

Introduction to Geographic Information Systems

Lesson Objectives

- Understand what a GIS is
- Understand how a GIS functions
- Understand how spatial data is represented in a GIS
- Look at some GIS applications

Data vs. Information

- Data, by itself, generally differs from information.
- Data is of little use unless it is transformed into information.
- Information is an answer to a question based on raw data.
- We transform data into information through the use of an Information System.

INFORMATION SYSTEM OVERVIEW

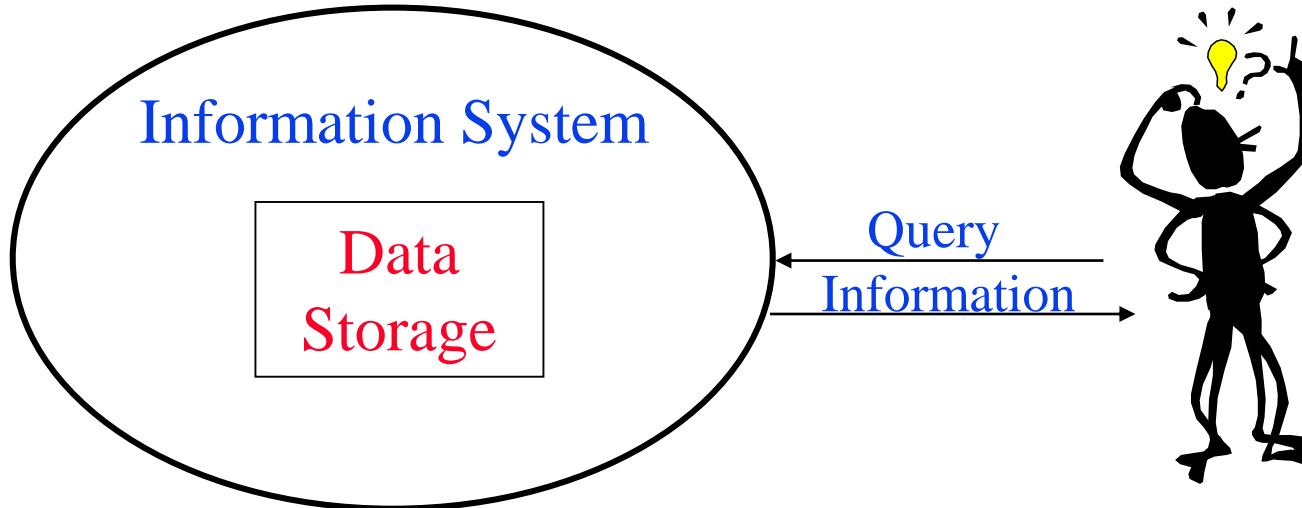
What is an Information System?

SYSTEM USED FOR:

**capturing
storing
updating
manipulating
analyzing**

DATA

What is an Information System?



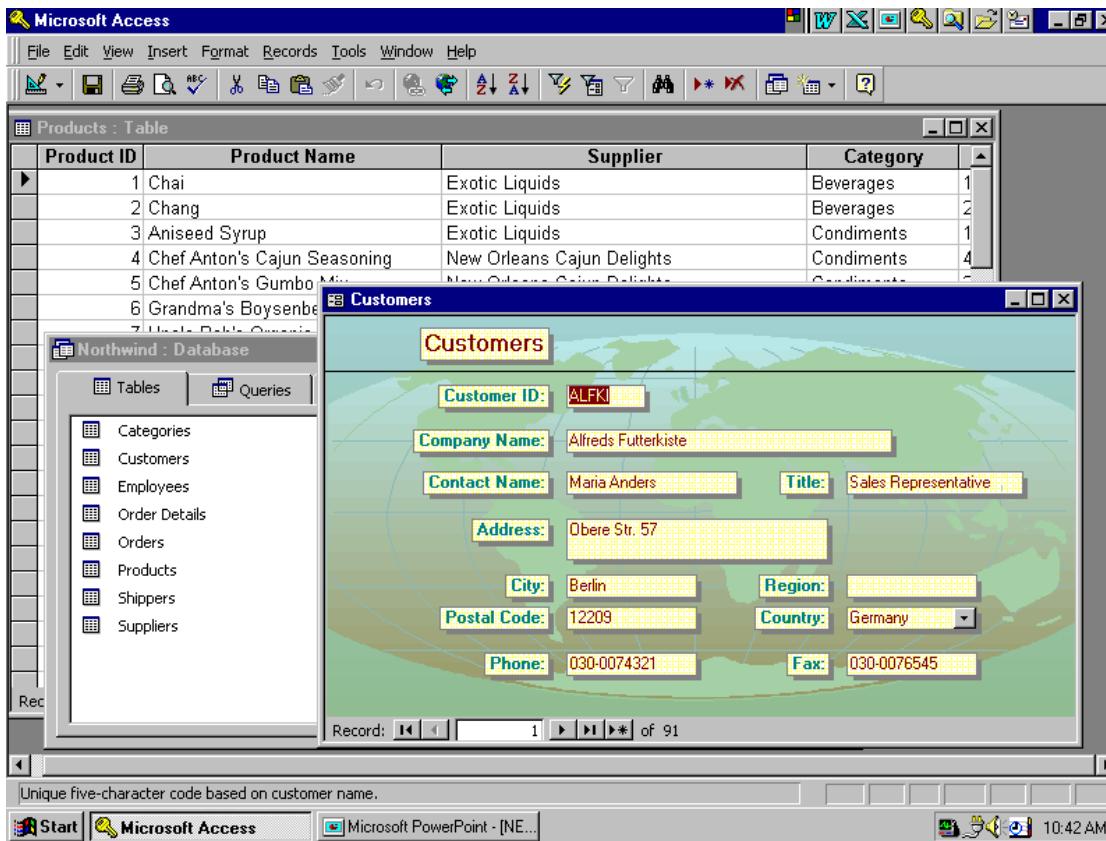
Information systems can be very simple, such as a telephone directory.



What is an Information System?

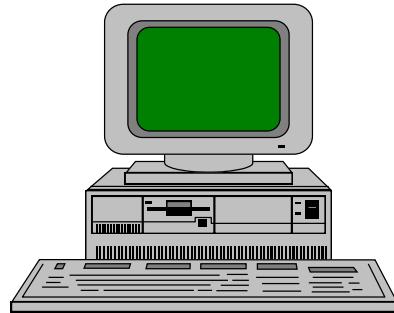
In the digital environment we use software to create complex information systems.

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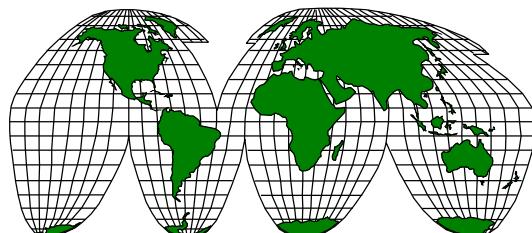
What is a GIS?

Information System



+

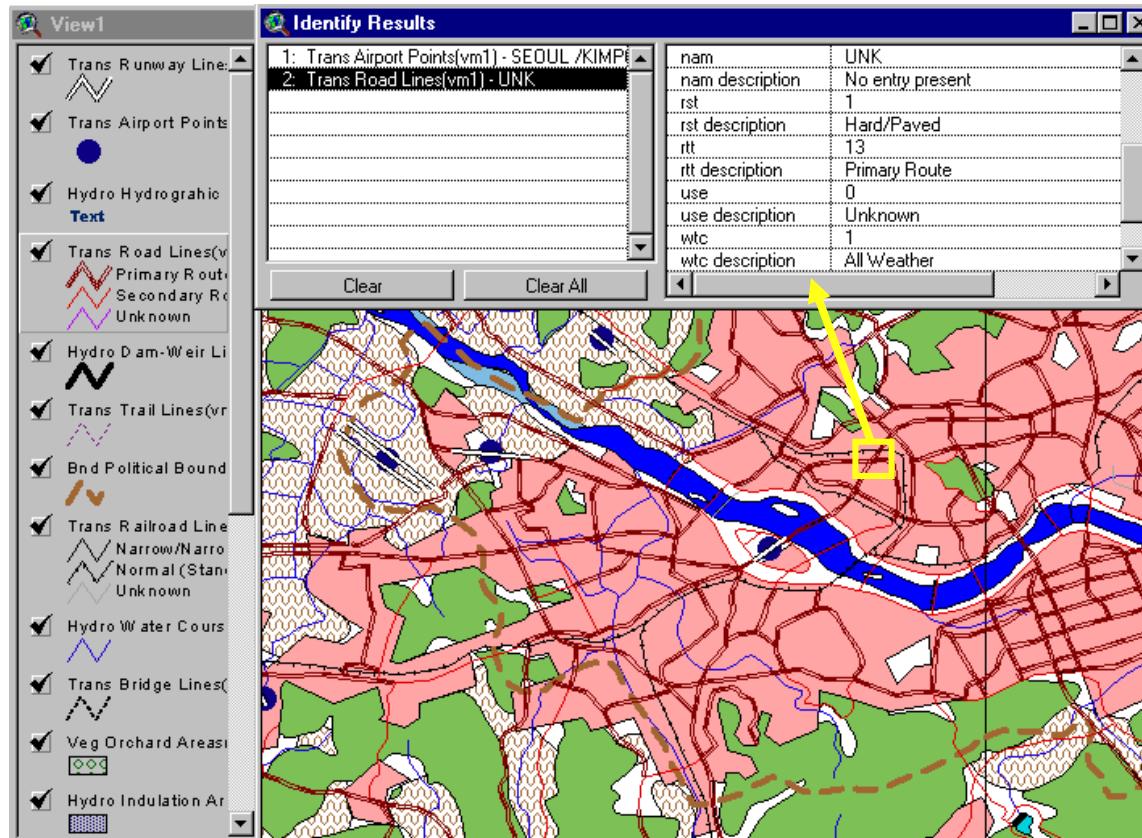
Geographic Position



A means of storing,
retrieving, sorting,
and comparing
spatial data
to support some
analytic process.

What is a GIS?

GEOGRAPHIC Information System



GIS links graphical features (**entities**) to tabular data (**attributes**)

GIS Definition

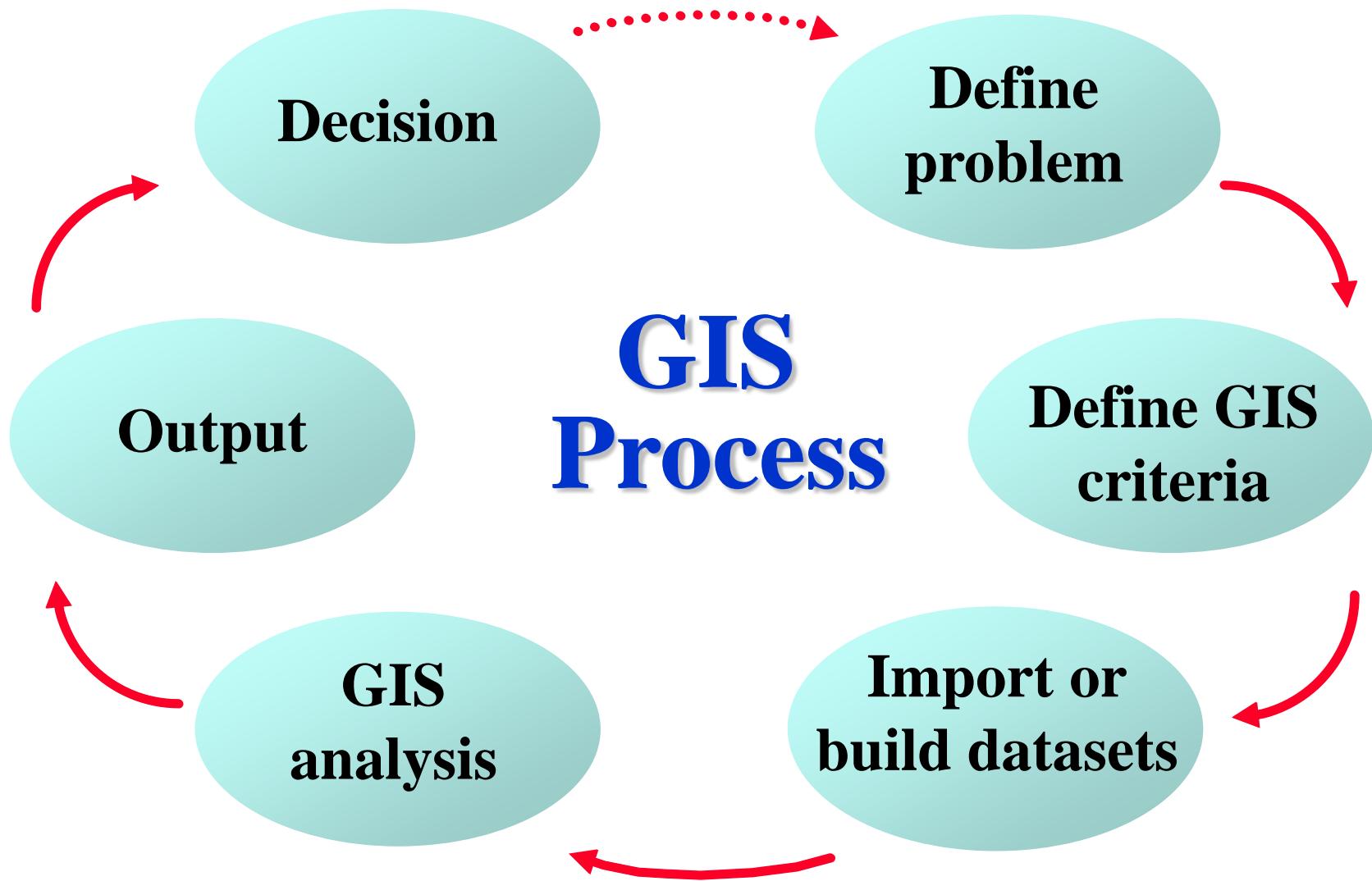
- A GIS is a system (hardware + database engine) that is designed to efficiently, assemble, store, update, analyze, manipulate, and display **geographically referenced information** (data identified by their locations).
- A GIS also includes the **people** operating the system and the **data** that go into the system.

Key Functions of a GIS

Data can be:

- 1.** Positioned by its known spatial coordinates.
- 2.** Input and organized (generally in **layers**).
- 3.** Stored and retrieved.
- 4.** Analyzed (usually via a Relational DBMS).
- 5.** Modified and displayed

Geographic Information Systems

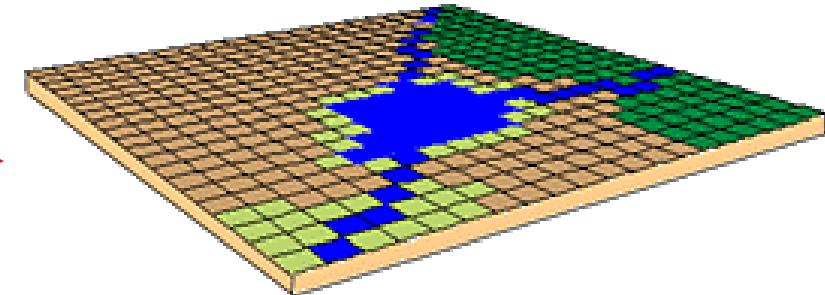


MODELLING AND STRUCTURING DATA

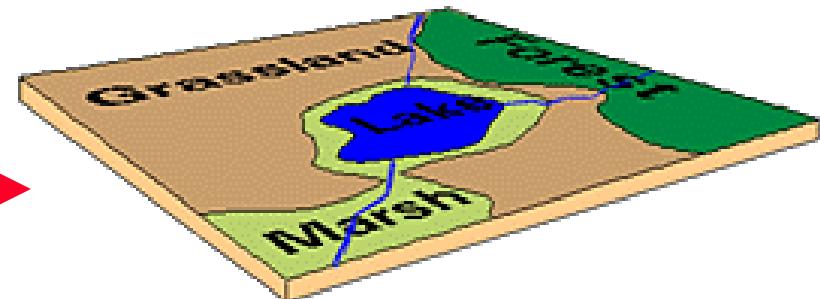
(How we represent **features** or spatial
elements)

Representing Spatial Elements

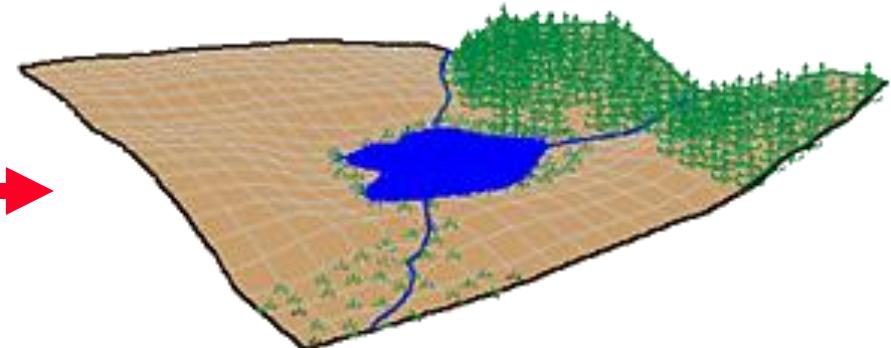
- RASTER



- VECTOR



- Real World



Representing Spatial Elements

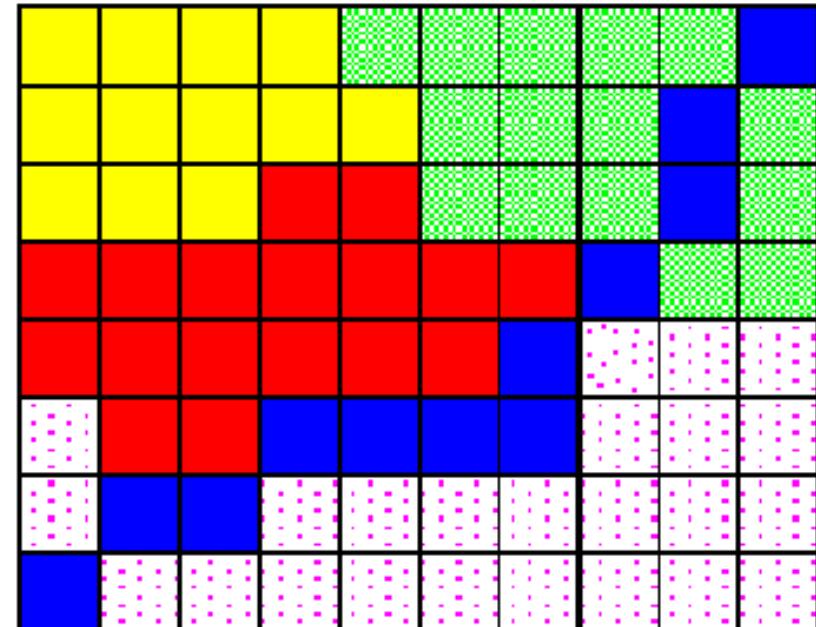
Raster

Stores images as rows and columns of numbers with a Digital Value/Number (DN) for each cell.

Units are usually represented as square grid cells that are uniform in size.

Data is classified as “continuous” (such as in an image), or “thematic” (where each cell denotes a feature type).

Numerous data formats (TIFF, GIF, ERDAS.img etc)

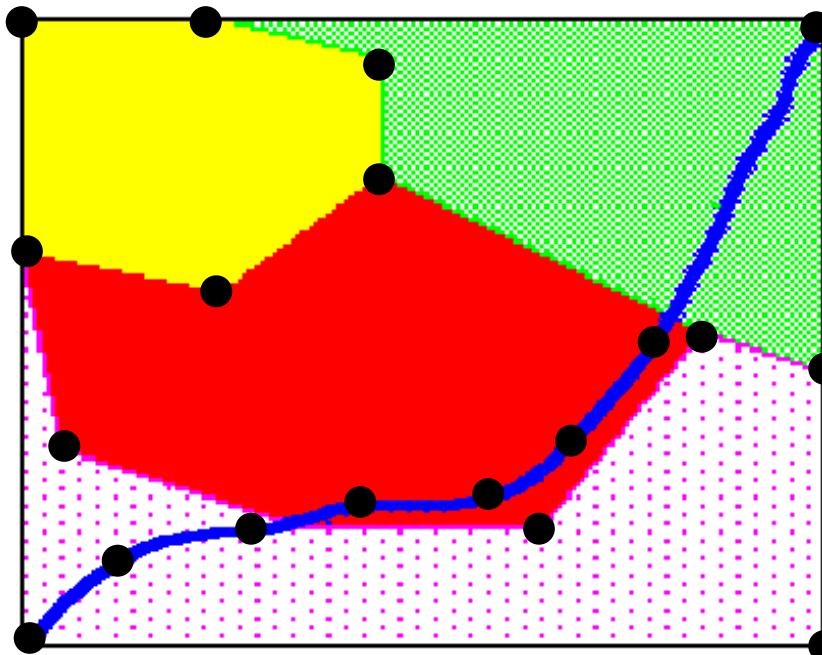


Representing Spatial Elements

Vector

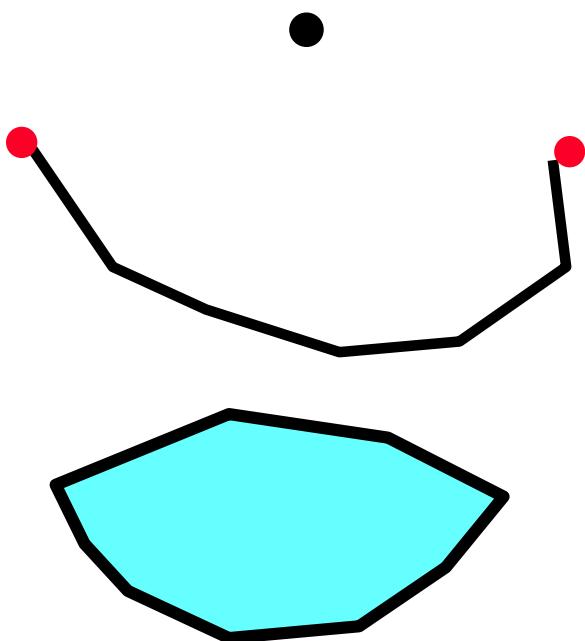
Allows user to specify specific spatial locations and assumes that geographic space is continuous, not broken up into discrete grid squares

We store features as sets of X,Y coordinate pairs.



Entity Representations

We typically represent objects in space as three distinct spatial elements:



Points - simplest element

Lines (arcs) - set of connected points

Polygons - set of connected lines

We use these three spatial elements to represent real world features and attach locational information to them.

Attributes

- In the raster data model, the cell value (Digital Number) is the attribute. Examples: brightness, landcover code, SST, etc.
- For vector data, attribute records are linked to point, line & polygon features. Can store *multiple* attributes per feature. Vector features are linked to attributes by a *unique feature number*.

Raster vs. Vector

Raster Advantages

The most common data format

Easy to perform mathematical and overlay operations

Satellite information is easily incorporated

Better represents “continuous”- type data

Vector Advantages

Accurate positional information that is best for storing discrete thematic features (e.g., roads, shorelines, sea-bed features).

Compact data storage requirements

Can associate unlimited numbers of attributes with specific features

GIS FUNCTIONALITY

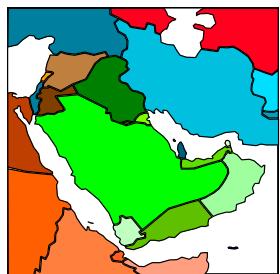
(What do they do?)

GIS Functions

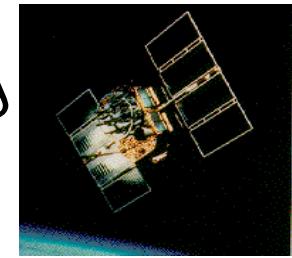
- Data Assembly
- Data Storage
- Spatial Data Analysis and Manipulation
- Spatial Data Output

GIS Functions

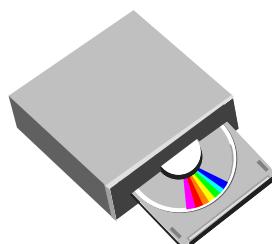
Data Assembly



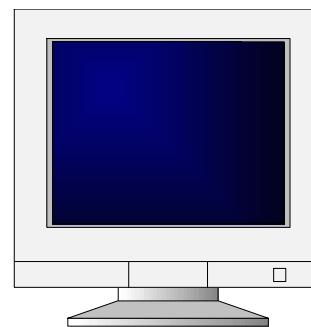
Maps



RSI



Intel Database

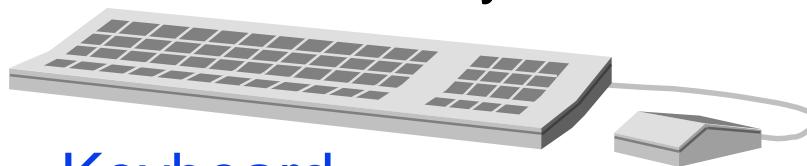


Manual Digitizing
Scanning

Manual Digitizing
Scanning

Data Transfer

Data Transfer



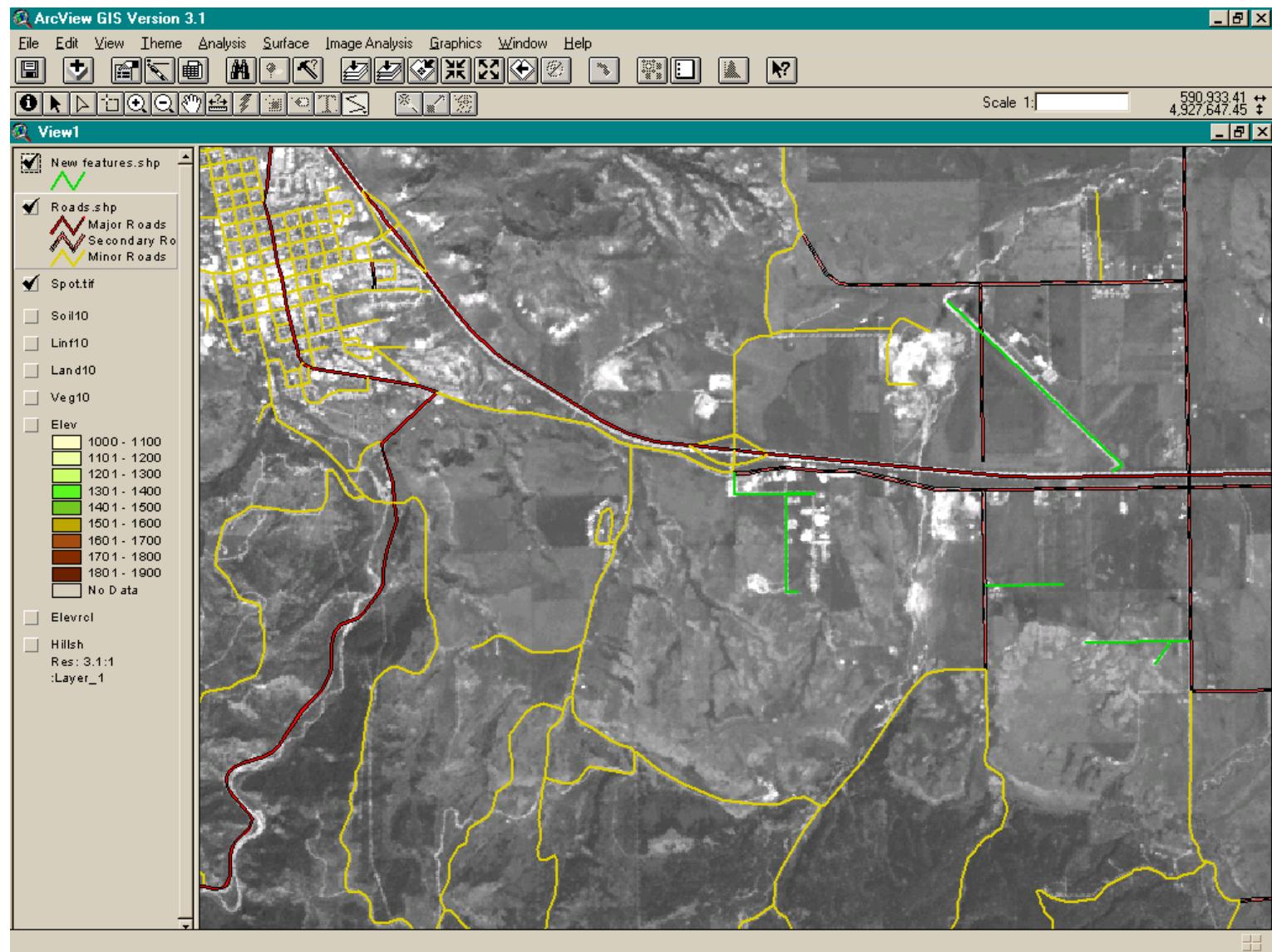
Direct Entry



GPS

Keyboard

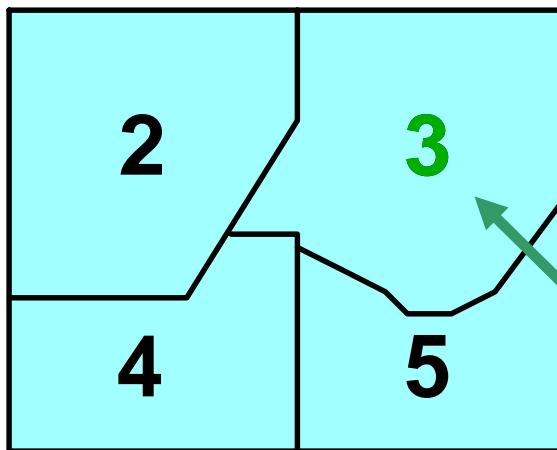
Data Input/Creation



GIS Functions

GIS Storage

1 (Universe polygon)



Spatial data
(ARC functions)

Attribute data
(INFO or TABLES functions)

COV#	ZONE	ZIP
1		0
2	C-19	22060
3	A-4	22061
4	C-22	22060
5	A-5	22057

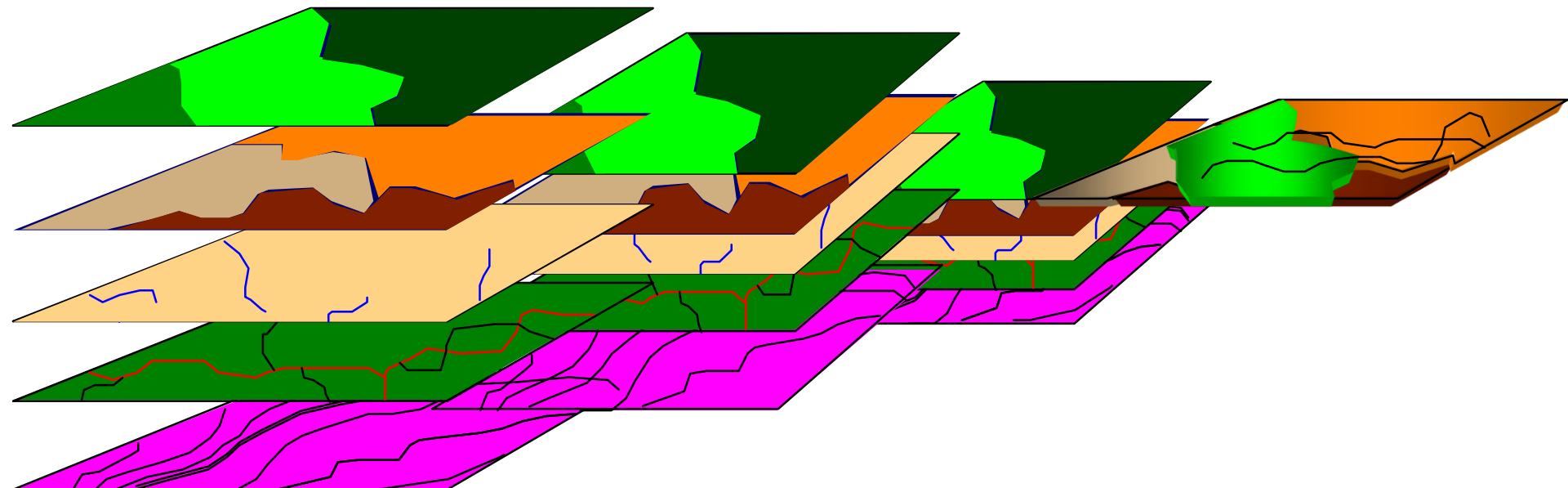
GIS Functions

Spatial Data Manipulation and Analysis

- Common Manipulation
 - Reclassification
 - Map Projection changes
- Common Analysis
 - Buffering
 - Overlay
 - Network

Spatial Analysis

- Overlay function creates new “layers” to solve spatial problems

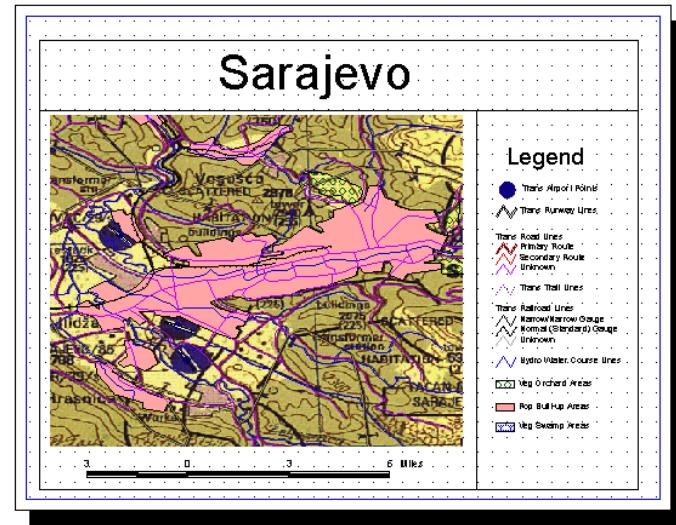


GIS Functions

Spatial Data Output

- Tables
- Maps
- Interactive Displays
- 3-D Perspective View

Shape	id	l_code	l_code description	ewc	ewc description	nam
Polygon	1	AL020	Built-Up Area	999	Other	Vinkovci
Polygon	2	AL020	Built-Up Area	999	Other	Nustar
Polygon	3	AL020	Built-Up Area	999	Other	Bobota
Polygon	4	AL020	Built-Up Area	999	Other	Otok
Polygon	5	AL020	Built-Up Area	999	Other	Bijelo Brdo
Polygon	6	AL020	Built-Up Area	999	Other	Trpinja
Polygon	7	AL020	Built-Up Area	999	Other	Komletinci
Polygon	8	AL020	Built-Up Area	999	Other	UNK
Polygon	9	AL020	Built-Up Area	999	Other	Backi Monostor
Polygon	10	AL020	Built-Up Area	999	Other	Hercegszanto



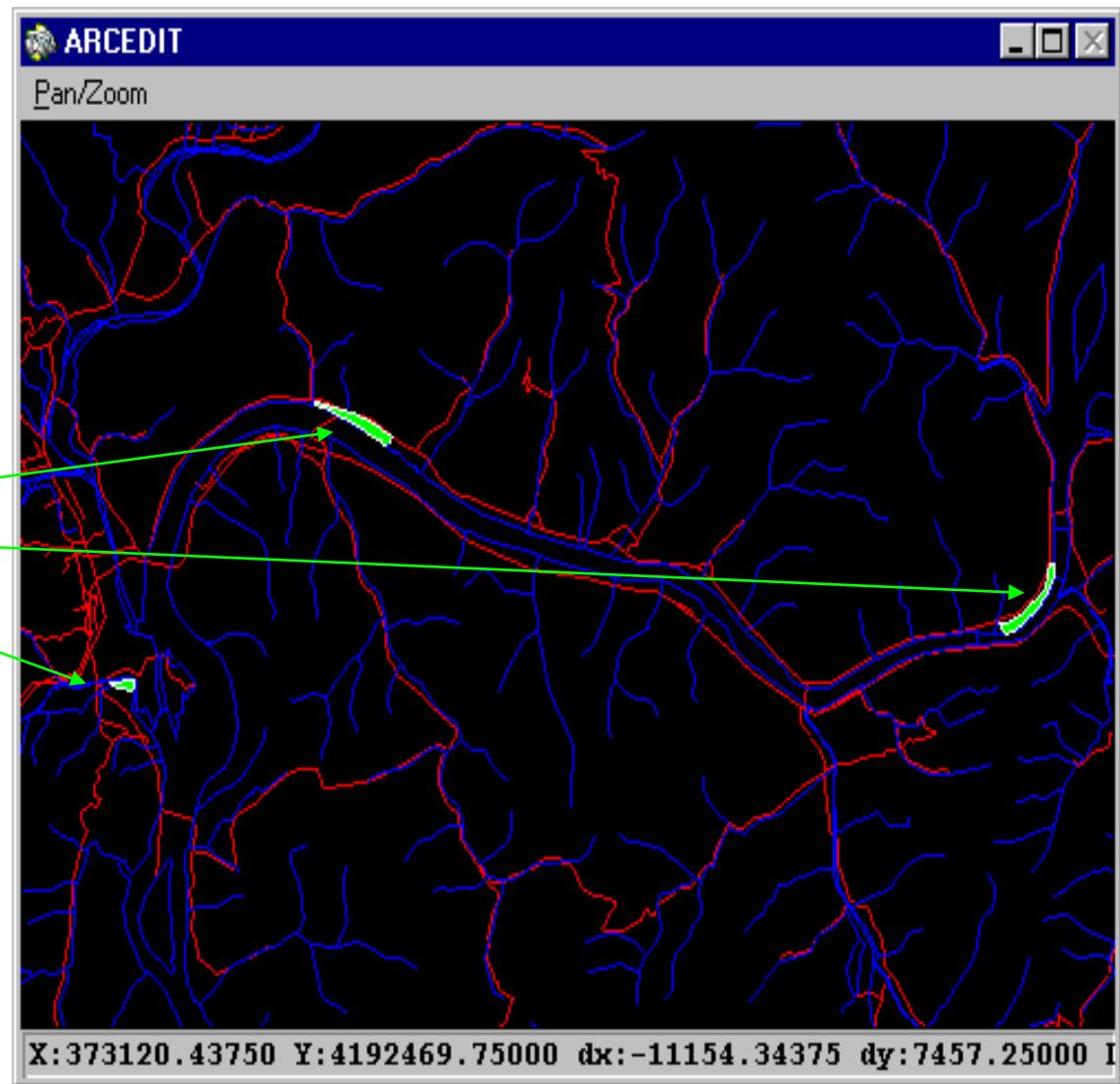
SOME EXAMPLES AND APPLICATIONS

GIS Applications

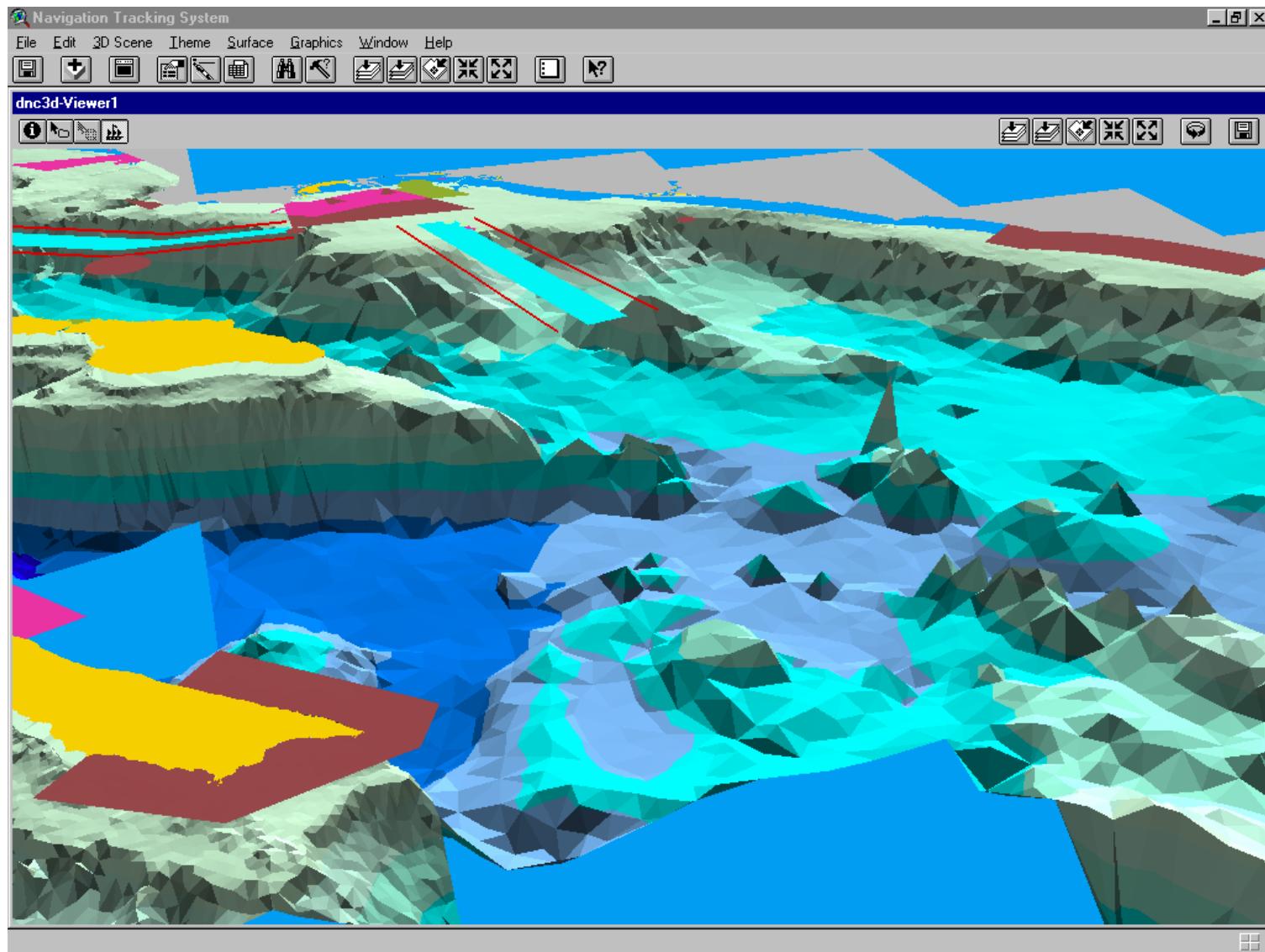
- Site selection
 - Helicopter Landing Zones
 - Amphibious Assault (Water Depth)
 - Buffer Zones
 - Flight Planning
 - Battlefield Visualisation



Helicopter Landing Zones

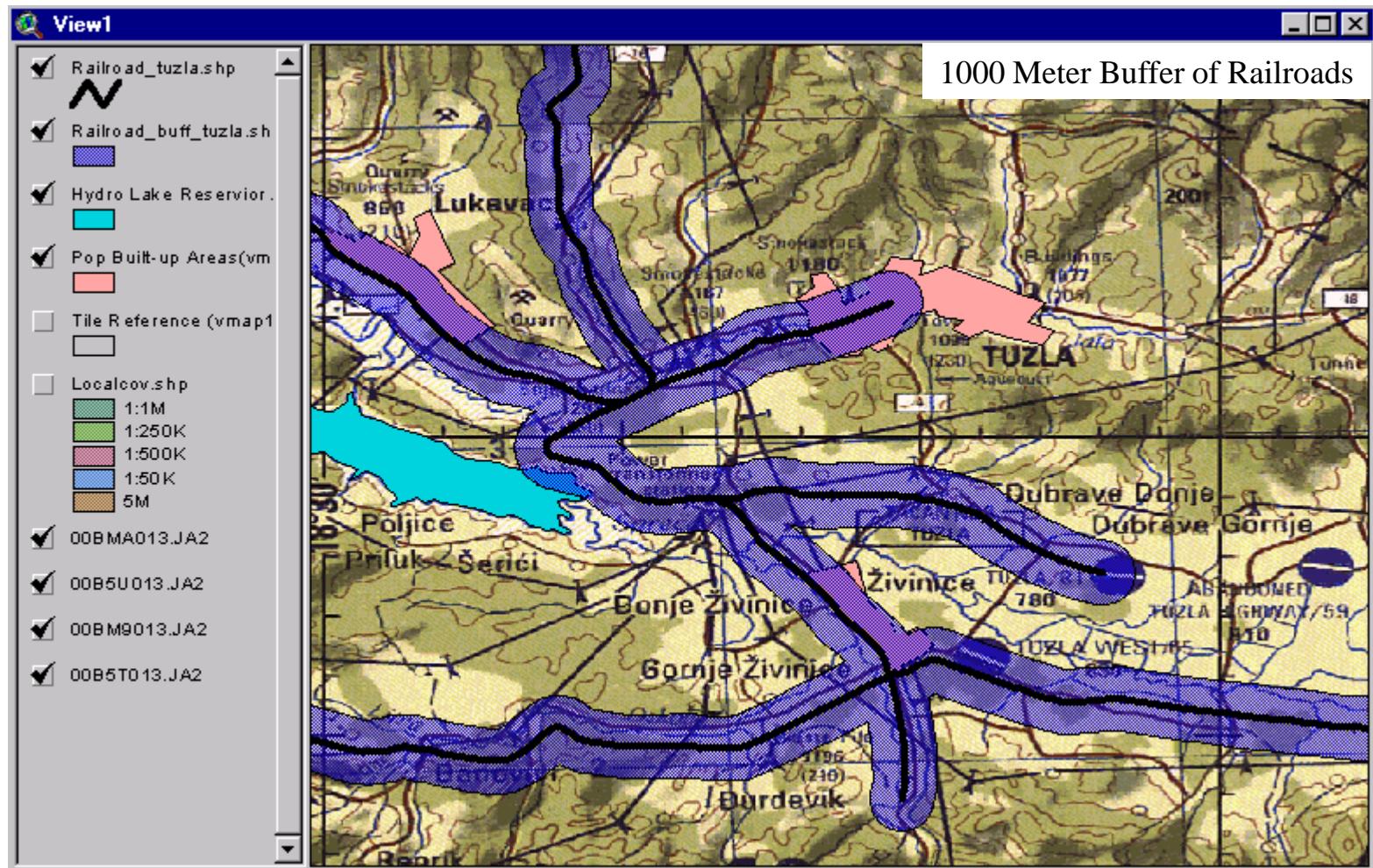


Amphibious Assault Planning

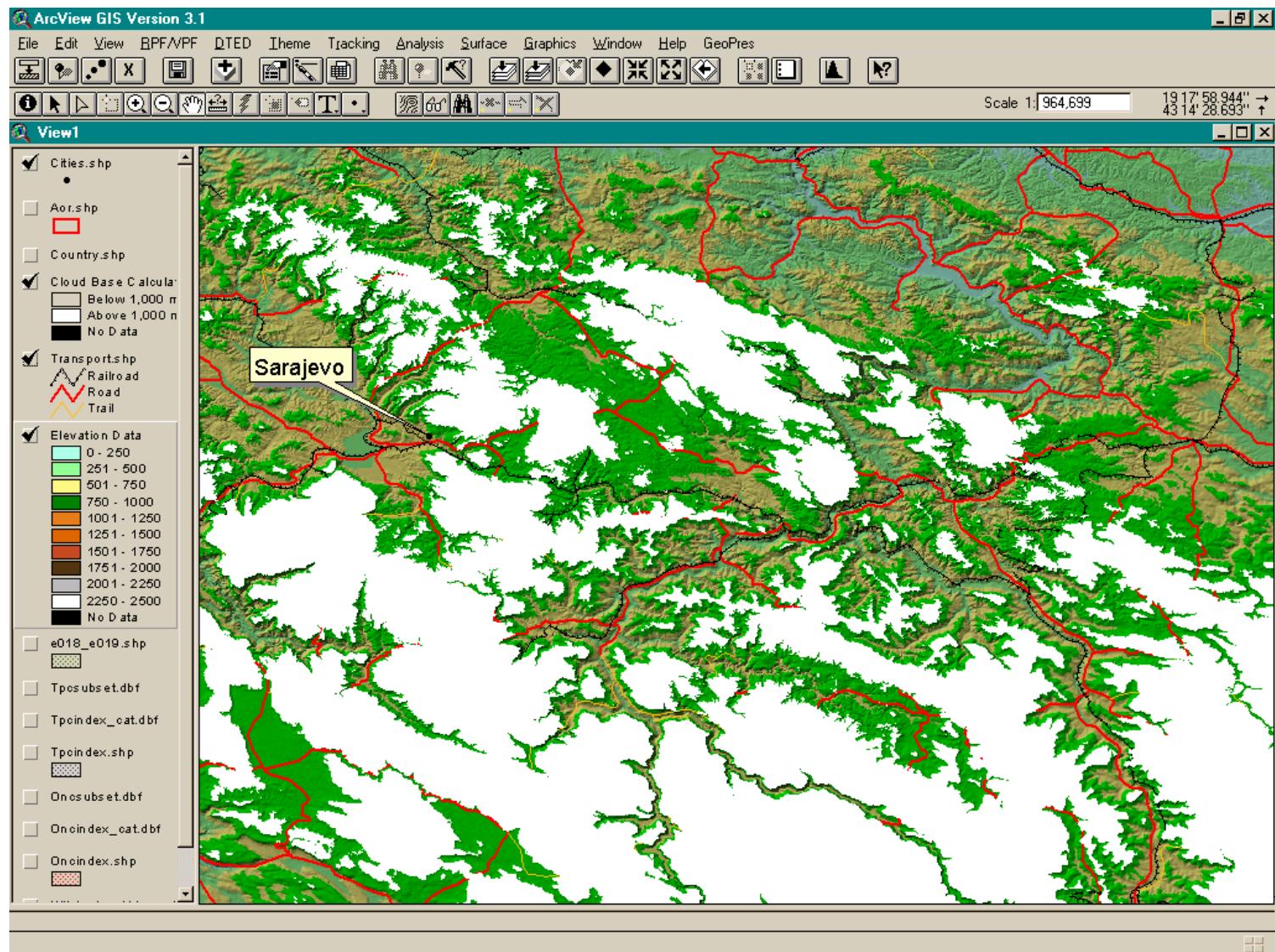


Spatial Analysis

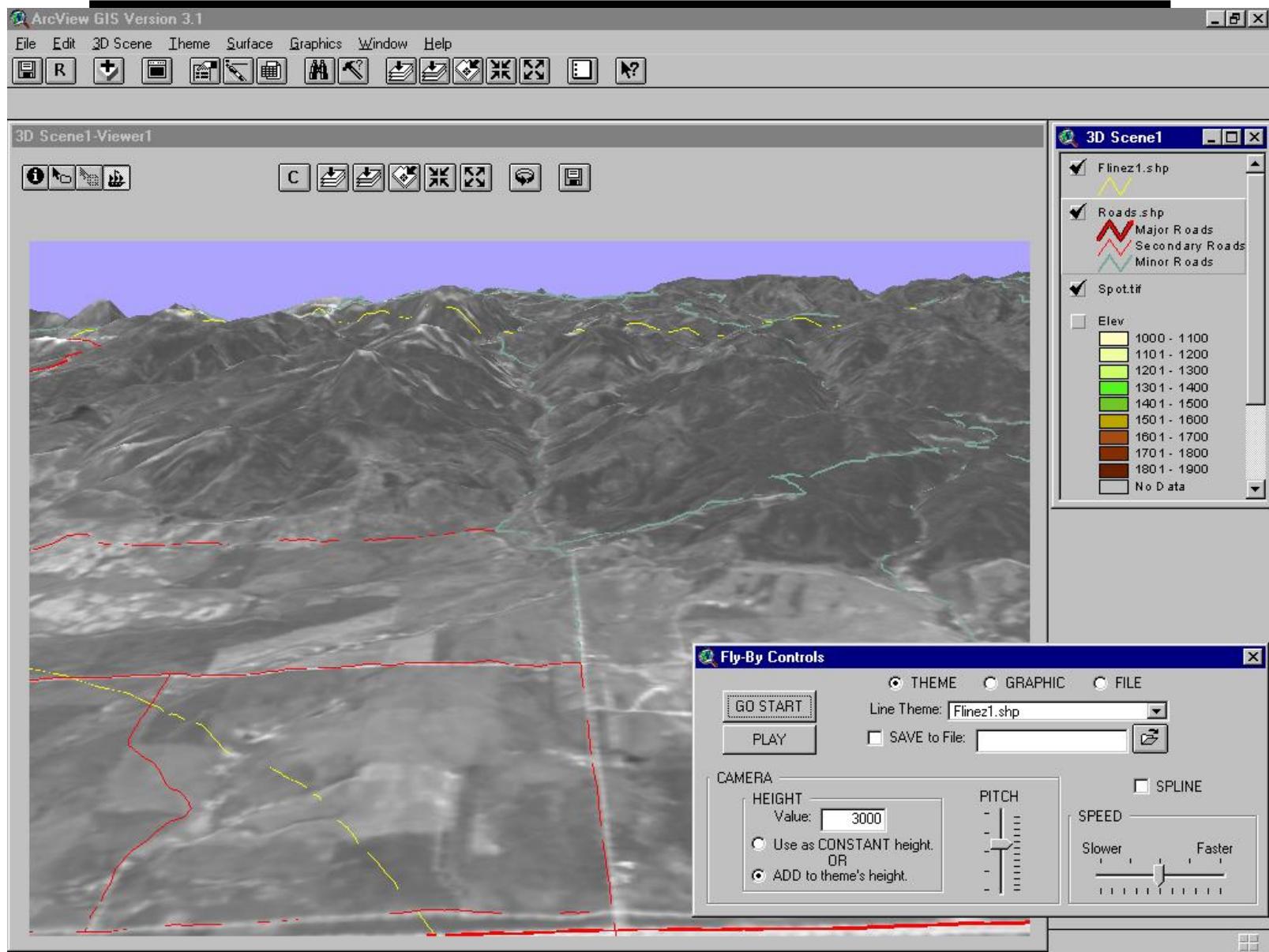
Proximity Analysis (Buffers)



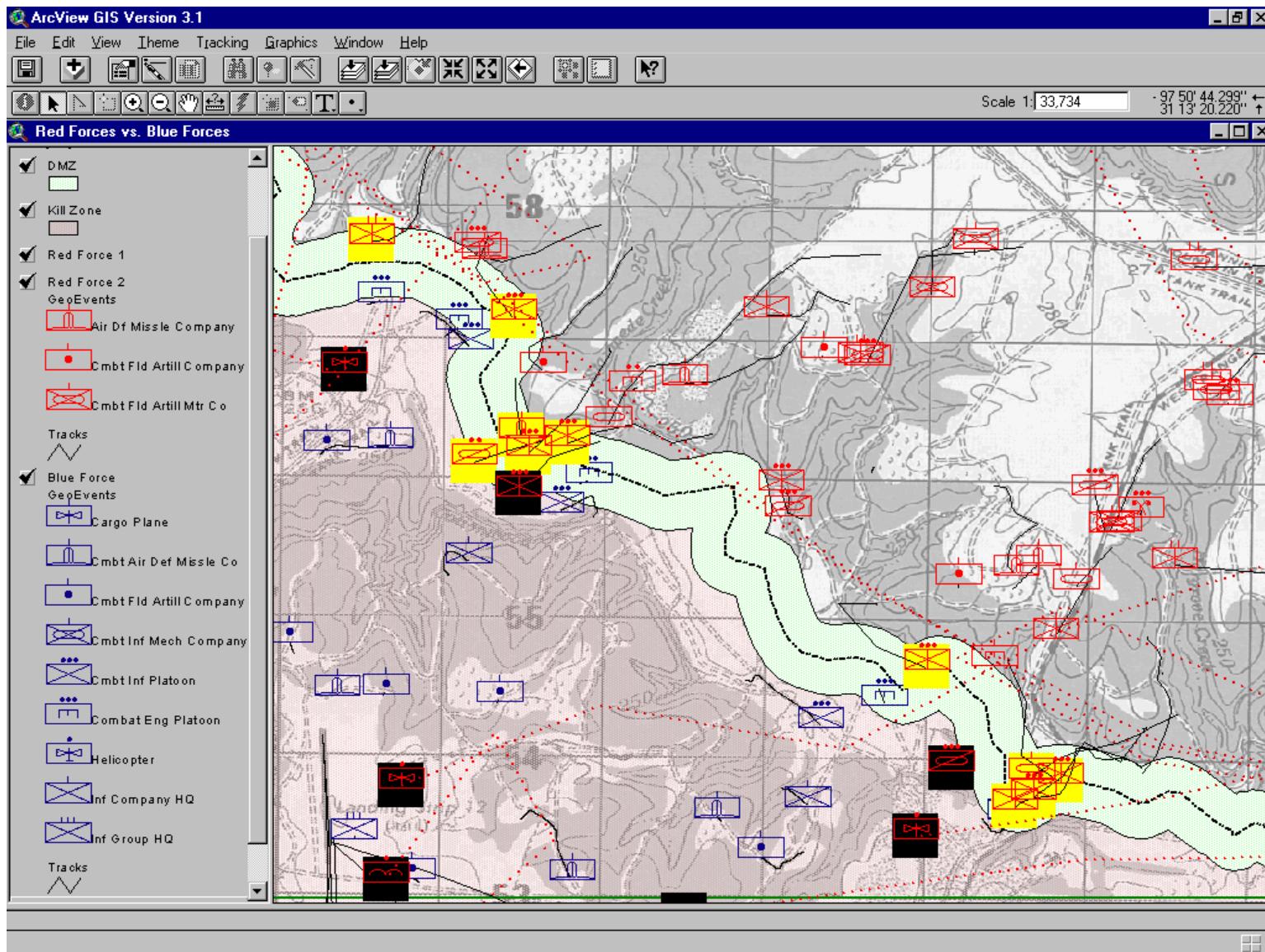
Flight Planning



Flight Planning/Flythroughs



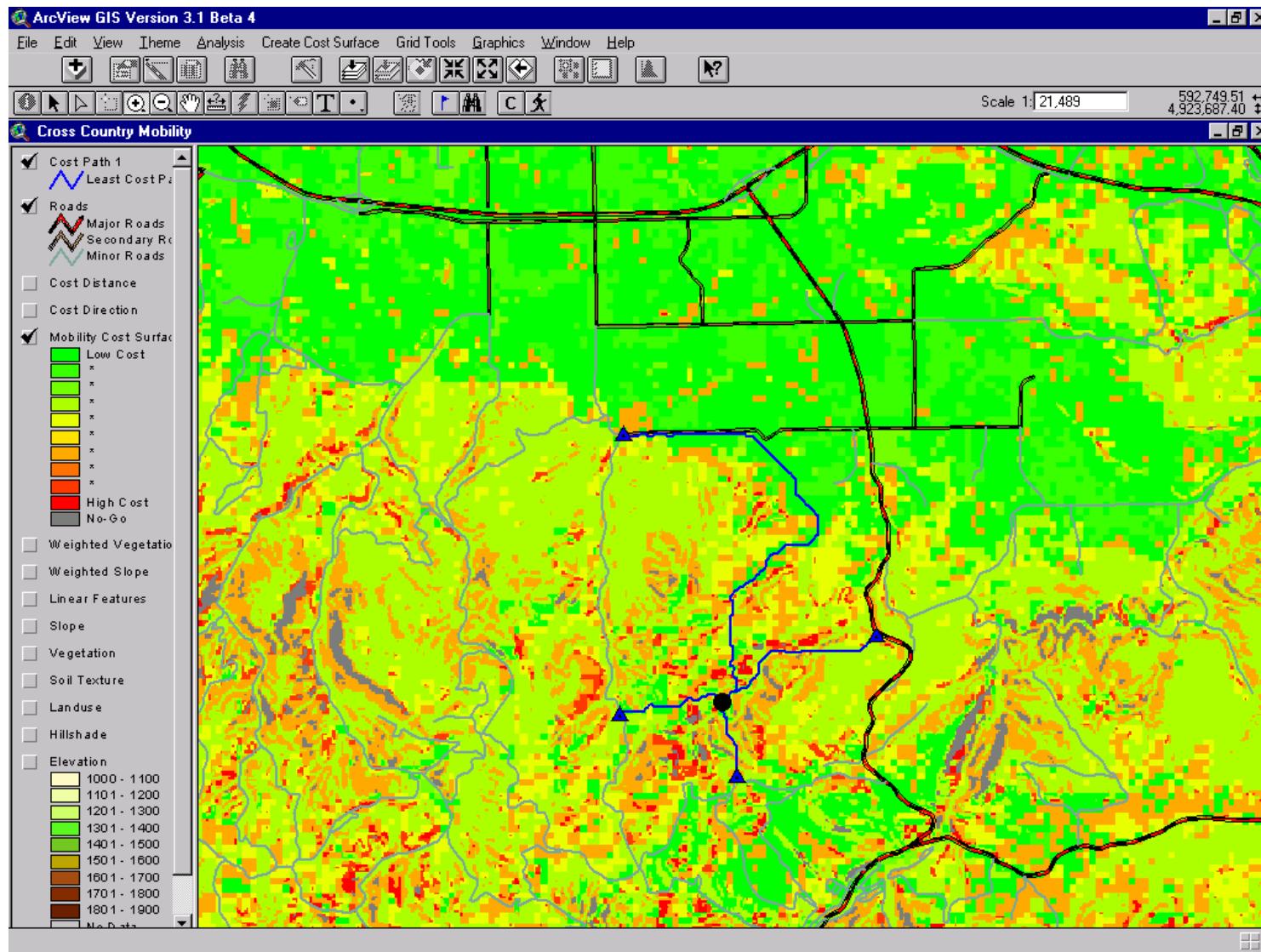
Battlefield Visualization and/or Situation Awareness



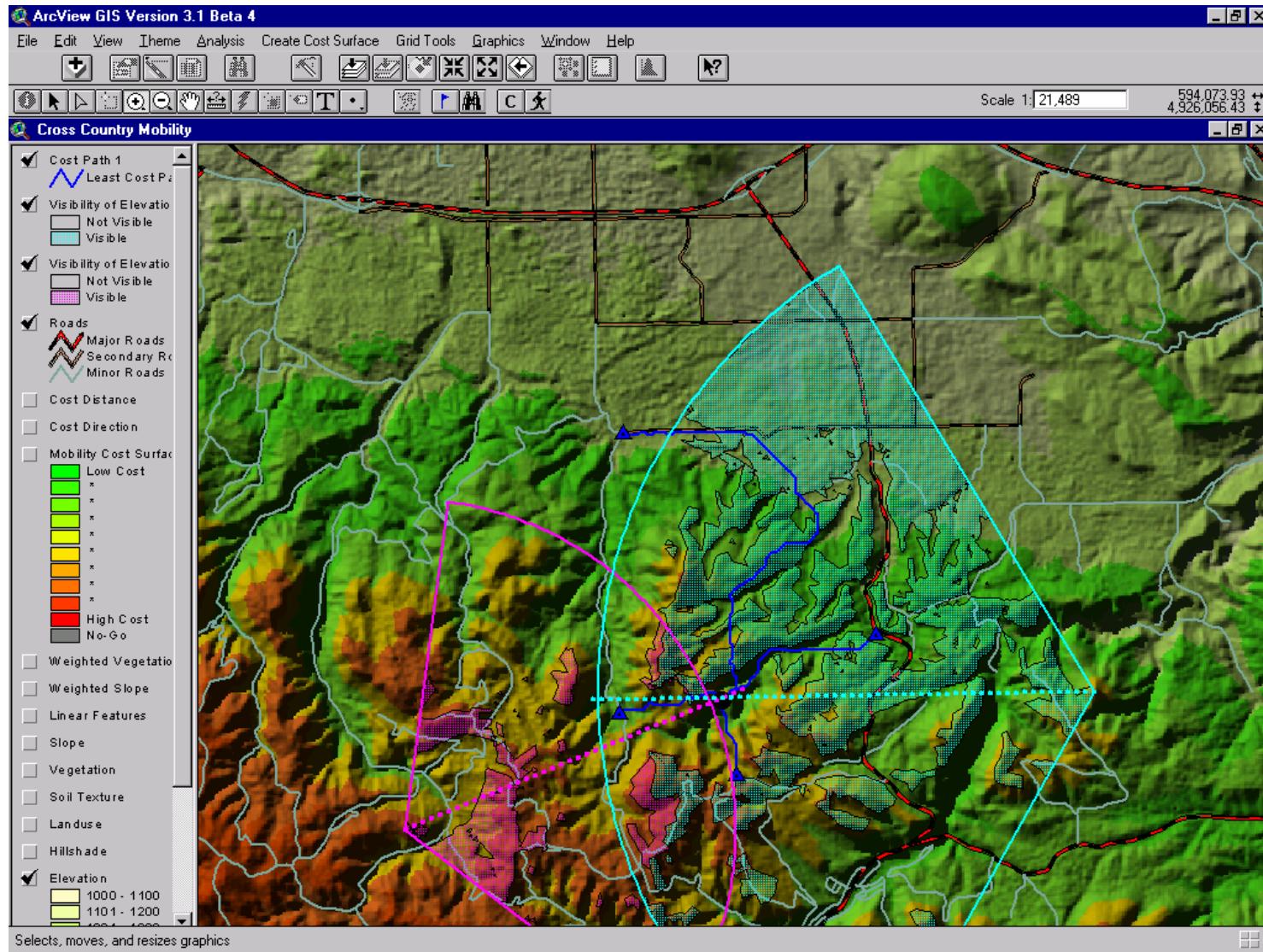
Other GIS Applications

- Cross country movement
 - Route planning
 - Intervisibility study
- Facilities management
- Airfield assessment
- Road network analysis (convoys)
- Propagation coverages
- Observation post siting analysis
- Perspective views

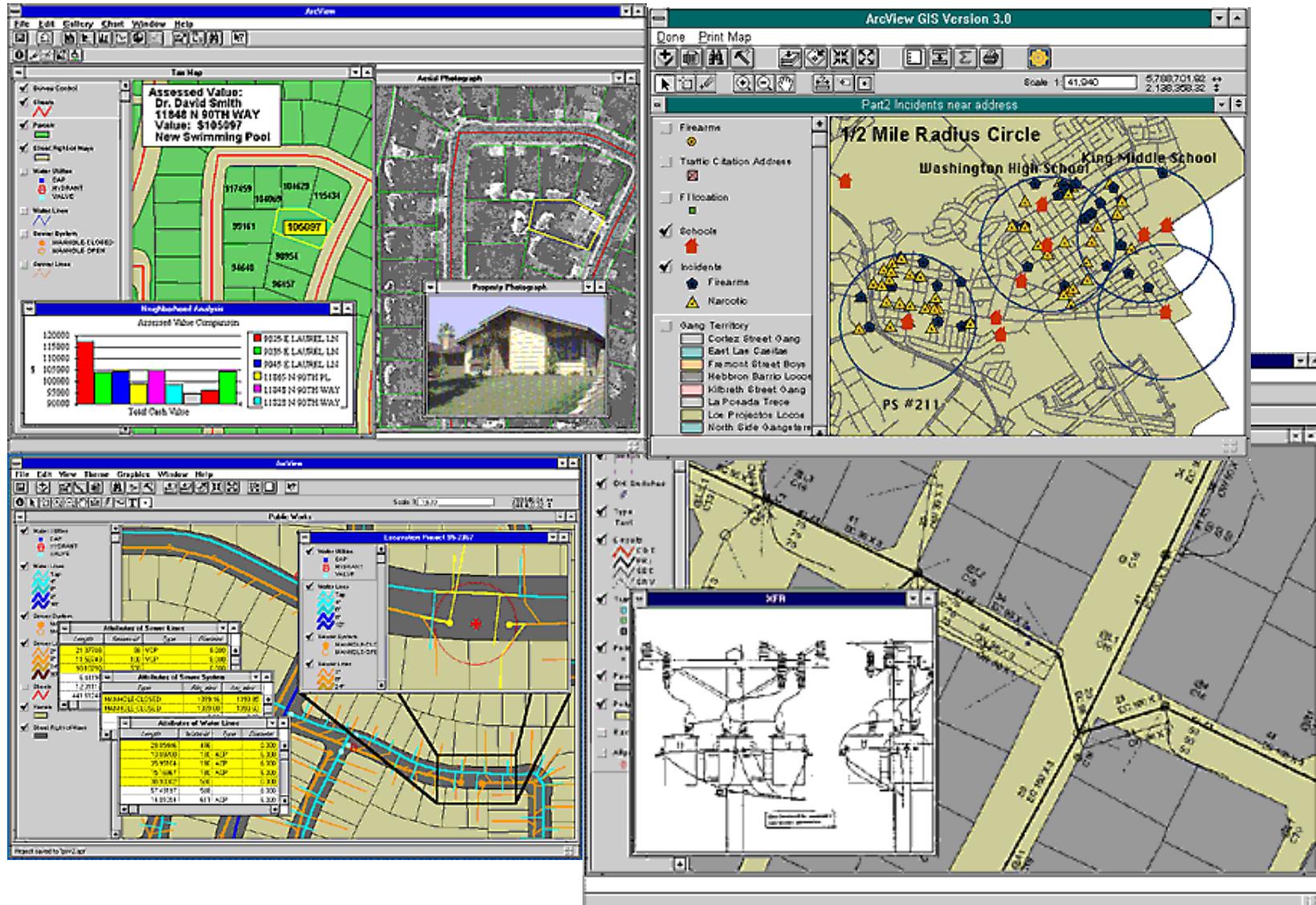
CCM Analysis



CCM & Viewshed



Facilities Management



Airfields

ArcView GIS Version 3.1

File Edit View Theme Create Cost Surface Tracking Analysis Surface Graphics Network Window Help Military

Scale 1:1,316,684 30.29 -1.14

A Key Point Dossiers

- Region AOI
- Rwanda AOI
- Runway Outline
- Rwandan Cities
 - Kigali
 - Urbanized Area
 - Other Population
- Rwandan Airports
- Neighboring Airport
- Rwandan Runways
- Military Bases
- Mine Buffers
- Land Mines
 - Mines
- Roads
- Rwanda
- Rwandan Lakes
- Rwandan Streams
- Urbanized Areas

Identify Results

1: Rwandan Airports - KIGALI

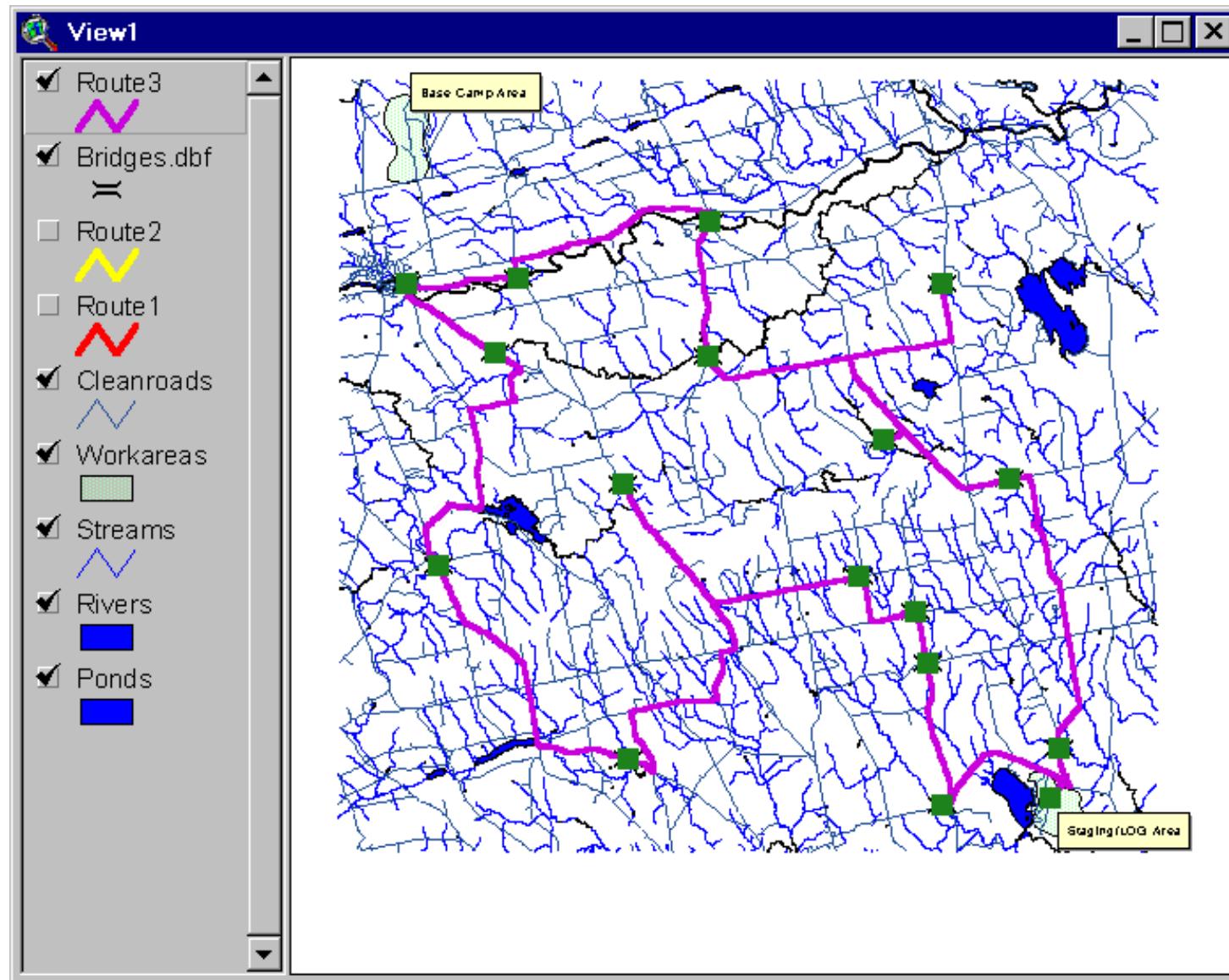
Shape	Point
Name	KIGALI
Ident	RW45746
Prov	
Icao	HRYR
Faa_ident	N
Lat	50158073/
Long	E03008221/
Loc_hdatum	WGE
Wgs_datum	WGE
Wgs_lat	50158073/
Wgs_long	E03008221/
Elevation	04891
Type	A
Mag_var	W000285 1297
Wac	0933

Image4

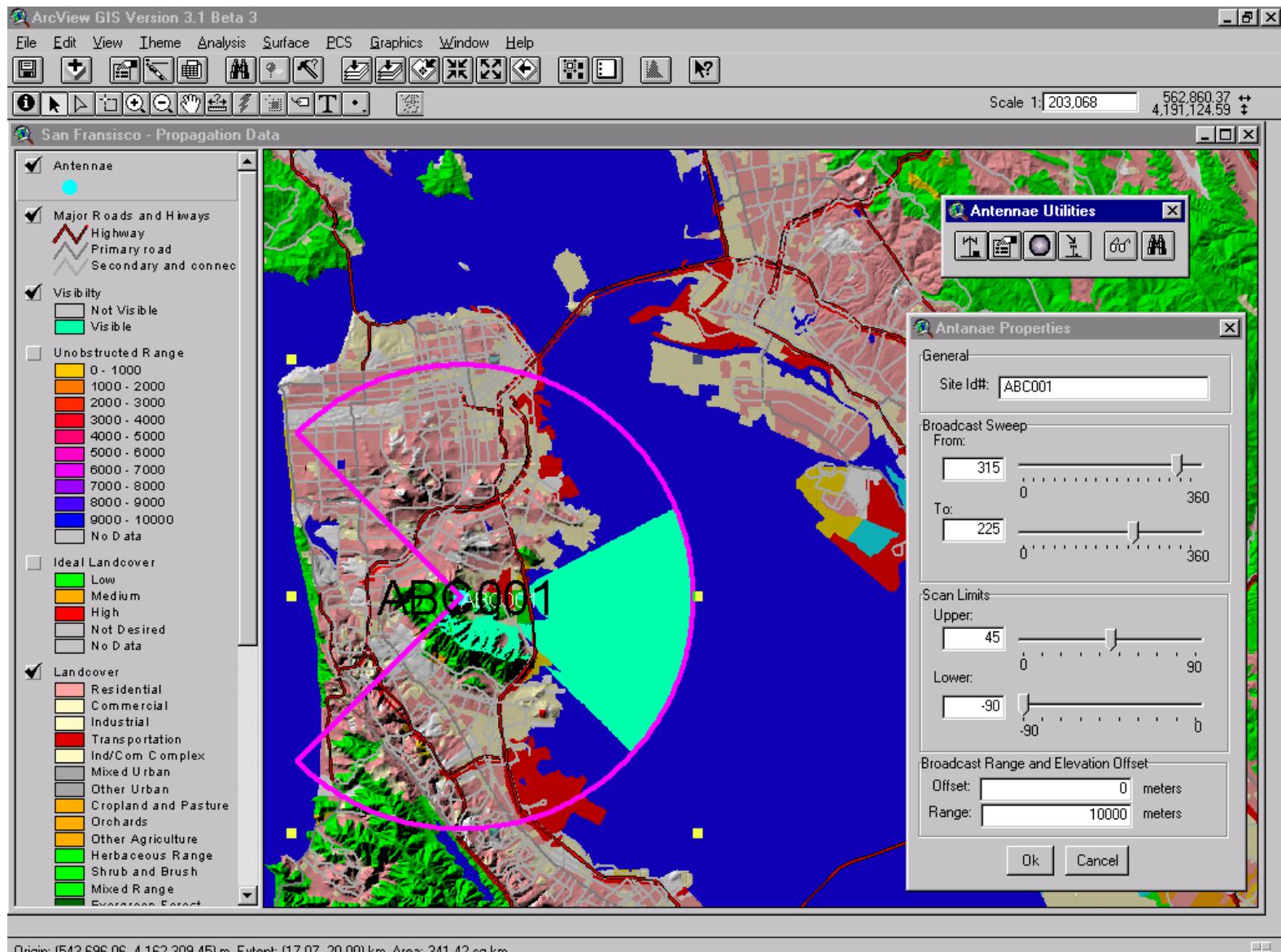


The screenshot displays a GIS interface for analyzing airfield locations in Rwanda. The main map shows the country's borders and internal regions, with various symbols indicating airports, runways, and other geographical features. A specific location in the center is labeled 'KIGALI'. On the right side, a detailed 'Identify Results' window provides specific information about the selected 'Rwandan Airports - KIGALI', including its name, ICAO code, coordinates, and elevation. Below this window is a small image showing a perspective view of a runway from an airplane's cockpit. The left panel contains a 'Key Point Dossiers' list where most items are checked, such as 'Region AOI', 'Rwanda AOI', 'Rwandan Cities', and 'Rwandan Airports'. The top menu bar includes options like File, Edit, View, Theme, Create Cost Surface, Tracking, Analysis, Surface, Graphics, Network, Window, Help, and Military.

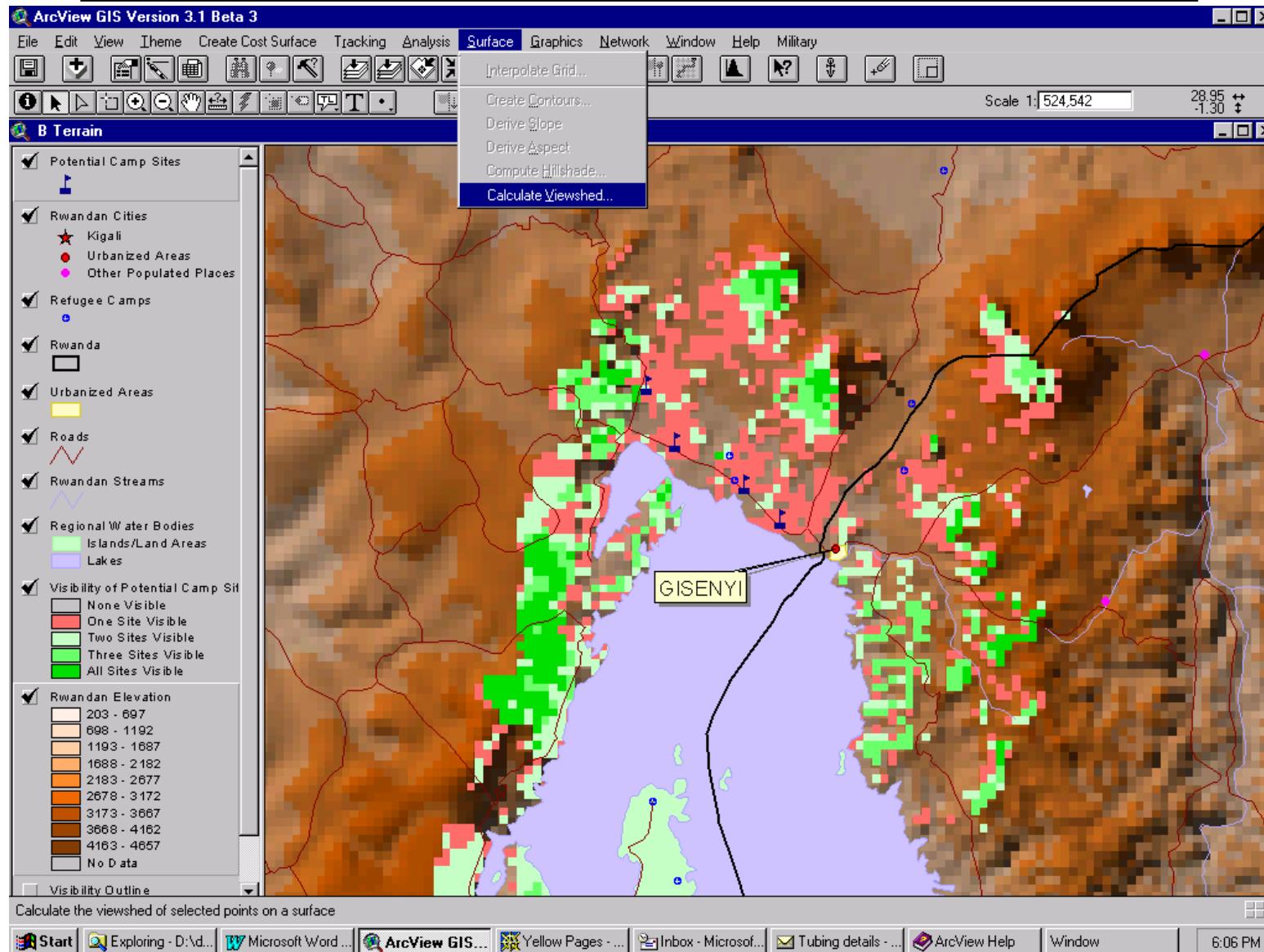
Network Analysis



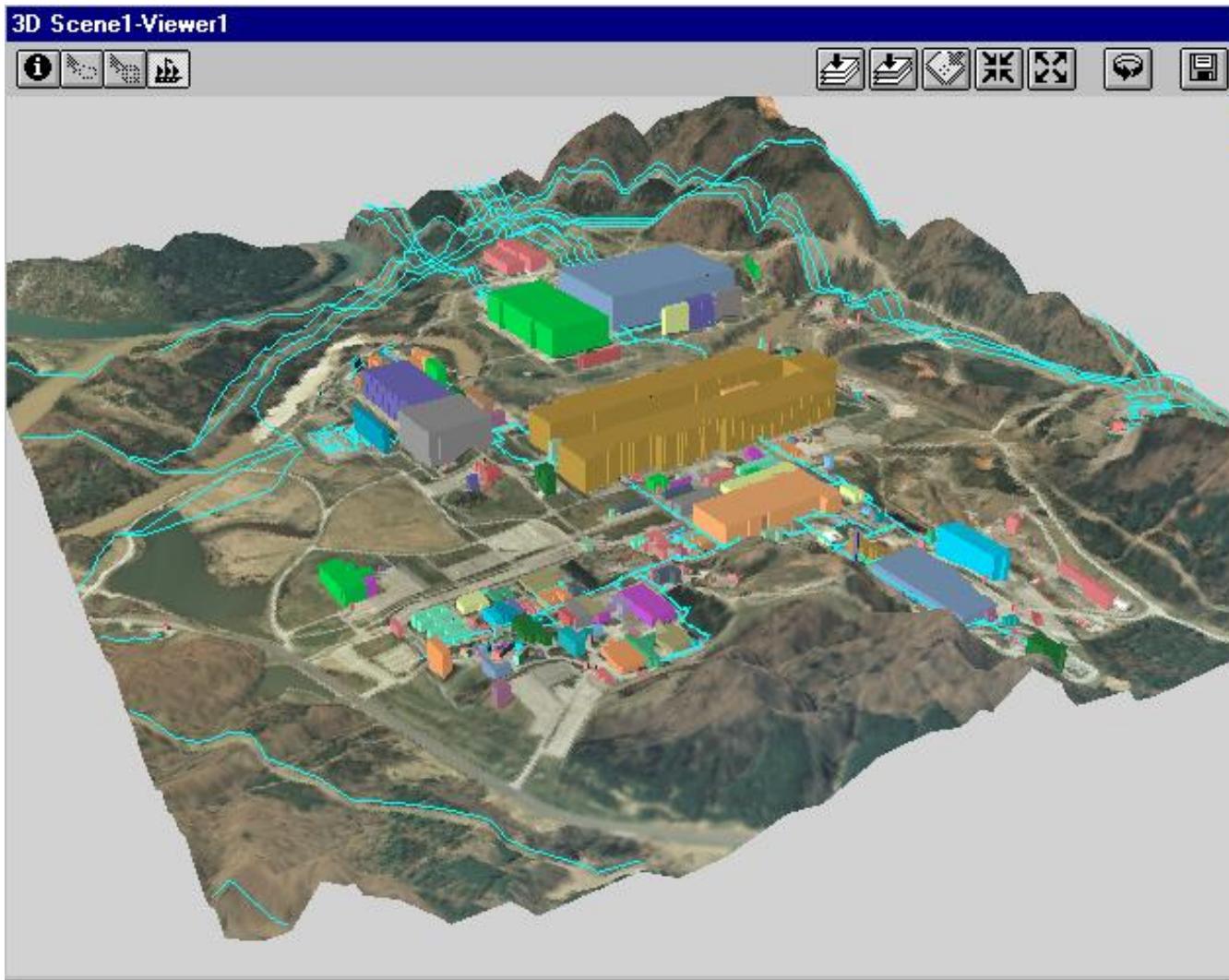
Antenna Propagation Coverages



Observation Post Siting Analysis



Perspective Views



SUMMARY

- ✓ Key Concepts
- ✓ Data representation
- ✓ Applications