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Subject: Towards an Agro-Environmental (Conservation) Ontology/Knowledge Base for OMS
Attachments: Ontology 101.pdf

The transition of agro-environmental models research to an operational phase requires a common understanding and adoption of the core concepts and data, and their relationships, associated with the delivery of technical services to customers. Developing an ontology and resulting knowledge base facilitates this understanding and provides a programmatic way to apply it in business applications. This message represents an initial step to work towards establishing the ontology and knowledge base supporting the delivery of OMS model services.

In a typical farm/field level business case, the customer, in other words the agricultural producer, or herein referred to as the producer, requests assistance for solutions to address one or more resource concerns on their land, or affecting their land.

The business case rests on the following concepts:

1. Problem area(s) – can be delineated on a map. The concept of problem area is established in USDA (NRCS) policy, as part of the resource inventory process, but there is no highly defined method to delineate them.
2. Resource concern(s) – USDA (NRCS) maintains a standard list of about 80 resource concerns, of which about 20 are cited the most during problem identification. The concept of resource concern is established in USDA (NRCS) policy. Resource concerns are a structured way to describe the problem areas.
3. Treatment unit (s) – can be delineated on a map, and usually are congruent with the outside boundary of a set of the producer's fields, or can be congruent with the problem area if the producer separates the problem area out as separate fields. The concept of treatment unit is established in USDA (NRCS) policy.
4. Response unit(s) – can be delineated on a map, and usually result from the intersection of treatment unit with soil map unit. However, other methods to delineate response units can be used, for example, via the intersection of treatment unit with a watershed boundary. The conservationist often applies professional judgment to delineate response unit boundaries. In many cases, the treatment unit boundary is designated the response unit, primarily by finding the worst case sub-response unit and having it apply for the entire treatment unit. The concept of response unit is established in USDA (NRCS) policy, albeit somewhat implicitly, and varying across disciplines as to the method to delineate them.

At the farm/field scale, it is important to note that treatment unit is elevated in importance, at least in a geospatial context. The treatment unit contains problem areas and response units. The emphasis is on treating the problems.

At the watershed/basin scale, emphasis shifts to assessing effects and impacts, a different business case. The response unit is elevated in importance. Program managers and oversight want to know the benefits of applying treatment on a broad scale. Response units therefore become aggregations of treatment units. The analyst goes through a process to roll-up, summarize, average, or assign representative treatment for a large delineated response unit. The emphasis is on evaluating the effects and impacts of treatment across producers on a broad scale.

The four concepts above apply at both scales, but they are handled somewhat differently in each.

There is a middle ground, actually an extension of the farm/field scale to develop treatment solutions for multiple producers for a set of problems affecting a larger area, often at the small watershed level. In this business case, the approach is almost the same as with working with a single producer. The emphasis is on treating the problems.

The OMS agro-environmental ontology and knowledge base should include the four concepts above as a foundation.

Next, let's look further at treatment unit.

A treatment unit is related to the problem areas and their resource concerns. (Precisely how they should be related in the ontology is to be determined).

A treatment unit contains a management system. Only one. Part of the definition of a treatment unit is that the treatment is considered the same within its boundaries.

The treatment unit management system contains management periods. A management period has a duration, start day and end day, is associated with a plant cover (crop, pasture, range, etc), and contains multiple management operations. Management operations include tillage, planting, pesticide application, fertilizer application, harvest, etc.

The treatment unit contains conservation practices. Conservation practices consist of two types: (1) physical engineering structure, e.g. waste storage lagoon, and (2) management practice, in other words a set of management operations that produce a desired conservation effect on a resource concern. The latter type of practice can be derived as a subset of the management operations recorded for the treatment unit management system. In one sense, the conservation management practice is an abstraction, although it results in a set of specifications and a job sheet for the producer to use as a reference during application. The conservation engineering physical structure practice contains design criteria, specifications, and detailed drawings used by the producer to apply the practice.

How do OMS model services relate to the fundamental conservation technical assistance delivery concepts discussed above?

The "treatment" in treatment unit consists of the plant cover, management operations, and physical engineering structures applied by the producer through the management period of the management system to produce the desired effects on the problem area resource concerns. Effective treatment depends on an estimate of the severity of the resource concerns in the problem area, followed by estimates of the effects of prescribed treatment options on the concerns. For example, the conservationist may estimate erosion rates within the problem area using model services, and do the same for alternate prescriptions that combine different mixes of plant cover (crops), management operations, and engineering structures.

In this case, the resource concerns focus on soil erosion. An erosion estimator model service requires climate, soil, and management system data The model service contains several biophysical processes: precipitation, infiltration, runoff, erosion, plant growth, etc. Several of these processes interact with the treatment unit management system: management period, plant cover, management operations, physical structures, etc. Therefore the biophysical processes should be represented in the ontology as concepts (or Classes in formal terminology) and related to the concepts (Classes) of the treatment unit management system.

We should consider establishing an agro-environmental ontology for each of the five model bases described in the OMS Strategic Plan. We probably start with a farm/field scale ontology to support the Conservation Delivery Streamlining Initiative (CDSI) and one for the watershed/basin scale CEAP modeling project. Doing this probably would enable adapting one or the other for the other three model bases.

An ontology supporting a model base helps to resolve the apples/oranges challenge. If we consider RUSLE2, WEPS, APEX, and other models as sources of components for the CDSI Model Base, we would discover differences in approaches and incompatibilities across sources, and conflicts with the concepts on the conservation delivery side

(treatment unit, response unit, management system, management operation, conservation practice, etc.). The ontology establishes the conceptual framework for fitting pieces into the model base and improving it over time. The ontology is more than a reference, as it can be programmatically accessed to assist the model building and integration process.

Initial listing of Classes (concepts) for the OMS Agro-Environmental Ontology set:

- Resource Problem Area
- Resource Concern
- Treatment Unit
- Management System
- Conservation Practice
  - Engineering Practice
  - Management Practice
- Management Period
- Plant Cover
- Management Operation
- Response Unit

Organization into a super-class, sub-class hierarchy is to be determined. Classes contain properties (or Slots in formal terminology) and facets (restrictions or acceptable values). Classes contain Instances (for example, a Resource Concern instance would be sheet/rill erosion). Classes are related to each through what are called Inverse Slots.

Other candidate Classes for the ontology set:

- Soil Mapunit
- Ecological site
- Hydrologic Unit
- Climate Station
- NRI Primary Sample Unit

Biophysical process Classes are to be determined for hydrology, soil, plant growth, pesticide fate/transport, nutrient fate/transport. We should start with the processes contained in the CEAP and PRM modeling projects.

A basic reference, which I think previously sent, is attached. Additional references can be found at http://protege.stanford.edu/