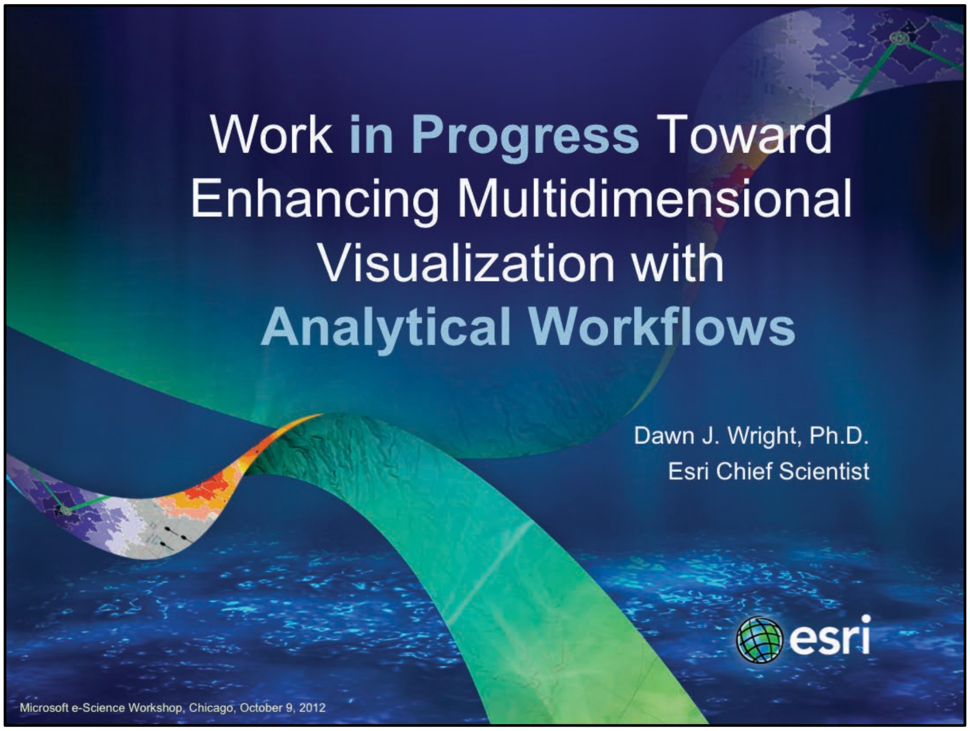
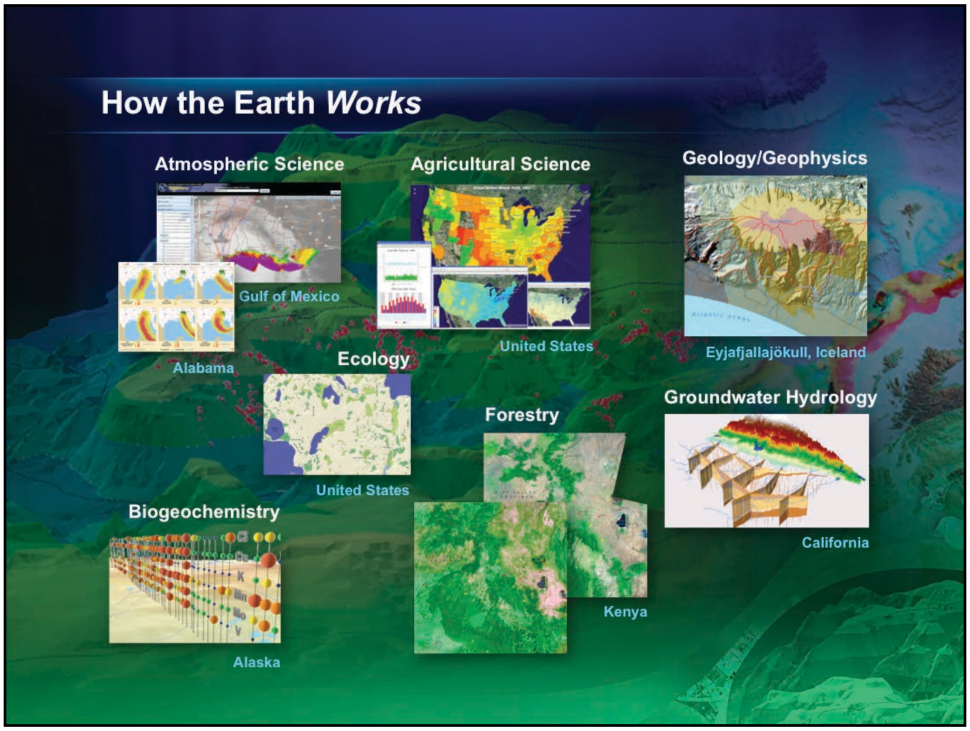


http://research.microsoft.com/en-us/events/escience2012/

Abstract: Big Data, particularly from terrestrial sensor networks and ocean observatories, exceed the processing capacity and speed of conventional database systems and architectures, and require visualization in three and four dimensions in order to understand the Earth processes at play. Successfully addressing the scientific challenges of Big Data requires integrative and innovative approaches to developing, managing, and visualizing extensive and diverse data sets, but is also critically dependent on effective analytical workflows. This talk will present an emerging agenda and work in progress toward this end at Environmental Systems Research Institute.

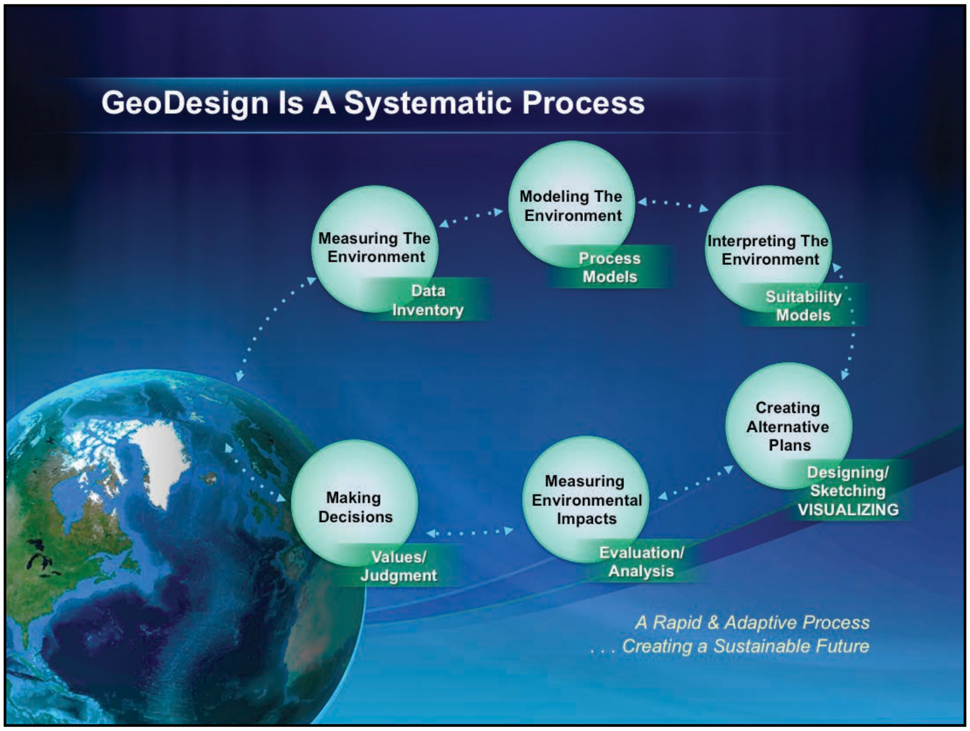
We are in an era of regional- to global-scale observation and simulation of the Earth as exemplified by these large NSF and GEO programs. These big programs of course produce big data.
In addition, the NSF EarthCube EarthCube community sees great value in workflow technologies to manage complex computations that use big data and have many steps for the future of geosciences.
Featured:
Critical Zone focuses on climate and land use, fluxes across watershed boundaries, Water, Carbon, Sediments, Nutrients
GEOSS – space-borne, airborne, in situ sensors, data mgmt architecture
EarthScope – seismometers, GPS on plate boundaries**, fault strain, crustal deformation**
OOI – cabled observatory – Endurance Array will have fleet of gliders—T, Sal, Dissolved O2, Chlorophyll, backscatter-- surface buoys, seafloor instruments

As an example from ocean OBSERVATORIES, here is a look at the technology currently and ~20 years into the future. This graphic, courtesy of the NRC ocean infrastructure report, captures a variety of issues, environments, and tools.

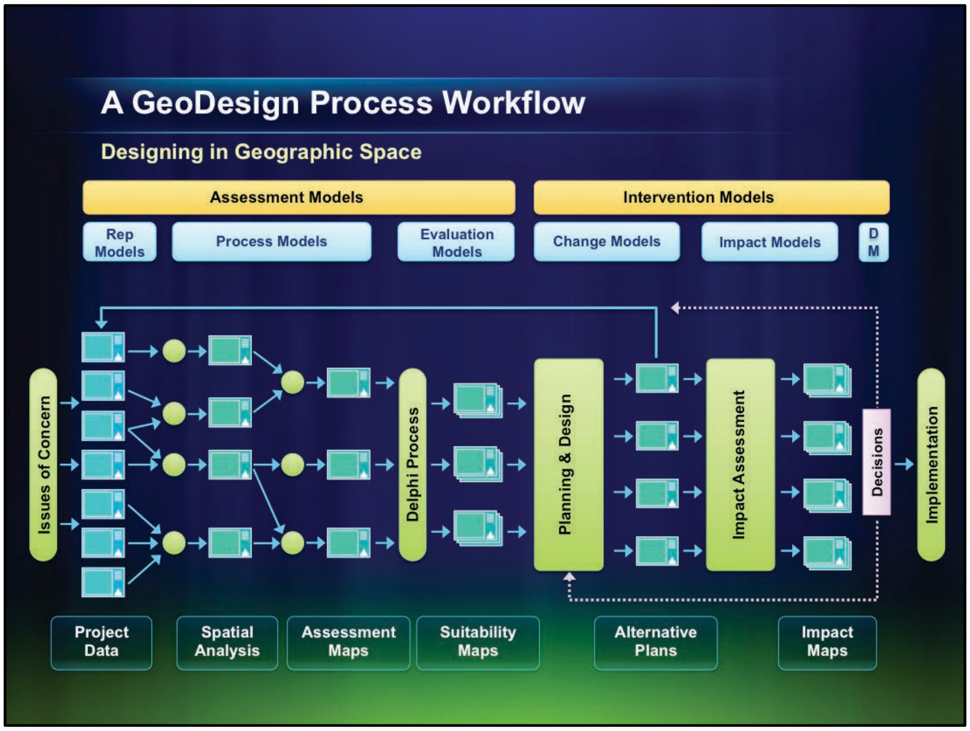


There are many natural science domains in which geographic information systems (GIS) is being used effectively to understand how the Earth works.

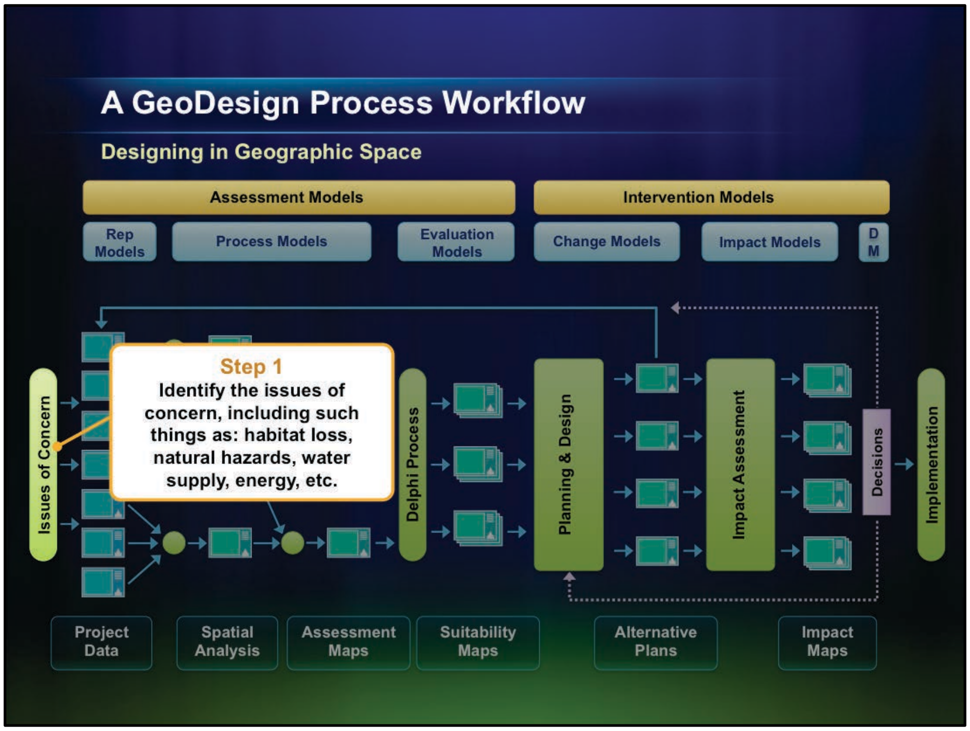
Scientists are indeed normally concerned with how the Earth Works.
But the dominating force of humanity begs the question of how the Earth should LOOK.
GeoDesign comes in here and is cross-cutting many of scholarly disciplines, bridging the natural with the social sciences
→integrating design directly into GIS workflows ←



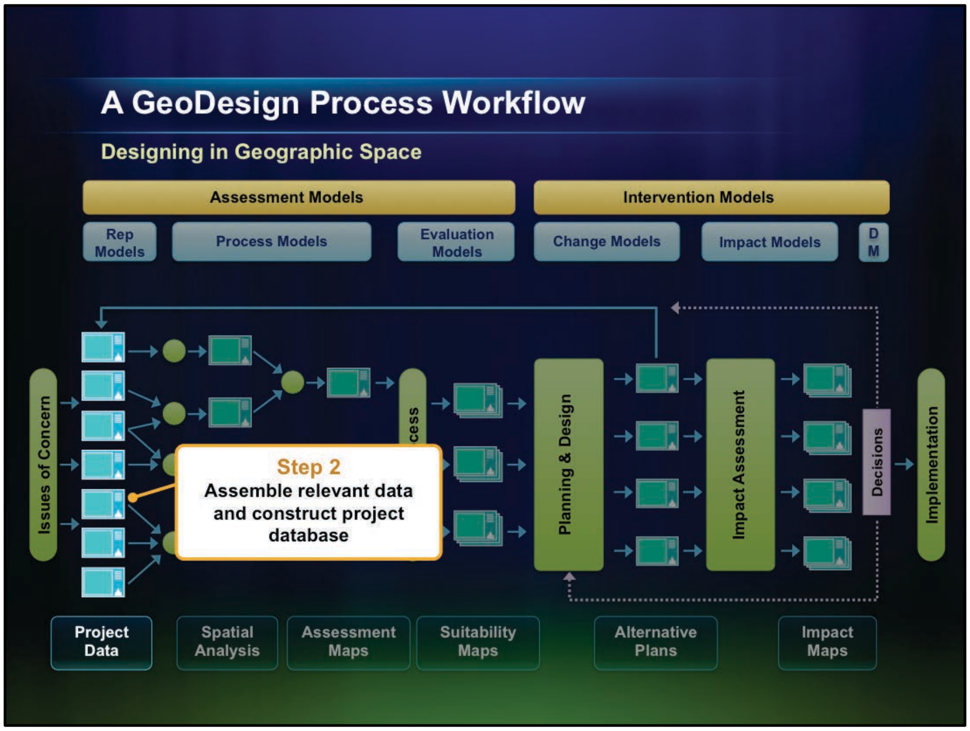
An interactive and *iterative* process for creating and evaluating alternative designs and making better decisions



With great thanks to Esri colleague Bill Miller



A GeoDesign Process Workflow
Designing in Geographic Space
Assessment Models
Intervention Models
Rep Models
Process Models
Evaluation Models
Change Models
Impact Models
D M
Step 1
Identify the issues of concern, including such things as: habitat loss, natural hazards, water supply, energy, etc.
Issues of Concern
Delphi Process
Planning & Design
Impact Assessment
Decisions
Implementation
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps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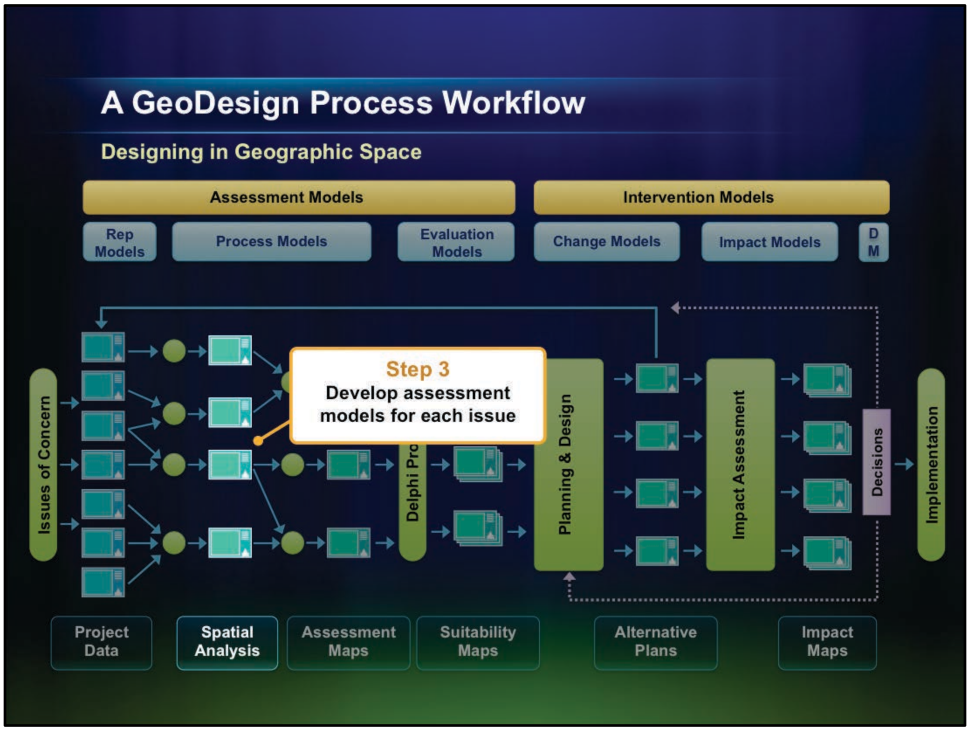
Impact Models
D M
Issues of Concern
cess
Planning & Design
Impact Assessment
Decisions
Implementation
Step 2
Assemble relevant data and construct project database
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps


A GeoDesign Process Workflow
Designing in Geographic Space
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Process Models
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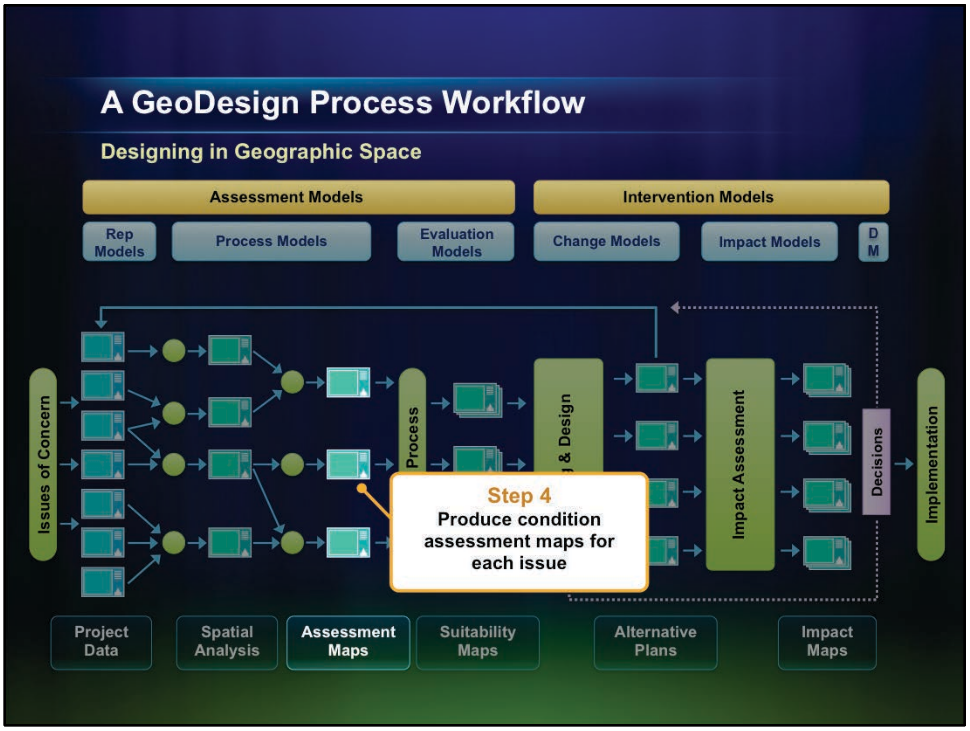
Change Models
Impact Models
D M
Issues of Concern
Step 3
Develop assessment models for each issue
Delphi Pro
Planning & Design
Impact Assessment
Decisions
Implementation
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps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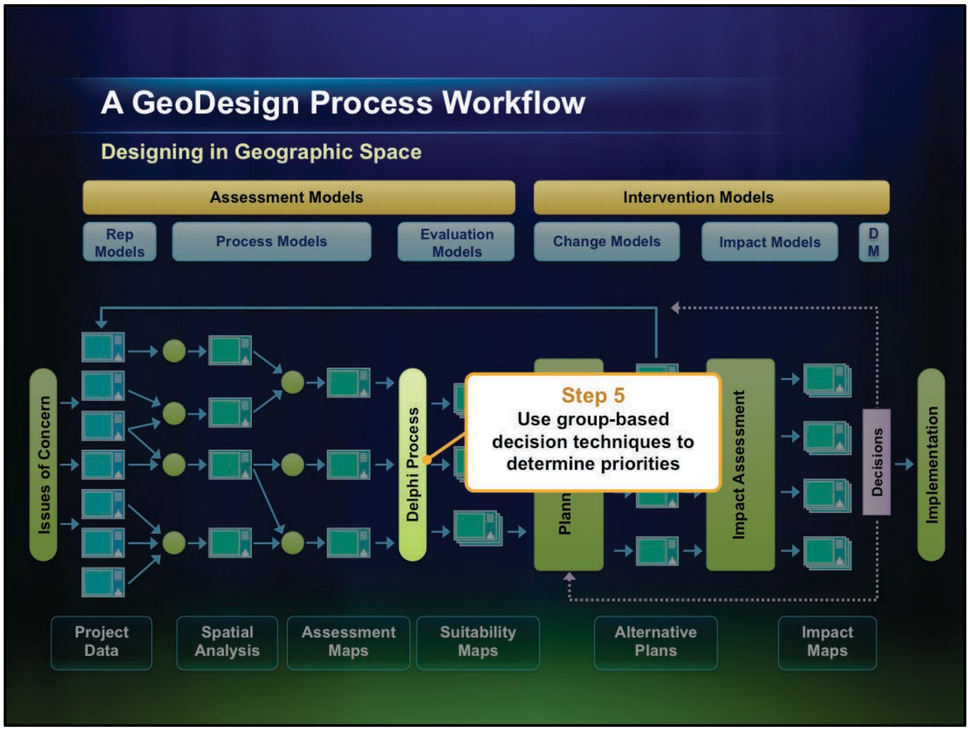
Change Models
Impact Models
D M
Issues of Concern
Process
& Design
Impact Assessment
Decisions
Implementation
Step 4
Produce condition assessment maps for each issue
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps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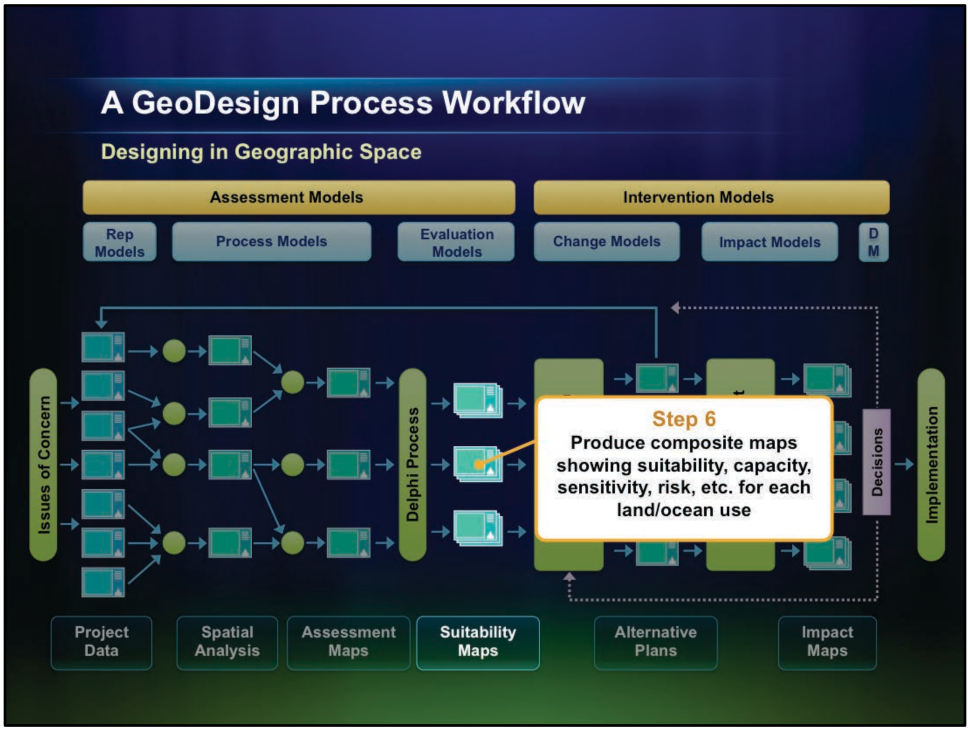
Process Models
Evaluation Models
Change Models
Impact Models
D M
Issues of Concern
Delphi Process
Step 5
Use group-based decision techniques to determine priorities
Plann
Impact Assessment
Decisions
Implementation
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps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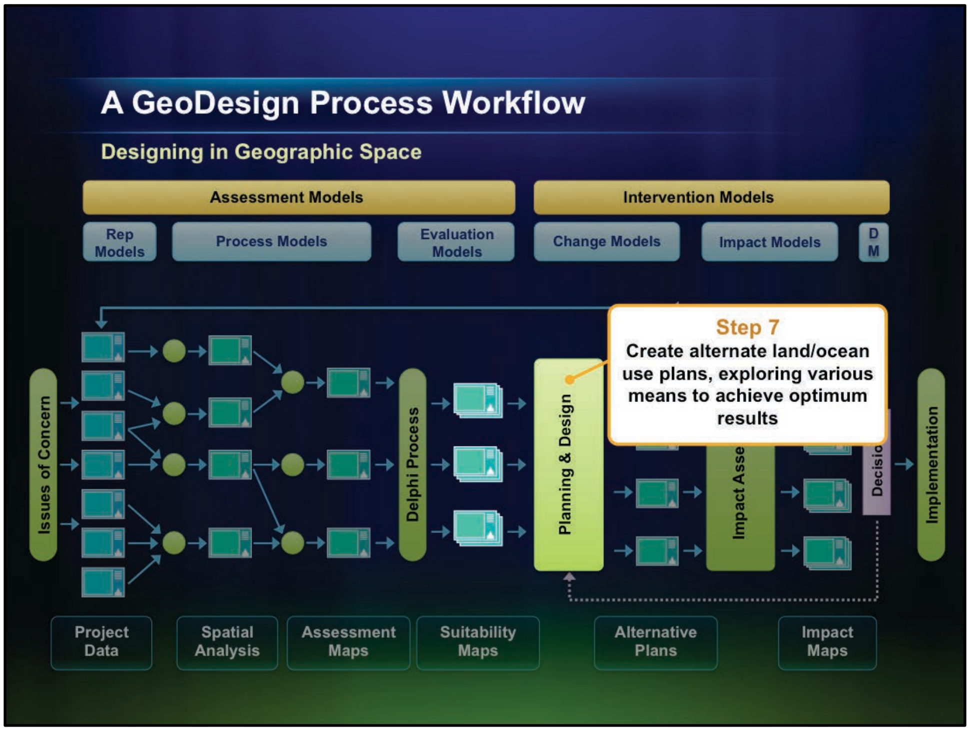
Process Models
Evaluation Models
Change Models
Impact Models
D M
Issues of Concern
Delphi Process
Step 6
Produce composite maps showing suitability, capacity, sensitivity, risk, etc. for each land/ocean use
Decisions
Implementation
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps


A GeoDesign Process Workflow
Designing in Geographic Space
Assessment Models
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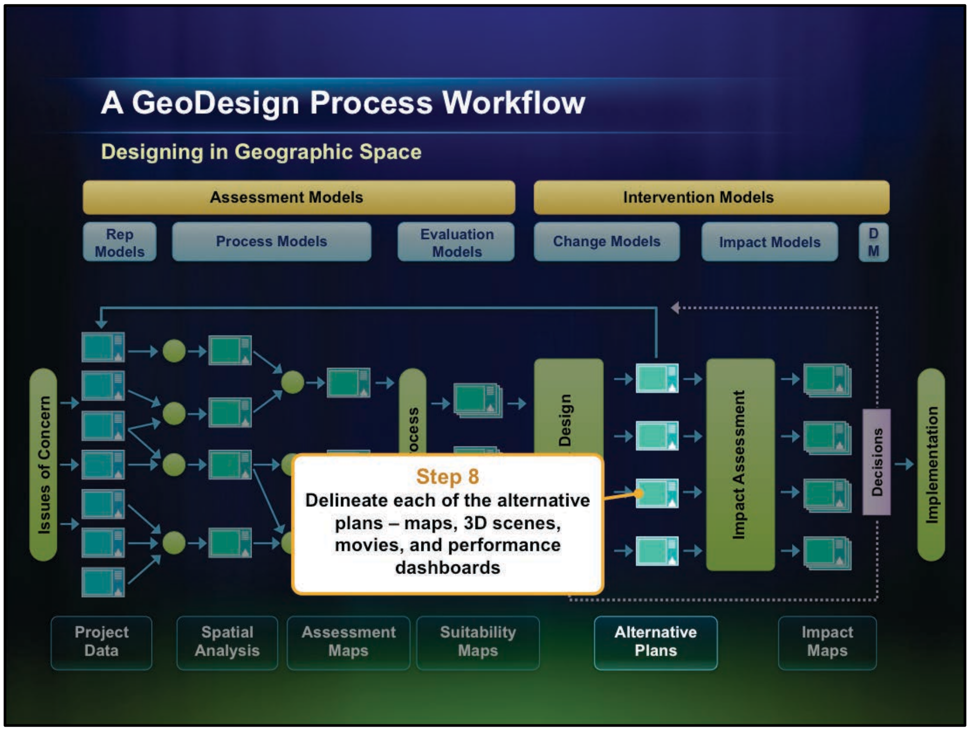
Change Models
Impact Models
D M
Step 7
Create alternate land/ocean use plans, exploring various means to achieve optimum results
Issues of Concern
Delphi Process
Planning & Design
Impact Asse
Decisio
Implementation
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps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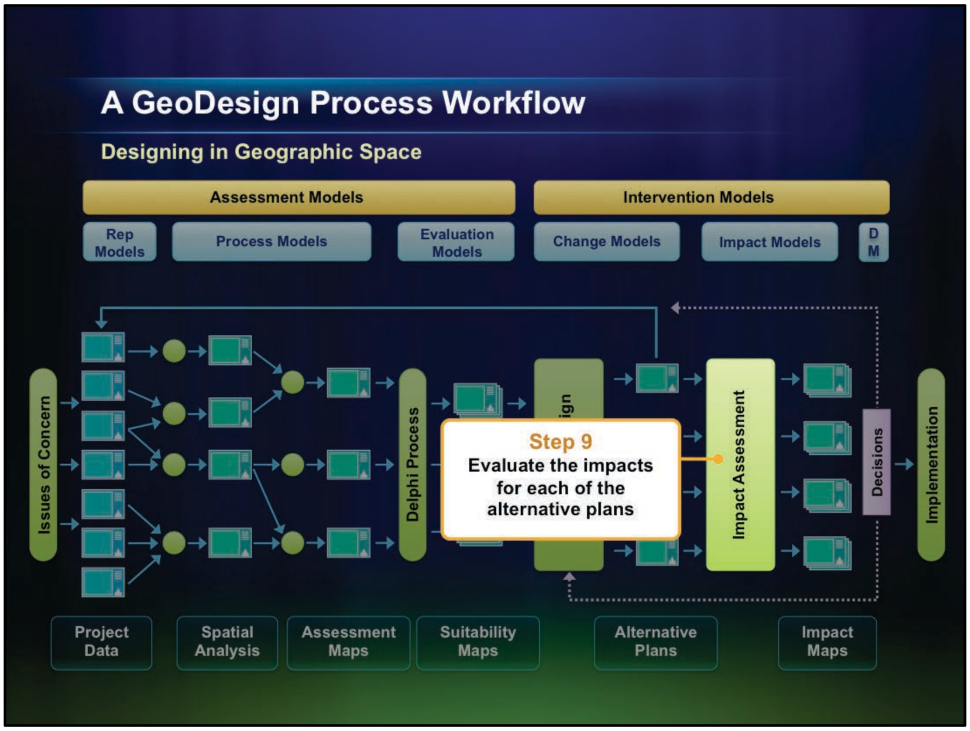
D M
Issues of Concern
Design
Impact Assessment
Decisions
Implementation
Step 8
Delineate each of the alternative plans – maps, 3D scenes, movies, and performance dashboards
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps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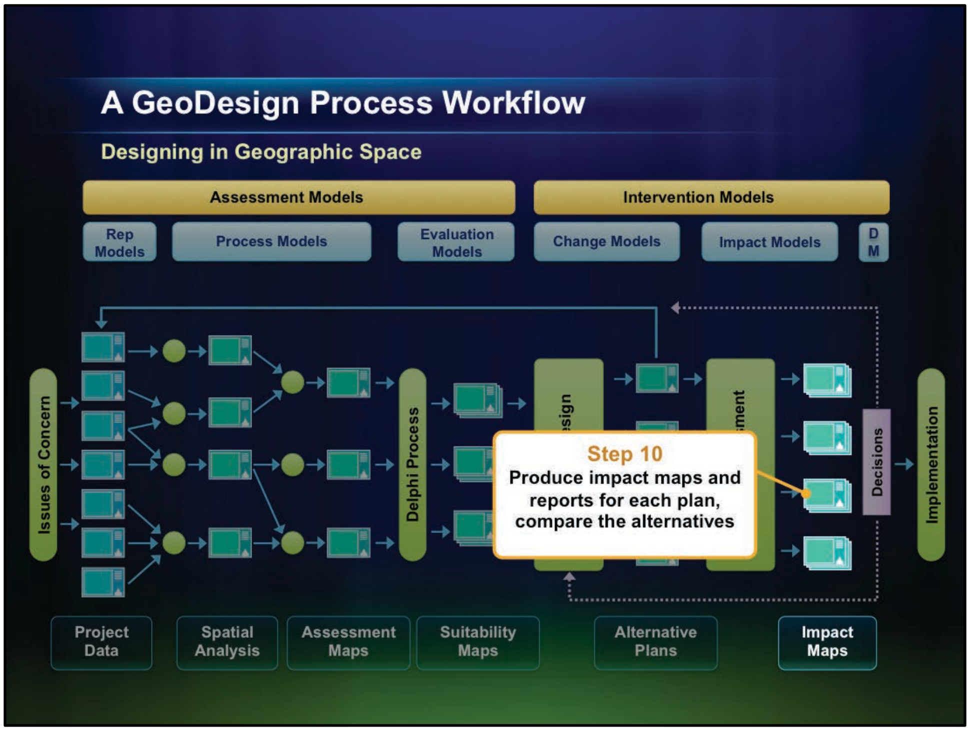
Change Models
Impact Models
D M
Issues of Concern
Delphi Process
Step 9
Evaluate the impacts for each of the alternative plans
Impact Assessment
Decisions
Implementation
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps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Process Models
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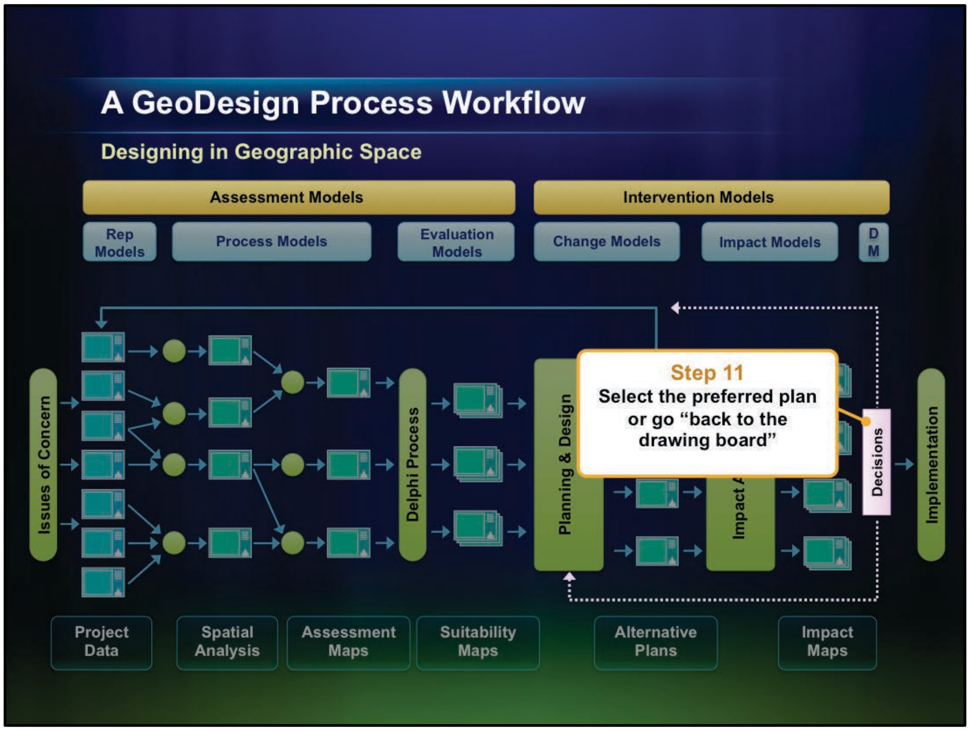
Impact Models
D M
Issues of Concern
Delphi Process
Decisions
Implementation
Step 10
Produce impact maps and reports for each plan, compare the alternatives
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps


A GeoDesign Process Workflow
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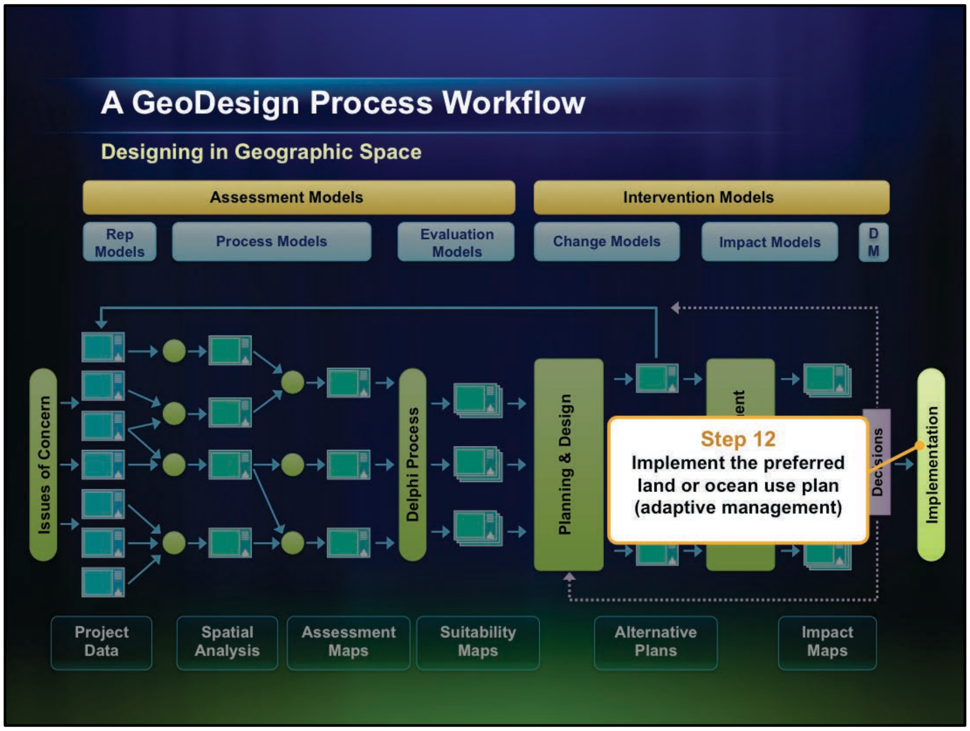
Process Models
Evaluation Models
Change Models
Impact Models
D M
Issues of Concern
Delphi Process
Planning & Design
Step 11
Select the preferred plan or go "back to the drawing board"
Decisions
Implementation
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps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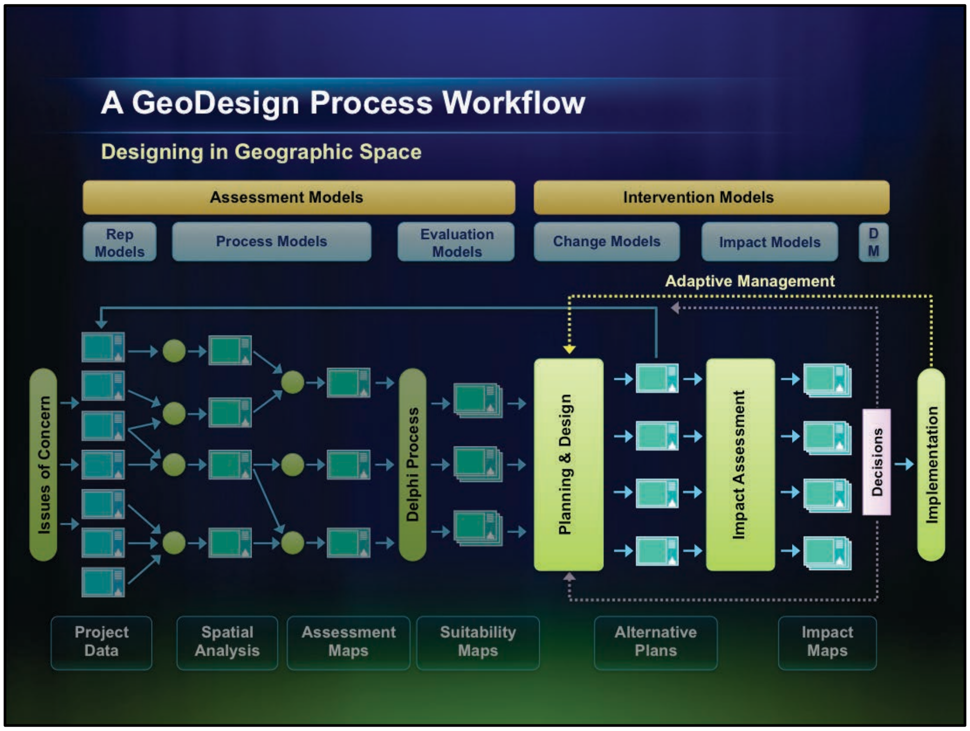
Process Models
Evaluation Models
Change Models
Impact Models
D M
Issues of Concern
Delphi Process
Planning & Design
Decisions
Implementation
Step 12
Implement the preferred land or ocean use plan (adaptive management)
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
Impact Maps



A GeoDesign Process Workflow
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Impact Models
D M
Adaptive Management
Issues of Concern
Delphi Process
Planning & Design
Impact Assessment
Decisions
Implementation
Project Data
Spatial Analysis
Assessment Maps
Suitability Maps
Alternative Plans
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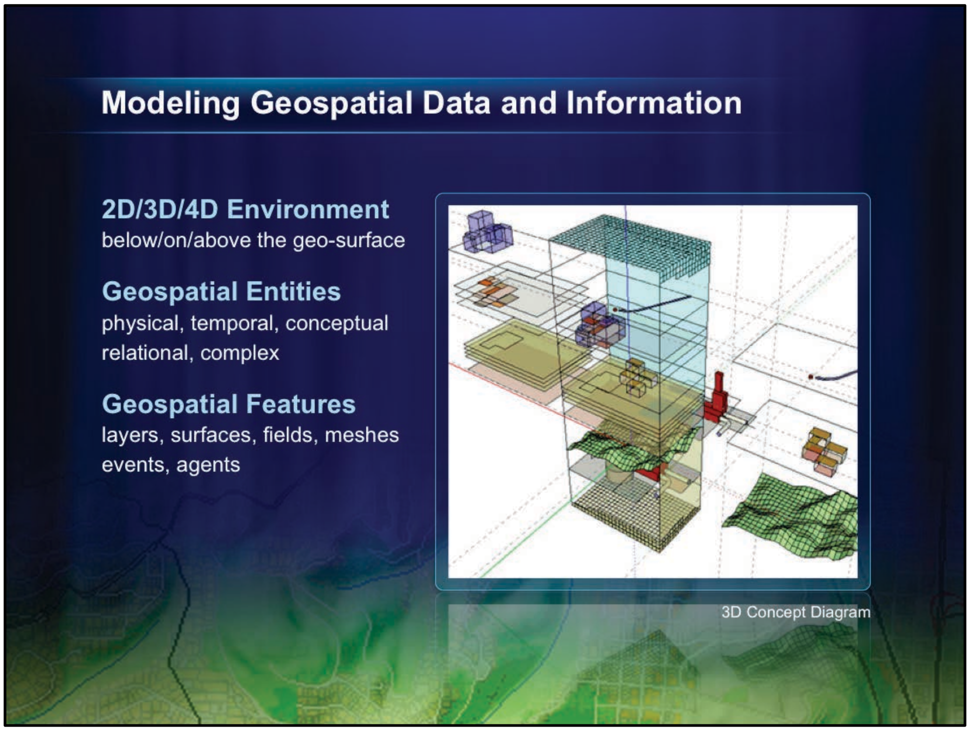
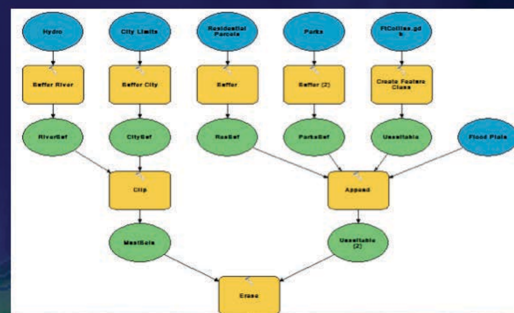
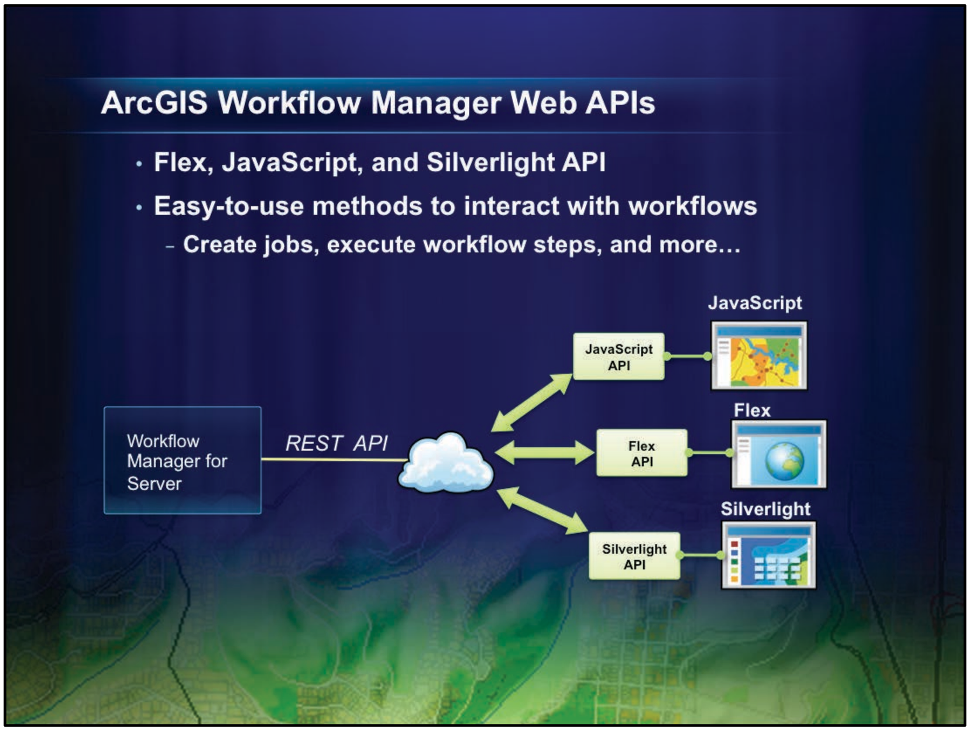


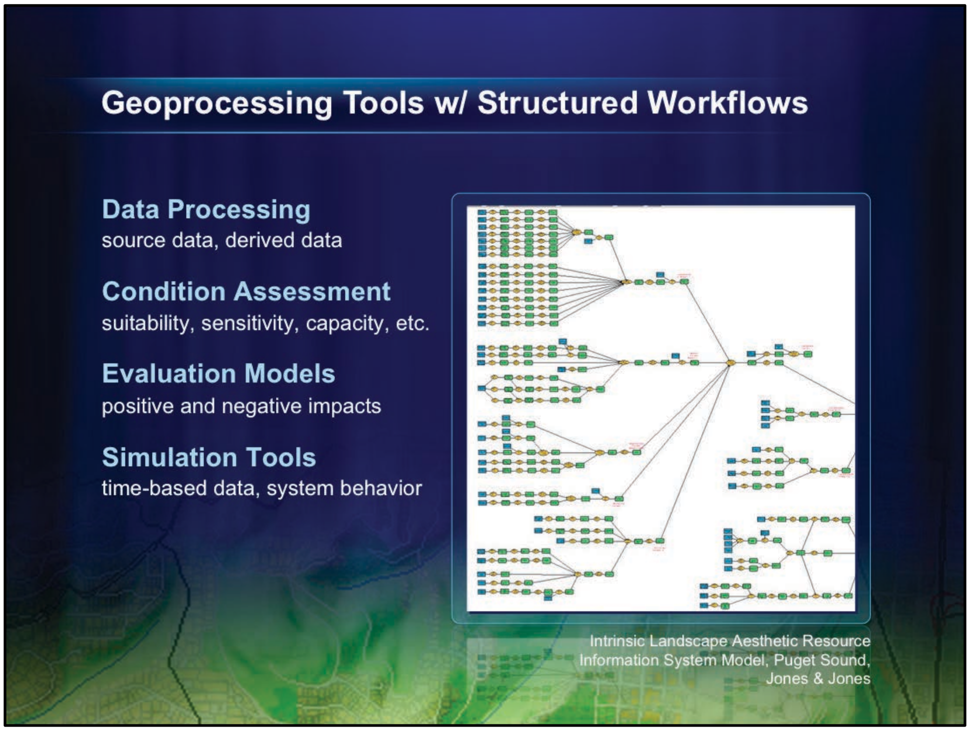
We are in the process of developing appropriate **technologies for GeoDesign**
Spatial data models are a primary aspect of GeoDesign technology
Others includes ontological frameworks, feedback and collaboration tools, future scenario tools

Automating Analysis Workflows

- ArcGIS ModelBuilder
  - Process flow diagram
- Scripting
  - Python
- System Languages
  - C++, .Net, Java




ArcGIS Workflow Manager Web APIs
• Flex, JavaScript, and Silverlight API
• Easy-to-use methods to interact with workflows
– Create jobs, execute workflow steps, and more…
Workflow Manager for Server
REST API
JavaScript API
JavaScript
Flex API
Flex
Silverlight API
Silverlight



The model consists of 40 ModelBuilder submodels and three Python scripts organized into seven ArcGIS Desktop toolsets. Together, all the ModelBuilder models inform a decision-support framework to allow the presence, quantity, and visual properties of different intrinsic landscape forms to be captured and the significance of these forms to be identified, as well as the cumulative effect of the viewshed and the relative uniqueness of Puget Sound's landscapes.

Visualization Tools

Maps
2D, 2.5D

Scenes
3D

Time Series Movies
4D

Graphics
charts, graphs, diagrams

Layouts
posters, reports

Portland, OR, Mei-Po Kwan

Scenario Management Tools

Version Control
alternate solutions, variations

Selection
evaluation, side-by-side comparison

Extraction
segments, portions, subsets

Synthesis
combine, further develop

3D Web Scenes: 3D in the Browser
- No plugin required (based on WebGL – Web Graphics Library, a Javascript API for rendering 3D graphics)
- Focus on Scenes (Fishtank View)
- For GeoDesign & Urban Planning
- Game-like visualization quality
- Quick share from CityEngine and ArcGIS

Key points for 3D as Esri moves ahead:
- Massive 3D data visualization on desktop (ArcGlobe / AGX)
- 3D Extensions in Local Government Data Model
- Easy creation / editing of 3D models (Multipatch Editor)
- Improved 3D analysis tools
- Share 3D scenes in a browser (without plugin, on AGOL)
- Extensive support for LiDAR

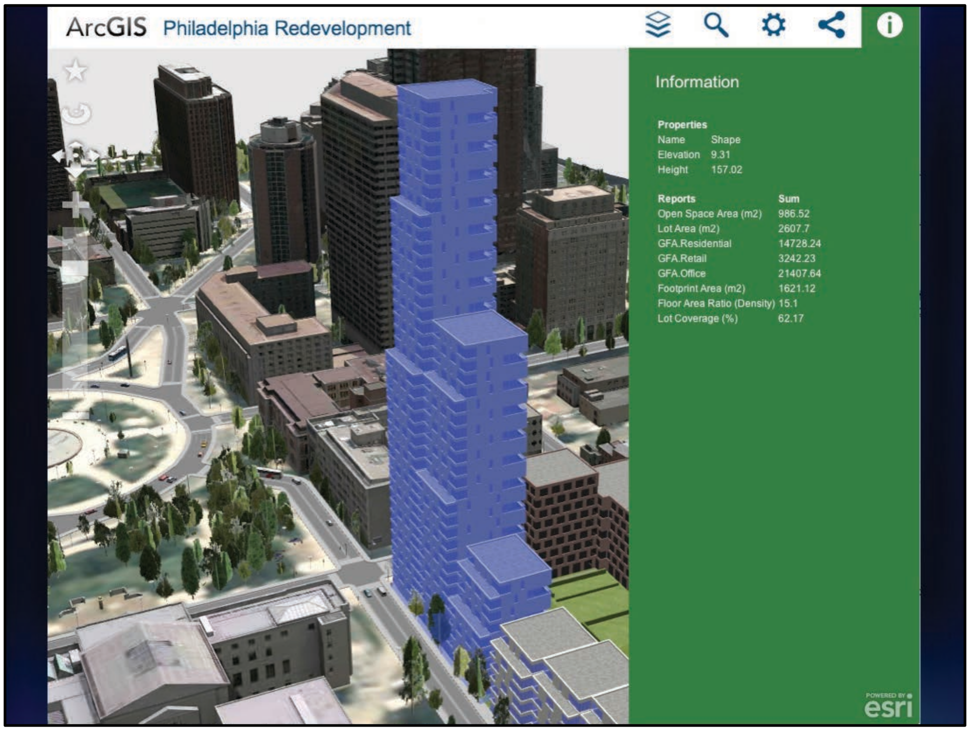
- Natural and artificial 3D objects with shadow effects

Philadelphia Redevelopment is a CityEngine workflow example showing an Urban Planning scenario.

- Use the swipe view on the Environment layer to switch between real and visibility analytics models
- Use the sunlight slider to see shadow impact of new developments
- Use the swipe view on the Redevelopment layer to compare as-built and proposal buildings
- Use the swipe view on the terrain to switch between satellite, schematic and right-to-light terrain visualization

Create a proposed building and perform visibility analytics

Creation workflow
- from a geodatabase containing 2D and 3D data create the real-world 3D model
- design new 3D buildings using procedural rules in the new development area
- perform 3d city analytics on the new development buildings using 3D analyst
- combine real-world, new development and 3d analytics models in CityEngine
- publish CityEngine scene to Web Scene



Information on that proposed building

Another "long tail" issue here is that we have a broad community of researchers in these areas that are not yet being served by best practices for workflows that support fundamental access to geospatial data, models and collaboration resources. Many data are "siloed" on disparate servers, slow access, difficult or unfamiliar file formats. Another argument for sharing and collaboration in the cloud instead. These points all made in the EarthCube Workflows Roadmap document.


Thank You
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dwright@esri.com
Twitter: @deepseadawn