problems – Why?

The Task Force noted a wide range of conditions that have cumulatively contributed to problems with planning models. These include the following:

Lack of Review

The decline of review of Corps' planning products over the past several decades is well documented in the National Research Council's "Review Procedures for Water Resources Project Planning" (2002). The Task Force noted that planning models have unavoidable suffered as they have been used and pushed forward without an adequate check of their soundness. Local "independent technical review" (ITR) generally focuses on model results and is usually not up to the task of validating the scientific validity of a model. External peer review of models has generally been left to the discretion of model developers. There is no business process or requirement in the Corps to review, validate and certify planning models that are relied on to provide advice about making wise investments of Federal funds in water resources projects.

Changing Planning Capability

Planners with extensive training and experience in developing and using models continue to retire and be replaced with a more mobile and less experienced work force. Next generation models must be able to be learned quickly and to be understandable to both technical and public interests. Certainly not every planner and probably not every office can be expected to have the capability to use the full range of models needed to inform (don't think inform is the word, but not sure what to replace it with) the planning process.

Focus on Project Delivery

The Corps' focus on delivering projects to non-Federal cost sharing sponsors ("customers") on time and within budget is seen by some as coming at the expense of adequate analysis and commitment of the study team to technical issues. Models may be abused or manipulated and their results may be misinterpreted or ignored in the interest of "giving the customer what they want".

Model Development

Historically, there has been no coherent model development process in the Corps. Many "homegrown" models have been developed out of necessity on an ad hoc basis for individual studies and projects. At the national level, models intended for nationwide application have been developed through the Research and Development program, which has seen planning and engineering-related funding decline from almost $30 million in FY 1993 to about $19 million in FY 2003. There is no major focus in the Research and Development program on planning models. Different people develop both local and national models for different purposes, and there is no standardization among models such as there is among the common Microsoft office programs.

Attitudes

The development and use of models often suffer from a "not invented here" attitude that places off-the-shelf models developed by others at a disadvantage. In addition, we may have an unrealistic expectation that a model will be the be-all and end-all solution when it was never intended to be so.

Model Input Problems

Inputs are the empirical data and assumptions that fuel a model. Models may be selected without enough attention to what it will take to use them. Consequently, some models require seemingly infinite amounts of input. The question "Can we afford to care for and feed the model?" should, but may not, be answered after considering:

- Financial cost to develop input required by the model.
- Time (including duration and timing) required for developing input required by the model.
- Type and level of expertise required for developing input required by the model.
- Quality of the input required by the model, including questions related to data uncertainty, accommodating incomplete data, and review of model inputs.

Model Problems

Theory

A model may be based on incomplete or inappropriate scientific theory. We may lack an understanding of the theoretical basis for model computation. We may not be able to point to accepted scientific theory, testing and assumptions that support the model. The model may not be an adequate abstraction of real world conditions, and may not produce and replicate data that is close enough to reality.

Computation

A model may include incorrect computational routines – "bad math" – and therefore, not calculate correctly**.**

Scale

A model may not be sensitive to the scale of the problem at hand. Study scales range from the very site-specific ("CAP-scale"), to local ("GI-scale") to regional ("watershed" and "comprehensive" scale). Models may be too demanding and expensive for small-scale problems, or inadequate to address larger and more complex problems. One model size does not fit all.

Robustness

A model may be limited to typical or average types of problems and may not work well "in the tails" of extreme or uncommon conditions. It may not be durable over time, accommodating transition and turnover of personnel in the organization as well as changes that occur during the course of a study. A model may be inflexible and difficult to improve to incorporate local variations, updates over time, and different scales of complexity and geographic area.

Complexity and Simplification

A model may be overly complex in terms of, for example, inputs, computations, and interpretation of results. On the other hand, a model may oversimplify what it is attempting to represent.

Efficiency

In addition to the costs of model inputs, a model itself may be expensive, in terms of financial costs, time and expertise, to develop, modify, and apply.

Reliability

A model may not be dependable in delivering and getting the job done as expected. Does it work? Does it do what it says it's going to do; does it do what it's supposed to do? Can you count on it?

Communication

A model may be a "black box" in which it is not easy to understand what it does, how it does it, what it requires, and what its results mean. Model limitations, assumptions, risks and uncertainties may not be clearly handled. Users may have difficulty in learning how to use and explain the model.

Difficult to Use

A model may not be user-friendly and just too hard to use for a variety of reasons, including, for example: burdensome data input requirements, lack of understanding by the user, poor instructions about how to use the model, and unintuitive or illogical procedures.

Linkage

Models are usually developed by different people for different and unrelated purposes, therefore models aren't linked and don't talk to each other when they should or could. Models don't link or fit well together; it's difficult to handoff data between models. Few models are compatible.

Early Identification

Very early in a study, and before a Project Management Plan can be completed, models must be identified and decisions and commitments must be made about their use. It is difficult to make those decisions and commitments when new local models must be developed.

Model Gaps

Some models don't exist; others do exist but we in the Corps don't use them. General categories of model gaps identified by the Task Force include:

- Environmental/ecosystem restoration analysis.
- Monetary valuation of environmental benefits.
- Plan formulation.
- Trade-off analysis, including NED-NER trade-offs.
- Public involvement.
- Forecasting.
- Models for large-scale watershed studies.

Model User Problems

Qualifications

People have limitations. Even within disciplines, not everyone is equipped with the education, training and experience necessary to use every model, and it is not realistic to expect them to do so.

Outputs

Some users may not review model outputs, or don't understand the outputs, or cannot properly interpret the outputs, or have difficultly in communicating the results. Some simply can't or don't understand if the results make sense.

Corporate Communication

Users find it difficult to learn what models are available for a given task, and what is being used elsewhere. There is no central point of contact for information and advice about planning models.

Human Error

Even the best user and model are not immune from unintended typos, omissions, and other errors.

Miss-use

Users may use the wrong model for the task at hand, or, they may use the right model but use it incorrectly or outside its limitations. In some instances models may be intentionally misapplied.

Turnover

Some locally developed models may not be well documented and are dependent on the knowledge of a single person for their use and explanation. When that person leaves it's usually difficult if not impossible to successfully use the model again.

Thinking

Some users may depend too heavily on models as substitutes for good clear thinking, rather than using the models to inspire creative thinking and improve their advice to decision makers.

Model Results Problems

Understandable

Model results may be difficult to understand and interpret, and difficult to communicate to lay persons. Results may lack helpful interpretive presentations such as tables, figures, graphs, maps and animation.

Believable
Do model results make sense? Do they pass the "red face test" and the "laugh test"? Results that don't make sense are probably not believable.

Useful
Even perfect model results may not fit the study at hand, and therefore, may not be useful in informing and advising in the decision making process.

Model Support Problems

Communication
It is difficult to exchange information about what models exist, and what models are in use, both inside and outside the Corps. Consequently, users may not know what models are available, what's been used successfully, and what not been successful.

Documentation
Many models lack adequate documentation. Manuals, instructions and other guidance may be hard to find, out of date, or nonexistent.

Training
Much like documentation, many models lack adequate supporting training. Workshops, classes, on-line courses and other training should be of adequate quality, and readily available at fair cost so that users can get up to speed quickly.

Maintenance
Few models receive adequate ongoing maintenance and rehabilitation, including user-friendly technical support. Maintenance includes remedial fixes based on testing and field applications, and state of the art updates and upgrades. Many times there is no responsible party or a way to pay for model maintenance.

Effects of Problems – So What?

Situational
Many models are ad hoc and unique to local problems and situations in the districts implementing the studies. Many are site and project specific. Large-scale models are not nationally applicable. If a model is computer-based, it may not be able to be used on a different computer. As a result, models have limited application and may not be portable from study to study or from district to district.

Redundancy

Situation models and poor communication about what models exist has resulted in some duplication, with multiple models doing the same thing (some probably less better than others).

Inconsistency

Few models are recognized and used nationwide, and no planning models are required to be used in all cases. Model use is not consistent over geography, over time, from office-to-office, or from analyst to analyst. This unavoidably leads to inconsistency in formulation, evaluation, policy application, and decision-making.

Replicability

In some cases, different model users or reviewers may not be able to replicate model results due to poor documentation, user error, or other factors.

State of the Art

Some models are outdated and do not reflect the state of the art or best practices. They may no longer be the based on the best available science and best tool available for the job.

Useful

Models and their results may not be useful in informing and advising decision-making, and meeting requirements of law or regulations. They may represent the technology or data available or affordable, which may not necessarily address the specific questions unique to a given study. Models need to fit the study at hand.

Credibility

The holistic result of these problems and other factors is that the credibility of Corps' planning analyses has suffered and recommendations are not necessarily accepted as being based on good science. There has been loss of trust in and acceptability of Corps' planning modeling and its results, and a sense that models may not withstand professional and public scrutiny.

D-4 Criteria for Good Models

Introduction

The U.S. Army Corps of Engineers uses a wide variety of models to make investment decisions about projects that have a Federal interest. The models are used to represent some aspect, situation, or problem of the real world. The models attempt to estimate and forecast variables that are not readily known. The results of Corps modeling provide the information necessary to make decisions regarding authorization and appropriation of water resource projects.

Planning models are a subset of the models used by the Corps. These models incorporate several levels of sophistication. Regardless of the level of sophistication, it is imperative that the Corps have and use good planning models. It is equally important that appropriate models are selected for use in various types of planning studies. Criteria for good models are therefore essential for the assessment and model validity and thus their approval for use in water resources planning. The following is a general discussion of the criteria for these models.

Criteria for Technical Soundness

The most important criterion for a model is its ability to represent or simulate the piece of the real world for which it was developed. In other words, does it work? Does it do what it purports to do? For a model to work correctly its underlying theory and computation must be correct and data used must meet what is required for adequate representation of the circumstances being modeled.

Theory

For a model to work, the architecture of the model must be based on validated and accepted theory (e.g. mathematical, economic, scientific, etc.). Models used by Corps of Engineers planners should employ what is currently accepted as "state of the art" theory. While this may not have changed for some time, Corps Planning models need to embody theory that is current and utilizes the best available science. Planning models need to incorporate in their design the policy and regulations the Corps adheres to for the type of study being conducted (e.g. risk analysis in models for flood damage reduction studies). If the model is a computer program, verification that the conceptual theory has been correctly incorporated into the code for the program must take place.

Transparency of the model's functions and processes are therefore important not only for model review but also so that the model is not a "black box" for its users. The source code of the model must be provided for an appropriate review. Experts should perform the review. They would verify the model for the purposes and situations it was constructed to address. An independent data set should be used. Additionally, input requirements for model use need to be verified. A beneficial outcome of model review can be the identification of the most critical or key input variables. The identification of these variables would assist both the users and the study reviewers.

Assumptions of the model cause deviation from the theoretical ideal. Assumptions regarding the underlying theory of the model should be identified. The reasonableness of these assumptions should be evaluated and compared to what is known about real world conditions. The implications of assumptions made should be well documented in terms of biasing and reducing the accuracy of the model's results. Because no model can perfectly reflect the situation that is being modeled, it is appropriate for the review to address model limitations and potential manipulations of the model to accommodate project specific conditions.

Computational Correctness

It is essential that the functions and processes of a model be computationally correct for the underlying theory to be correctly applied and for a model to be technically sound. Included in computational correctness are not only employment of proper functions and mathematics, but also the ability of the model to estimate and forecast the actual parameters that it is intended to provide. Assessment of the mechanics of the model, including the computer program's code and routines, is therefore necessary to determine the model's validity. "Valid" is defined as "well-grounded on principles or evidence; able to withstand criticism or objection as an argument; sound." Software validation should be based on numerous runs with varied data inputs. Different users should be able to produce a range of outputs that can be consistently estimated and statistically replicable. Models need to be thoroughly reviewed and accepted by scientific peers for approval and validation. Once a model is assessed and approved, users should be able to assume that model functions are valid within the limitations of the model.

Criteria for Usability

Usability is important for the practical application of the model. If a model meets its stated purpose well and yet is very difficult to use, it may be avoided and a less accurate model may be selected. In addition to model selection, efficiency, effectiveness, support, documentation, data preparation, and output interpretation are important factors in model usability.

Model Selection

Model selection should be made early in the study process. The primary criterion in model selection should be the degree to which the model replicates the situation in question and accuracy of information provided for making necessary decisions for Federal actions. To that end, the scope of a model's applicability should be understood. It is important to recognize the aspect of the real world along with the specific problem that the model is attempting to represent. A model is not a perfect representation of reality. Limitations that are inherent among different models directly affect their scope and applicability. Robustness of a model determines how applicable it is to a large variety of situations and how it accommodates changes that may occur during the course of a Planning study. The relevance of the model to the problem that is to be addressed directly affects model selection. The decision the model is intended to support should be compared to the outputs the model provides.

Efficiency

With a more sophisticated model/user interface (e.g. a graphical user interface), the ease of use should increase but model cost will typically increase also. The cost of procuring the model should be commensurate with the scale of the project or program it will be evaluating. Reasonable data input costs and scale also should be considered for the type of project to which the model is being applied. Hardware requirements should be well defined and compatible with that available for Corps District users. Models need to be transportable between various computers for broad application. Of course, execution speeds that are as fast as possible are desirable.

Models should require reasonable technical skill levels for users, commensurate with the complexity of the projects they are evaluating. Hands-on training and technical support should be available for model users. Data import and export capabilities to facilitate flexibility among varying software formats (e.g. databases, spreadsheets, presentation graphics, etc.) are usually important model capabilities. Use of tabs in dialogue boxes to manage numerous options, for example, allow the user to be intuitive in using the system.

Effectiveness

There are several desirable features of computer models that enhance their usability and effectiveness. For example, statistical models that require random number generation capability should be robust enough to have several different sources of randomness streams and not just generation based on the internal clock of the computer. These models should also have all potentially desired continuous and discrete distributions available for use. Statistical confidence intervals around the data mean should be identified. Models should be flexible enough to accommodate regional or project specific existing and modified conditions. Output displays should have the ability to select standardized or customized reports. These should be compatible with a Common Delivery Framework system. Tabular model output data should be exportable in various formats for use with databases (e.g. Access) and statistical packages. Graphical output displays, including histograms, bar charts, pie charts, and even animation, enhances interpretation in the context of the project. Animation often facilitates understanding of changes over time. A model may need the ability to run animation either post process or concurrently as the model runs. Animation should allow zooming and speeding up/slowing down of the display. Pixel based graphics may not be desirable, vector based graphics may be needed to provide dimensional rotation. Importing CAD drawings and clip art into the animation may be desirable with the goal of understandable and acceptable results.

Documentation

Documentation for users should be produced for initial training, reference during continued use of the model, and to assist in consistent model application among various users. Design documentation for programmers should also be produced for potential future modifications of the code that may be needed for model improvement. Inherent assumptions of the model should be clearly stated in the documentation and potential bias caused by these should be identified. Data requirements for the model and appropriate data selection and development should be discussed. Documentation should be sufficient enough for users to correctly run the model and interpret its output. Errors often occur while "running" a model, which usually stops it's processing. The model should be able to provide correct error messages and the documentation should clearly define these along with the best action to handle the error. Minimum computer system speed and platform requirements for models should be specified in its documentation.

Data

Quality of input data is an extremely important consideration in applying any model for a Corps of Engineers Planning study. Data gathering is often the most time-consuming and costly part of the modeling process for the user. The best data for a model is usually also the most difficult and expensive to obtain. At times other, less preferred, yet still acceptable, data is readily available. Assumptions in the type of data that are used should be recognized. Differences between the best type of data for the model and actual data collected should be understood and accounted for. Data for each study should also be validated. Data validation includes source validation and data checking. Models may assist in organizing and error checking of the data to minimize human error. These activities may be accomplished by statistical procedures and by sorting or plotting in order to find outliers and inconsistencies. Calibration of the model by reproduction of model output with a range of historic data lends credibility to the model. Data inputs should be empirically based to the greatest extent possible. When empirical data is not available synthetic data is often created, usually based on regression analysis. The appropriateness of such data for a specific study should be addressed.

Interpretation

Models, along with data collected and used in modeling, are only representations or abstractions of the real world. Therefore, model results must be interpreted. Models can be made infinitely more complex in an attempt to mimic the real world. Modelers must avoid overly complex models that may not allow interpretation of results. Sometimes less complex models may be of greater value in understanding the problem and in informing the decision making process. In some cases, an effective model will need to be hierarchical. Hierarchical modeling is necessary when several basic modeling constructs are needed as input into a more complex model. User interpretation of model output includes evaluating its reasonableness in the perspective of its real world situation and communication of model results. Planning modeling should enhance and cannot substitute logical and rational interpretation of model output.

Support

It is imperative that a model has a documented/advertised user support system in place. Regardless of how good the model or its documentation, at times, the user needs to ask questions of the model developer or of a designated expert user. If a good support structure is in place, the user will be able to obtain timely and expert advice quickly. If the support structure is not in place, the users could become frustrated, loose patience with the model, and therefore stop using it. Lack of support may cause users to spend too much time trying to figure something out on their own and may possibly result in an incorrect solution. A model maintenance program, such as the one the Hydrologic Engineering Center employs, is one way that model maintenance and support could be handled for other Corps planning models. Another approach would be to designate Centers of Expertise as the points of user support for their respective business functions.

Summary

Applying the above criteria for selecting a model for use in a USACE Planning project should define models that are acceptable, efficient, effective, and complete. Models that are easy to use are often desired, but if the model itself is limited or invalid in its mathematical construct, then it is not worth using. Therefore, the first criteria applied should be the review of the model's acceptability (theory and computational correctness) by scientific peers. Once the model is determined to be acceptable then other criteria, such as model appropriateness for the study tasks, should be applied.

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D-5 Mandatory or Not?

Introduction

One of the proposals before the Planning Model Improvement Program Task Force is to mandate the use of a suite of planning models. These models would be peer reviewed, nationally recognized models. After examining the issues, we believe a better tact would be to mandate that models used for studies be peer reviewed. In addition, we could build incentives into the peer review process that would steer users to models that are more widely recognized and accepted. Planners need the flexibility to develop and/or use the models that are most applicable to their water resource problem. Often this requires new models or adaptation of old models that more accurately represent local conditions or concerns. A peer review or validation process that discourages redundant model development while allowing for the advance of new necessary models would be a logical improvement to our Planning model program.

National Models

Examples of nationally recognized planning models might include HEC-FDA and IWR-PLAN. These models are very familiar to those in Corps Planning and may be recognizable to those in the planning community outside the Corps. These national models have the advantage of being widely used and therefore widely accepted. Because of the effort necessary to construct these types of models, professional programmers often develop them. These professionally developed models often have the advantage of user-friendly interfaces, less programming errors, and appropriate documentation. To the extent they are used appropriately, their use should be encouraged. To further substantiate the credibility of these national models they should go through a validation / peer review process.

Standardization

Standardizing models would make them user-friendlier. Different people develop models for diverse and unrelated purposes. These models can have vastly different user logic and interfaces. Planners who use multiple models must be proficient in multiple model languages. In addition the import and export of information between models can be difficult because of the differing formats used. Resources could be used to standardize planning models similar to the Microsoft Office suite of programs. Standardization would make the most sense with a small widely used contingent of models. Other less stringent standardization that may be useful could require that models all have basic commonalities. For instance, all models should have a user guide and basic documentation. The validation process could be used to ensure some level of standardization. The use of fewer models that are nationally recognized would also allow for easier technical review. Reviewers would not be faced with learning a new model each time a study is submitted for review.

Local Models

Models developed in the field can be very valuable. These "local" models are usually the precursors for the more highly developed and nationally recognized models like IWR-PLAN. The breeding grounds for future national models are local models developed in the field. Most nationally recognized models were originally developed in the field for a specific problem. As others encounter similar problems, the local model is used more widely. As the model becomes more popular, it is refined and improved until it becomes a model widely used and nationally accepted. It is important that we allow the development of local models when the application warrants.

Local models are common now because computer-programming language has become very user-friendly allowing novice programmers to build very sophisticated easy to run models. These models can often be easily reprogrammed to allow modeling of different local conditions and concerns. The more nationally recognized models are less flexible and often require an experienced computer programmer to change.

The shortcoming of the local models is that they are untested, and therefore, viewed as less credible. The key is to ensure that models developed in the field are reputable by instituting a validation process. The process needs to be rigorous enough that a supportable conclusion is ensured, but not so onerous as to discourage the development of models that are legitimately needed by the field. This process should discourage redundancy in developing models. Where possible, existing models should be modified or enhanced to make them applicable to the site-specific needs of the field.

Validation

A process needs to be put in place to assure models are validated. A validation process would improve credibility with our stakeholders, allow for more reliable independent technical review, and communicate model limitations. The issue becomes the extent or scope of the validation. Validation that includes the model, but not the user leaves room for mistakes. A few of the possible errors that come to mind when you validate the model but not the user are listed below.

1. Model validation would not ensure that the problem is formulated correctly.
2. Model validation would not ensure that input to the model was correctly entered.
3. Model validation would not ensure that model output was correctly interpreted.
4. Model validation would not ensure that the user understands how to use the model.

If a validation process for the users is included, the number of errors are reduced but not eliminated. The scope and cost of the validation would likely increase significantly if all users are subjected to a validation process.

Differing Levels of Validation

The use of validated models should be mandatory. The question then becomes what does validation entail. We believe that validation should ensure that the model produces reasonable results when used properly. The level of validation should be commensurate with the level of risk associated with the study. Models constructed for use on highly controversial, costly, or complex studies require a more rigorous process for validation. Models like IWR-PLAN and HEC-FDA that are widely used for many feasibility level studies will likely require peer review from inside and outside the Corps. Models developed for small Continuing Authority Program (CAP) studies would require less rigorous review. The use of the best tool should be encouraged.

D-6 Peer Support and Peer Review Process/Certification

Peer Review Process

(Recommend changing all instances of "National Centers of Expertise" to "Planning Centers of Expertise" to be consistent with the memorandum signed by MG Griffin on 25 Aug 2003)

Introduction

Existing peer review mechanisms or protocols used by various government or private sector entities were reviewed, and recurring/key themes or elements were drawn from the review. Some of the key considerations are:

- the need for confidentiality or anonymity of reviewers to assure independence and openness of review;
- need for some level of remuneration for reviewers;
- peer review and independent technical review (as utilized by the Corps) should remain separate;
- potential conflicts of interest must be addressed in selection of reviewers;
- review documentation in the form of peer review record is essential.

The May 2003 Navigation Economic Technologies Symposium (NETS) devoted a session to the topic of peer review and validation. Information generated from this session, combined with the key points noted above, provided a starting point for developing a proposed peer review process flow chart (Enclosure __). A detailed description of the flow chart follows.

Purpose

The purpose of the review is to assist the authors and/or modelers in making their product (model, tools, techniques, etc.) as accurate and effective as possible and to ensure the credibility of product, product results, and the U.S. Army Corps of Engineers. The review not only fulfills the institutional obligation to exercise oversight, but also improves quality control, quality assurance, and provides the authors and/or modeler with preliminary reactions from a diverse group of experts, resulting in enhanced clarity, effectiveness, and credibility of the final product.

Peer Review

Peer review is defined as the product review by one or more peers that is knowledgeable in the particular subject area. These peer reviewers could be internal and/or external to the Corps. The level of review required and the availability of knowledgeable peer reviewers will dictate the number of reviewers and whether they will be internal or external to the Corps. The levels of review are discussed later in this appendix. Peer Review does not and should not take the place of Independent Technical Review (ITR), but be the means by which a model in certified for use. Peer Review is focused on whether the model is computationally correct, theoretical sound, and does what it is proposed to do. The ITR should focus on whether the model fits the application, utilized appropriate data, and results interpreted correctly.

Peer Support

"Peer support" is a complement to "peer review". The purpose of peer support is to provide Districts with the early and seamless advice, assistance, and review from experts in the development and initial application of models. Because of the early involvement of experts it is expected that models developed through the peer support process will be "certified" upon completion of model development and appropriate documentation. Emphasis will be placed on the model development and the model review process to ensure that upon completion of the model, the development and peer review process utilized will lead to product certification. Peer support will be initiated, for example, from a District's request to the appropriate Planning Center of Expertise for the need of a model to evaluate a problem. The Center of Expertise will determine if an existing model can be used, or if a new or modified model is needed. The Center will then provide the expert support to utilize the existing model or support to develop and/or modify an existing model as required. The Corps Labs and Lab experts will serve as sponsors for new complex (non-routine) models and/or work with the Districts and Centers of Expertise in model development. The Centers of Expertise and Labs will identify and involve appropriate experts from academia, industry and other agencies as needed. Peer support could be provided from the Centers of Expertise, HQ, MSC's, Districts, IWR, ERDC, and non-Corps individuals.

Process

The Headquarters' Chief of Planning and Policy will be responsible for the peer review process. The National Centers of Planning Expertise for the major Civil Works business lines (ecosystem restoration, flood damage reduction, deep draft navigation, inland navigation, and hurricane and storm damage reduction) will be responsible for the peer review, product certification, and peer support process. It is suggested that a peer review committee and/or panel be created to have general oversight responsibility to insure process consistency. A process to select external and internal to the Corps, Functional Area Leaders for the appropriate business line to serve as project managers to manage the product review and have final call on review issues must be established. The Headquarters' Chief of Planning and Policy and the National Centers of Expertise will be responsible for the development of the protocols for the required levels of review and a process to select a roster of internal and external reviewers, experts by business lines/functional areas. It is suggested that an independent external organization or group (e.g., NAS; Blue Ribbon Panel) be utilized to select roster individuals to review products. The Functional Area Leader in consultation the appropriate National Planning Center of Expertise and product owner develop the statement of review tasks. The

Functional Area Leader in consultation with the National Center of Expertise selects independent reviewers, from the roster of reviewers, with diverse perspectives on key issues considered in the product. Reviewers receive the complete product including all documentation along with the statement of tasks. Reviewers are asked to provide written comments on any and all aspects of the draft product, but to pay particular attention to the review criteria, i.e., tasks provided. Review comments are provided to the Functional Area Leader who when satisfied provides comments to the product owner who in turn provides a response to comments and if necessary a work plan to adhere to review comments. The National Center of Expertise in consultation with the Functional Area Leader approves the work plan. Reviewers get a second chance to assess the responses to comments and if developed the work plan to determine if comments were correctly alleviated or if the work plan will lead to settling review comments. The product owner gets to respond to review comments until the Functional Area Leader approves the review of the product.

Confidentiality and Anonymity

To encourage reviewers to express their views freely, the review comments are treated as confidential documents and are given to product owners with identifiers removed. Identity of reviewers remains anonymous to the product owner until the report is released (usually by acknowledgment in the printed report), but their comments remain confidential.

Consensus and Dissent

The National Center of Expertise and Functional Area Leader strive for consensus, but one or more reviewers may not concur with the views of the majority. Matters of disagreement should be addressed forthrightly in the report. As a final recourse, a reviewer may choose to prepare a brief dissent describing the issues of contention and the arguments in support of the minority view. The Functional Area Leader in consultation with the National Center of Expertise will have the final call on product approval.

Product Checklist Requirements

The National Center of Expertise determines if a product and product documents are sufficient to begin the review process. All products must adhere to a checklist of review requirements specific to each type product before the product is entered into the review process. The Functional Area Leader in consultation with the National Center of Expertise and business line/functional area experts develops the product checklist requirements.

Levels of Review

Criteria will be established to determine the level of review required for a specific product. The Headquarters' Chief in consultation with the National Centers of Expertise will be responsible for development of the protocols of each the level of review. The criteria will be established based on the study and model complexity, cost, controversy, and risk. For example, if the result of the model leads to an investment decision that has a high risk, i.e., benefits not realized or forgone and/or large expenditures with small returns, a high level of review would be appropriate. Examples of levels are: Level 1, highly complex, costly and controversial models and studies where the risk of making an incorrect investment decision may result in major negative impacts will dictate top priority review to be conducted by several reviewers external to the Corps; Level 2, normal study and model complexity with minimum risk and minimum impacts will dictate fewer reviewers made up of both external and internal reviewers form the review roster; Level 3, routine studies and models and project application with minor risk and minor impacts will dictate an internal review by Corps experts from the National Centers of Expertise, who may elect to also utilize reviewers from the review roster list. Also, included in Level 3 are those current existing models and tools that have withstood informal reviews but have not had a formal review. The National Center of Expertise will review and certify the model and/or tool and document the review recommendations.

Review Cost

All necessary travel and minor administrative expenses would be funded by the USACE. External reviewers would be paid labor expenses based on the projected time commitment required for review as described in the scope of work. Some external reviews may generate interest of reviewers without compensation for labor when they are motivated to volunteer to enhance his/her own prestige. The reviewers would receive all travel expenses for services rendered. Reviews conducted by the National Centers of Expertise and personnel internal to the Corps will be either centrally funded and/or funded fully or partially from project funds depending on the products potential for use on other project.

Reviewers

Peer reviewers should have the expertise to understand the key issues and arguments of the product and/or model. Reviewers with both theoretical knowledge and practical experience would be preferred. .

Feedback

The product owner will review comments and respond through the Functional Area Leader with a plan to respond to reviewer's comments. The appropriate National Center of Expertise approves the work plan. The reviewers are allowed to review the product and if necessary the product work plan until all review comments are settled or the Functional Area Leader (PM) in consultation with the National Center of Expertise finalizes the review.

Approval and Publication

Upon completion of the review process the National Center of Expertise responsible for the review will document and publish the product and/or model review results and recommendations. The reviewers will be encouraged to work with the National Center of Expertise and product author to submit the product for publication in appropriate journals and publications.

Planning Models and Tools Improvement Review Process Flow Chart Description

(1) National Planning Centers of Expertise

Planning products (model, tools, techniques, etc.) for each of the three (3) levels of review will be submitted to the appropriate National Planning Center of Expertise for the business line, i.e., ecosystem restoration, flood damage reduction, deep draft navigation, inland navigation, and hurricane and storm damage reduction. The National Center of Expertise is responsible determining the appropriate level of review, conducting the peer review process and providing any necessary peer support. The National Centers will be responsible for documentation of peer reviews conducted, maintain and update planning models in partnership with Corps' research offices, work with the Corps' national data collection program, provide training and peer support, identify and reduce model redundancies., and develop a long-term strategy. The National Centers will function as a clearing-house for planning models and tools that are certified for use and assist in directing Districts and/or model developers to the appropriate peer support for new model development.

(2) Product Review Requirements

The National Centers of Planning Expertise will utilize the model review checklist requirements (to be developed at a later date by the Planning Centers of Expertise) to determine if the product warrants review and the package is complete and ready for review. If the product review package is not complete the Center of Expertise works with the product owner to revise the review package (step 2). The National Center of Expertise in concert with Headquarters' Chief of Planning and Policy guidance establish criteria to determine the appropriate level of review (step 3).

(3) Level of Review

The appropriate National Center of Expertise in consultation with the Internal Functional Area Leader utilizes established criteria to determine the appropriate level of review. The National Center of Expertise has final approval on the level of review.

(4) Level 1 Review

Level 1 review is for highly complex products used on large investment projects that are highly controversial. This review level is for those products that may result in a high risk of making the wrong decision that results in numerous impacts, i.e., benefits foregone or benefits not materializing, unnecessary impacts, economic and environmental impacts, etc.

(5) Level 2 Review

Level 2 review is for products of normal complexity and where the risk of model utilization would lead to the wrong investment decision resulting in minimum impacts.

(6) Level 3 Review

Level 3 review has two basic purposes; a) review of new routine and non-complex products that have a minor impact on project decision-making and; b) review of current frequently used products that were developed by Corps Districts, Corps Labs and other agencies and contractors that have withstood historical informal reviews. The review of frequently used existing products will include examination of the individual product's informal review documentation to determine if the product warrants certification without a level 1 or 2 review.

(7) External Functional Area Leader

The National Center of Expertise utilizing established guidance will select external to the Corps, Functional Area Leaders (ecosystem restoration, flood damage reduction, deep draft navigation, inland navigation, and hurricane and storm damage reduction etc.) to serve as project managers to manage the product reviews and have final decision on review issues. The Functional Area Leader should be recognized professionally as an expert in the functional area. The Functional Area Leaders in consultation with the National Center of Expertise develops the review charge and scope, and selects the individual product review team.

(8) Internal Functional Area Leader

The National Center of Expertise will select internal to the Corps, Functional Area Leaders (ecosystem restoration, flood damage reduction, deep draft navigation, inland navigation, and hurricane and storm damage reduction etc.) to serve as project managers to manage the product reviews and have final call on review issues. The Internal Functional Area Leader should be a professional recognized as an expert in the functional area. The Internal Functional Area Leaders in consultation with the National Center of Expertise develop the review charge and scope, and selects the individual product review team.

(9) Internal Functional Area Leader

The National Center of Expertise will select internal to the Corps, Internal Functional Area Leaders (ecosystem restoration, flood damage reduction, deep draft navigation, inland navigation, and hurricane and storm damage reduction etc. etc.) to serve as project managers to manage the product reviews and have final call on review issues. The Internal Functional Area Leader should be recognized professionally as an expert in the functional area. The Internal Functional Area Leaders in consultation with the National Center of Expertise will determine the appropriate level of review, develop the review charge and scope, and select the individual product review team.

(10) Review Charge and Scope

The Functional Area Leader in consultation with the National Center of Expertise develops the review charge and scope. The National Center of Expertise has final approval of the review charge and scope. The review charge and scope should guide the product reviewers and direct them to key issues, assumptions, routines, and aspects for review.

(11) Formation of Review Team Roster

The National Centers of Expertise utilizing Headquarters' Chief of Planning and Policy guidance to establish a roster of external and internal individuals for the Level 1 reviews.

(12) Review Team Selection

The Functional Area Leader in consultation with the National Centers of Expertise selects from the roster individuals to conduct specific product reviews. These individuals will conduct Level 1 and 2 reviews.

(13) Center of Expertise Review and Assessment

The Internal Functional Area Leader for Level 3 reviews in consultation with the National Center of Expertise selects the appropriate internal and/or external Corps individuals to conduct product reviews.

(14) Review Comments

The review team and/or Center of Expertise will provide a consolidated documentation of review comments and recommendations to the Functional Area Leader. The review should adhere to the review charge and scope provided by the National Center of Expertise. The National Center of Expertise and Functional Area Leader strive for consensus, but one or more reviewers may not concur with the views of the majority. Matters of disagreement should be addressed forthrightly in the report. As a final recourse, a reviewer may choose to prepare a brief dissent describing the issues of contention and the arguments in support of the minority view. To encourage reviewers to express their views freely, the review comments are treated as confidential documents and are given to product owners with identifiers removed. Identity of reviewers remains anonymous to the product owner until the report is released (usually by acknowledgment in the printed report), but their comments remain confidential.

(15) Comment Assessment

Review comments are provided to the Functional Area Leader to assess whether review fulfilled the review charge and scope provided. When the Functional Area Leader is comfortable that the review charge and scope have been met the comments are provided to the product owner for review. Feedback from the product owner is transferred through the Functional Area Leader back to the review team until all comments are either resolved or all parties reach an agreement on outstanding issues. The National Center of Expertise and Functional Area Leader strive to resolve all comments, but not all comments may be resolved. The Functional Area Leader in consultation with the Center of Expertise will have the final call on comment and product approval.

(16) Product Owner Feedback

The product owner can provide to the reviewers through the Functional Area Leader responses to the review comments. This feedback process continues until the Functional Area Leader determines that all comments are resolved and/or no progress is being made in the feedback loop. The Functional Area Leader has the final call on review comment and product owner responses.

(17) Final Comments

When the Functional Area Leader determines that further product owner feedback and reviewer assessment will not result in any additional modifications to the comments they are finalized and presented to the National Center of Expertise for approval.

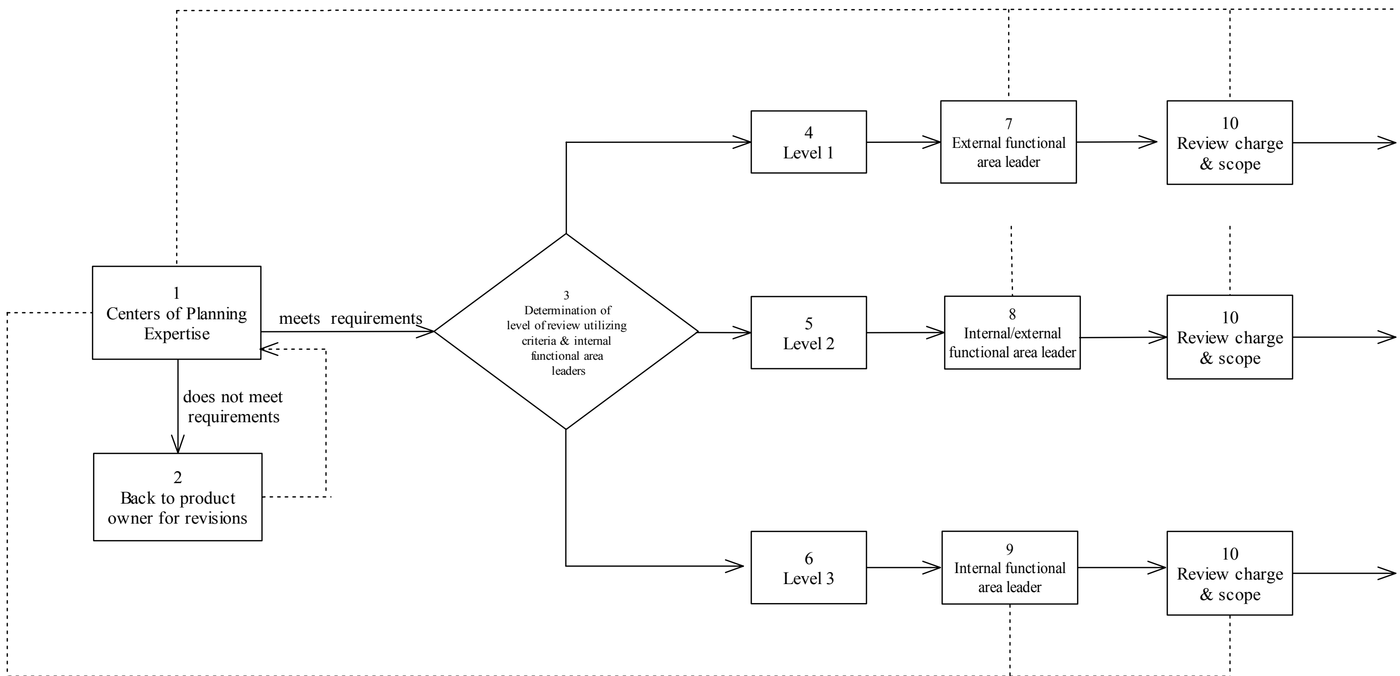
(18) Product Certification

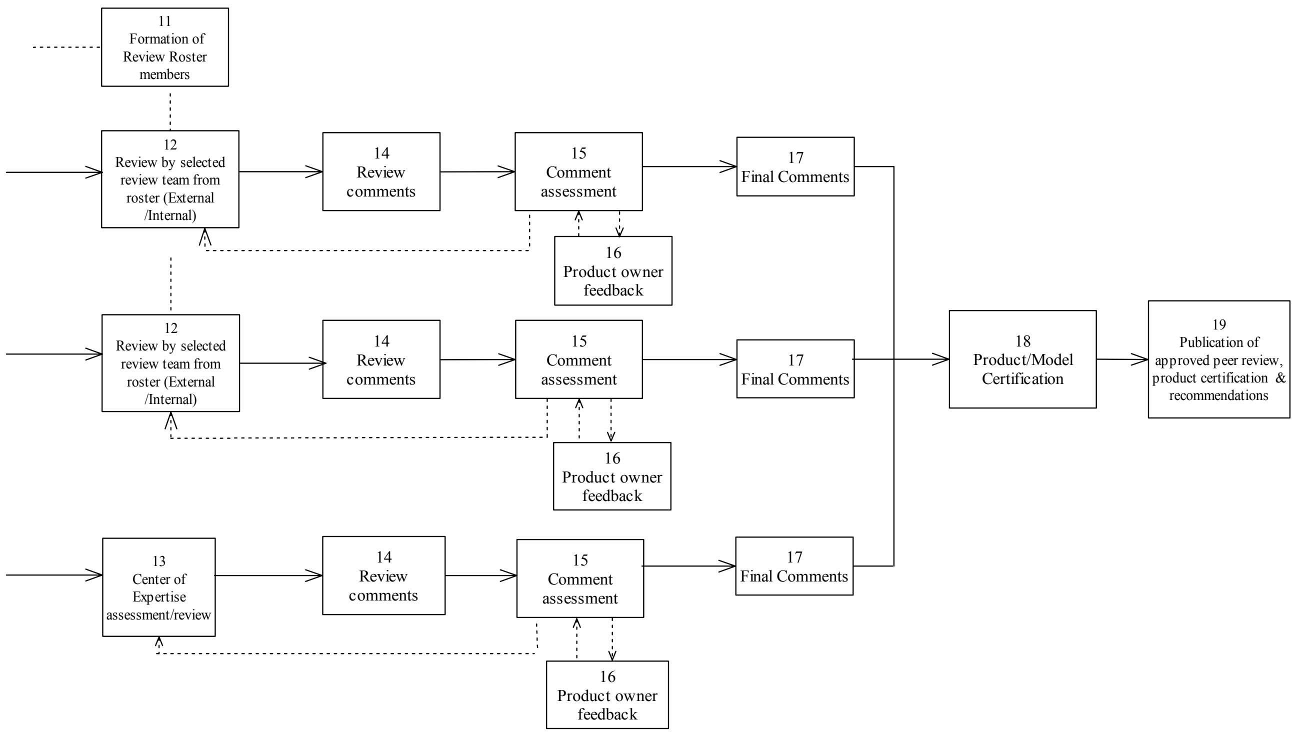
The National Center of Expertise that conducted the review certifies the product and provides recommendations. The National Center of Expertise will furnish Headquarters' Chief of Planning and Policy documentation of the review, certification, and recommendations.

(19) Product Publication

The National Center of Expertise will encourage and assist the product developer and reviewers to publish product, product documentation, and product review in professional journals and publications.

Peer Review Process




11
Formation of Review Roster members
12
Review by selected review team from roster (External /Internal)
14
Review comments
15
Comment assessment
17
Final Comments
16
Product owner feedback
12
Review by selected review team from roster (External /Internal)
14
Review comments
15
Comment assessment
17
Final Comments
18
Product/Model Certification
19
Publication of approved peer review, product certification & recommendations
16
Product owner feedback
13
Center of Expertise assessment/review
14
Review comments
15
Comment assessment
17
Final Comments
16
Product owner feedback

D-7 User Support

Introduction

Improvements to planning models cannot be done in isolation. Equally important or more important are model users who are knowledgeable and competent. Even models that have been through a stringent peer review process when improperly applied can lead to erroneous results. A good user understands the limitations and weaknesses of the model he is using and communicates those shortcomings to the stakeholders and decision makers clearly. A good user also mitigates for weaknesses in the model by communicating those limitations and devising work around solutions where possible.

Problems with Users

A number of problems are encountered when users are not knowledgeable or competent with the model they are using. They can put in the data improperly. They can misinterpret the output or results of the model. They can use the wrong model for the problem. Poor users of the model are inefficient. They don't know how to operate or navigate the model, or where to look for problems and answers. Poor users don't understand what the model is doing and treat it like a black box that will automatically come up with the right answers.

Good User Attributes

A good user understands the weaknesses of the model and where possible he supplements the model with another technique to reduce the weakness. He also recognizes the limitations of the model and is able to clearly articulate those limitations. A good user understands the theory behind the model and can simplify the model so that non-users can understand how it works. A good user recognizes what model is most applicable to the problem or opportunity, and applies that one. A good user recognizes the potential for data entry errors and develops processes for data import and export that minimize mistakes. A good user knows the model well and uses it efficiently. A good user understands the outputs and is able to communicate clearly their meaning to stakeholders and decision makers.

Improving Users

There are variety of ways the Corps can improve the use and users of planning models.

Tech Support.

One of the most basic ways to improve model use is to ensure that there is proper technical support for the planning model. At a minimum, this should include a user manual, documentation on model development, and a contact person for questions and concerns. A user's manual should assist the user in ascertaining whether they are capable of using the model proficiently. A user's manual should also aid the user in efficiently using the program and giving examples of how data is inputted and extracted from the model. In addition, technical support should be available.

Training.

Model training, where necessary, should be made available. Training classes could be offered to introduce the theory behind the model, its applications, and some actual use of the model in a controlled setting. This has been done in the past for some of the IWR models such as IWR-PLAN and Hydro-REPAIR.

Mentoring.

Another effective means of improving model users is to set up mentoring relationships--pair a novice user with an expert. This is most easily applied when there are expert users within your own District. The expert users work with the novice user to ensure that the model is used correctly and that limitations are well understood. Mentoring can also be done virtually with some site visits. The mentor is paid to work with the novice to ensure that the model is correctly applied to the on-going study. In addition the mentor teaches the novice how the model is used so that the novice can become self-sufficient in future applications of the model. The mentor could also confirm that the novice does understand the model adequately and is able to apply the model in a self-sufficient manner.

Qualifications.

Another way to ensure the proper use of models is to establish user qualifications required to correctly use different models. The proper use of a model is easier for those who are comfortable with computer applications. This is often the case with newer planners who were raised during a computer age. Therefore, the number of years with the Corps is probably not a good criterion for a qualified user. Repeated use of the model with verifiable results would be reasonable qualification. Those that use the same models repeatedly quickly begin to understand how to operate them efficiently and can recognize their limitations.

User Groups.

User groups can improve model use. These users groups can meet virtually or face-to-face. Questions or concerns can be raised within the group of knowledgeable users for resolution. The user group can assist in ensuring maintenance of the model and influencing improvements to the model.

D-8 Data Sources and Input for Planning Tools and Models

Introduction

The diagram below simply describes the process of obtaining results from planning tools or models.

Input or Data → Planning Tool or Model → Output or Results

A good model or planning tool is imperative to ensure that the results are accurate. Equally important to ensure accurate results are a competent user and proper input or data.

Input or Data

The amount and types of data required must be known for all models. The saying "garbage in, garbage out" is often too true. The output or results can be adversely affected if the input is not the correct data set, is in the wrong form, is at a different level of accuracy or detail than what is required, or is non-existent. It is critical that all data requirements for planning tools or models are documented so that users are aware of them. Additionally, users must have the expertise to apply the models properly so that they know what is appropriate data and can understand the limitations of their analyses based on the data used.

The amount and types of data for Corps planning models can vary widely based on the phase of study, availability of data, resources available to collect data, and the mechanisms and resources required to maintain databases. Description of data requirements and sensitivity of the model output to varying data sets (if appropriate) should be part of the documentation required for certifying Corps planning models. Intimately tied to the proper use of a model is a user who can understand the requirements and the potential or actual impacts of using more or less data than is optimal.

Future Data Needs

The gap in data collection and maintenance from the current project level to the desired basin wide scope will grow more acute with advances in computing technology and the ability of models to use a vast amount of data, or with the use of geo-spatial data such as in Enterprise GIS (Geographical Information Systems). The Corps may need to find ways to leverage our capabilities with other agencies that have or collect data as a matter of their core business missions so that we can access their databases for the mutual benefit of all.

Summary

The results from a model are as highly dependent on the input data set, as they are on the proper model user, sound assumptions used in model development, good source code, and appropriate interpretation of the output. We must place emphasis on using relevant and accurate data, as limitations on available data will certainly affect model outcomes. We must also pursue further collection or identification of good, accessible data because neglecting this could possibly curtail development or use of future models that follow the leading edge of technological advances.