Multiple Uses of Geographic Information Systems (GIS) in Cumulative Effects Assessments

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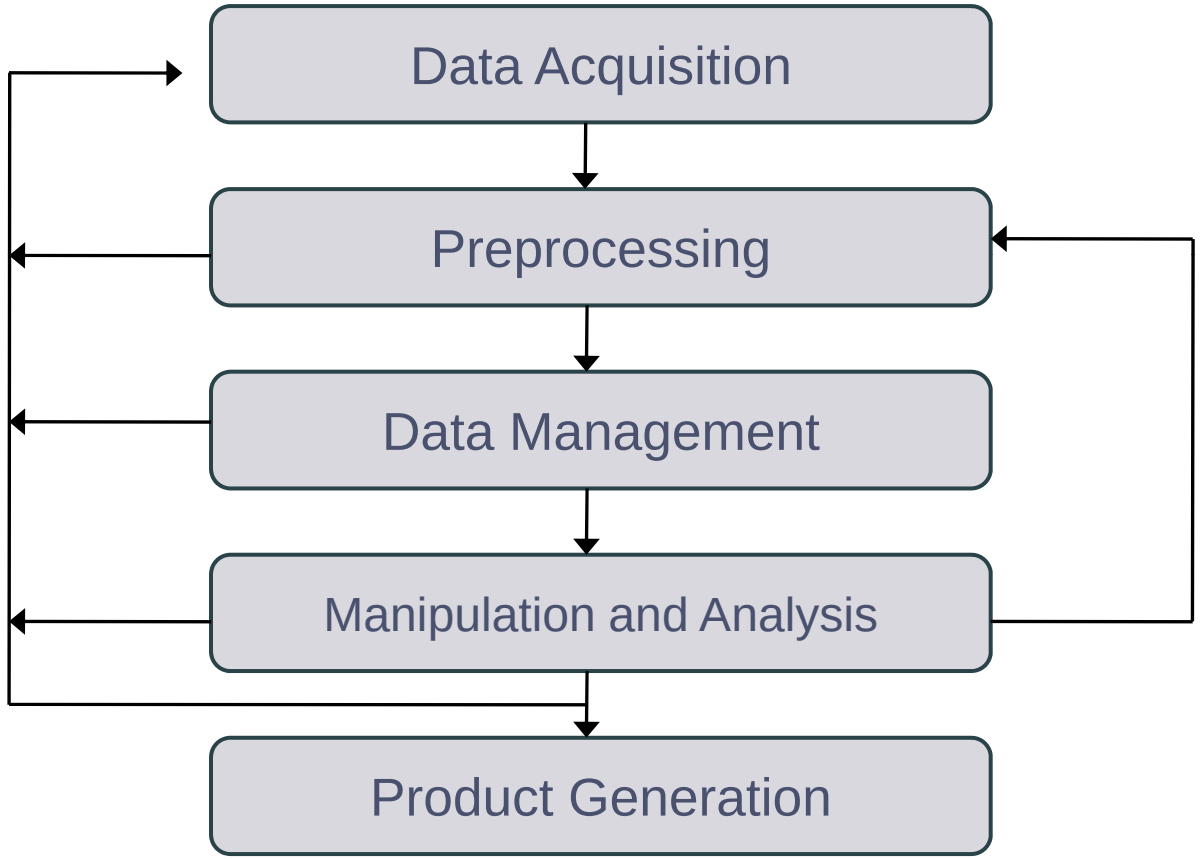
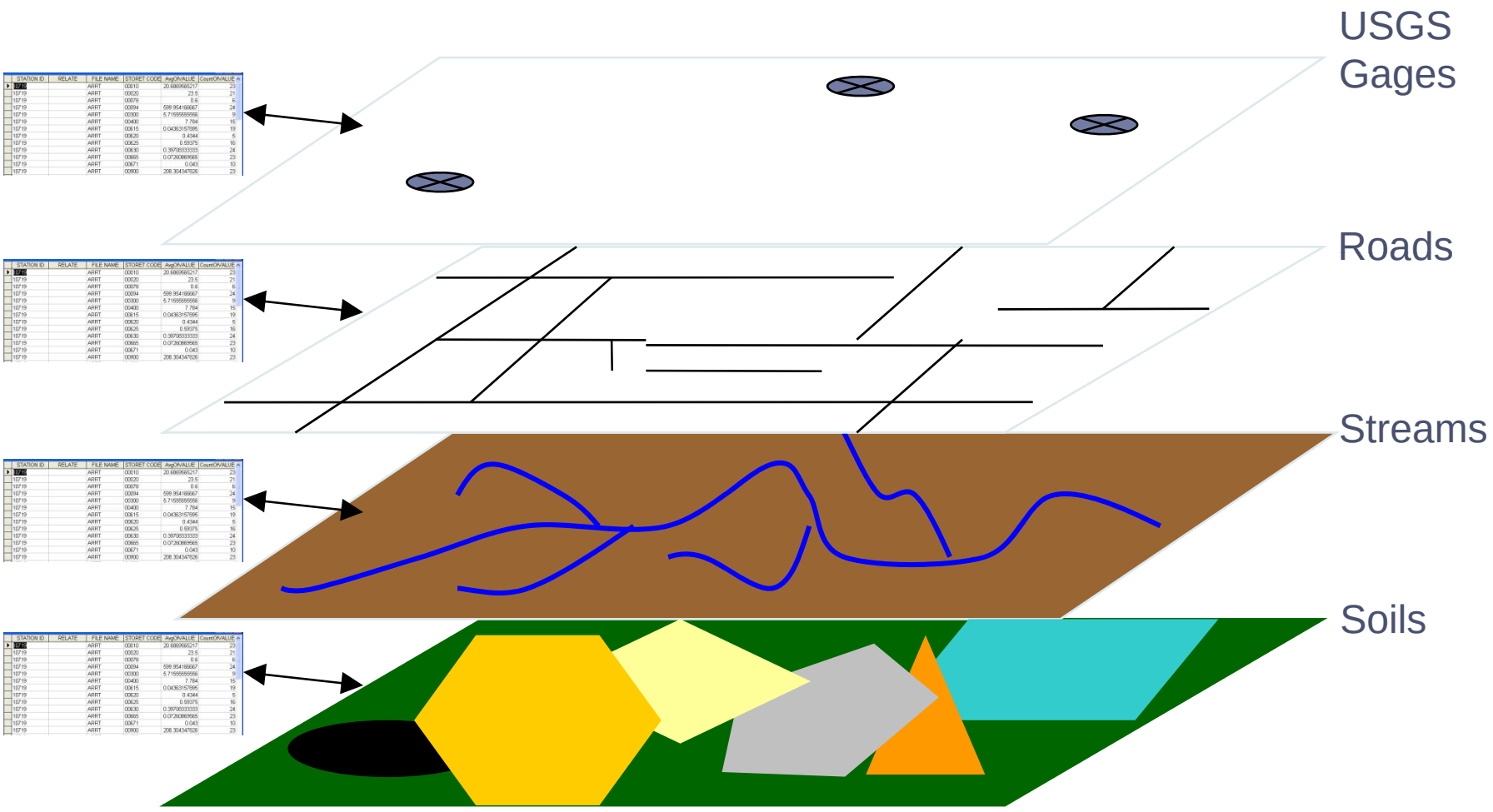
Fundamental Information on GIS

1) 5 Elements



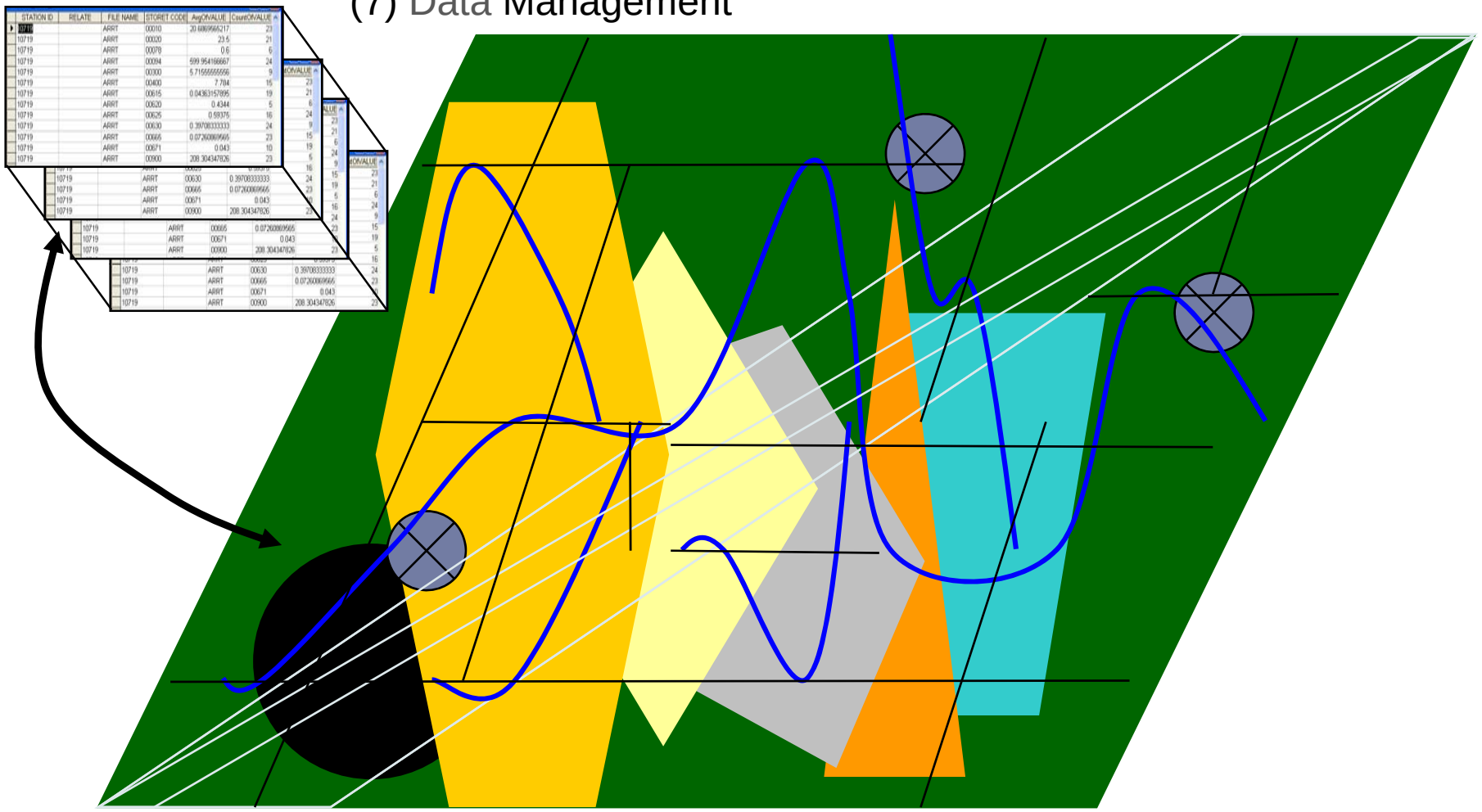
(adapted from Star & Estes, 1990; Antenucci, et al., 1991; Canter, et al., 1994)

Layer Concept



(1) Data Overlay and Analyses (2) Trend Analyses (3) Integration with Models
(4) Habitat Evaluation tools (5) Aesthetic Evaluation tools (6) Public Consultation

(7) Data Management



GIS Applications in EIA Process

Situations Conducive to GIS in EIA:

a. When data can used beyond the EIA process
b. Show interactions of complex systems
c. Present baseline environmental information
d. Impact identification and evaluation
e. Changing project-related information

GIS Applications in EIA Process

f. Need for consensus building under varying scenarios
g. Need for audit trail to reconstruct decision
h. Need to tie environmental changes to spatial locations
i. Communicate complex scientific data to the general public
j. Analysis needed over layers

Examples of GIS in EIA

1) Pre and post-project modeling
2) Communication tool
3) Study interactions between/among
4) Predict future conditions
5) Address “what if …” questions

Examples of GIS in EIA

6) Model species distribution/diversity
7) Develop management strategies
8) Visual display of impacts
9) Delineate study area

EIA Phases and Possible GIS applications (after Joao and Fonseca, 1996)

Stage	Possible Usage of GISs
Screening and scoping	data gathering, spatial modeling, calculation of impact magnitude
Description of the project	geographical context
Description of baseline conditions	biophysical inventories , hydrology, soils, archaeological and historical resources, land ownership, topography, roads, utilities
Impact identification	overlay analysis, modeling , habitat suitability analysis.

Stage	Possible Usage of GISs
Prediction of impact magnitude	percentage change, impact magnitude maps, risk maps, modeling results
Assessment of impact significance	maps impact significance by alternative
Impact mitigation and control	identify mitigation measures or effectiveness of mitigation, spatially and/or temporally
Public consultation and participation	preparing presentation material, to explain the project to the public, responses to comments
Monitoring and auditing	design monitoring programs, processing and storage of monitoring data, comparison of actual outcomes with predicted outcomes, impacts over time.

Selected Case Studies
Wetlands, Water Quality, and Modeling

1. Relationships between resource loss and degradation
2. GIS can help study
   a) Direct and indirect wetland impacts
   b) CEA as a by-product of GIS analysis
   c) Changes over time
   d) Wetland functions
   e) Landscape-level role of wetlands

Johnston, et al., 1988, Johnston, 1994

Selected Case Studies
Wildlife Species and Habitat

1. Correlate disturbance to actions
2. Habitat fragmentation and loss
   a) Land classification converted to suitability
   b) Layered with other coverages
   c) Calculate habitat loss
3. GIS can provide defensible tools

Hegmann, et al., 1999

Selected Case Studies
Pesticides and Drinking Water

1. Atrazine is the most common herbicide produced today.
2. Implicated in breast cancer and endocrine disruption.
3. GIS based atrazine pollution potential model.
    1. Land use
    2. Surface slope
    3. Soil erodibility
4. APP scores generated.
5. Measured atrazine concentrations high where APP scores high.

Atkinson, Waller & McDonough, 2001

Selected Case Studies
Military Installations

1. Military has embraced GIS
2. Ex. Environmental and Natural Resource Mgt
    1. Inventory Valuable Resources
    2. Maps and Data Supporting NEPA Compliance
    3. Noise Level Displays
    4. Endangered Species Locations
3. Ex. Cultural Resources Management
    1. Archaeological sites
    2. State Historic Preservation Sites
    3. Link Digital Reports, Photos
4. The existing layers can be used and combined for CEA

Keyes, Melchior, & Guthiel, 2002

Does GIS stand up in U.S. courts?

LexisNexis®:

"NEPA"

then "cumulative effects"

then "GIS"

LexisNexis® Search of Federal Cases:

Time	NEPA	Cumulative Effects	GIS
< 1975	313	16	0
75-80	428	32	0
80-85	435	32	0
85-90	310	43	0
90-95	317	48	0
95-00	342	54	1
00-05	556	127	6
05-08	679	144	2

Overview of Courts reactions:

Kettle Range Conservation Group vs USFS, 2001

GIS used to estimate impacts of a wide range of alternatives satisfied NEPAs requirement to **examine all reasonable alternatives** to meet the stated purpose and need of bark beetle infestation recovery plan and that GIS based erosion/ sedimentation model provided sufficient “hard look”.

Kettle Range Conservation Group vs USFS, 2001

GIS analyses upheld for **impact analyses**: fuels and fire; vegetation; watershed; fisheries, and; wildlife.

However, court found that (1) soils had not been sufficiently analyzed – **no site survey** (potassium - harvest methods based on geology layer), and (2) cumulative effects had not been subjected to a sufficient "hard look", in part because numerous **other projects were known, and not included in the GIS** database.

Oregon Natural Resources Council Fund vs. BLM, 2004

GIS used to identify spotted owl nesting sites and owl activity centers, and although **a few small errors** in the GIS data base were uncovered, agency adequately took “hard look” by using, in part, GIS.

Cascadia Wildlands Project vs Scott Conroy, Rogue River-Siskiyou National Forest Supervisor, 2006

GIS adequately supplants ground-based, site specific soil surveys and provides **“hard look”** requirement in preparation of management plan impact assessment.

Oregon Natural Desert Association vs BLM, 2006

GIS based wilderness inventory prepared by plaintiff in 2005 and provided during public review constituted “new information” over previous inventory prepared by agency in 1992 and should have been considered by agency before making decision. Agency found to be arbitrary and capricious.

Observations and Lessons Learned

1) GIS Benefits:
   a) Spatial Analysis/Modeling*
   b) Attractive Data Display*
   c) Store, Manage, Organize, & Manipulate Data*
   d) Analysis of Planning Scenarios
   e) Best with larger-scale EIA
   f) Technology Expected to Increase
   g) Technology upheld in courts

2) GIS limitations:
   a) Complex Modeling Difficult**
   b) EIA Specific Programs Not Readily Linkable to GIS**
   c) Form of most EIA Data**
   d) Time and Cost*
   e) Accuracy
   f) Training

** (Joao, 1994) * (Joao & Fonseca, 1996)

Concluding Lessons:

- GIS has been used in both EIA and CEA for both baseline information and analysis of impacts
- Larger scale CEA studies very conducive to using GIS
- GIS evolving – use will likely increase in CEA
- GIS in litigation – so far, so good.

Thank you.

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