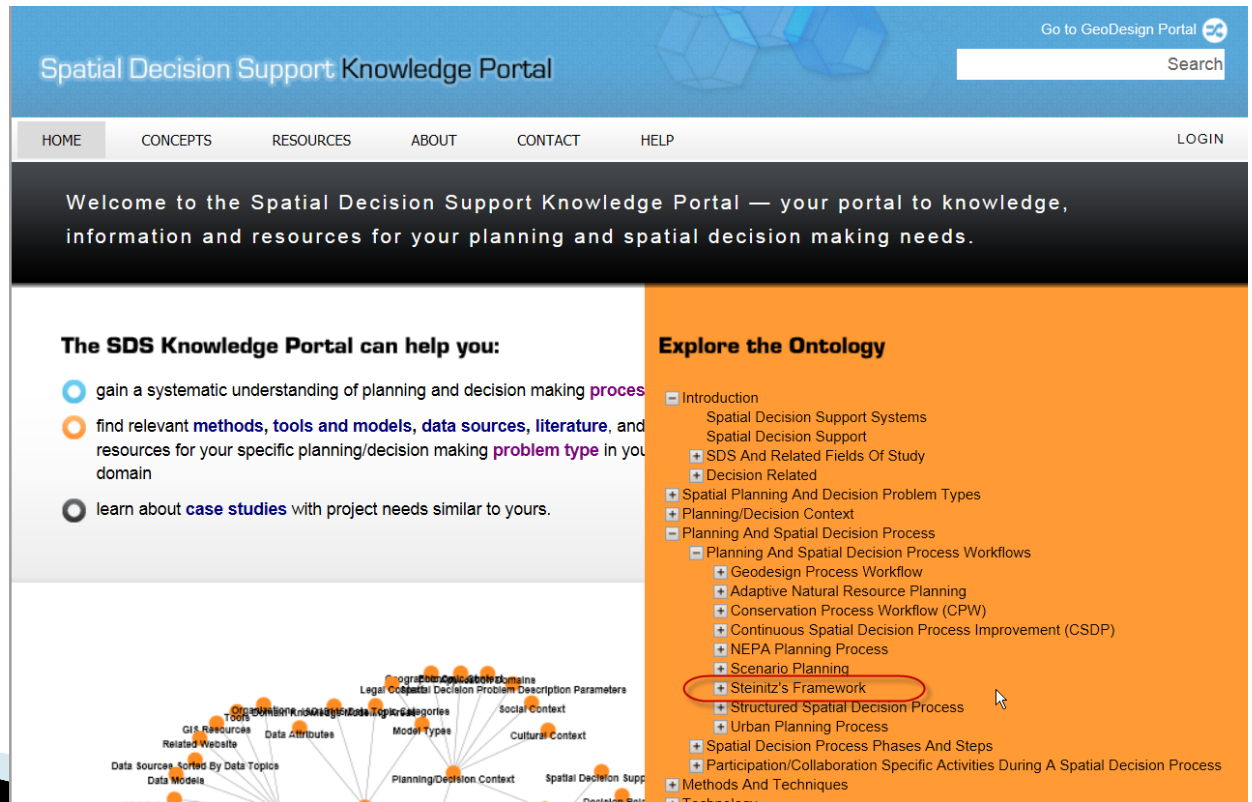
Open Decision Support

eScience: Open Data for Open Science

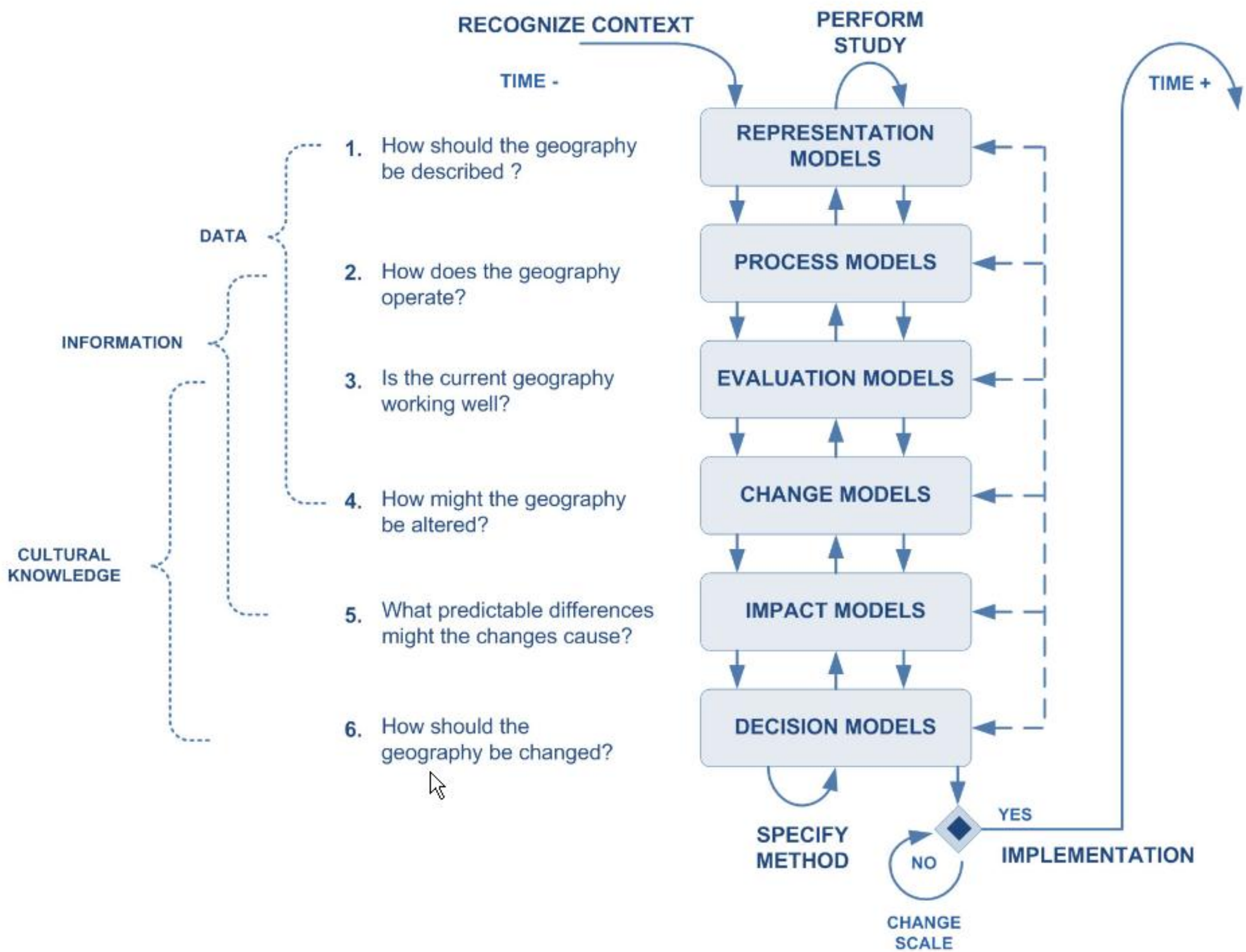
(Spatial) Decision Support

Using best available science to support decisions that will change the landscape.

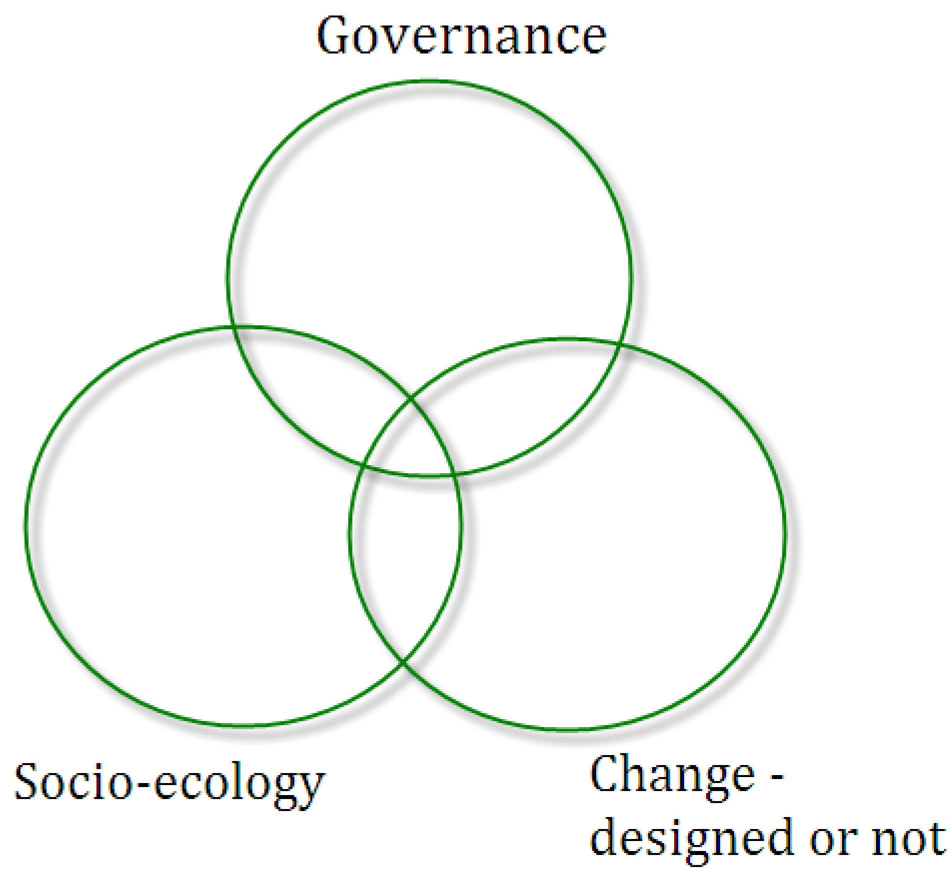
http://www.spatial.redlands.edu/sds



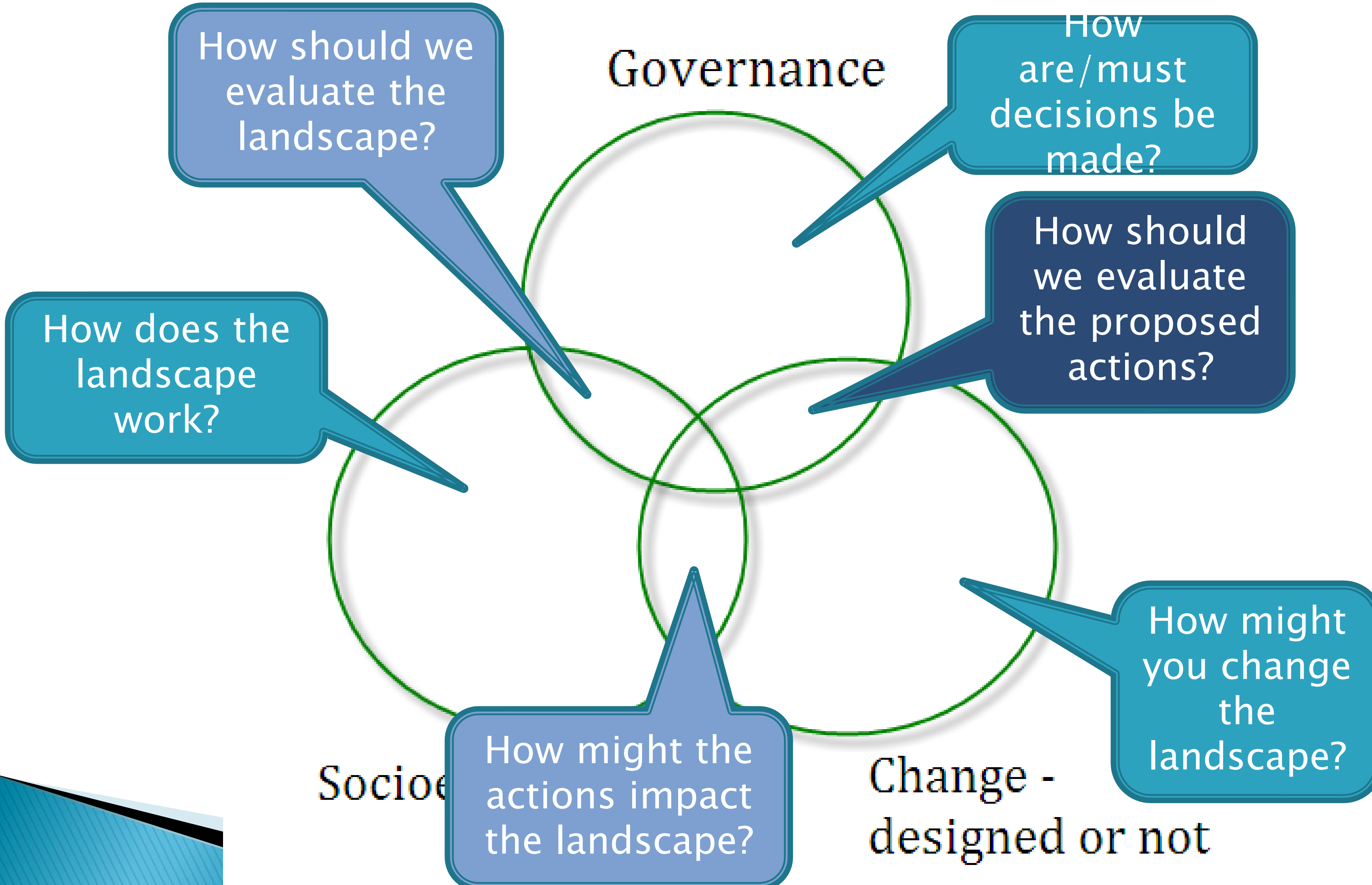
Steinitz Process/Workflow



Planning Support Venn view



Planning Venn/Steinitz



How does SDS synthesize w. eScience?

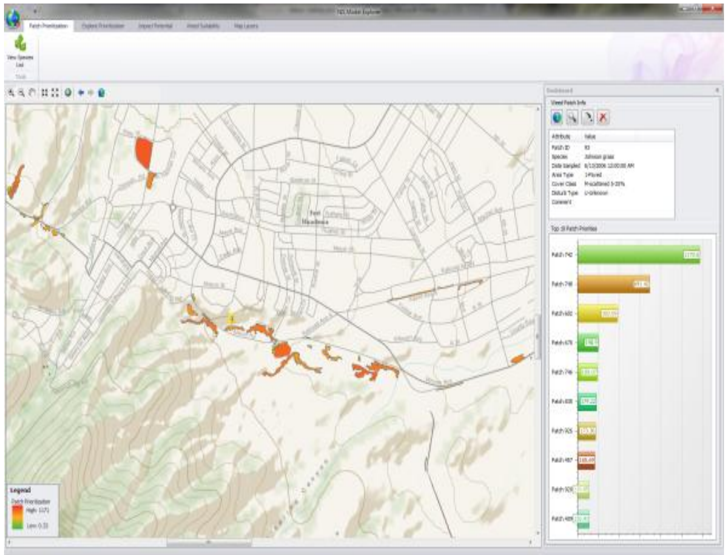
- Can’t work without eScience describing the processes and state of the socio-ecology**
- Very focused on decisions about intentional actions (but has to accommodate external actions)
- Change models/representation must be integratable with socio-ecology system models
- Both need to be validated & uncertainty estimated
- Computation is key

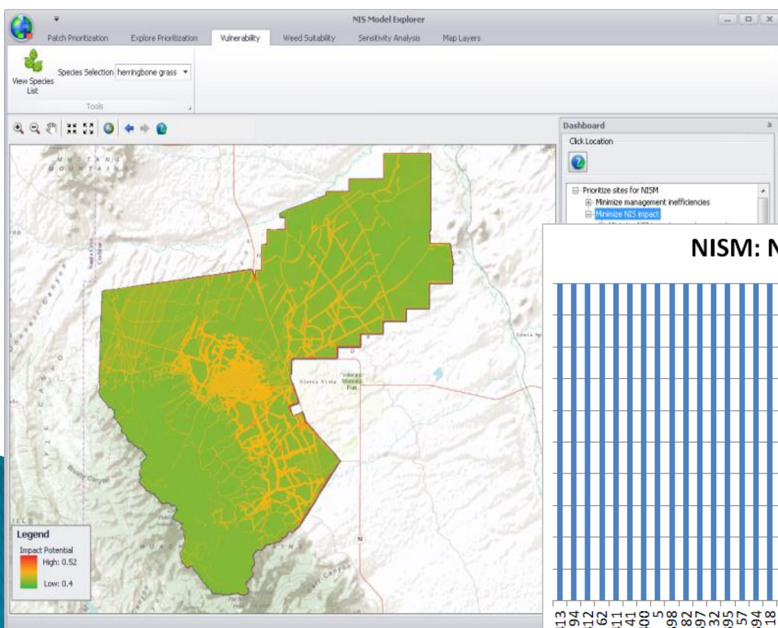
How does SDS differ from eScience?

- Governance (Cultural) Models explicit: Evaluation and Action Decision models
- Type II errors often less acceptable than Type I errors – the need to act while still time
- SDS even more likely to be X-discipline
- Can be more directly experimental >> adaptive management, but…
- Can require even longer timescales to validate
- Decision Efforts are often episodic

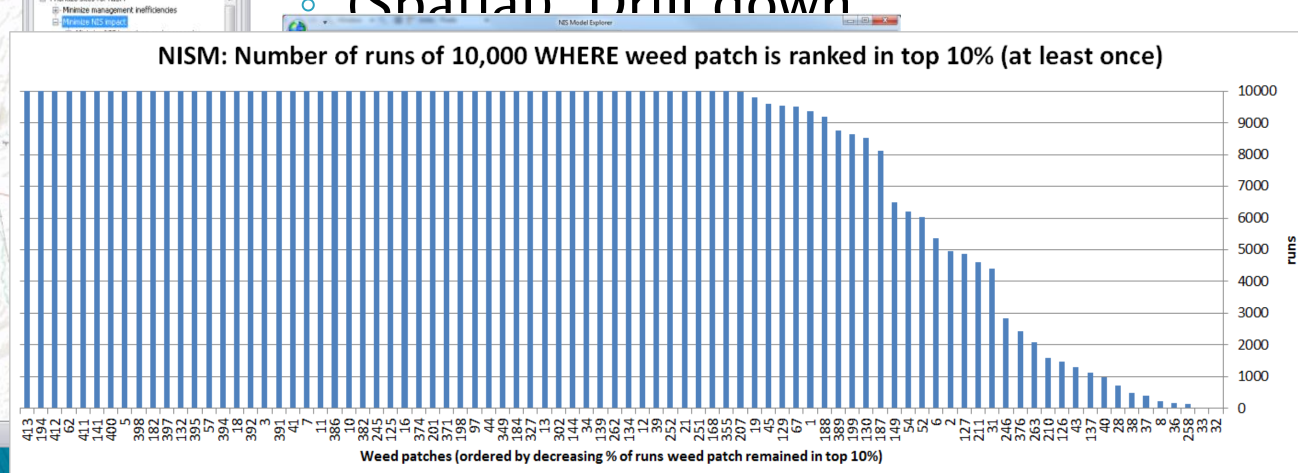
II. Examples of SDSs

1: Non-native Invasive Species Management

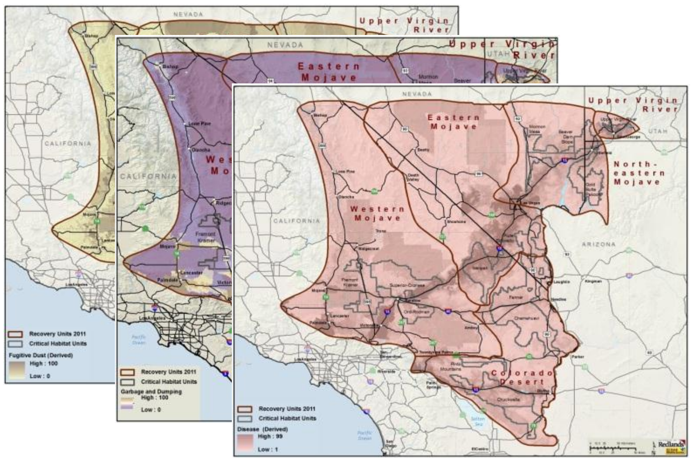


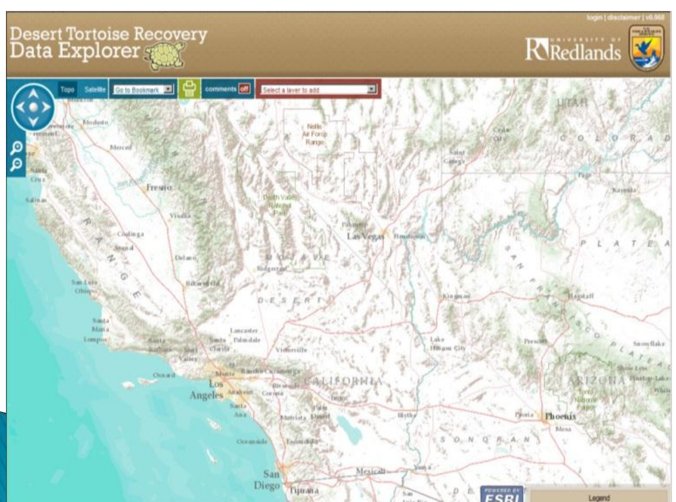


- Data: Curated from Installation datasets
- Model = Threat & Vulnerability & Importance
  - Geo processing of standard weed models
  - Expert Assessment of Resource Vulnerability
  - Operational Expert Evaluation of Resource Importance Key Features
  - Weed propagation forecasting
  - Dashboard like rendering
  - (Spatial) Drill down



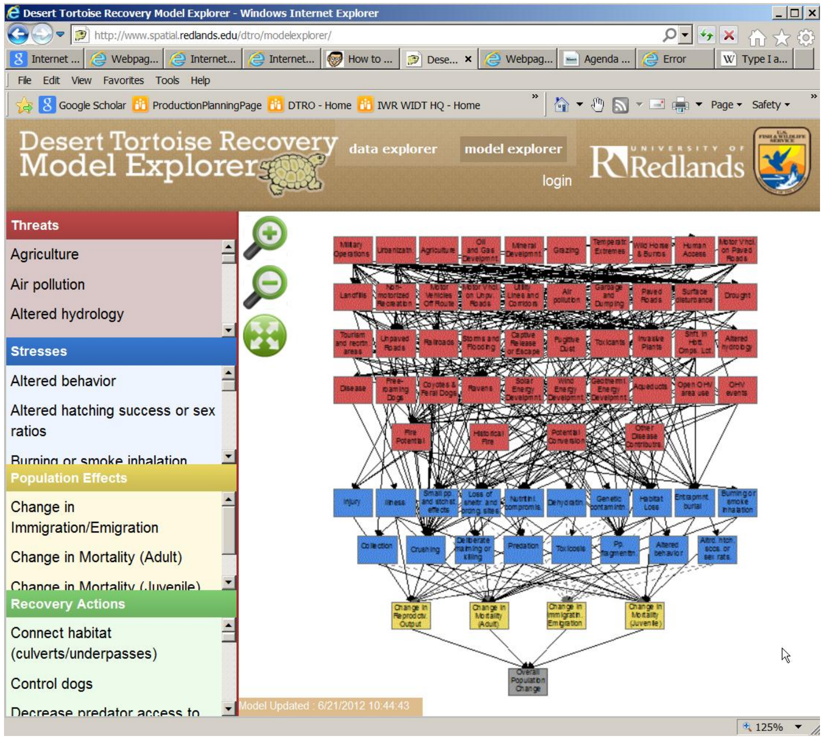
2: Desert Tortoise Recovery Action Prioritization

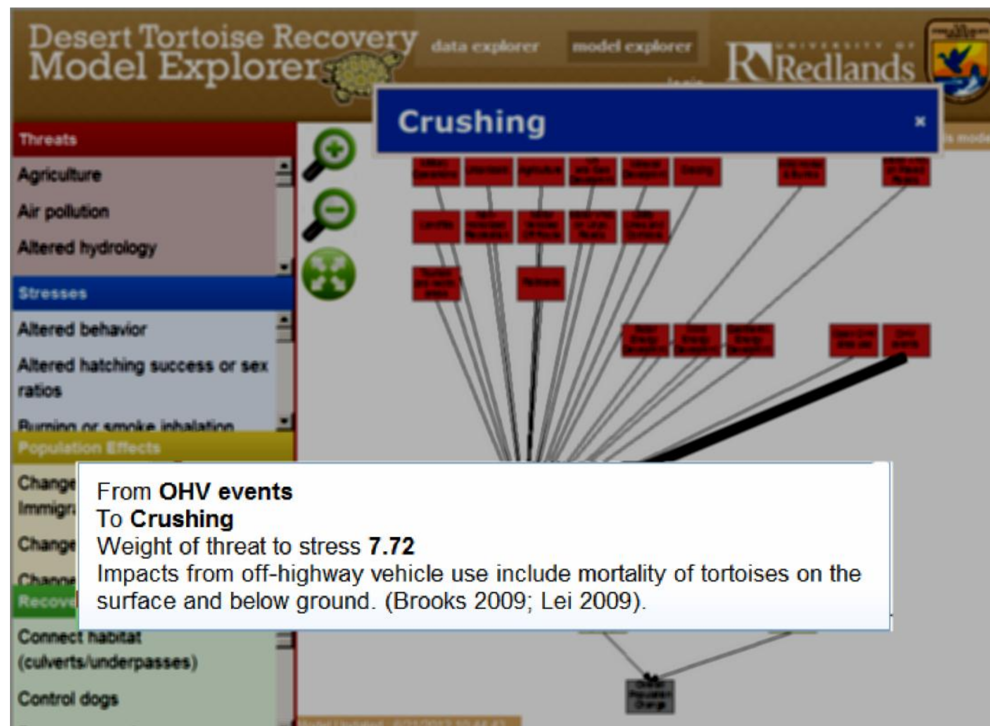




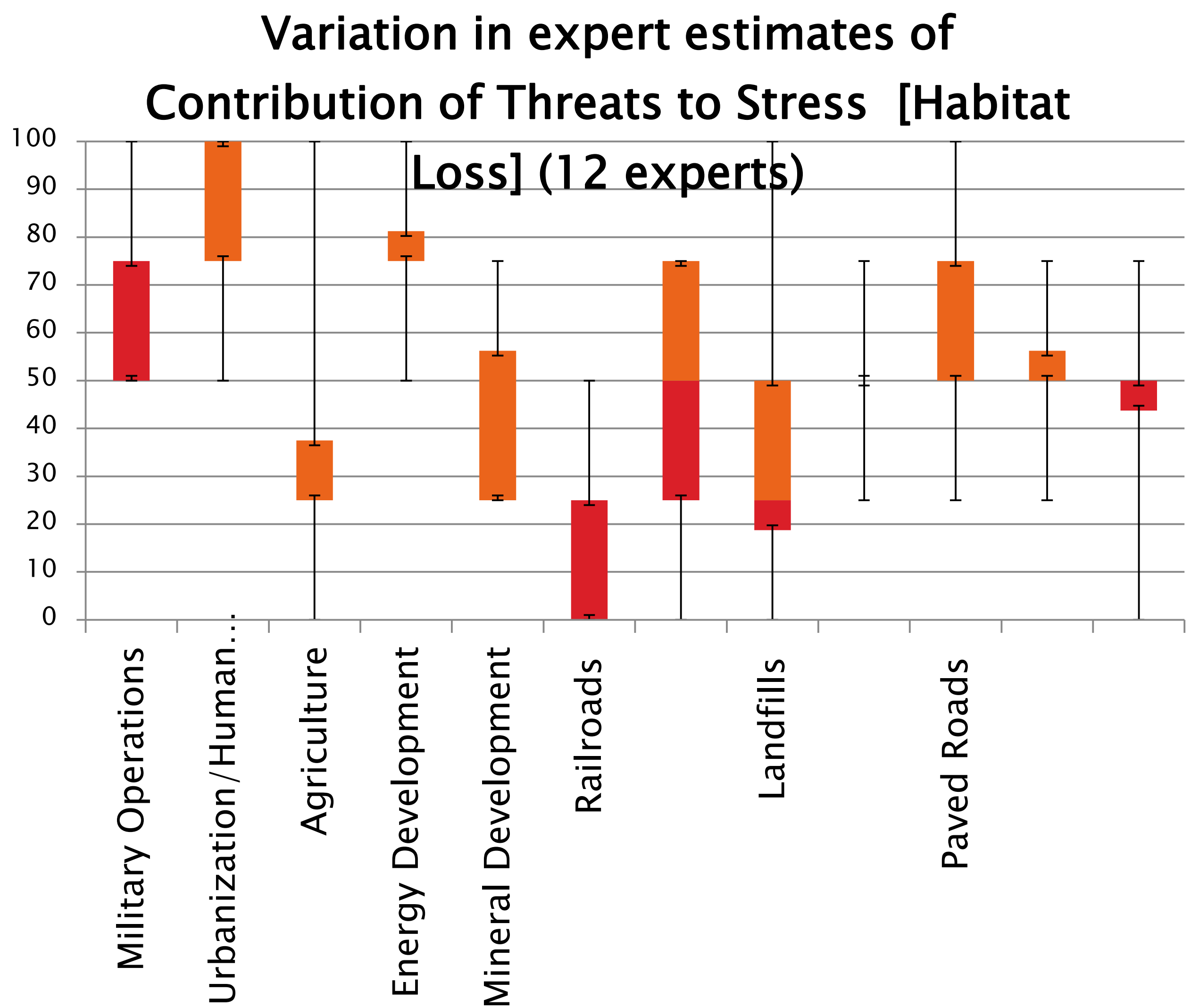
- Data Curated from multiple sources, published to web as web services
- Model: Risk to DT Recovery = Pop Change Risk x Population Density
  - Threat > Stress > Demographic weights > Pop Chang
  - Threats can also drive other threats – calculated
- Recovery Actions suppress (Threats > Stresses) links
  - Reduction of threat effects > Reduction in Pop Change Risk
- Key Features
  - Recovery Actions explicitly target Threat-Stress mechanisms
  - Sensitivity Analysis + Uncertainty in Data and Expert Opinion > Error Bars

2: Desert Tortoise Recovery Action Prioritization



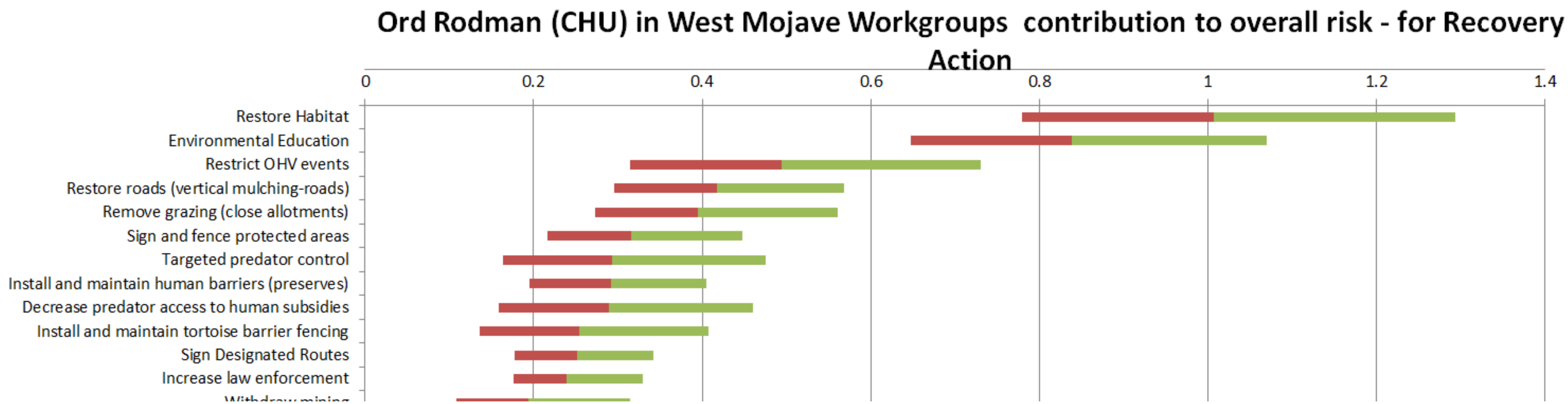


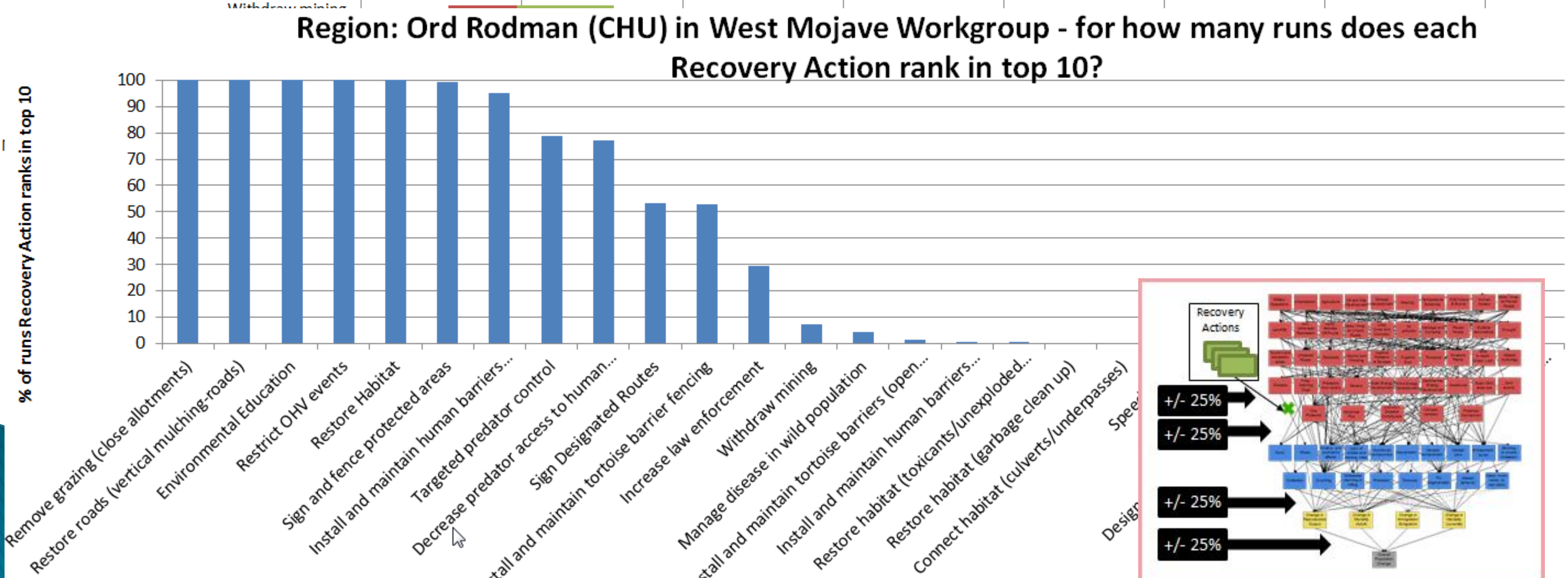
Characterization of Uncertainty



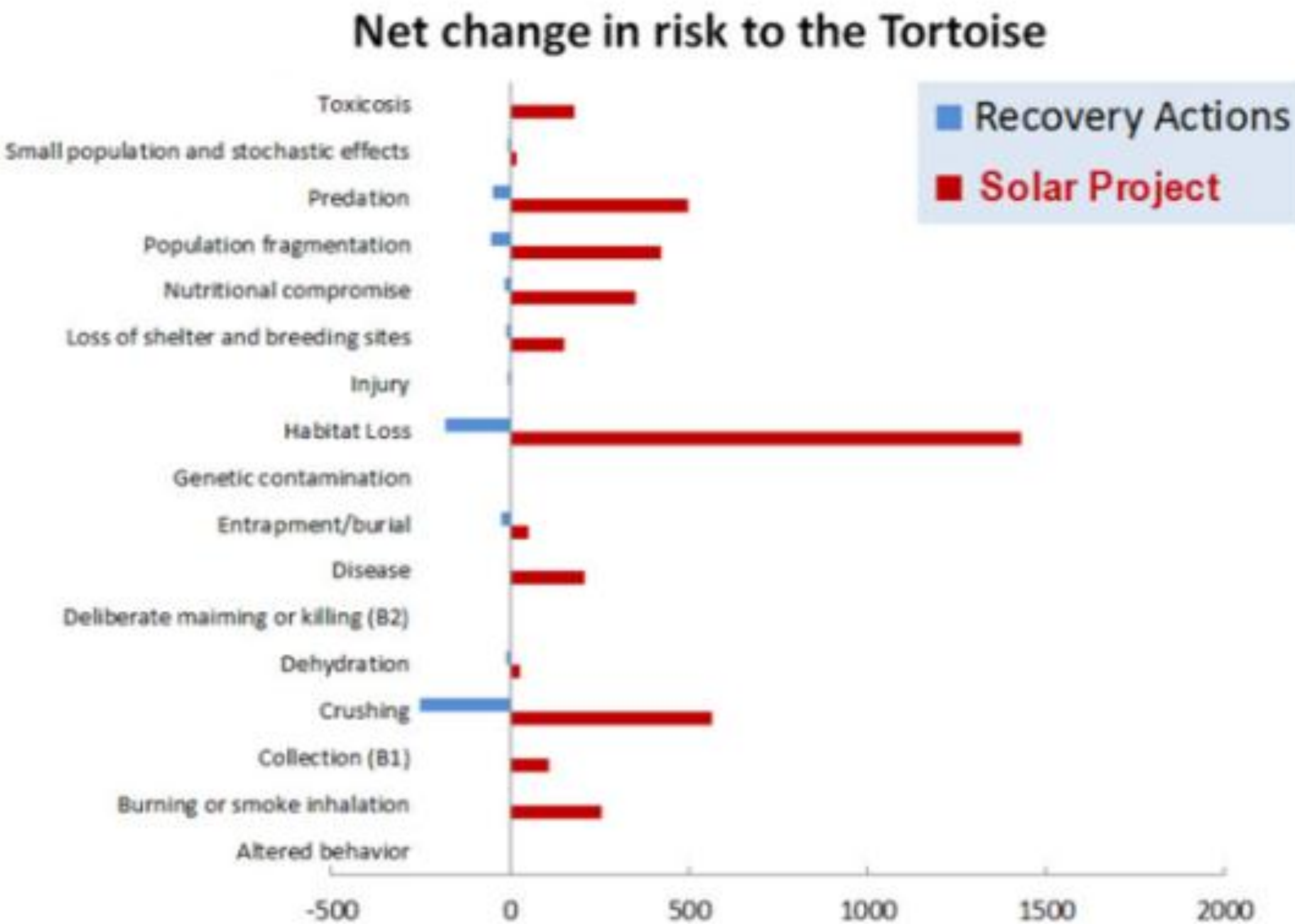
2: Desert Tortoise Recovery Action Prioritization

WEMO TCA: Ord Rodman – RAs

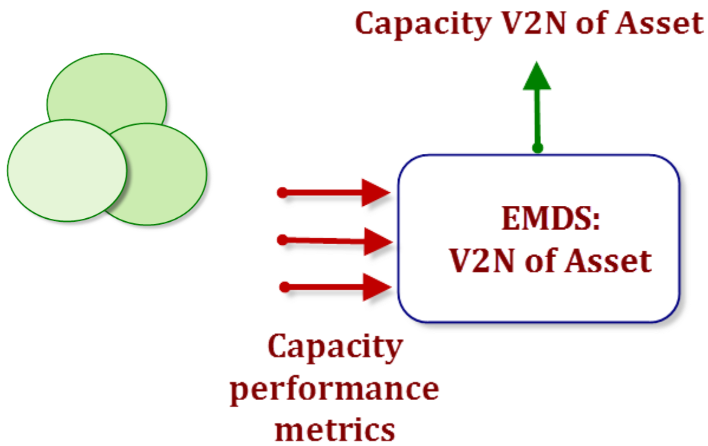


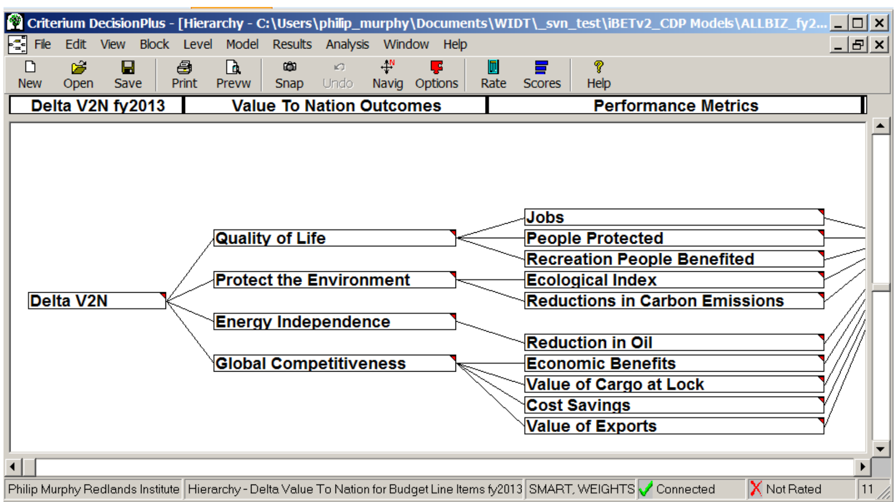


2.5: Desert Tortoise Solar Project Offsets

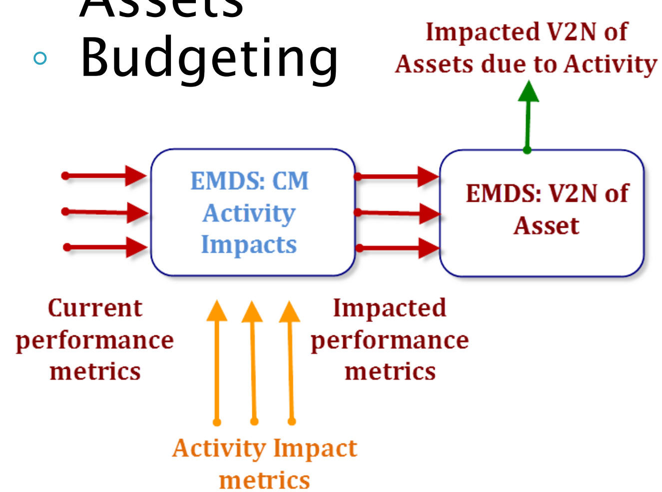


3: National Infrastructure Investment

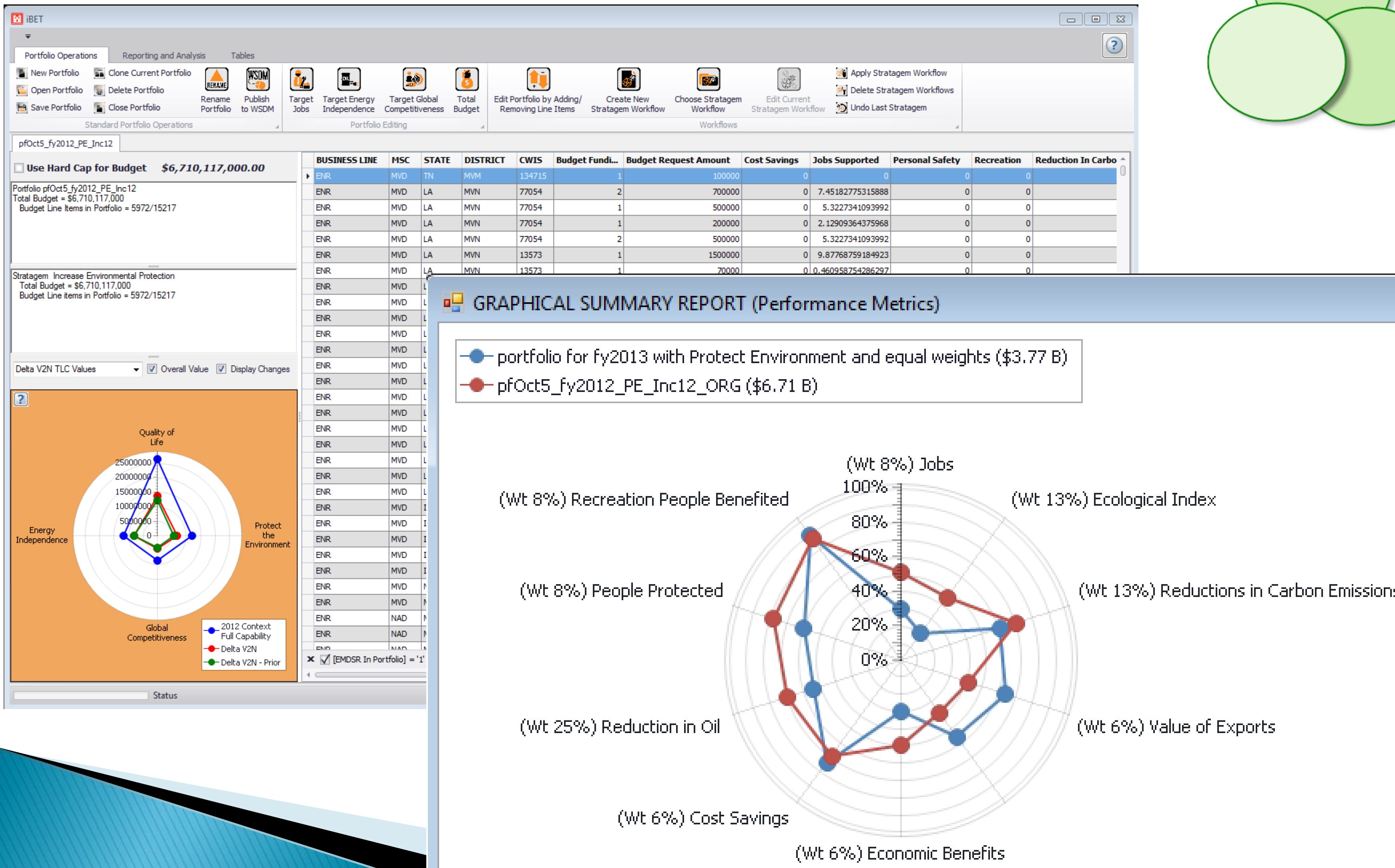




- Data: Internal to Corps
- Asset Value to Nation
  - Processes > Performance metrics > Value
- Action Delta Value to Nation
  - How access changes processes
  - Changed processes > Changed Value
- Key Features
  - Actions impact processes of Assets
  - Budgeting



3: National Infrastructure Investment



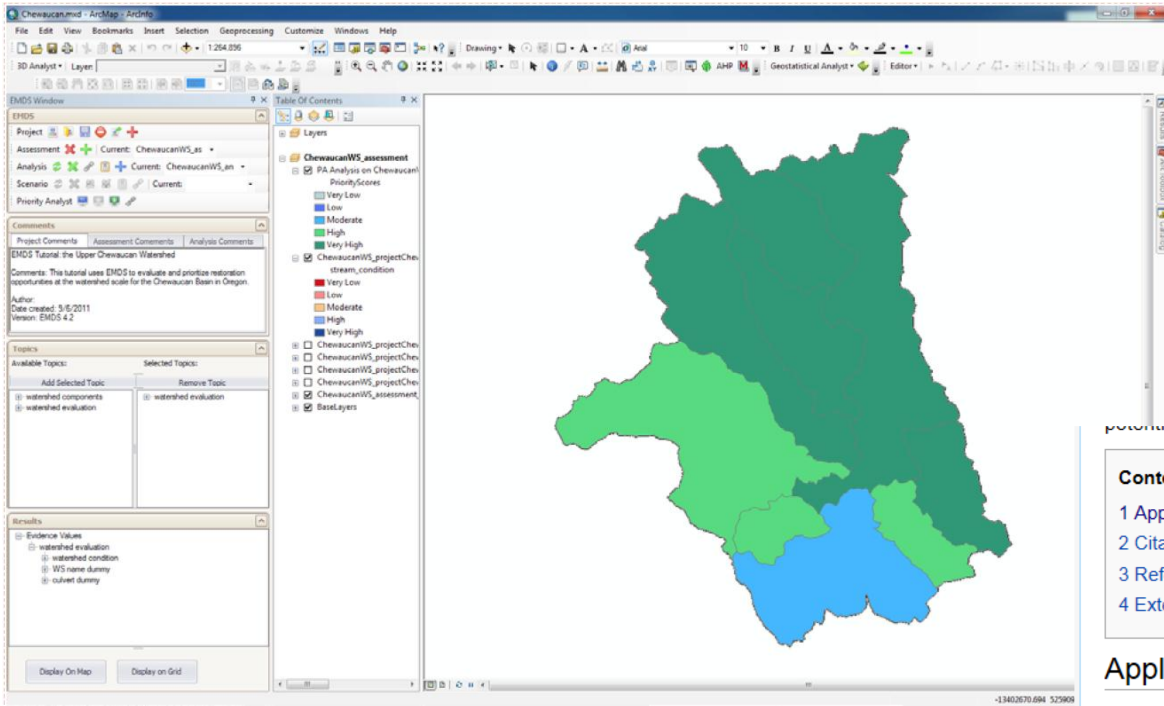
Summary of Examples

- All are examples of planning workflow
- All have very different End User Interfaces
- User Types: Analysts, Decision Makers, Stakeholders
- All had underlying process, change and governance models – each created in its own authoring application
- All should have had
  - Drill down
  - Parameter editing
  - Sensitivity & Uncertainty handling
  - Provenance

III: Ecological Management Decision Support (EMDS)

- Open modeling system
- Spatial System Evaluation
- Fixed Workflow:
  1. Spatial Identity – data representation
  2. Set Study Area
  3. Run authored fuzzy logic models
  4. Generate map outputs – state of system
  5. Run prioritization models
  6. Generate map outputs – evaluation of state

EMDS "Classic"

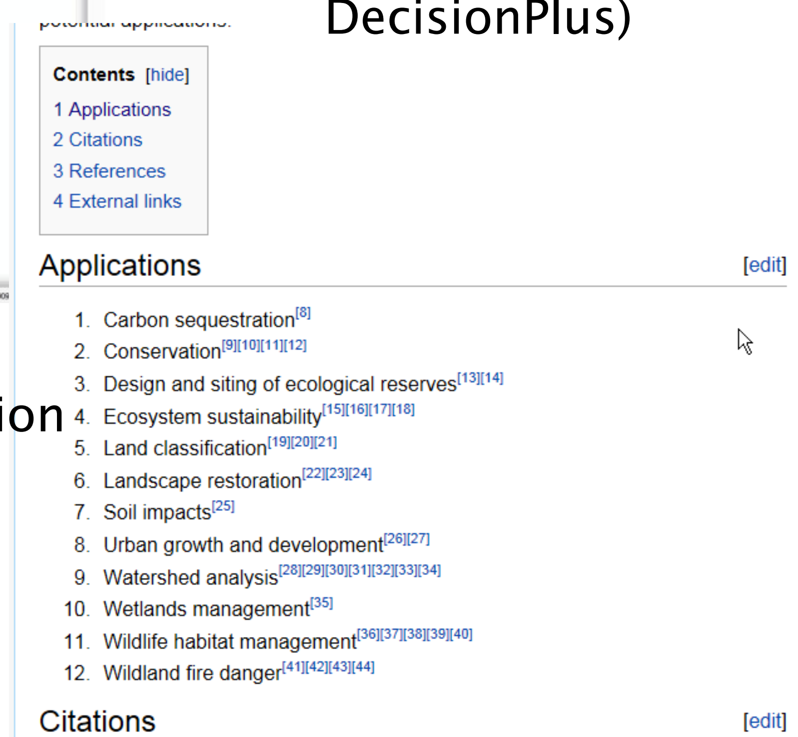


http://www.spatial.redlands.edu/emds/

1. Fixed Workflow for landscape evaluation
2. Desktop
3. Single Thread
4. Data – ESRI geodatabase
5. Max ~ 1,000,000 features

GOOD:

1. Freely available
2. User Community
3. No-CODE Process/governance models
   1. Spatial (ESRI)
   2. Fuzzy Logic (Net Weaver)
   3. MCDA (Criterium DecisionPlus)



Contents [hide]

Applications [edit]

1. Carbon sequestration[8]
2. Conservation[9][10][11][12]
3. Design and siting of ecological reserves[13][14]
4. Ecosystem sustainability[15][16][17][18]
5. Land classification[19][20][21]
6. Landscape restoration[22][23][24]
7. Soil impacts[25]
8. Urban growth and development[26][27]
9. Watershed analysis[28][29][30][31][32][33][34]
10. Wetlands management[35]
11. Wildlife habitat management[36][37][38][39][40]
12. Wildland fire danger[41][42][43][44]

Citations [edit]

IV: EMDS 5 – Open Decision Support

- Data: Catalog Search & Publishing
- Ontology: Connect to SDS Ontology via Domain Ontologies (e.g Salfasky's Species Recovery lexicon)
- Re-architect EMDS into:
  - EMDS Back-end Web Services
  - Infrastructure for wrapping 3rd party engines
    - Adding inference, optimization, geoprocessing, ..
  - Workflow Architecture
    - Windows Workflow
    - Trident Workbench: Workflow Composer, provenance, ..
  - Analysis GUI: Specific data and modeling visualization
  - Decision Manger GUI (decision visualization)??

What Does EMDS get from Trident?

- Work flow composer
- Workflow orchestration
- Fault Tolerance
- HPC
- Utilizes Windows Platform

EMDS5 and SDS Ontology

- Populate Analytic models from domain Ontologies
- Augment Workflow Composition using SDS Ontology
  - Workflows, steps, tools, methods

SDS ontology as integration framework

SDS for Tortoise Recovery – Conceptual Model

Conceptual Models

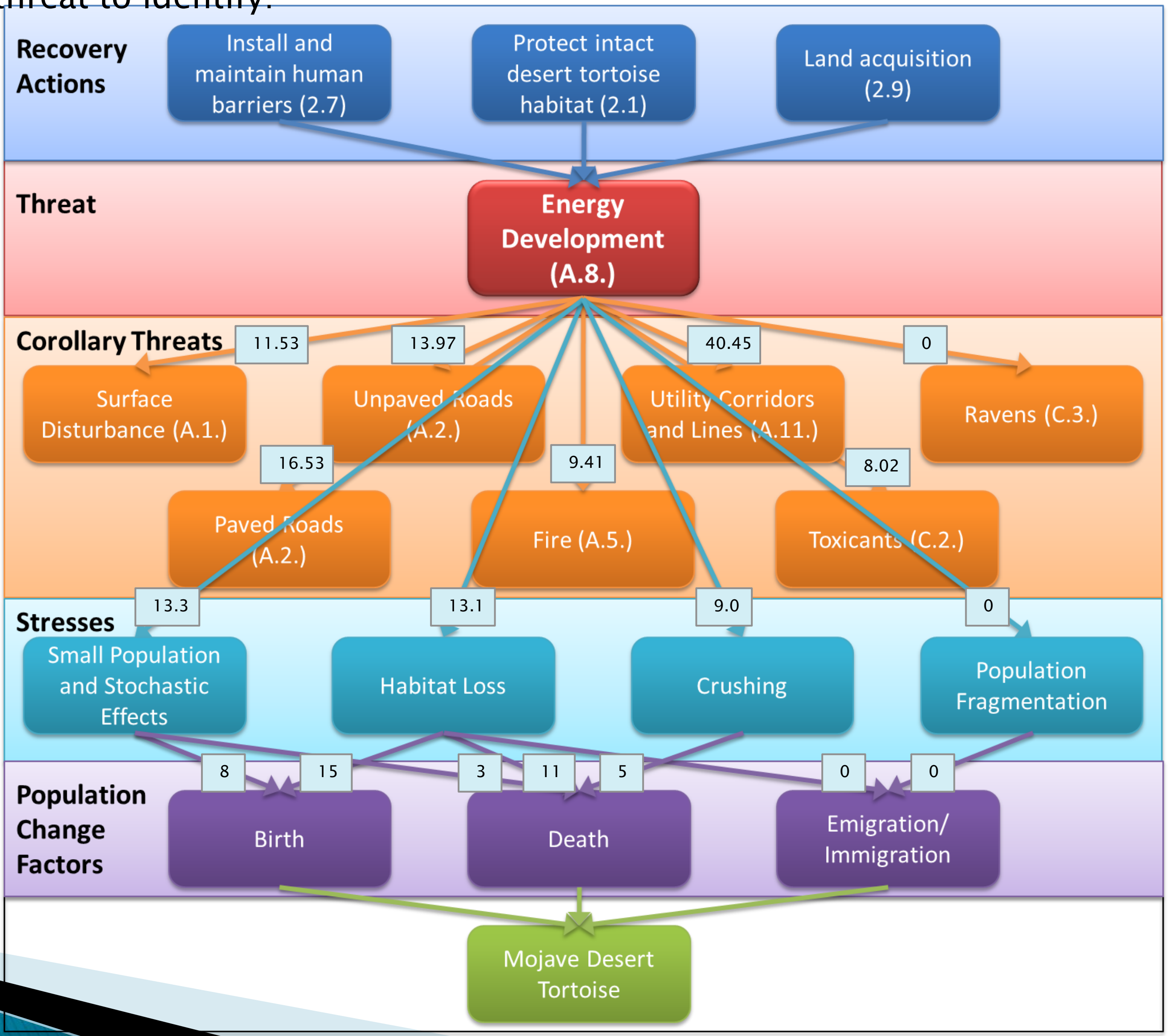
The DTRO worked threat-by-threat to identify:

Which *Recovery Actions* can be introduced to abate the threat

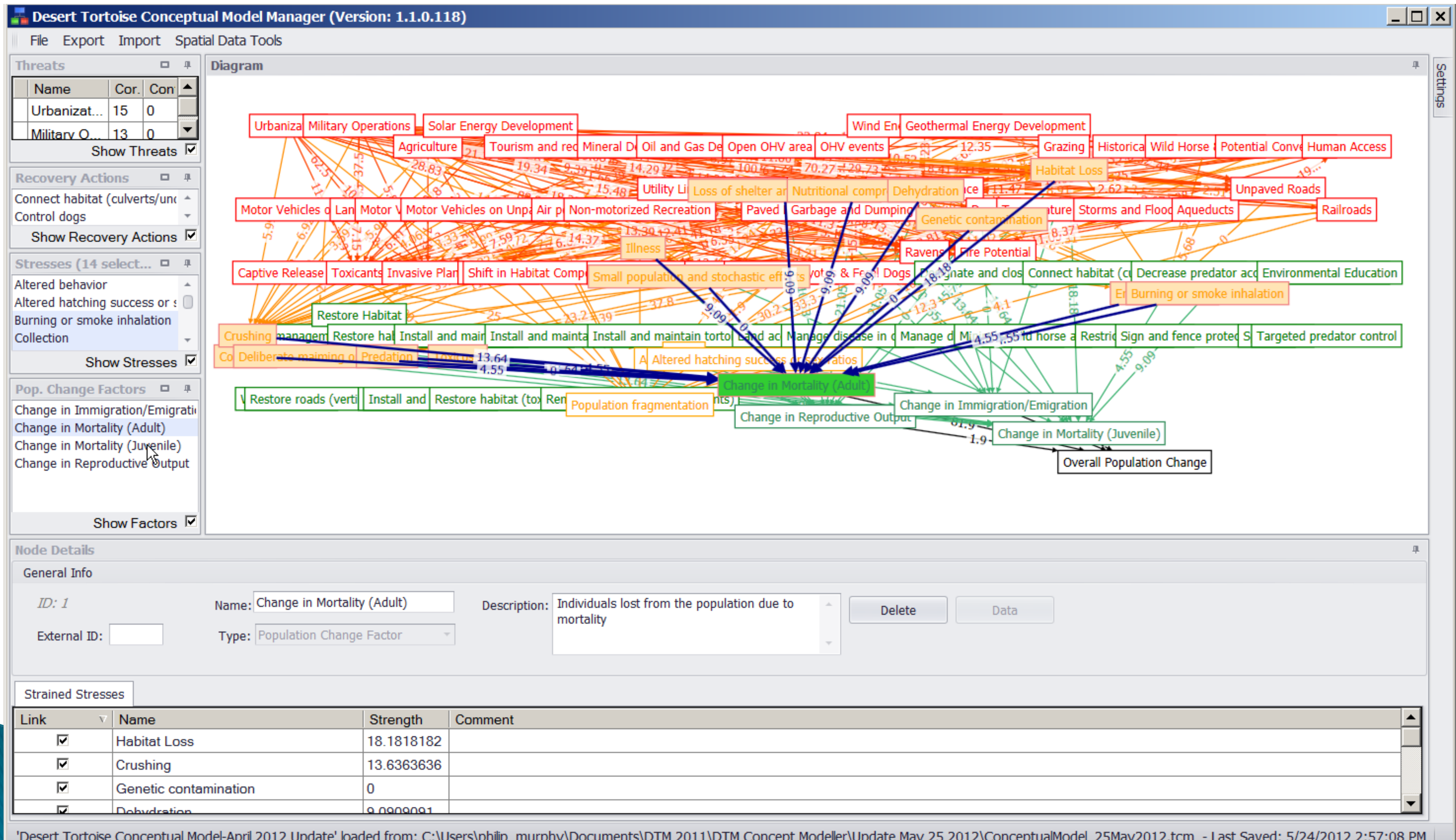
The *threats* caused by each threat

The *stresses* caused by each threat

Which *factors* each stress causes to *overall population change*

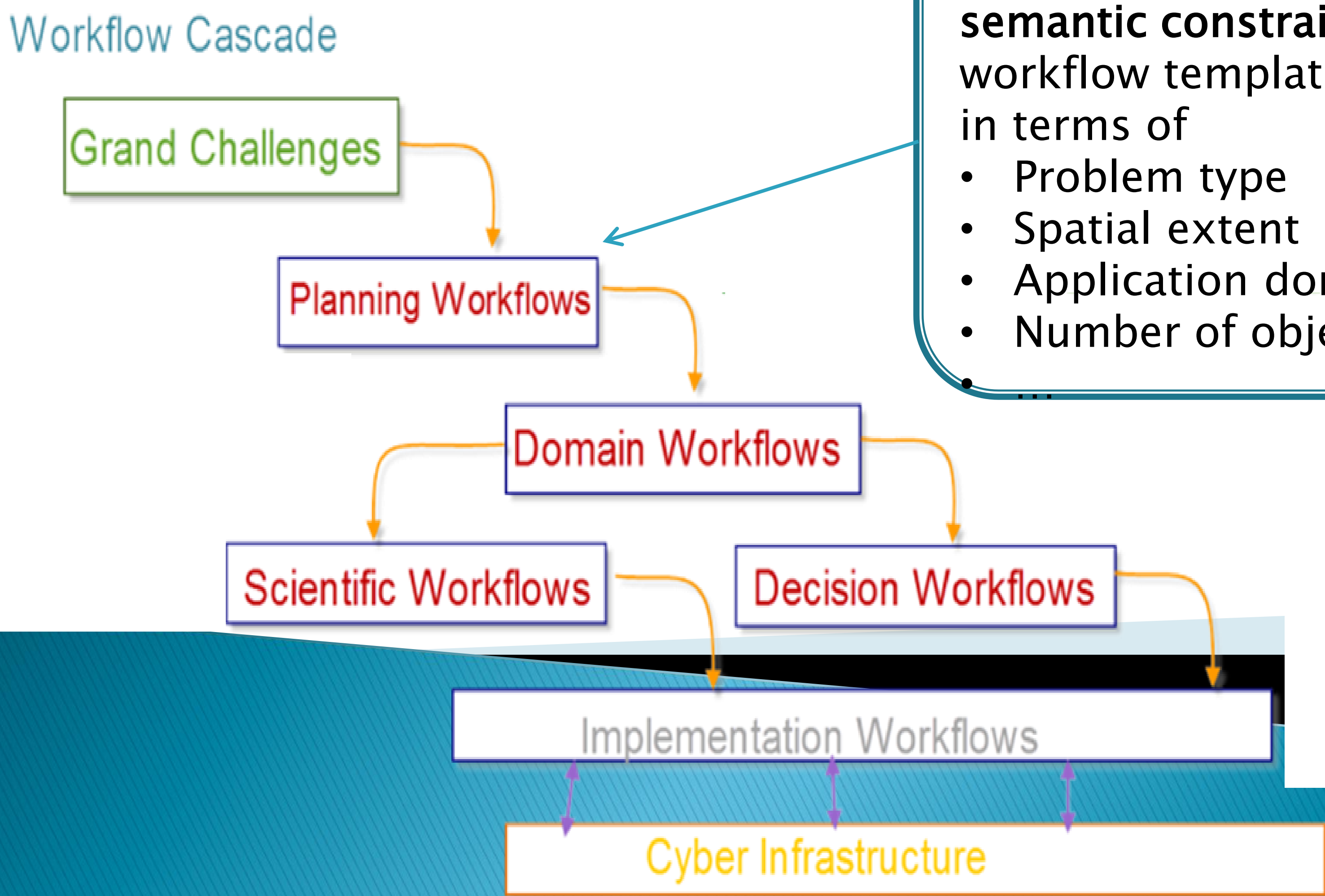


SDS for Tortoise Recovery > Conceptual Model



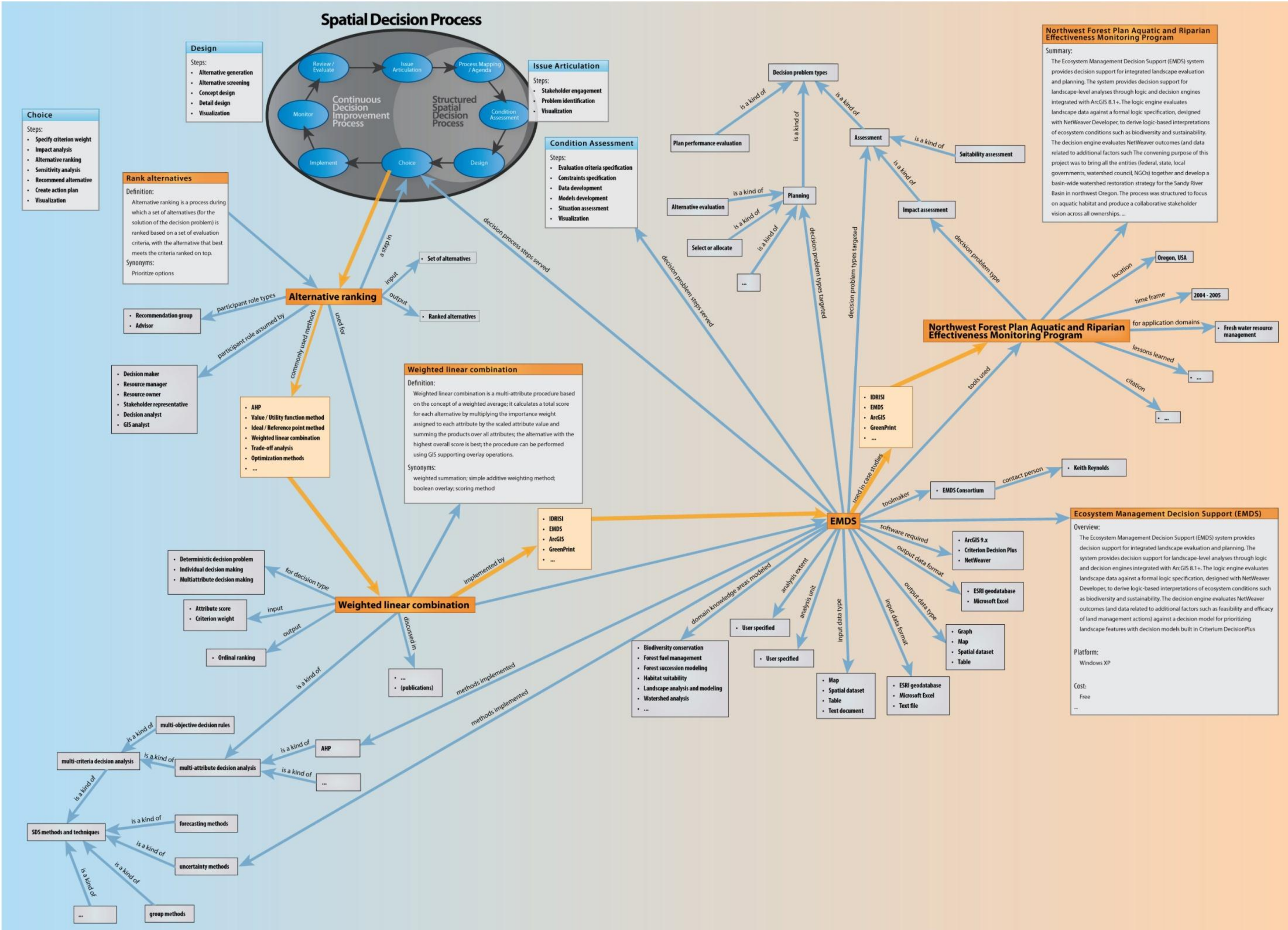
created for basic

SDS ontology as Composer support



User's planning problem description providing **semantic constraints** for workflow template selection in terms of

- Problem type
- Spatial extent
- Application domain
- Number of objectives
- ...



Spatial Decision Process
Review / Evaluate
Issue Articulation
Process Mapping / Agenda
Monitor
Continuous Decision Improvement Process
Structured Spatial Decision Process
Condition Assessment
Implement
Choice
Design
Design
Steps:
Alternative generation
Alternative screening
Concept design
Detail design
Visualization
Issue Articulation
Steps:
Stakeholder engagement
Problem identification
Visualization
Choice
Steps:
Specify criterion weight
Impact analysis
Alternative ranking
Sensitivity analysis
Recommend alternative
Create action plan
Visualization
Condition Assessment
Steps:
Evaluation criteria specification
Constraints specification
Data development
Models development
Situation assessment
Visualization
Rank alternatives
Definition:
Alternative ranking is a process during which a set of alternatives (for the solution of the decision problem) is ranked based on a set of evaluation criteria, with the alternative that best meets the criteria ranked on top.
Synonyms:
Prioritize options
Alternative ranking
a step in
input
Set of alternatives
output
Ranked alternatives
participant role types
Recommendation group
Advisor
participant role assumed by
Decision maker
Resource manager
Resource owner
Stakeholder representative
Decision analyst
GIS analyst
commonly used methods
used for
AHP
Value / Utility function method
Ideal / Reference point method
Weighted linear combination
Trade-off analysis
Optimization methods
...
Weighted linear combination
Definition:
Weighted linear combination is a multi-attribute procedure based on the concept of a weighted average; it calculates a total score for each alternative by multiplying the importance weight assigned to each attribute by the scaled attribute value and summing the products over all attributes; the alternative with the highest overall score is best; the procedure can be performed using GIS supporting overlay operations.
Synonyms:
weighted summation; simple additive weighting method; boolean overlay; scoring method
decision process steps served
decision problem steps served
IDRISI
EMDS
ArcGIS
GreenPrint
...
implemented by
Deterministic decision problem
Individual decision making
Multiattribute decision making
for decision type
Attribute score
Criterion weight
input
output
Ordinal ranking
Weighted linear combination
discussed in
...
(publications)
is a kind of
methods implemented
methods implemented
multi-objective decision rules
is a kind of
multi-criteria decision analysis
is a kind of
multi-attribute decision analysis
is a kind of
AHP
is a kind of
...
is a kind of
SDS methods and techniques
is a kind of
forecasting methods
is a kind of
uncertainty methods
is a kind of
is a kind of
...
group methods
Decision problem types
is a kind of
is a kind of
is a kind of
Plan performance evaluation
Assessment
is a kind of
Suitability assessment
is a kind of
Impact assessment
Alternative evaluation
is a kind of
Planning
is a kind of
Select or allocate
is a kind of
...
decision problem types targeted
decision problem types targeted
decision problem type
Northwest Forest Plan Aquatic and Riparian Effectiveness Monitoring Program
Summary:
The Ecosystem Management Decision Support (EMDS) system provides decision support for integrated landscape evaluation and planning. The system provides decision support for landscape-level analyses through logic and decision engines integrated with ArcGIS 8.1+. The logic engine evaluates landscape data against a formal logic specification, designed with NetWeaver Developer, to derive logic-based interpretations of ecosystem conditions such as biodiversity and sustainability. The decision engine evaluates NetWeaver outcomes (and data related to additional factors such The convening purpose of this project was to bring all the entities (federal, state, local governments, watershed council, NGOs) together and develop a basin-wide watershed restoration strategy for the Sandy River Basin in northwest Oregon. The process was structured to focus on aquatic habitat and produce a collaborative stakeholder vision across all ownerships. ...
location
Oregon, USA
time frame
2004 - 2005
Northwest Forest Plan Aquatic and Riparian Effectiveness Monitoring Program
for application domains
Fresh water resource management
lessons learned
...
citation
...
tools used
IDRISI
EMDS
ArcGIS
GreenPrint
...
used in case studies
toolmaker
EMDS Consortium
contact person
Keith Reynolds
EMDS
Ecosystem Management Decision Support (EMDS)
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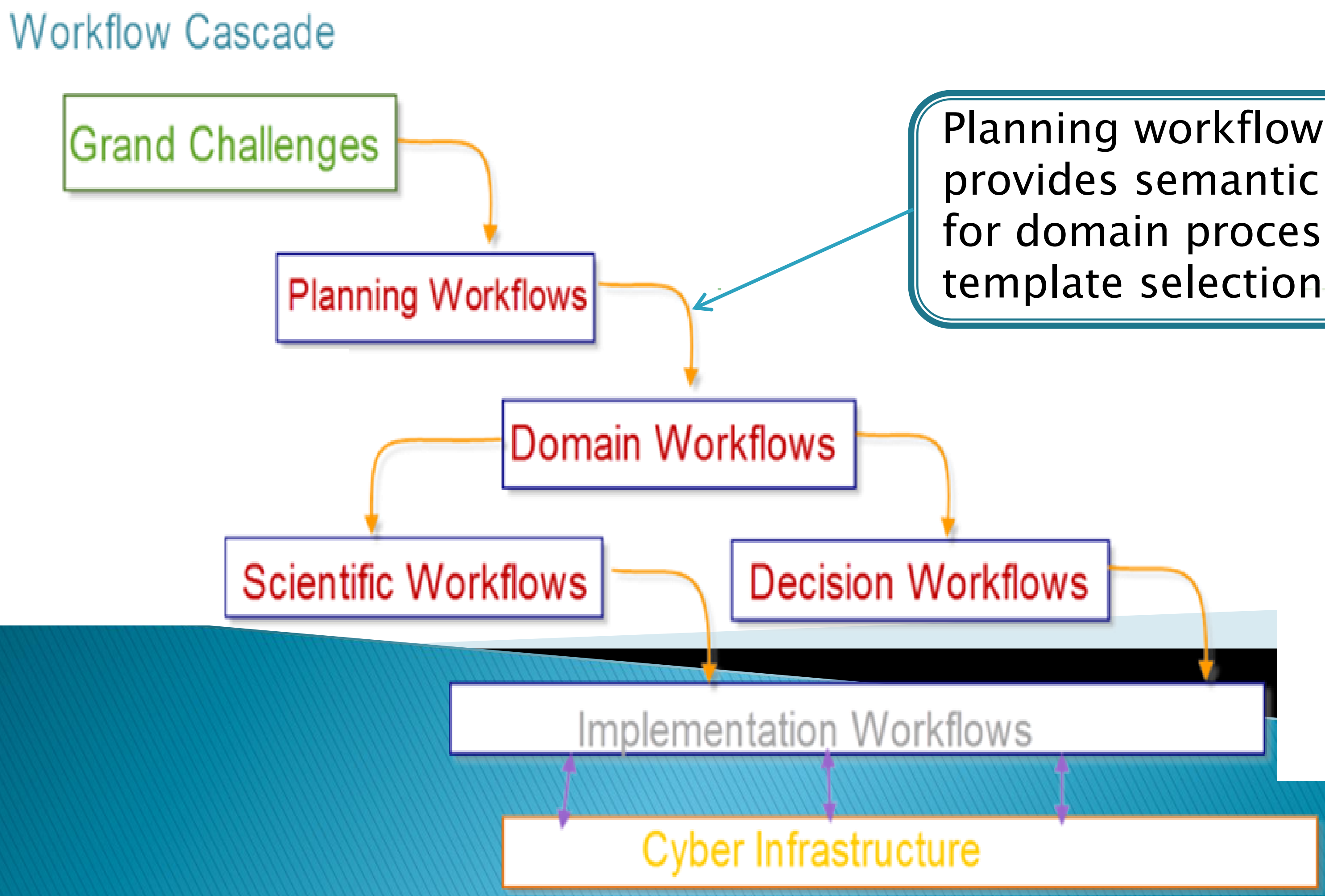
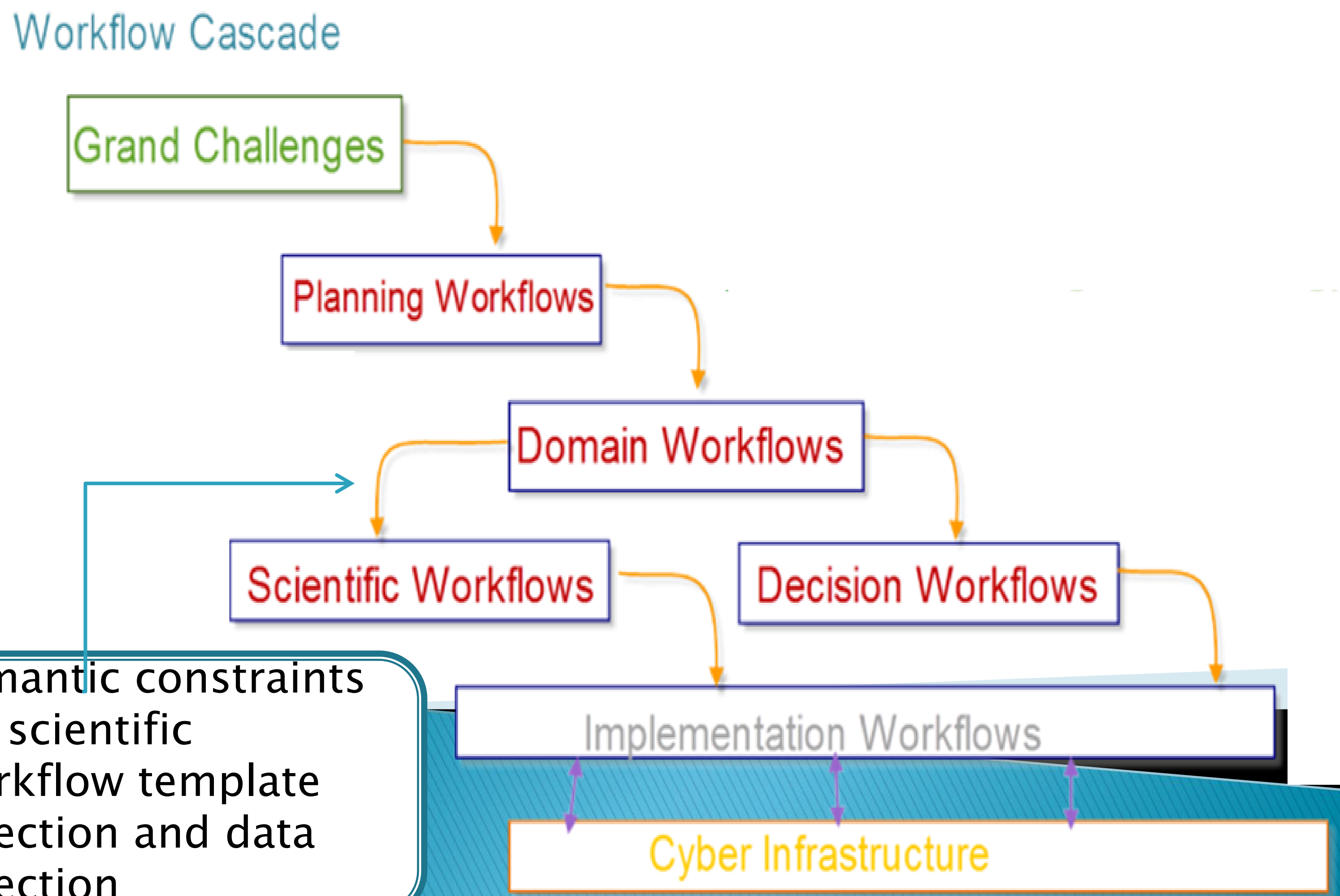
Platform:
Windows XP
Cost:
Free
...
software required
ArcGIS 9.x
Criterion Decision Plus
NetWeaver
output data format
ESRI geodatabase
Microsoft Excel
output data type
Graph
Map
Spatial dataset
Table
input data format
ESRI geodatabase
Microsoft Excel
Text file
input data type
Map
Spatial dataset
Table
Text document
analysis unit
User specified
analysis extent
User specified
domain knowledge areas modeled
Biodiversity conservation
Forest fuel management
Forest succession modeling
Habitat suitability
Landscape analysis and modeling
Watershed analysis
...

SDS ontology as a bridging framework



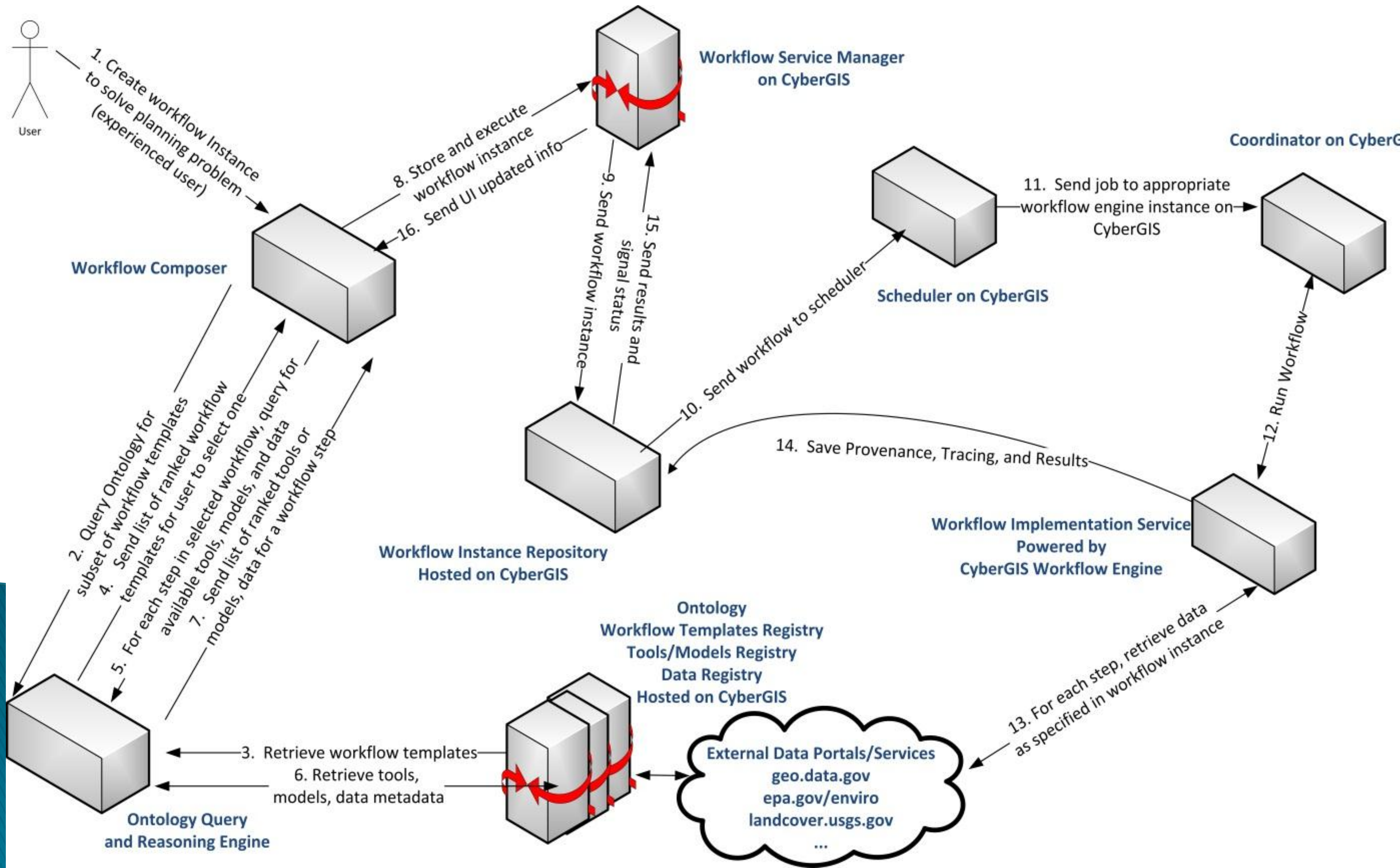
Planning workflow template provides semantic constraints for domain process workflow template selection

SDS ontology as a bridging framework



semantic constraints for scientific workflow template selection and data selection

Ontology-driven SDS workflow orchestration



Work for us

- Have EMDS back end running on Windows Workflow
- Have Persistence Layer in place
- Have wrapped 3 engine**
- Starting design for Trident integration
- Extending SDS Ontology to Species Recovery domain ontology

Questions (for you)

- How far to go with auto-composed GUI for Decision Makers?
- What Modeling standards will work well for mapping process/change/governance engines?
- How to implement sensitivity and uncertainty analysis along the analysis workflow?
- How to practically achieve Conceptual Interoperability?
- How to handle Activity Scales in Trident?
- How to test our emerging system on Interop Testbed?

Thank You

University of Redlands, The Redlands Institute	**The Redlands Institute**	University of Redlands	PennState	**Krzysztof Janowicz**	Pennsylvania State University
Forest Research	**Stephen Bathgate & Duncan Ray**	Forest Research		**Karen Kemp**	The Kohala Center
University of Twente, ITC	**Luc Boerboom**	University of Twente	What if?, Inc.	**Richard E. Klosterman**	What if?, Inc.
The University of Georgia	**Susan Crow**	University of Georgia	PlaceMatters	**Jason Lally & Ken Snyder**	PlaceMatters
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Indiana University Bloomington	**Hamid Ekbia**	Indiana University	Western	**Jacek Malczewski**	University of Western Ontario
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Interforest LLC	**Sean Gordon**	Interforest LLC		**Mingzhen Wei**	USGS
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San Diego State University	**Piotr Jankowski**	San Diego State University	UF University of Florida	**Paul Zwick**	University of Florida