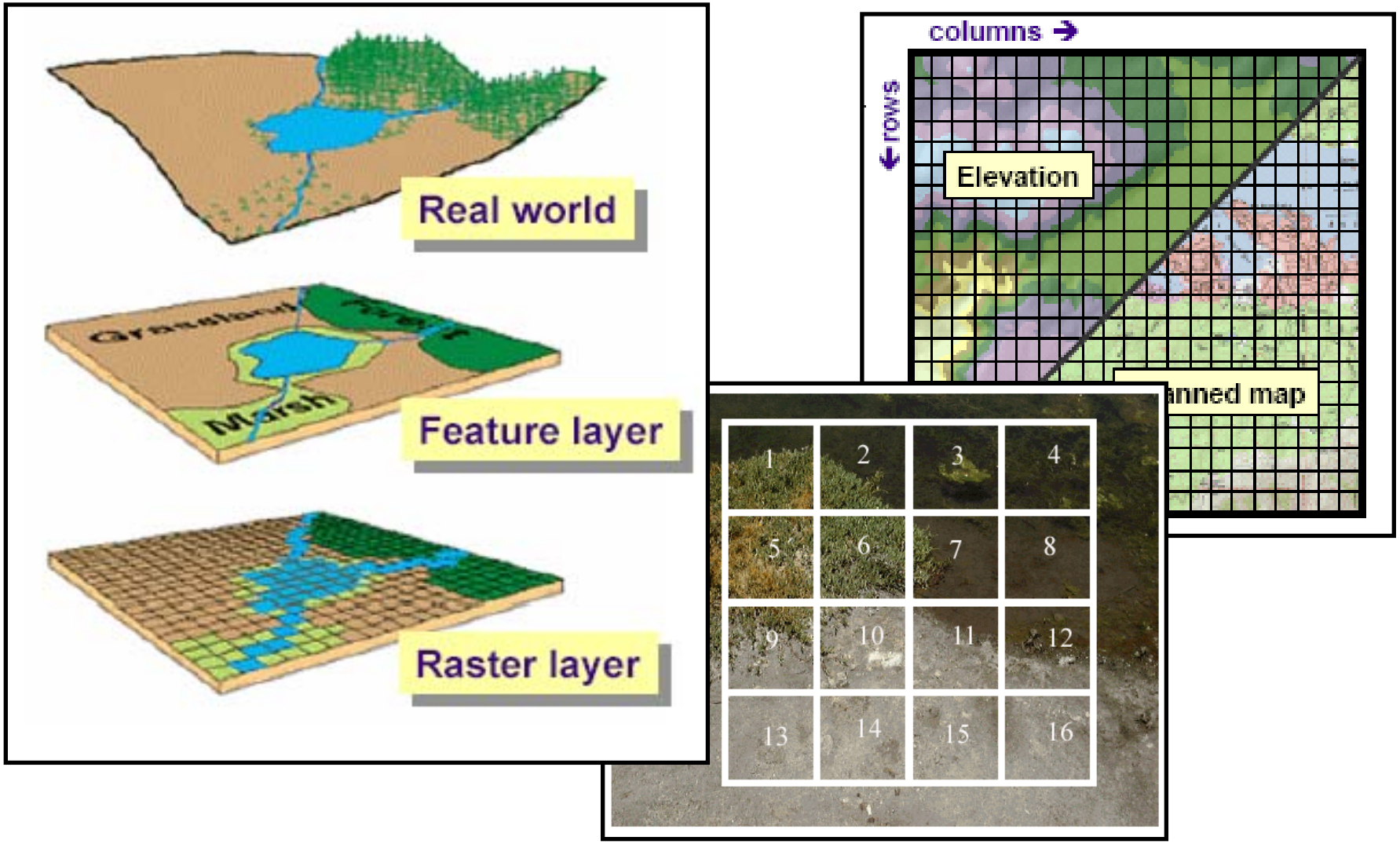
EEOS 465 / 627 – Environmental Modeling with Raster GIS



EEOS 465 / 627 – Environmental Modeling with Raster GIS

Course Description:

- This course consists of **three parts**:
- In the **first four weeks**, we will **focus** on **raster data models**, their **structure and function**, and in particular on their use in a **modeling context**.
- In other words, we will first study what **modeling capabilities** the GIS provides.
- This will be accomplished primarily through **readings**, **discussion** and **laboratory exercises**.

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Course Description Continued:

- Once a more **thorough knowledge** of **GIS capabilities** is attained, we will proceed to the **design, modeling and implementation** phase of the course.
- From the **fifth to eighth week**, we will introduce the **design of GIS projects** and **spatial interactive modeling**.

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Course Description Continued:

- In the **final seven weeks**, the class will be used to conduct a **final project**.
- Upon **completion** of the course, students will be in a **position to participate** (most likely as a junior GIS analyst) in **studies utilizing these techniques** and, as a user of GIS technology or as an organizational manager concerned with GIS, to **intelligently** deal with the results of such investigations.

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Course Description Continued:

- The course will **include** lectures, laboratory exercises, and a final project (7 weeks).
- In the **final project**, you will **design your own project** as a **real-world experience**.
- This will give you an **opportunity** to **employ your knowledge** within a **real design scenario**.

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- Students will be expected to **read reference materials** and be **prepared to discuss them** each week
  - Class meetings will begin by focusing on the key concepts from the reference materials (from the course text in the first half, and various materials pertaining to the projects in the second half)
- In the **first half** of the course, this will be followed by **weekly lab exercises** designed to augment the readings and to **sequentially build capability and understanding** in the application of raster GIS approaches to environmental modeling applications
- In the **second half** of the course, lab time will be devoted to **project development and execution**

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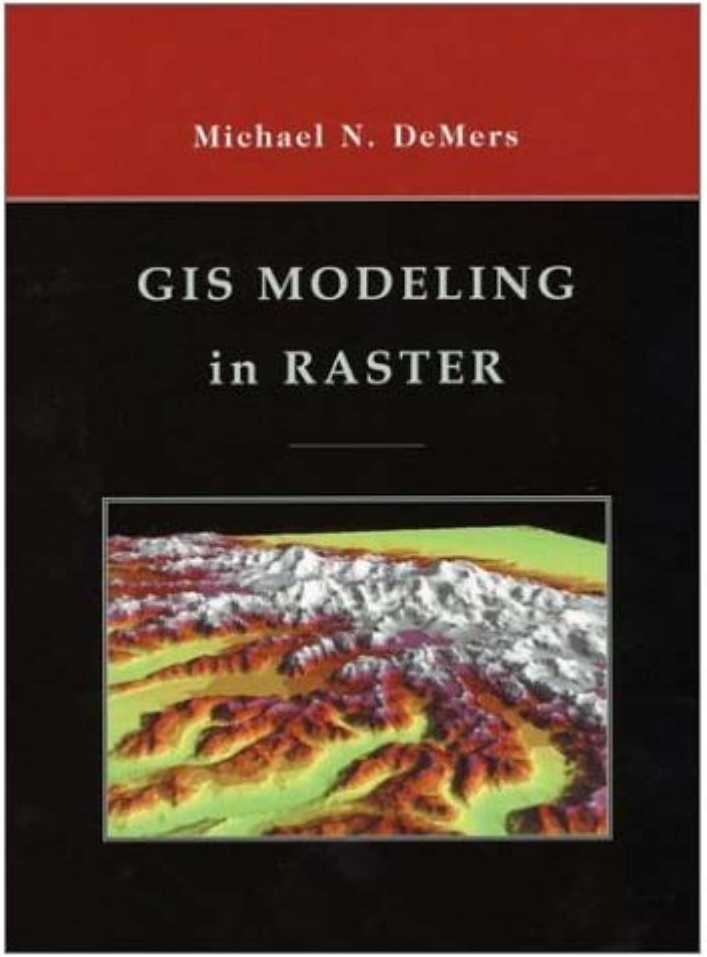
- **Text:** Michael N. DeMers. GIS Modeling in Raster. Wiley, 2002. ISBN 0-471-31965-1.



EEOS 465 / 627 – Environmental Modeling with Raster GIS

- **Course Web Page:**
  - **http://alpha.es.umb.edu/~david.tenenbaum/eeos465**

- **Lab Exercises:**
  - Instructions are online, linked from the course web page
  - Data will sit in a course directory on the s:\ drive
  - There be will an exercise each week, throughout the first half of the course
  - These are due 1 week later at the beginning of the class meeting

- **Lateness Penalty: -10%** of total mark per weekday
  - Approach your instructor/TA for extenuating circumstances
  - Exercises more than a week overdue will not be accepted

Date	Topic	Background Material	Lab / Project Work
AN INTRODUCTION TO ENVIRONMENTAL MODELING WITH RASTER GIS			
01/28/09	Course Intro.	• Chapter 1: Introduction, pp. 1-9.	• Exercise 1 – Explore Class Data
02/04/09	Raster Data and ArcGIS Spatial Analyst	• Chapter 2: Nature of the Data, pp. 10-34.	• Exercise 2 – Raster Concepts
02/11/09	Raster Representations and Calculations	• Chapter 3: Map Algebra, pp. 35-57.	• Exercise 3A – Build A Raster Database • Exercise 3B – Georeference a Raster
02/18/09	Raster Analysis and Functions	• Chapter 4: Characterizing the Functional Operations, pp. 58-80.	• Exercise 4A – Use Objects, Operators, and Commands • Exercise 4B – Build Expressions with Functions
02/25/09	Building Spatial Models	• Chapter 5: Modeling Essentials, pp. 94-120. • Chapter 6: Conceptualizing the Model, pp. 121-139.	• Exercise 5 – Raster Processing Tools • Exercise 7 – Analyze Topography
03/04/09	Building Spatial Models II Raster Analysis and Functions II	• Chapter 7: Model Formulation, Flowcharting, and Implementation, pp. 140-161. • Chapter 4: Characterizing the Functional Operations, pp. 81-93.	• Exercise 8A – Surface Hydrology Tools • Exercise 8B – Groundwater Hydrology Tools
03/11/09	Model Design and Evaluation	• Chapter 8: Conflict Resolution and Prescriptive Modeling, pp. 162-174. • Chapter 9: Model Verification, Validation, and Acceptability, pp. 175-190.	• Exercise 10A – Modeling Techniques and Tools • Exercise 10B – ModelBuilder and Weighted Suitability
03/18/09	*Spring Vacation*	N/A	N/A

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Project:

- The final project will **simulate a real-world setting** by establishing a **GIS consulting firm**.
- The **CEO** of the firm is the **instructor**, who will be **responsible for helping** the project teams **complete their work** in a **timely and professional** manner.
- The CEO will also **review team performance** and the **quality of their output**.

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Project, Continued:

- Students may **conduct the project in a team** consisting of **no more than 3 members**.
- Each team will have an **elected team leader**. This team leader is **responsible for communications** between the CEO and individual team members. In other words, the team leader is the **'point person'** for **project management**.

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Project, Continued :

- The classroom time allocated for **lab sessions** will provide **a common time** for project teams to **meet each week**.
- During **certain phases** of the project, **additional team meetings** will need to be scheduled.
- From the **9th week**, each team or individual will give a **5-to-10 minute report** on that week's **progress** either to the entire class or to the instructor.

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Project, Continued :

- Team members will **take turns** to **presenting** your project progress each week.
- This **'staff meeting'** will allow **everyone** to follow the **progress of the group as a whole**, and should **eliminate duplication of effort** during the data collection phase of the project.
- **All members** should **feel free** to **offer comments and suggestions** to other teams.

Date	Topic	Background Material	Lab / Project Work
PROJECTS USING ENVIRONMENTAL MODELING WITH RASTER GIS			
03/25/09	Group Formation and Proposal Creation	•Project Outline	•Preliminary Project Work
04/01/09	Project Design and Document Preparation	•Project Implementation	•Progress Report 1, Discussion, and Collaboration
04/08/09	Formulation and Implementation I	•Graduate Reading Assignments	•Graduate Presentations
04/15/09	Formulation and Implementation II	N/A	•Progress Report 2, Discussion, and Collaboration
04/22/09	Verification and Validation	N/A	•Progress Report 3, Discussion, and Collaboration
04/29/09	Document and Presentation Preparation I	N/A	•Progress Report 4, Discussion, and Collaboration
05/06/09	Document and Presentation Preparation II	N/A	•Progress Report 5, Discussion, and Collaboration
05/13/09	Project Presentations	N/A	•Project Presentations

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Course Evaluation:

Lab exercises	**40%**	**(30% Grads)**
Graduate presentations		**(10% Grads)**
Class participation	**10%**	
Team self-evaluation	**10%**	
Progress reports	**10%**	
Final project presentation	**10%**	
Final project report	**20%**	

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- **Class Meetings**:
  - McCormack 02-0621, moving to S-3-020 for lab
  - Wednesdays from 5:30 - 8:00 PM
- **Lab Availability**:
  - S-3-020 when open and not used by a class
  - S-3-34 anytime 24/7 when not used by a class
- **Instructor Office Hours**:
  - S-1-060
  - Mondays and Wednesdays from 1:00 - 2:30 PM

David Tenenbaum

- Hon. B.Sc. at the University of Toronto
  - **Majors**: Physical and Environmental Geography & Environment in Society
- M.Sc. at the University of Toronto
  - **Thesis**: RHESSys-ArcView Integrated Modelling Environment
- Ph.D. at the University of North Carolina at Chapel Hill
  - **Dissertation**: Surface Moisture Patterns in Urbanizing Landscapes
- Canadian Government Lab Visiting Fellow at the Water & Climate Impacts Research Centre
  - **Research**: NAESI - In-Stream Flow Needs

How to Reach Me

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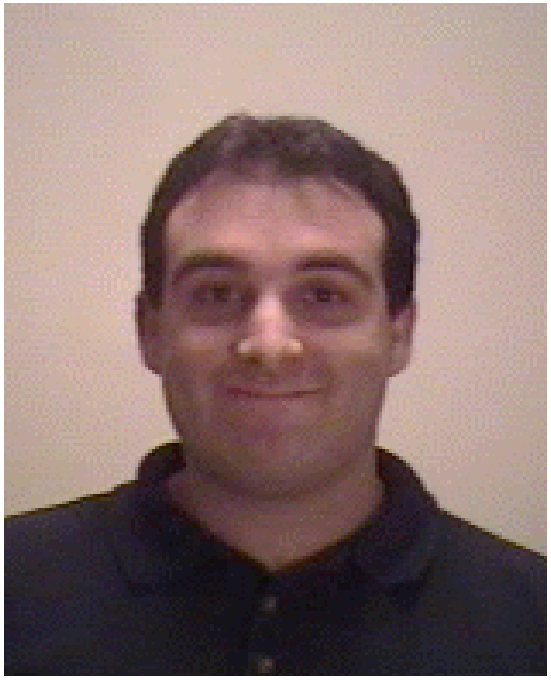


Teaching Assistant

- Jun Zhu
- Ph.D. Candidate: Environmental Science
- TA experience:
  - EEOS 370 and EEOS 465
- Email: jun.zhu@umb.edu
- Office Hours:
  - Wednesdays 11:00 AM – 2:30 PM S-3-020
  - Wednesdays 4:00 PM – 5:30 PM S-3-020

Course Objectives

- To **develop** students' **capability** to **use GIS** in **raster spatial modeling**.
- To **develop** students' **capability** to **use GIS** in a **modeling context** (that is, to be able to **implement mathematical models** in GIS).
- To **examine GIS modeling** from the point of view of a system analyst toward the **design** and **implementation** of **GIS projects**.

Student Introductions

- Name
- Department and Pursuing Degree
- Research interests (for grad. students)
- Expectation from this course
- GIS and math (stats.) background
- Computer background
- Work experience?

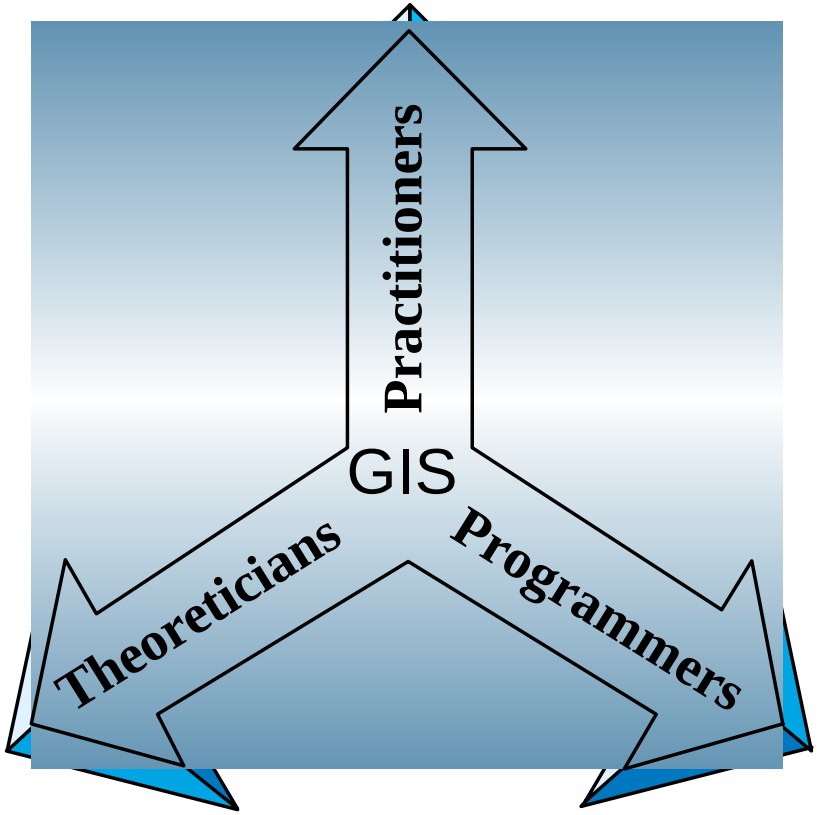
Chapter 1 – Introduction: Environmental Modeling

- The term **'modeling'** is used in **a few senses** in the **context of GIS**, but we can **generalize** their meaning somewhat:
  - **Modeling** in the context of GIS occurs whenever the operations of the GIS **attempt to emulate geographic processes in the world** (environmental systems), at one point in time or over an extended period.
- This can range from **simple representation**, to **evaluation**, to very **involved prediction**
- We must be aware of the roles of **scale, complexity, and accuracy**

The Role of GIS Modeling

- A **key application** of GIS to **solve geographic problems**, of a variety of sorts:
  - As a tool for **decision-making**
  - To render **explanations of distributional patterns** (people, plants, animals, places, things)
  - To **predict new distributions and arrangements**
  - As a **laboratory for exploration of theories** from which GIS derived
  - To allow scientists to **challenge hypotheses**
- **Practitioners, theoreticians and programmers** all participate in this endeavor (and frequently a single person is **more than one** of these)

Three Activities Practiced by GIS Professionals



How GIS Professionals Operate in These Roles

- Practitioners
  - Must learn how to **employ** models
    - **Solve** problems
    - Provide **justifications** for decisions
- Theoreticians
  - Seek **repeatable, quantifiable explanations** through simplification and abstraction
    - Develop a framework for **more detailed** modeling

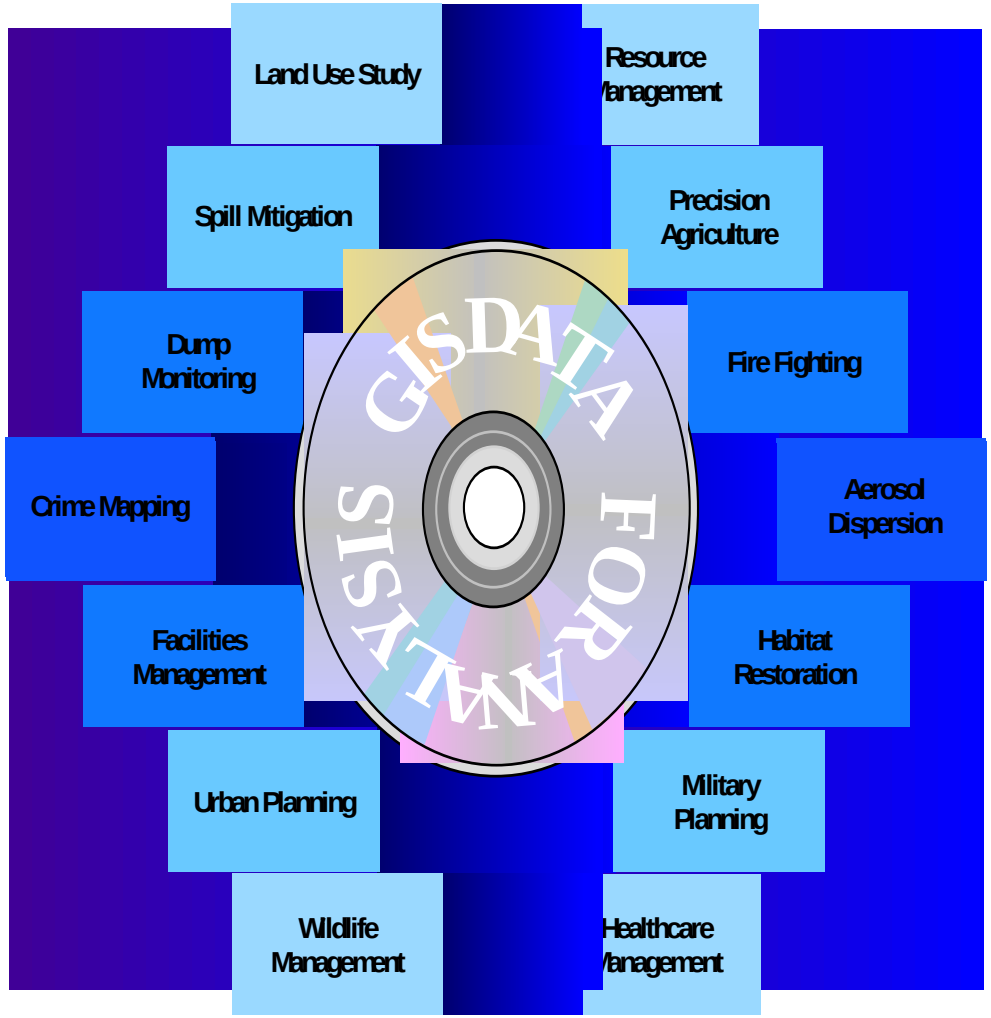
Realizing GIS Capabilities

- **Geographic problems** to be solved can be:
  - **Simple**, repetitive, computationally exhaustive
  - **Complex**, computationally elaborate
  - Problems may have **no solutions** at all
    - No **theoretical basis** yet
    - A GIS can be viewed as an **automated laboratory** for **hypothesis formulation and testing**

GIS' Primary Purpose: Analyzing Geographically-referenced Data

- This is often done using **formal models**:
  - Represent **some aspects** of the human or physical environment, using:
    - **Aggregate or disaggregate** mapped data:
      - Aggregate data – Data that have been **combined** from data for components.
      - Disaggregate data – Data that are **separated into units**, not combined.
    - **Predict new distributions** of phenomena
    - **Define the locations** of selected activities
    - Describe the **results of patterns** of one variable on itself or on other variables

A Primary Purpose … Now Applied in a Wide Variety of Disciplines



Geospatial data and products, including **maps, simulations, and databases**, are **invaluable tools** in the effective management of utility infrastructure, transportation, energy, emergency management and response, natural resource management, climate analysis, disaster recovery, homeland defense, law enforcement, protection planning and other civilian or military strategic issues

Understanding the Modeling Process

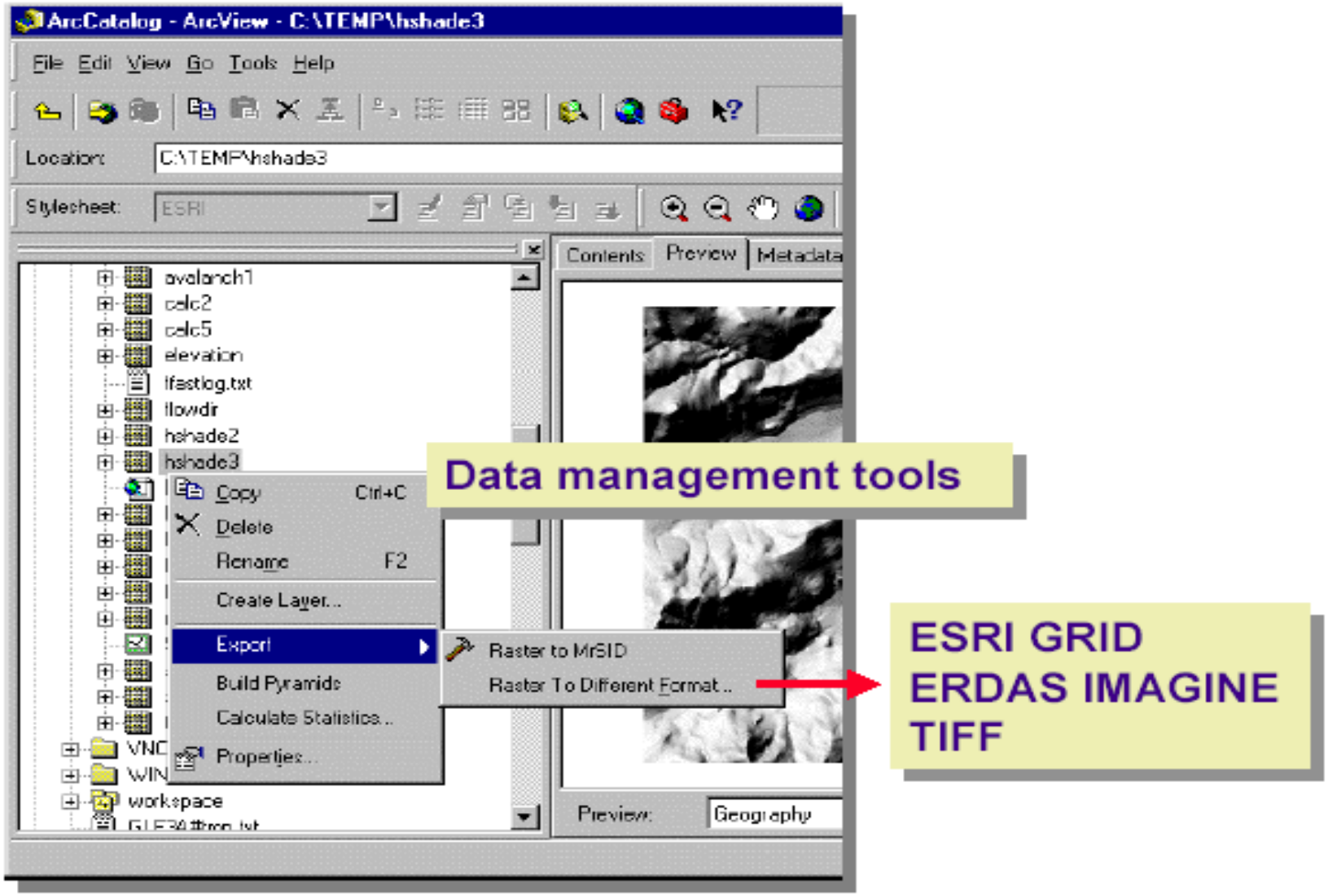
- What is the **model** supposed to do / what is it for?
  - A **database** allowing me to **ask questions about what and where** things are?
  - A model **quantifying existing patterns** for better understanding?
  - A model **examining multiple relationships** from different maps?
  - A model showing how things **change through time**?
  - A model **predicting** something?
  - Locating the **best places, routes, or scenarios** for some form of activity?

Application Software

ArcMap, ArcCatalog, ArcToolbox, and ModelBuilder:

- **ArcMap** - for cartography, map analysis, and editing
- **ArcCatalog** - organizes and manages all GIS information: maps, data sets, models, metadata, and services. including
  - Browse and find geographic information
  - Record, view, and manage metadata
  - Define, export, and import geodatabase schemas and designs
  - Search and browse GIS data on local networks and the Web
- **ArcToolbox** - geoprocessing functions including tools for
  - Data management
  - Data conversion
  - Vector analysis
  - Geocoding
  - Statistical analysis
- **ModelBuilder** – for building models!

ArcCatalog Raster Tools



Data Formats in Arc Products

- **ArcView 3.x**
  - Shapefile
- **ArcInfo**
  - Coverage
  - GRID
- **ArcGIS**
  - GeoDatabase
  - (.mdb)
  - (.gdb)

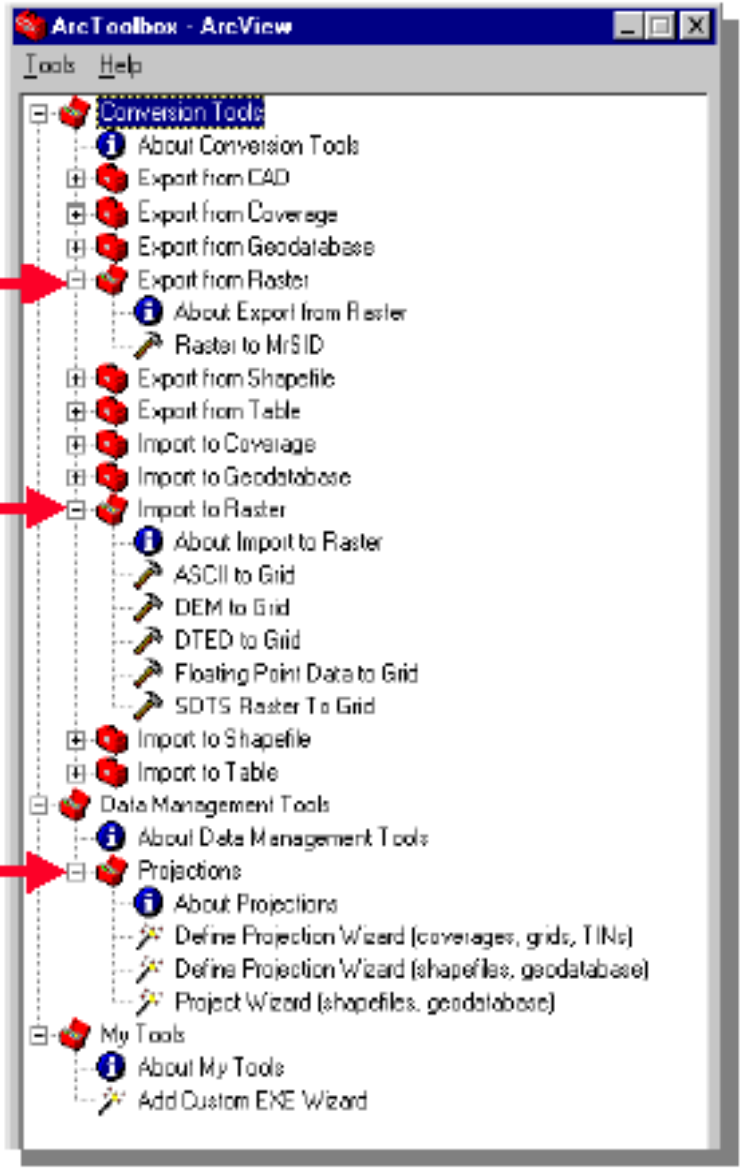
ArcToolbox raster tools

Export from Raster

Import to Raster

Projections

Additional tools available in ArcInfo



ArcGIS Extensions

- Spatial Analyst
- Geostatistical Analyst
- 3D Analyst (includes ArcGlobe)
- Survey Analyst
- Tracking Analyst
- Network Analyst
- Schematics

Next Topic:

Raster Data and ArcGIS Spatial Analyst