SID No. 1220029

Nomination Received by Council on Environmental Quality, Executive Office of the President
For the CEQ NEPA Pilot Project Program
http://www.whitehouse.gov/administration/eop/ceq/initiatives/nepa/nepa-pilot-project-nominations

PART I. NOMINATOR

First Name:	Richard
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Organization:	Applied Ecosystem Services, Inc.
Project Title:	NEPA Compliance: Producing Technically Sound, Legally Defensible Documents
Submitted by:	Member of the Public
Date Received:	06/13/2011

PART II. SHORT ANSWERS

I. What Federal agency or agencies will be involved in this pilot project?

Potentially, all. The Nevada BLM has been aware of this approach for several years and would be an ideal agency for implementation of this pilot project.

II. What is the Federal action to which this NEPA pilot project applies?

Potentially all. For the Nevada BLM it would be a mining EIS.

III. How will this pilot project reduce the costs and time needed to complete the NEPA process?

By quantifying subjectivity and addressing the major reasons NEPA documents are appealed or challenged in court, the process moves smoothly and efficiently. The decision-maker has an objective basis to compare alternatives and existing conditions so the ROD is technically sound and legally defensible.

IV. How will this pilot project ensure rigorous environmental protection?

By proving that all aspects of NEPA, CEQ regulations, and agency guidelines have been completely followed. The public's input is solicited early and all values and beliefs of agencies, stakeholders, and the public are incorporated into the assessment's scope and used in characterizing existing conditions and each alternative.

V. How will this pilot project improve the quality and transparency of agency decisionmaking?

It eliminates claims that the decision is arbitrary and capricious. Comprehensive scoping includes all willing participants, anonymously, with the values of each being equal. Characterization of current and alternative future environments determined by robust mathematics for objectivity. Audit trail of mathematical model run validates transparency, technical soundness, and legal defensibility.

VI. Will this pilot project develop best practices that can be replicated by other agencies or applied to other Federal actions or programs? Please describe?

Yes, it will. The process (described in my book, "Quantifying Environmental Impact Assessments Using Fuzzy Logic" was published by Springer in 2005. The process is consistent and universally applicable but the results are site- and project-specific and represent the values and beliefs of all agencies, Tribes, neighbors, environmental NGOs, and others who contribute to the scoping of the assessment.

PART III. PROJECT DESCRIPTION

(See attachment on following page.)

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NEPA Compliance: Producing Technically Sound, Legally Defensible Documents*

NEPA, CEQ regulations, and agency directives describe in detail *what* is to be done in preparing an EA or EIS that is compliant with the law and all regulations. It does not direct staff or external contractors *how* each requirement is to be met. This white paper presents specific requirements and explains how the Applied Ecosystem Services' quantitative approximate reasoning model, *Eikos*^{TM} fulfills these requirements so that the results are demonstrably technically sound and legally defensible.

This objective approach takes away no control from ID Team resource specialists or management decision-makers. Rather, it gives everyone more control over the process because every contributor's expertise is more fully incorporated into the final document.

The value of our approach is most clearly seen when projects are likely to be contentious and might end up in a court of law. NEPA litigation in federal District Courts almost always includes a claim that the decision was arbitrary and capricious[1]. The courts are

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[1]Absence of a rational connection between the facts found and the choice made. Natural Resources. v. U.S., 966 F.2d 1292, 97, (9th Cir.'92). A clear error of judgment; an action not based upon consideration

asked to determine if the lead agency took a "hard look[2]" at all facts, alternatives, and description of the environmental consequences. A mathematically-robust model that emulates how highly experienced experts would make a decision and provides an audit trail that documents how results are derived from input values is the most technically sound and legally defensible way to prepare a NEPA document. This white paper examines a few components of NEPA documents and explains how *Eikos*^{TM} fulfills requirements for objectivity, completeness, and robustness; elements of a hard look resulting in a decision that is neither arbitrary nor capricious.

Scoping/Public Involvement

While external scoping is usually associated with the preparation of EISs, CEQ[3] guidelines at 40 CFR 1501.4(b) note that a lead agency "shall involve environmental agencies, applicants, and the public, to the extent practicable" in preparing EAs. Therefore, the same scoping process and products required for EISs may be applied to EAs, depending on the complexity of the proposed action, alternatives and issues.

What scoping is and what it can do

Scoping is a process that actively includes the public, other agencies, and the lead agency, and results in identification of the proper scope of the NEPA assessment. Thus, as the NEPA document is prepared it will include the concerns, issues, and alternatives identified by the lead agency, cooperating agencies, and the public. This inclusive involvement reduces the chances of overlooking a potentially significant issue or reasonable alternative and minimizes delays. It also helps ensure the success of the FONSI[4] or ROD[5] during protests, appeals, and litigation. Scoping is the foundation for the rest of the decision-making process. If the EA or EIS includes all the necessary information for formulating and making rational choices, the agency will be able to make a sound and prompt decision which is supported by a legally defensible administrative record.

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of relevant factors and so is arbitrary, capricious, an abuse of discretion or otherwise not in accordance with law or if it was taken without observance of procedure required by law. 5 USC. 706(2)(A) (1988). (`http://www.lectlaw.com/def/a064.htm`)

[2]Neither Congress nor the courts have indicated precisely how much detail an EIS must contain. However, courts consistently have held that, at a minimum, NEPA imposes a duty on Federal agencies to take a "hard look at environmental consequences" (Natural Resources Defense Council v. Morton, 458 F.2d 827, 838 (D.C. Cir., 1972). Hence, courts have carefully checked EISs for completeness of information and detail, soundness of analysis, thorough discussion of alternatives, and disclosure of sources. (`http://www.aphis.usda.gov/regulations/compliance/environmental_hard_look.shtml`)

[3]Council on Environmental Quality

[4]Finding Of No Significant Impacts

[5]Record Of Decision

Use of scoping comments

Comments from other agencies, agency stakeholders, the interested public, and lead staff must be evaluated. Findings must be made as to which issues and alternatives must be analyzed in detail in the EA or EIA and which ones can be dismissed with a brief rationale. Scoping will identify what the interested participants and lead agency specialists consider to be the principal areas for study and analysis. Every issue that is raised during scoping should be documented and considered in the EA/EIS, the administrative record, or both.

Regardless of EA scoping involving only lead agency staff, or including other agencies, Tribes, and/or the general public, not all issues have equal importance. For example, a project might have negligible influence on waters of the United States yet be in an area with the potential to contain historic cultural values. The former most likely has lower value for consideration of project effects, and quantifying the relative importance of these issues contributes to demonstrating that the resulting decision is not arbitrary and capricious and that the lead agency took a hard look at the environmental consequences of the preferred alternative.

When the document is a RMP[6] or an EIS and requires public participation it is very likely that project objectors will be seen and heard. It is particularly important to legal defensibility that the lead agency documents that no group was deliberately excluded from participating, that all participating individual's opinions were solicited and accepted, that everyone's opinion was treated equally, and that all expressed opinions contributed to the final decision. Applying an objective and robust technique to collect scoping data and analyzing it preempts a major claim for harm as standing to file a lawsuit.

CEQ and agency regulations include directions to staff and managers responsible for planning or implementing NEPA assessment programs to develop and use procedures to consult, coordinate, and cooperate with relevant State, local, and tribal governments; other bureaus and Federal agencies; and public and private organizations and individuals concerning the environmental effects of these plans and programs on their jurisdictions or interests. Further, such efforts should, to the extent allowed by law and in accordance with the Federal Advisory Committee Act (FACA), include consensus-based management whenever possible. This is a planning process that incorporates direct community involvement into agency activities from initial scoping through implementation of the decision.

The *Eikos*^{TM} approximate reasoning model provides responsible officials with a well-established procedure based on mathematics and psychology[7] that results in a quantitative consensus of the relative importance of issues (assessment components). Equal weight is given to each individual's feelings regardless of their position relative to the

[6] Resource Management Plan

[7] We use an extension of Thomas Saaty's analytical hierarchy process. For a brief description of the AHP see `http://en.wikipedia.org/wiki/Analytic_Hierarchy_Process`; for details of how we use it in environmental impact assessments see *Quantifying Environmental Impact Assessments Using Fuzzy Logic* by Richard Shepard.

project (supporting, neutral, opposing) or affiliation (agency staff, Tribal member, neighbor, environmental NGO supporter). Because the process is anonymous, based on a procedure that has been applied for almost 40 years, and mathematically robust it is easy to defend. When agency requirements mandate there be direct community involvement this requirement is easily met with the *Eikos*^{TM} approximate reasoning model. In addition, because the calculated environmental consequences are derived from the relative importance of issues determined in scoping, the lead agency can prove that these opinions are included in the final decision. The path from input values and data to objective Environmental Condition Index (ECI) of the affected environment and the environmental consequences of each alternative analyzed (including cumulative effects) is provided in the model run's audit report. The robustness and objectivity of the quantified environments makes the resulting decision more robust, technically sound, and legally defensible.

Characterizing Affected Environments and Impacts of Alternatives

The need for characterization

Descriptions of the affected environments (i.e., existing conditions) in EAs and EISs are long, divided into components (issues), and assume they represent a desired condition. In many cases the latter assumption is unwarranted; the land has been overgrazed, invaded by noxious weeds, previously disturbed by past developments, or otherwise far from ideal. This degree of desireability, acceptability, or goodness cannot be determined directly from reading the text and tables and examining graphs and other figures.

In almost all aspects of business and our personal lives we rely on statistical or other summaries to make comprehensible the complexities that surround us and make decisions difficult. There is every reason to apply such a summary value that appropriately characterizes the complexities of the economic, natural, and societal environments that exist at the location and time when a NEPA document is prepared in response to a major federal action. Similarly, each project alternative impacts the existing conditions and is predicted to result in a future environment different from now. The question of how different cannot be answered by additional textual, tabular, and plotted descriptions. The environmental effects of each analyzed alternative also needs to be summarized using the same criteria and process as the affected environment in order to allow clear, transparent, and informed decisions. In addition, use of a robust characterization of these complex environments allows the decision-maker to determine the significance of each alternative's effects.

Environmental condition index

A summary statistic of complex economic, natural, and societal environments has to be mathematically robust, scientifically sound, and meaningful within the context of NEPA.

Our *Eikos*^{TM} approximate reasoning model fulfills these criteria by calculating an environmental condition index (ECI) for the existing and alternative future environments. It is mathematically robust because it uses set theory and logic. It is scientifically sound because the ECI captures subject-area knowledge of resource experts using IF-THEN rules of situations and consequences. It is meaningful within the context of NEPA because it incorporates the relative importance weights of each issue identified during scoping, includes cumulative effects of past, present, and foreseeably future activities, and provides a means for determining significance of the effects of each alternative.

The ECI is derived from the collective expertise of resource specialists. Their knowledge is acquired in two stages: describing how the environments work and how to value each resource variable.

How environments work

The knowledge of experts might start with formal schooling but it is tempered and tuned by real-world experiences. They often make decisions based on their experiences without consciously thinking of each important factor or processing step. To a large degree, we all sometimes make decisions this way. For example, when we want to drive from a side street to a main road we look at traffic in both directions, make instantaneous decisions about the speeds and distances of approaching vehicles and the response and acceleration of our vehicle, then decide to make the turn or wait. Similarly, exploration geologists have a good sense of whether valuable minerals (solid or fluid) might be present at a given location by looking at the rocks and topography; foresters can determine whether a slope can be safely logged and replanted by looking at slope, tree size and spacing, ground cover, and soils; and aquatic ecologists can tell what sort of macroinvertebrates and fish could be found in a specific stretch of stream or river by looking at the channel and surrounding landscape. The first step in characterizing existing and alternative future environments is to extract the details of decision-making from these experts. This involves ID Team members (assembled from all participating agencies and other entities). Their subject area expertise is acquired through questions and recorded as IF-THEN rules that describe conditions and their meaning.

IF-THEN rules have been used in expert systems for more than 50 years and obtain greater power and increased degrees of truth by the use of multi-value sets that provide value to measured or observed resource amounts. Expert system rules generally have crisp thresholds which results in thousands of rules capturing expertise of a single issue. For example:

```
IF Slope is greater than 20 percent,
  AND Soil_thickness is less than 5 cm,
  AND Vegetation_cover is less than 25 percent,
  AND Soil_moisture is greater than 75 percent
THEN Erosion_risk is Increased by 80 percent.
```

You can imagine all the rules required to include all possible combinations of Slope, Soil_thickness, Vegetation_cover, and Soil_moisture. This makes for unwieldy large models that always miss some situation and whose crisp result (80 percent in the above example) is open to challenge. In comparatively simple cases (e.g., diagnosing why a vehicle will not start), classical expert systems have a manageable number of rules and clear demarcation among conditions that produce useful and "correct" results. In more complex situations such as medical diagnoses and characterizing the overall value of economic, natural, and societal environments classical expert systems either fail totally or produce results whose truth is unknown.

To overcome these limitations the *Eikos*^{TM} approximate reasoning model uses linguistic variables and multi-value sets combined by multi-value logic.

Linguistic variables are terms that are not directly measureable but may be related to a range of measurements. For example, the word "tall." The measured height of a tall professional basketball player might be greater than 78in (198cm) while the measured height of a tall 8 year old boy would be greater than 45in (114cm). Linguistic variables commonly encountered in environmental impact assessments include "significant," "minimal," and "large." The degree of tall, significant, minimal, and large can be measured by the degree of membership in the appropriate set; that is, the set of all tall things, all degrees of significance, and all measures that could be considered minimal or large. These sets have multiple values in the range of 0.0 (not at all a member of the set) to 1.0 (absolutely a member of the set). There is no excluded middle as there is with the classical sets we commonly use (for example, the set of metal mines in Nevada or the set of Senators in Congress). Applying these mathematically robust multi-value sets to the rule example above yields this more realistic rule:

```
If Slope is Steep,
  AND Soil_thickness is Low,
  AND Vegetation_cover is Thin,
  AND Soil_moisture is High
THEN Erosion_risk is Greatly Increased.
```

Among the many benefits gained by project proponents, regulators, and the public are increased reality and closer approximation to truth, inclusion of varying professional judgements, and focus on the core issues rather than specific details of one among many variables, components, and issues.

What too often gets lost in the traditional approach to assessing potential alternatives on the existing (affected) environment are the great variability of environments and the uncertainties of forecasting future conditions. We all are aware of these concerns when we look at weather and financial market forecasts, and we know that past performance is no guarantee of future performance, yet we tend to suspend this insight when caught up in the emotional feelings that frequently accompany the NEPA process.

Cumulative effects analysis

Incorporating past, present, and foreseeable future activities that might produce cumulative effects greater than those expected by the project being assessed has been a serious concern of regulators in various agencies. There are temporal and spatial factors that need to be part of the analysis and these lead to complexities in traditional approaches to NEPA compliance. The results include delays and disagreements on what to include and how to interpret the results of the analyses.

Because the *Eikos*^{TM} model uses linguistic variables it is much easier to include both temporal and spatial variations in other activities that might accumulate with those of the specific project being assessed. Different combinations (scenarios) of past, present, and foreseeable future activities can be modeled and assessed by including them in variations of the basic alternatives. Since the model calculates an ECI for each alternative, and the complex analysis uses robust mathematics performed by computer, more alternatives can be analyzed quickly, equally, and objectively in full compliance with NEPA, CEQ, and agency regulations.

FONSI/ROD Decision Support

The *Eikos*^{TM} approximate reasoning model not only captures interdisciplinary expertise in characterizing environments based on inclusive scoping of assessment issues and concerns but it supports management findings of no significant impacts (in an EA) and selection of the preferred alternative (in an EIS or RMP). This support allows writing the record of decision demonstrating that it is technically sound and legally defensible.

The assessment results are presented as a set of ECI (one for each of the affected environment/existing conditions and every alternative, including cumulative effects of other activities). Each ECI value is based on the collective expertise of interdisciplinary resource specialists as subject matter experts and weighted by the relative importance of each issue (component) as calculated from the involvement of lead and cooperating agencies, Tribes, stakeholders, neighbors, environmental NGOs, and other interested public who participated in the scoping of the assessment[8]. The set of ECI values represent possibilities, not probabilities, that are measures of the "truthfullness" of the environments' characterizations.

The management decision-maker now has a set of technically sound and legally defensible assessment results that allow a well-informed selection of the preferred alternative and to justify that selection. The degree of "truth" associated with each ECI value, the numeric relationship of the ECI values, and having the model audit trail showing how each ECI results from the input values of the experts and scoping participants gives the decision-maker a higher degree of comfort and more information than does the tradi-

[8]This means that public involvement spans the NEPA process from scoping the assessment to determining the characterization of the existing and alternative future environments.

tional approach. The model does not make any decisions, but provides support for the manager's experience and knowledge in selecting the preferred alternative.

Conclusions

Taking all the above into consideration, our approximate reasoning model, *Eikos*^{TM}, is the only objective, quantitative tool currently available to regulators and project proponents to meet the "how to fulfill EA and EIS" requirements of NEPA. When there is a high likelyhood of a NEPA document being appealed or legally challenged this tool allows the responsible official, ID team resource specialist, and other participants to quickly and efficiently produce a document that is technically sound and legally defensible. It takes away no control or participation from anyone but provides the "how" that is missing from all the statutes, regulations, and guidelines that mandate "what" is to be done.