Augmenting Geographic Reality

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University of California
Santa Barbara

Geographic information systems

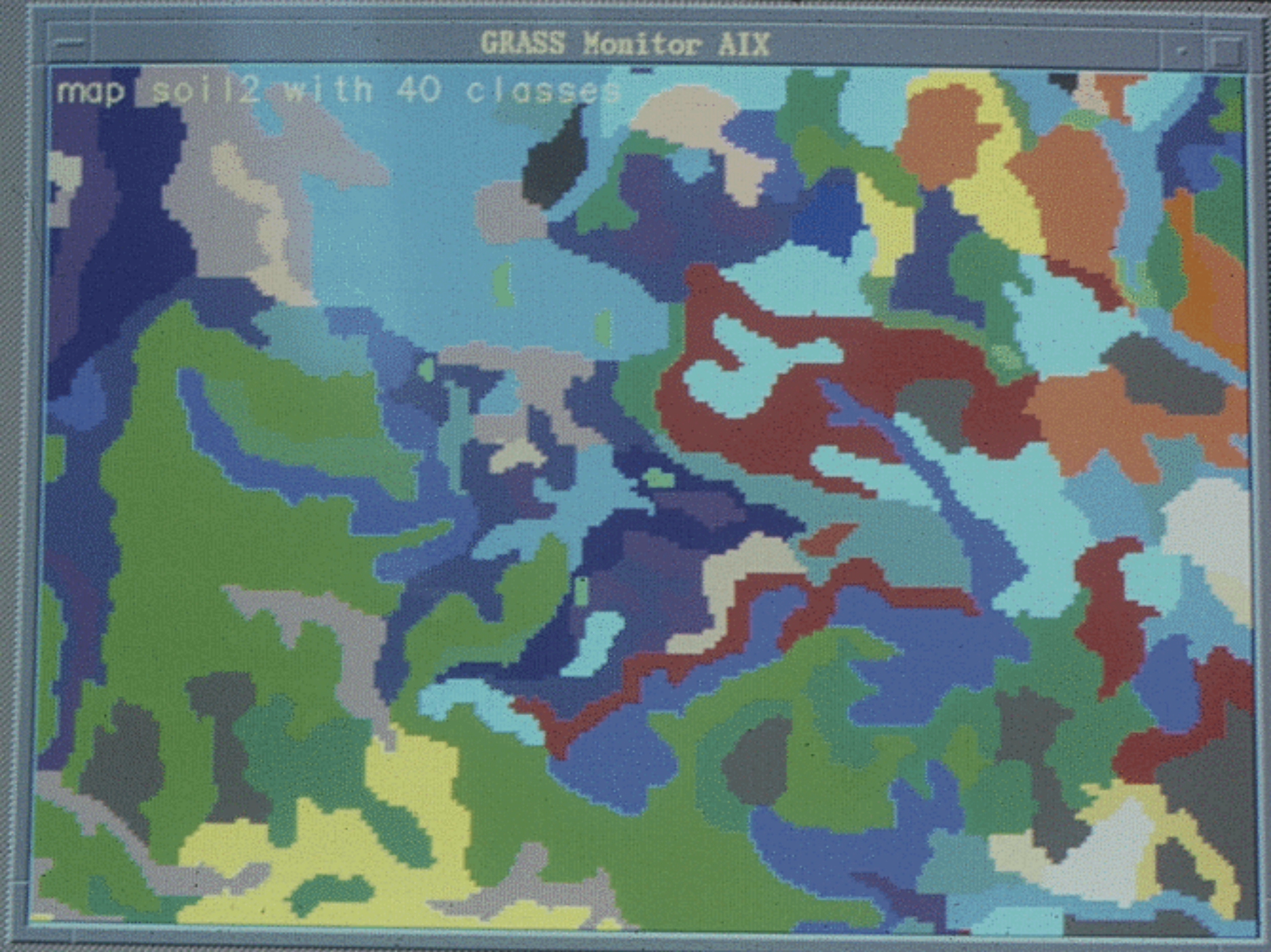
- Systems to acquire, store, transform, analyze, display, share, archive geographic information
- Geographic information
  - information about the specific characteristics of places on or near the Earth's surface
  - <***x***,***z***> where ***x*** is a location in space-time and ***z*** is some set of general properties

Three GIS paradigms

- GIS as assistant
  - performing tasks that are too tedious, complex, inaccurate, or expensive to do by hand
  - pre 1995
- GIS as communicator
  - allowing us to share what we know about the planet's surface
  - replacing earlier media
- GIS as a means for augmenting the senses

Origins of GIS

- The Canada Geographic Information System
  - circa 1965
  - support for the Canada Land Inventory
  - $20 million investment by the Government of Canada
  - justified by accurate cost-benefit analysis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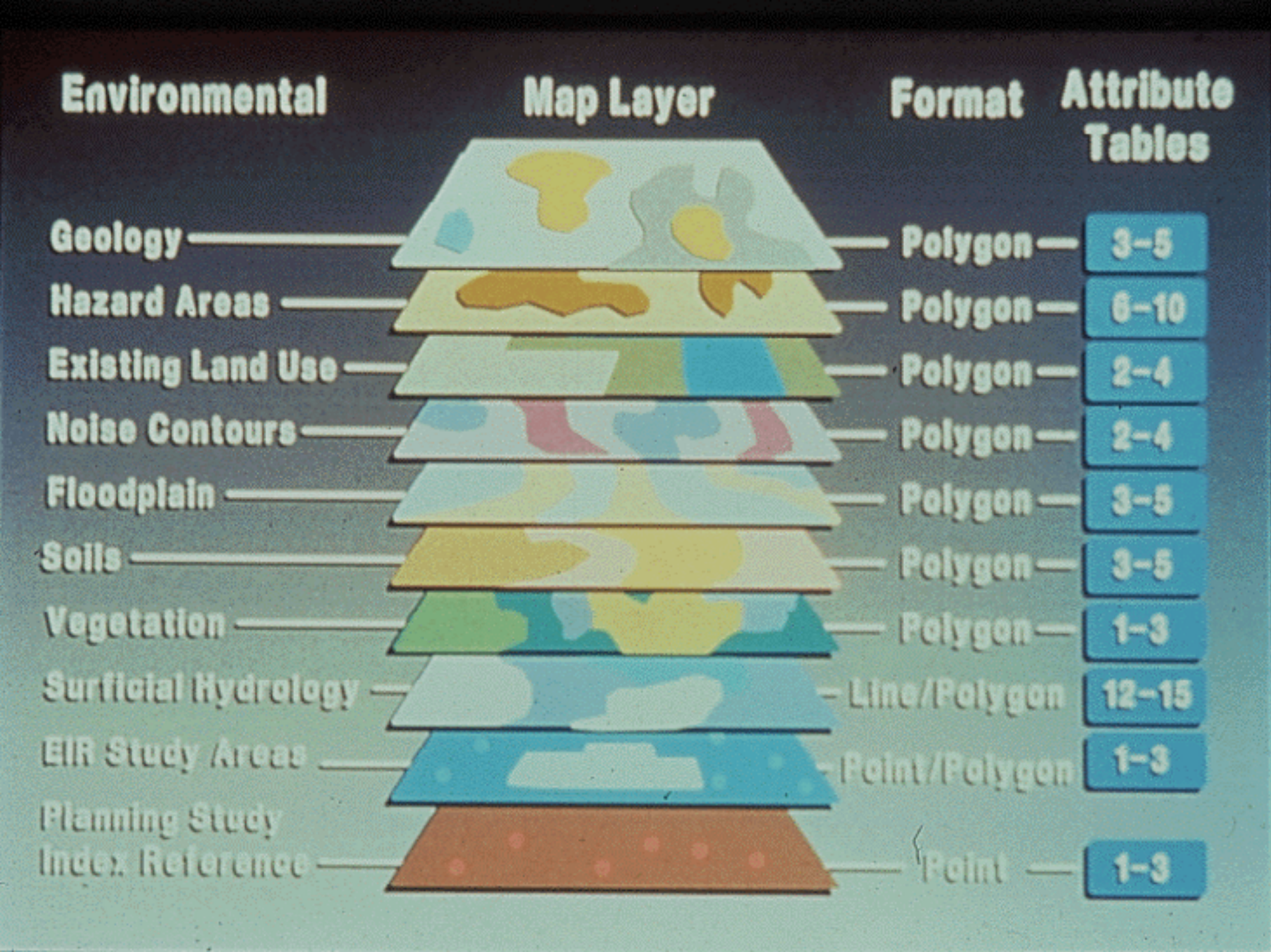
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Surficial Hydrology
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Planning Study Index Reference
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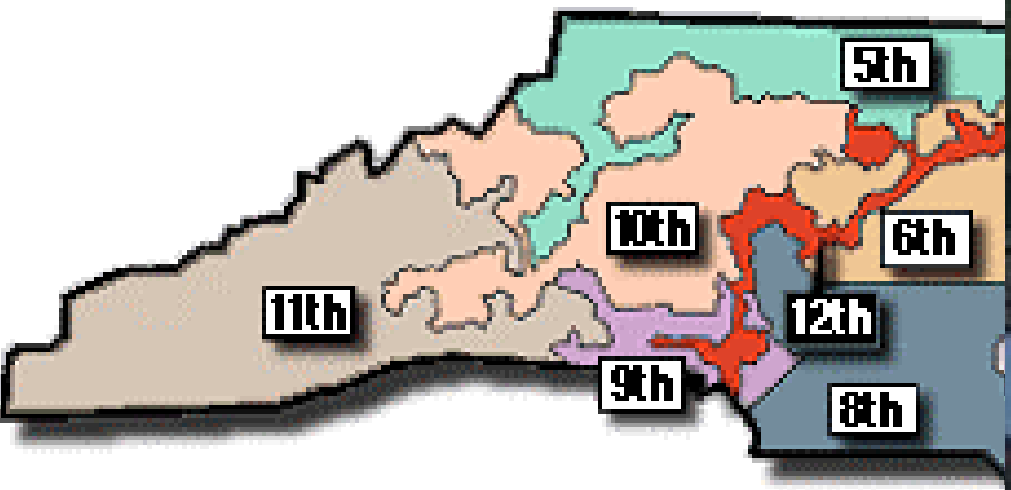
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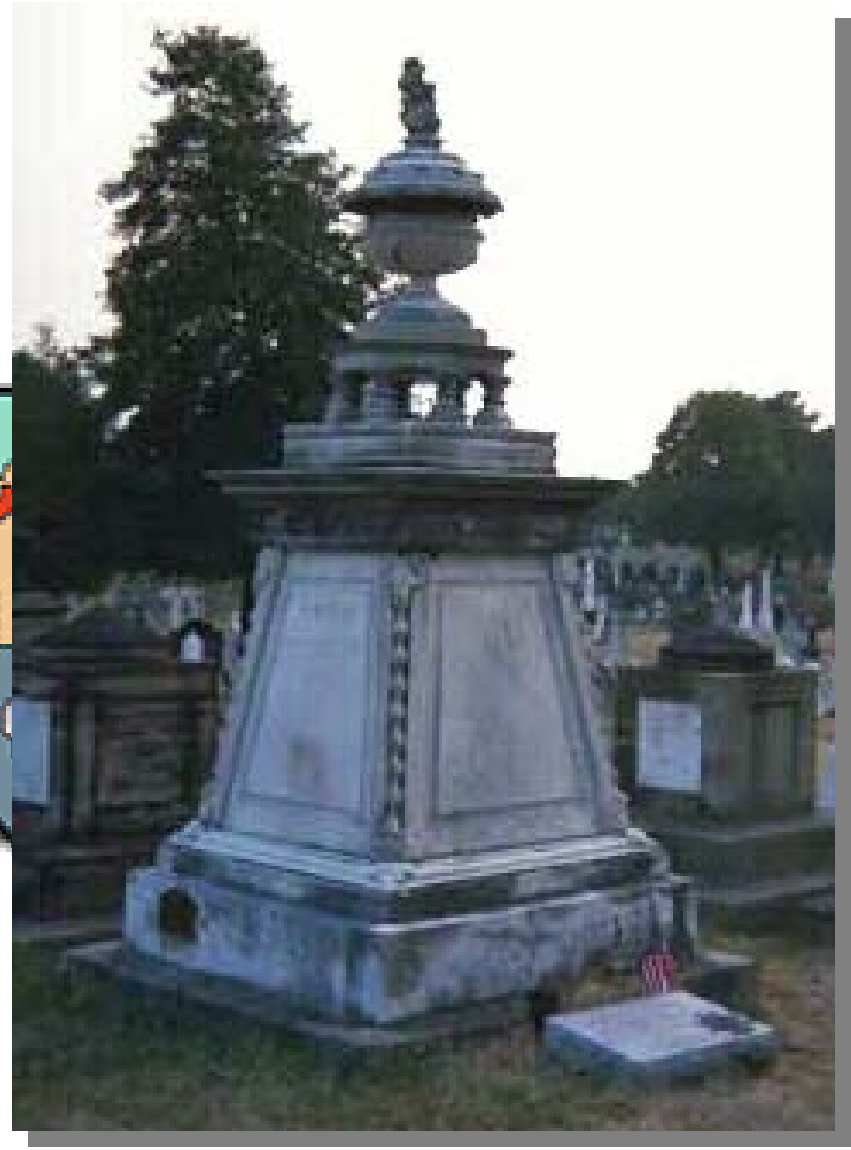

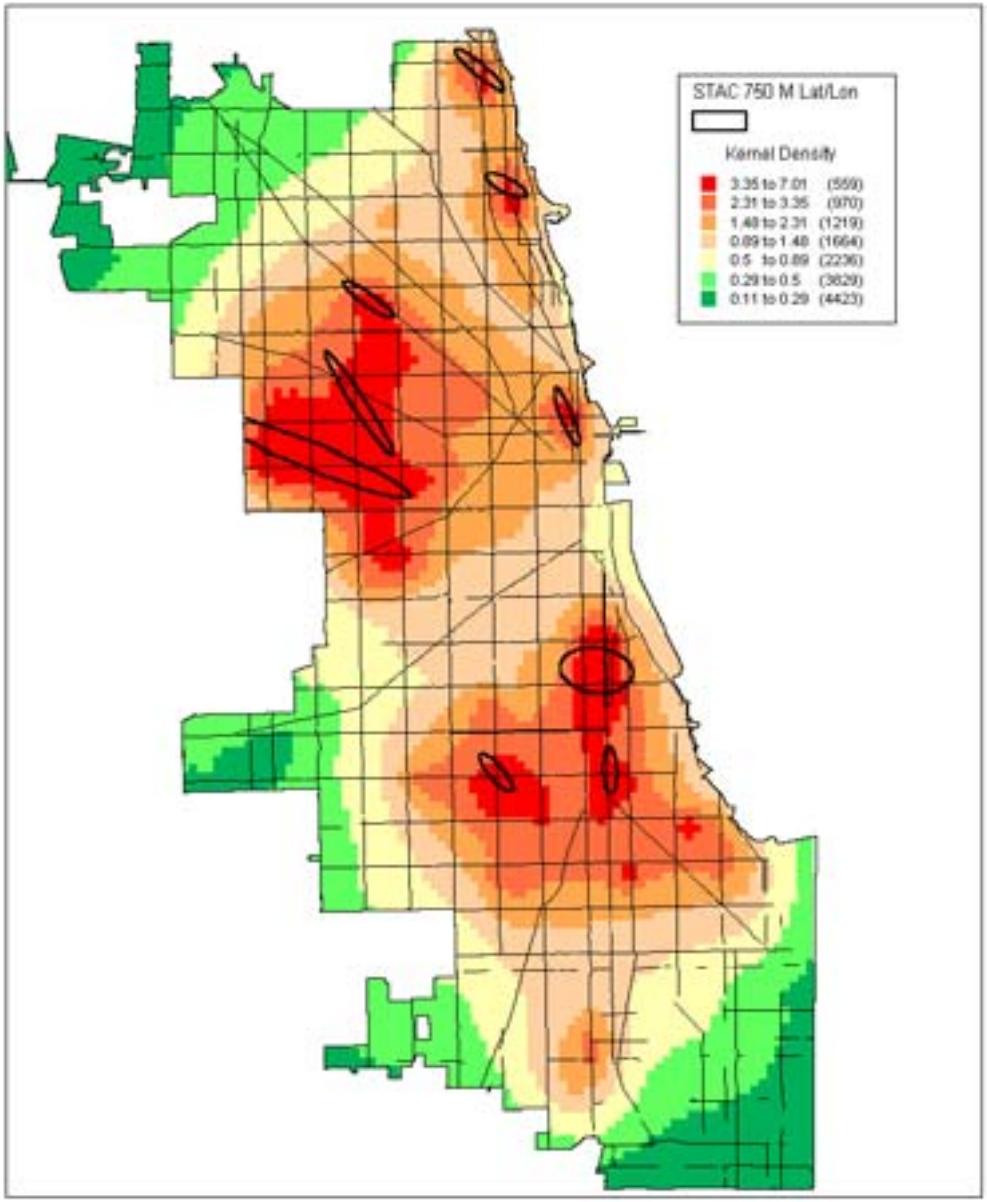

Courtesy of Dick Block

Directions	Distance
1:Start out going East on HENLEY ST towards WARREN ST.	0.1 miles (0.1 km)
2:Turn RIGHT onto WARREN ST.	0.0 miles (0.1 km)
3:Turn RIGHT onto CHELSEA ST.	0.0 miles (0.1 km)
4:CHELSEA ST becomes CHELSEA ST/CITY SQ.	0.1 miles (0.1 km)
5:Turn RIGHT onto CITY SQ/NEW RUTHERFORD AVE/SR-99 N.	0.0 miles (0.1 km)
6:Stay straight to go onto NEW RUTHERFORD AVE/SR-99 N.	0.2 miles (0.3 km)
7:Turn SLIGHT LEFT onto SR-99 N.	0.4 miles (0.6 km)
8:Turn SLIGHT LEFT onto SR-99 N/RUTHERFORD AVE.	0.1 miles (0.1 km)
9:Turn SLIGHT LEFT onto SR-99 N.	0.3 miles (0.4 km)
10:Turn SLIGHT LEFT onto SULLIVAN SQUARE OPAS.	0.4 miles (0.7 km)
11:Turn SLIGHT LEFT onto MYSTIC AVE.	0.7 miles (1.1 km)
12:MYSTIC AVE becomes MYSTIC AVE/SR-38 N.	1.2 miles (2.0 km)
13:Turn LEFT onto HARVARD ST.	0.6 miles (1.0 km)
14:HARVARD ST becomes WARNER ST.	0.2 miles (0.3 km)
15:Turn RIGHT onto POWDER HOUSE SQ.	0.1 miles (0.1 km)
16:Turn RIGHT onto BROADWAY.	1.0 miles (1.6 km)
17:Turn LEFT onto ALEWIFE BROOK PKWY/SR-16.	0.4 miles (0.7 km)
18:ALEWIFE BROOK PKWY/SR-16 becomes ALEWIFE BROOK PKWY/SR-16/US-3.	0.4 miles (0.7 km)
19:Take CONCORD TURNPIKE/SR-2 W.	4.7 miles (7.6 km)
20:Take the WALTHAM ST. exit, exit number 54B, towards LEXINGTON.	0.2 miles (0.3 km)
21:Merge onto WALTHAM ST.	1.9 miles (3.0 km)
22:Turn RIGHT onto MASSACHUSETTS AVE/MASS AVE/SR-225.	0.0 miles (0.0 km)
Total Distance:	12.9 miles (20.8 km)
Estimated Time:	24 minutes

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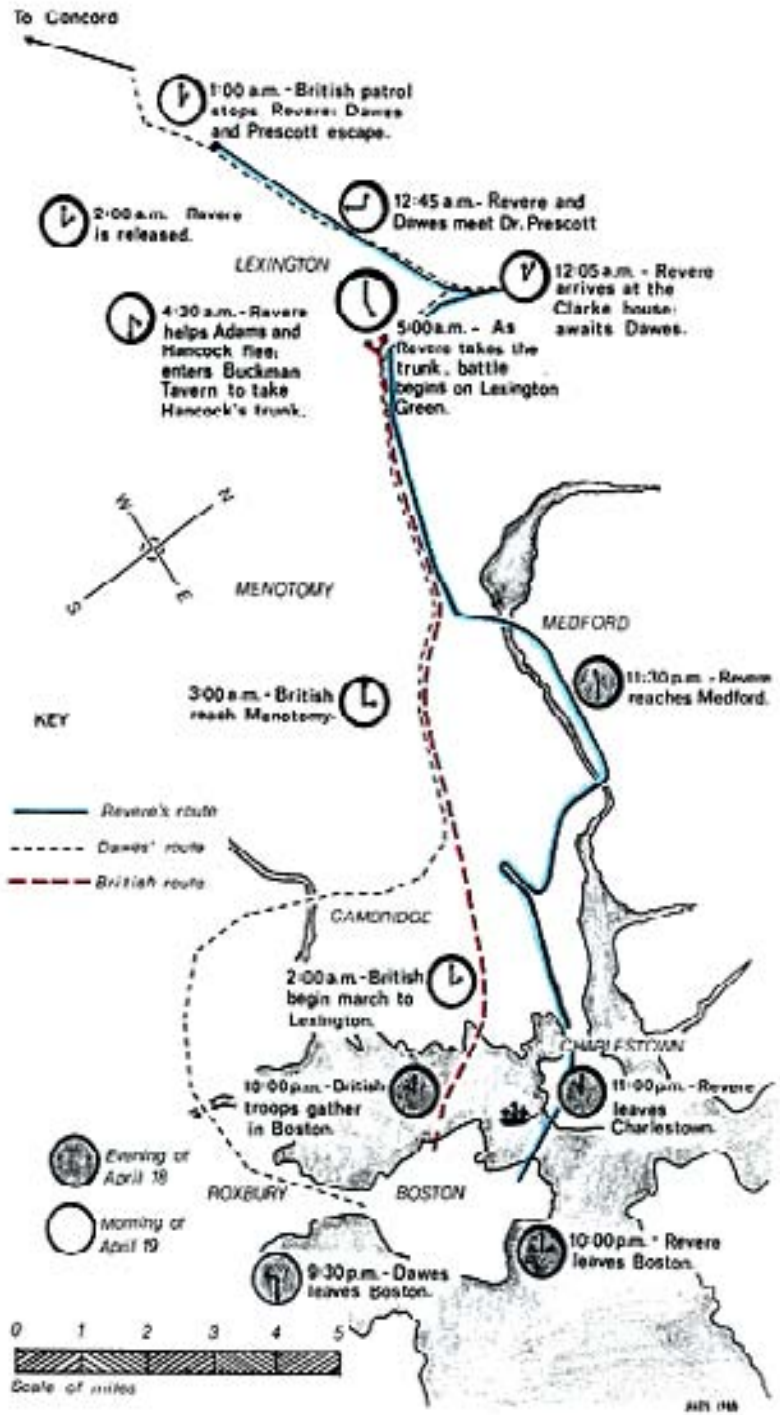


PASS

File View Tools Window Help

List View

WorkCtr | Location | Visit | M067124

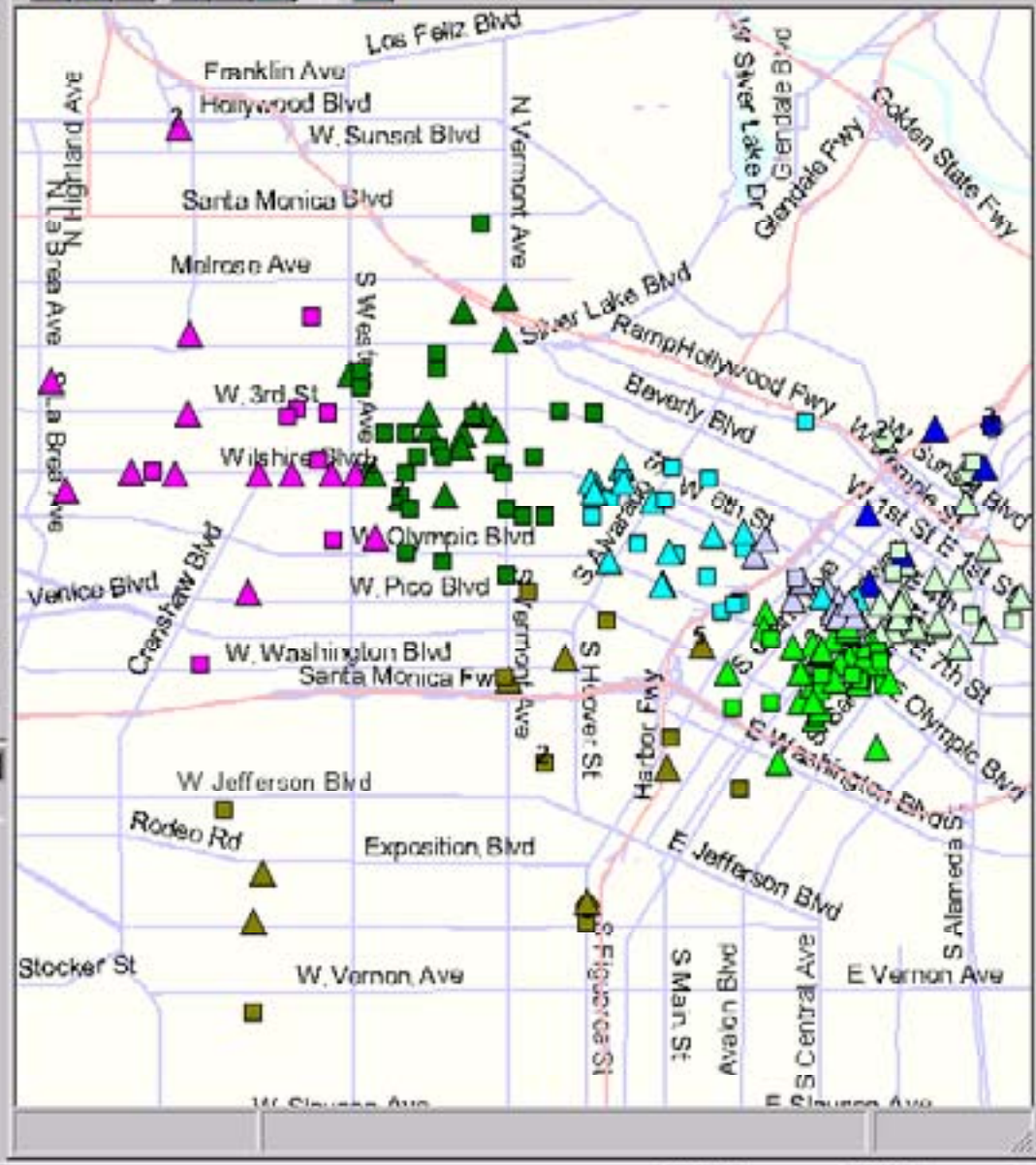
Name	Address	Units	Hrs/Mth	M	Type
1130 VERMONT	1130 VERMONT S	1	0.9	7	HY
625 NEW HAMPSHIRE	625 NEW HAMPSHII	1	0.9	2	HY
3611 WILSHIRE	3611 WILSHIRE BLV	1	0.6	6	HY
114 OXFORD	114 OXFORD S	1	0.8	3	HY
3099 OLYMPIC CAL KOREA B	3099 OLYMPIC BLVI	1	0.9	5	HY
542 MARIPOSA GORDON CHI	542 MARIPOSA S	1	0.8	5	HY
140 MARIPOSA AVE	140 MARIPOSA AVE	1	0.9	9	HY
209 MARIPOSA S	209 MARIPOSA S	1	0.8	5	HY
2930 FRANCIS	2930 FRANCIS	1	0.9	4	HY
248 OCCIDENTAL	248 OCCIDENTAL	1	0.9	3	HY
601 WESTMORELAND	601 WESTMORELAI	1	0.7	4	HY
303 COMMONWEALTH	303 COMMONWEAL	1	0.9	9	HY
2830 FRANCIS	2830 FRANCIS	1	0.9	7	HY
187 OXFORD OXFORD VILLA	187 OXFORD	1	0.9	8	HY
601 ARDMORE PUBLIC COUI	601 ARDMORE AVE	1	0.7	5	HY
3535 SIXTH ST.	3535 W SIXTH	1	0.7	5	HY
1052 MARIPUSA AVE	1052 S MARIPUSA	1	1.0	0	HY
128 MARIPOSA AV S	128 MARIPOSA AV S	1	0.8	4	HY
449 KINGSLEY BLDG	449 KINGSLEY DRIV	2	1.9	2	HY
445 HOBART	445 HOBART	2	1.8	6	HY
350 CATALINA BLDG	350 CATALINA STRE	1	0.9	6	HY
3500 EIGHTH STREET BLDG	3500 EIGHTH STRE	1	0.9	5	HY
3020 WILSHIRE BLDG	3020 WILSHIRE BLV	2	0.0	0	HY

Chart

Chart All | Dollars | Units | Hours | C1

Map

Show selected only



9/12/99 10:39 PM

Spatial analysis

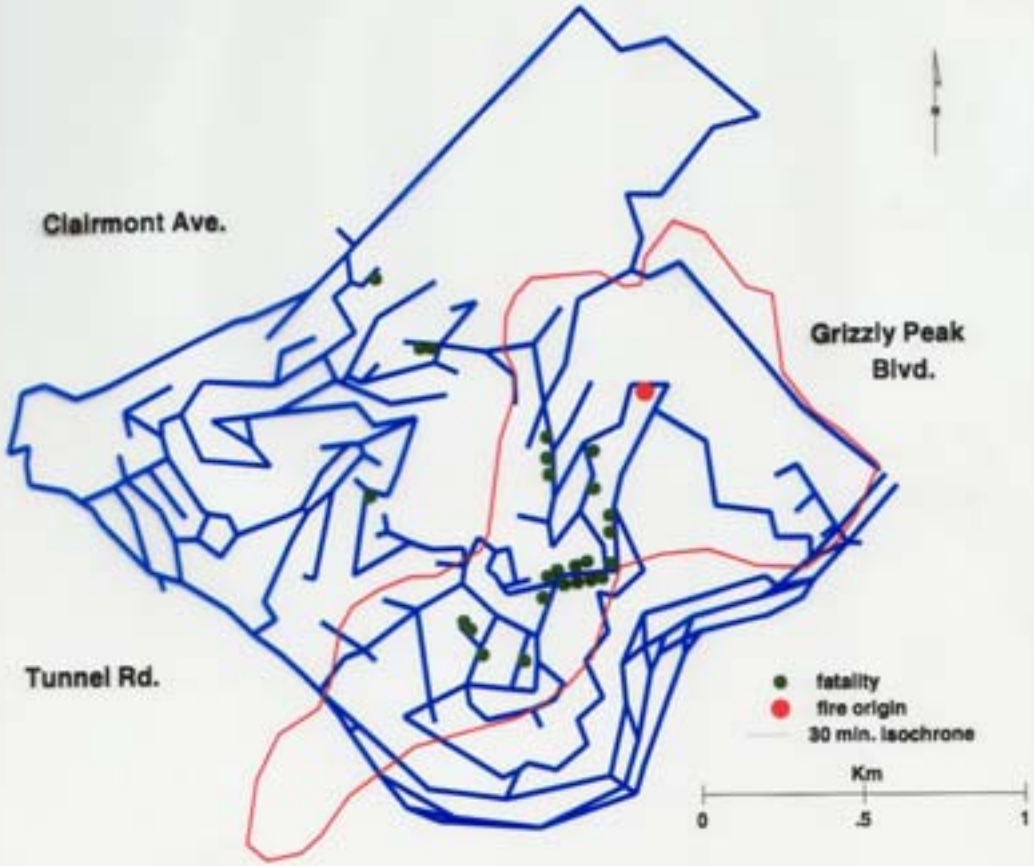
- Supported by GIS as statistical analysis is supported by statistical packages, writing by word processors
- Mining data for patterns or anomalies
- Revealing what is not obvious to the observer

Spatial modeling

- Applying simple rules to systems that emulate transformations resulting from natural or social processes
- Supporting the evaluation of scenarios, plans, alternative actions


Oakland Tribune
GONE
Tragic four
Grim pilgrimage
for hill dwellers
Toll rises to 21;
37 are listed
as still missing

Oakland Fire Fatalities and 30 Minute Fire Isochrone



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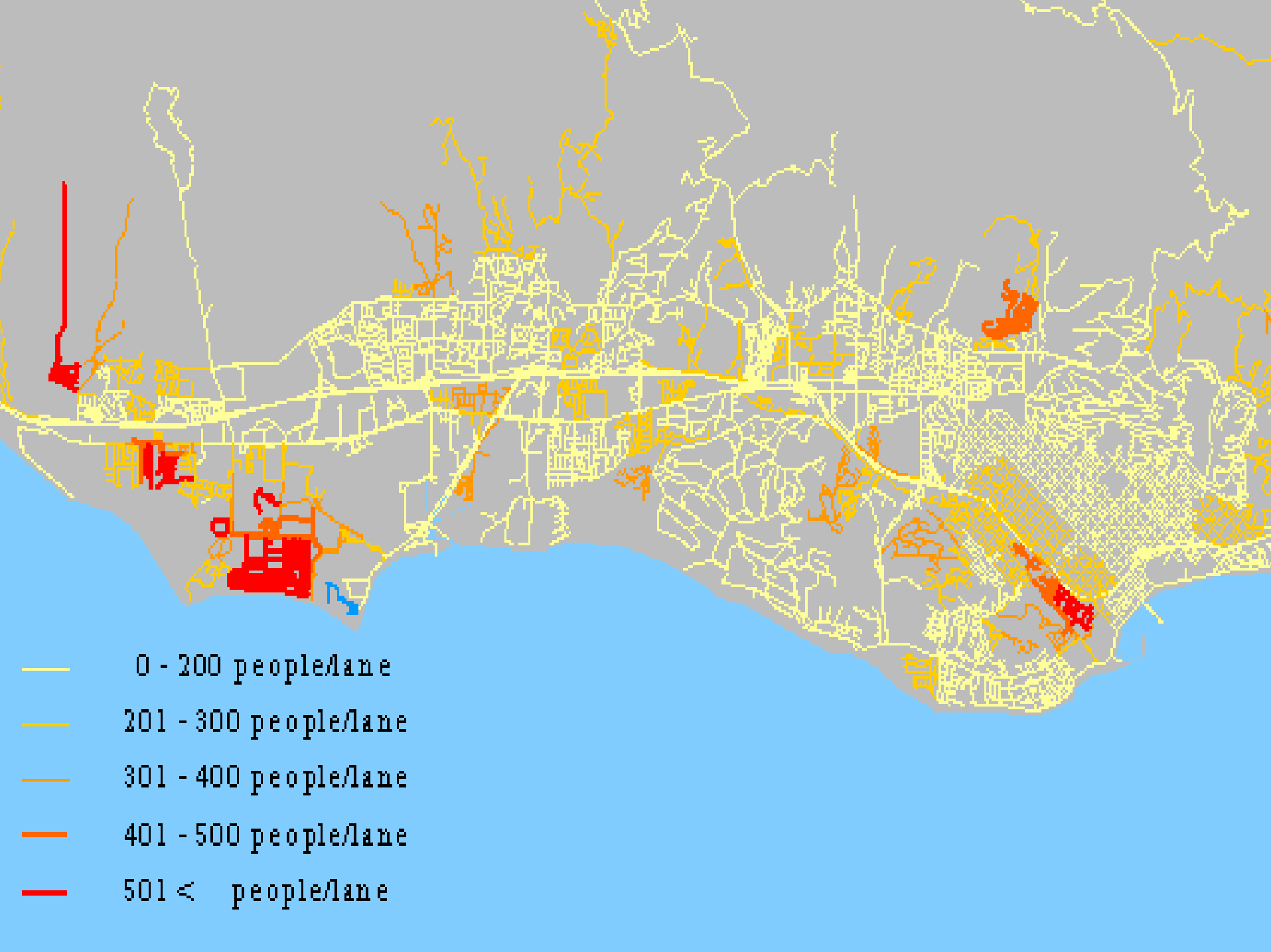
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501 < people/lane


0 - 200 people/lane
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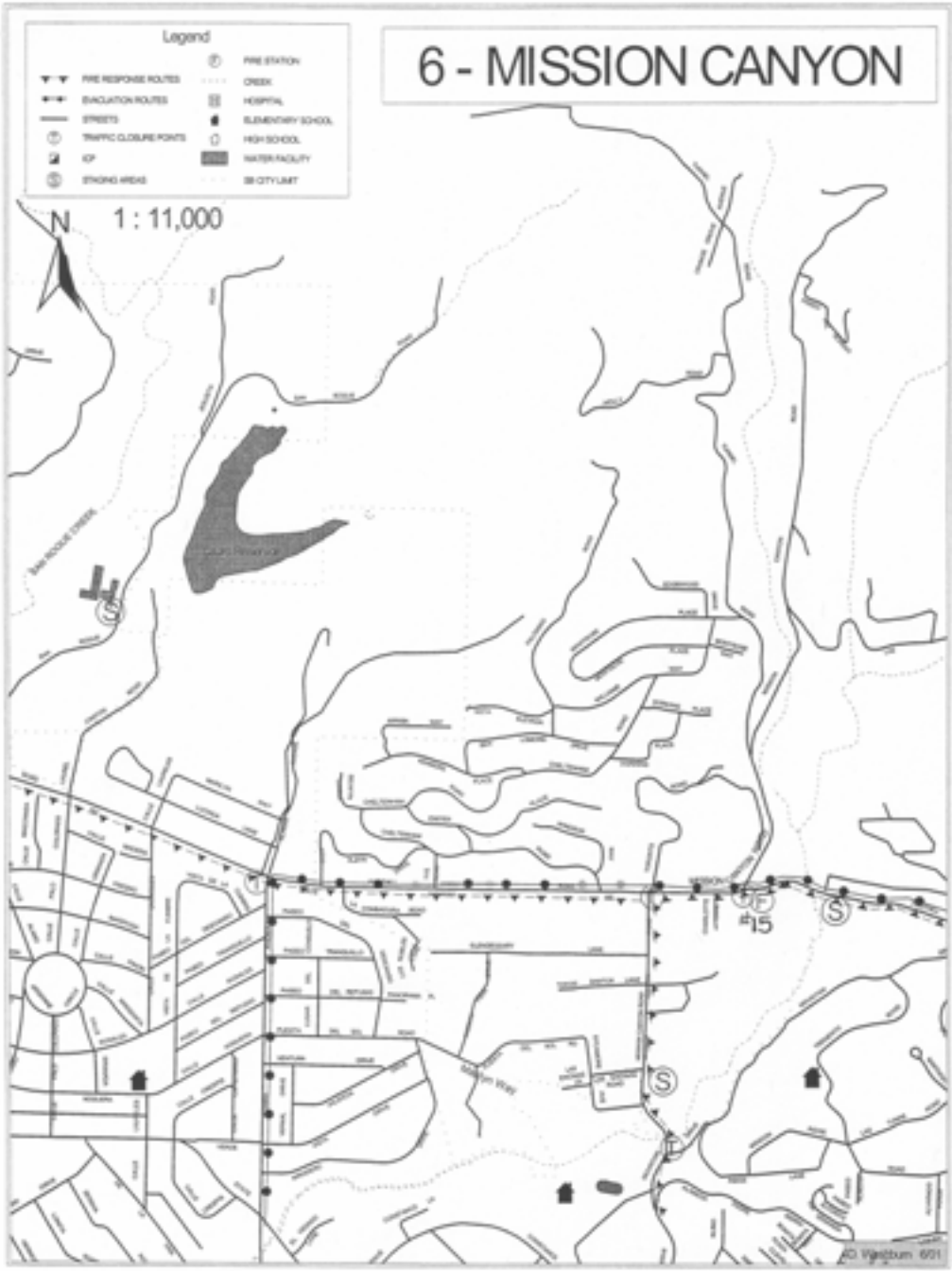
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FIRE RESPONSE ROUTES
EVACUATION ROUTES
STREETS
TRAFFIC CLOSURE POINTS
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STAGING AREAS
FIRE STATION
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HOSPITAL
ELEMENTARY SCHOOL
HIGH SCHOOL
WATER FACILITY
SB CITY LIMIT
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Simulations

- 1.8 vehicles per driveway
- Driver behavior influenced by:
  - lane width
  - slope
  - view distances
  - traffic control mechanisms
  - information feedback
  - driver aggressiveness
- 770 homes
  - clearing times > 30 minutes

2D clip

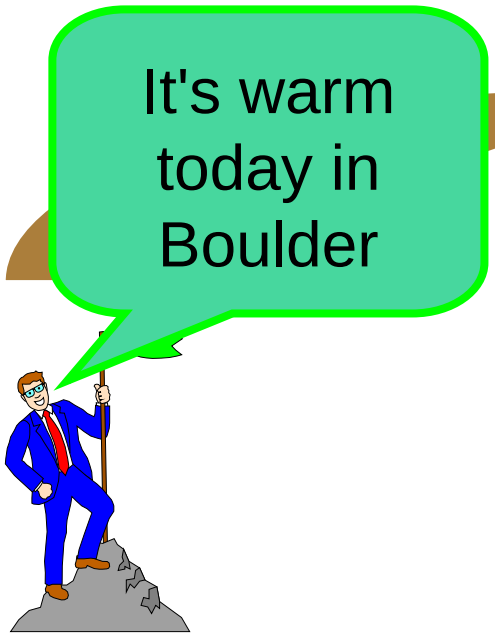
3D clip

The impact of the Internet

- Communication of geographic knowledge as the new purpose
  - sharing what we know
  - geographic information as a public good
  - spatial analysis as added value, manipulation of the message
  - spatial data archives and clearinghouses, the National Spatial Data Infrastructure

Fundamental parameters of the communication paradigm

- Technical
  - bandwidth, speed, access, reliability
  - interoperability, semantics, understanding
- Media and formal structures
  - visual, auditory, tactile
  - speech, text, imagery, maps, tables…
  - facilitating or imposing



Spoken word

Text

Picture

x, *y*, *T*

Interoperability

- Common understanding of meaning
  - semantics over syntax
  - ***x*** is more commonly understood than ***z***

Dear Waldo

View of the Outer Banks of North Carolina from Apollo 9

This photograph was taken on March 12, 1969 at 4 10:00 a.m. EST, from an altitude of about 120 miles.

Posted at the old seafaring village of Hatteras, I know this card, with its complete and accurate address will get to you.

A pinhole shows you where we are—

Yours Geographically

B

El zabeth City News Co. Elizabeth City, North Carolina

Plastichrome®

PRINTED IN IRELAND

POST CARD

Professor Waldo Tobler

34° 26' 41" N

119° 48' 26" W

EXANDRIA DIGITAL LIBRARY

CDL CALIFORNIA DIGITAL LIBRARY

ADL HOME · CDL HOME · HELP

NICK PLACENAME SEARCH

earch the entire world for...

Find

er "Rome" if you want Rome, Italy.
e information

NERAL SEARCH

Select collection to search

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Set geographic region

the map to the right to set the geographic
ent of the search, or directly enter bounding
rdinates below.

N 34.43

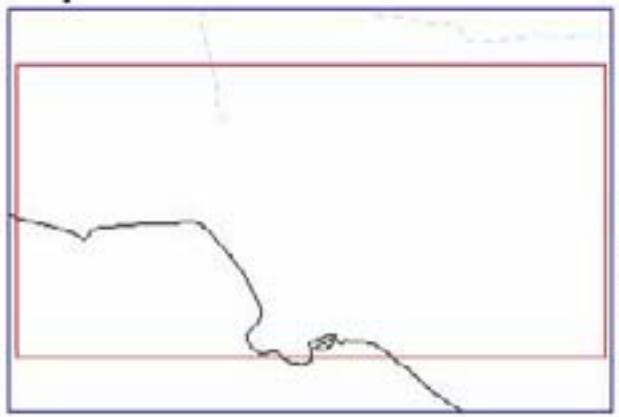
W -118.97 -117.57 E

33.73 S

Words to search for

Any of the above words
All of the above words
Exact phrase

Map Browser



Click map to:

Recenter & Zoom in

Change location to:

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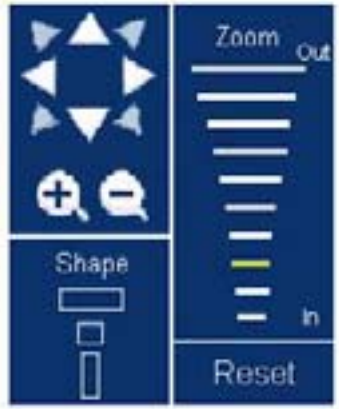


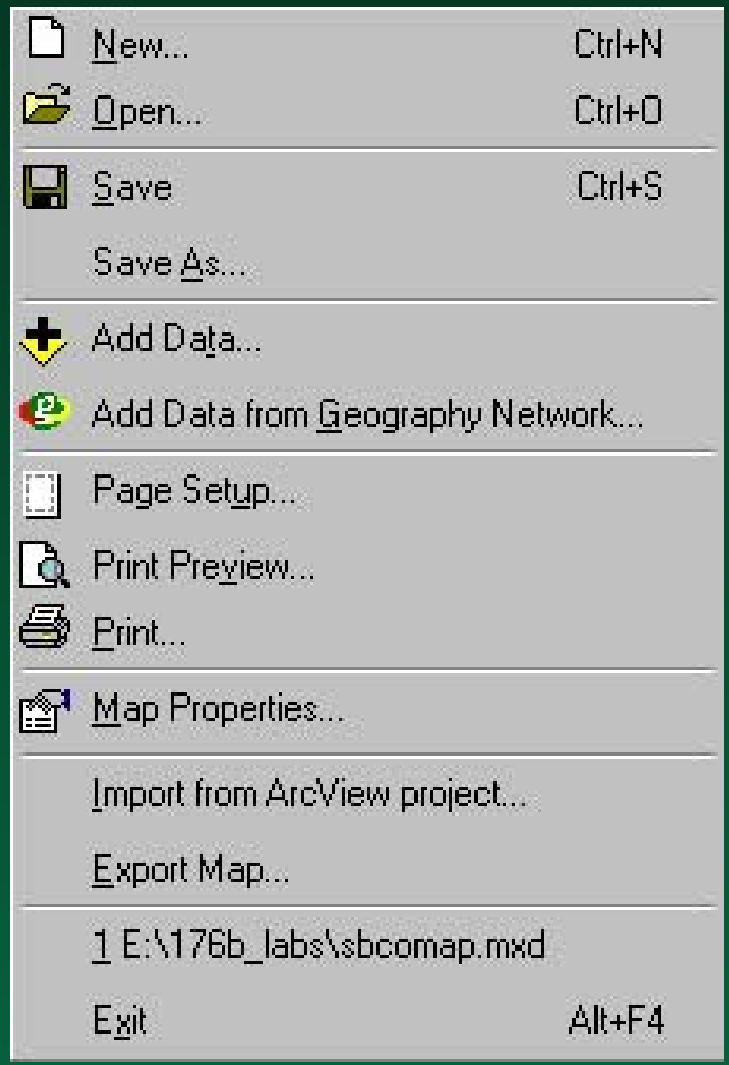
ADL Search Results

The query that produced these results can be found at the bottom of this page.

1. **DRG o33117g6, Digital Raster Graphic of BLACK STAR CANYON, CA.**
   Type: maps. **Format:** TIFF. **Date:** 1988. **ADL identifier:** adl_catalog:800279.
   HIGHLIGHT IN MAP · COMPLETE DESCRIPTION · BROWSE GRAPHIC · ACCESS/DOWNLOAD

2. **DRG o33117g7, Digital Raster Graphic of ORANGE, CA.**
   Type: maps. **Format:** TIFF. **Date:** 1981. **ADL identifier:** adl_catalog:800280.
   HIGHLIGHT IN MAP · COMPLETE DESCRIPTION · BROWSE GRAPHIC · ACCESS/DOWNLOAD

3. **DRG o33117g8, Digital Raster Graphic of ANAHEIM, CA.**
   Type: maps. **Format:** TIFF. **Date:** 1981. **ADL identifier:** adl_catalog:800281.
   HIGHLIGHT IN MAP · COMPLETE DESCRIPTION · BROWSE GRAPHIC · ACCESS/DOWNLOAD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Exit Alt+F4

geography network

ACCESS A WORLD OF INFORMATION

ABOUT

MAPS

DATA

GEOSERVICES

SOLUTIONS

COMMUNITY

Geography Network Explorer

Free Resources

Be a Publisher

Challenge

SEARCH & VIEW

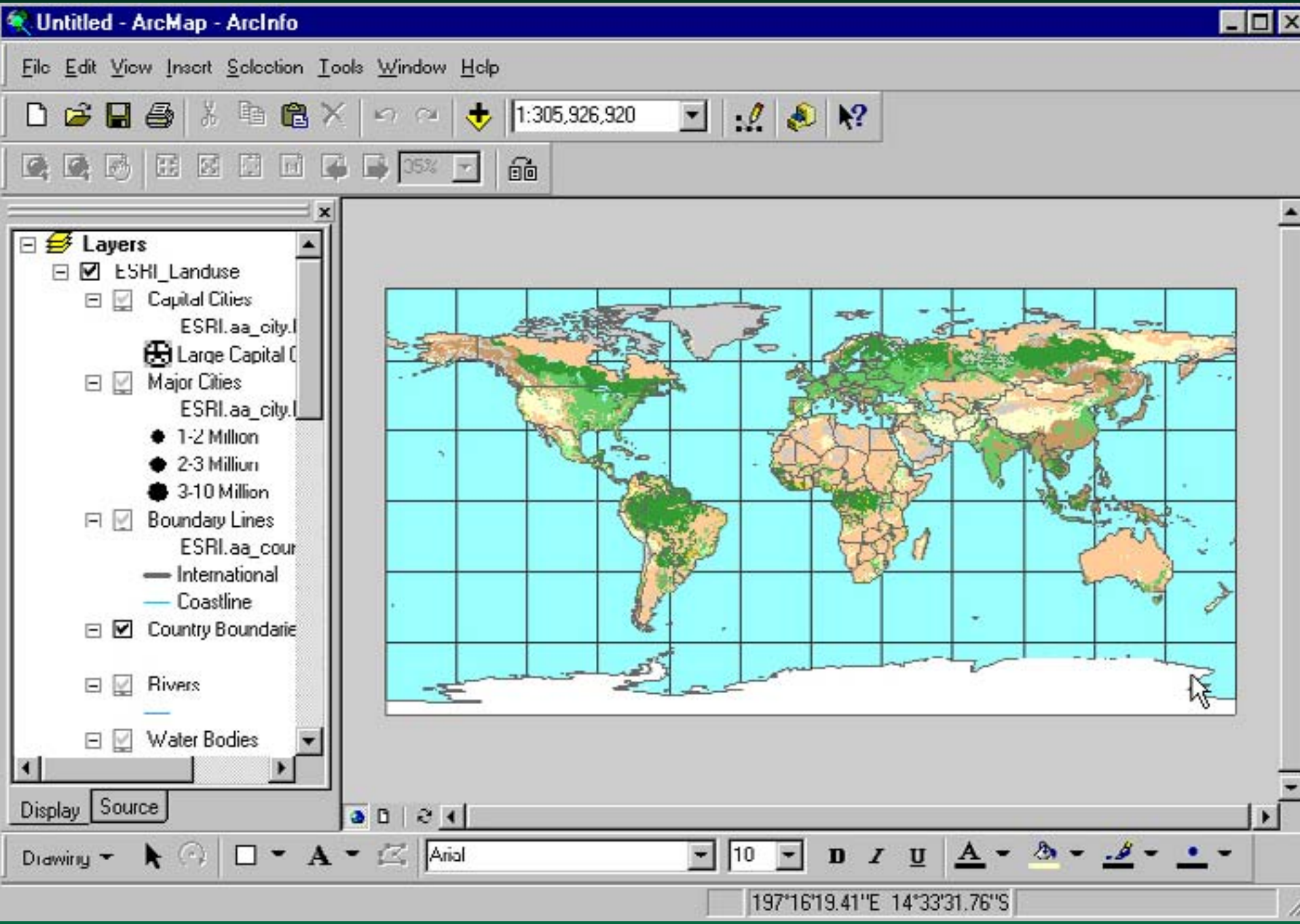
use the **Geography Network Explorer** to search and view maps and other geographic content over the Internet

The Geography Network is a global community of data providers who are committed to making geographic content available. This content is published from many sites around the world, providing you immediate access to the latest maps, data, and related services. This portal to the Geography Network enables you to discover this content and share your own.

Featured Content

U.S. Census TIGER 2000

- View Live Maps
- Download Data Sets
- Build Custom Apps
- Publish Your Content
- Find Useful Tools
- Share Your Ideas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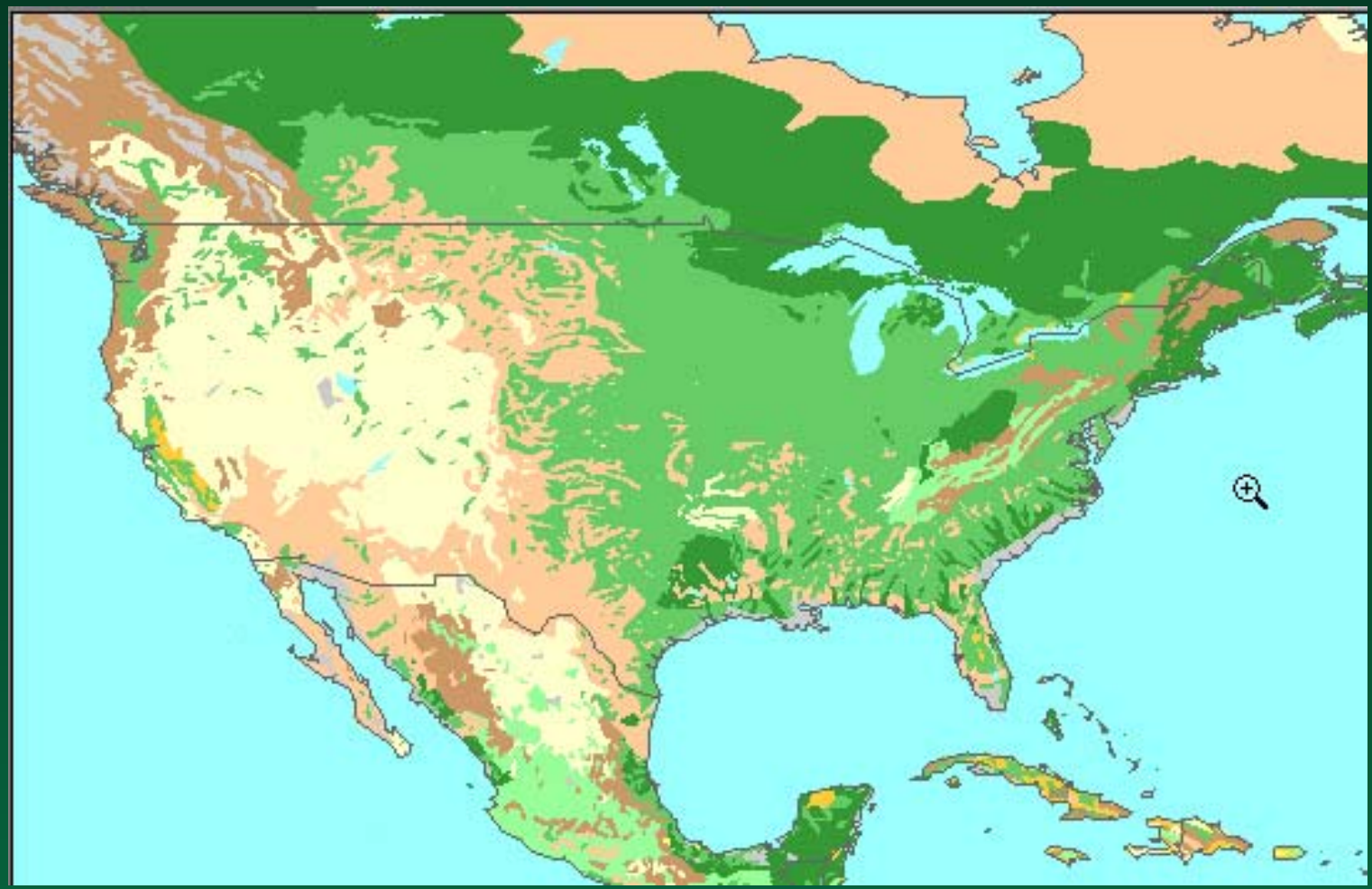

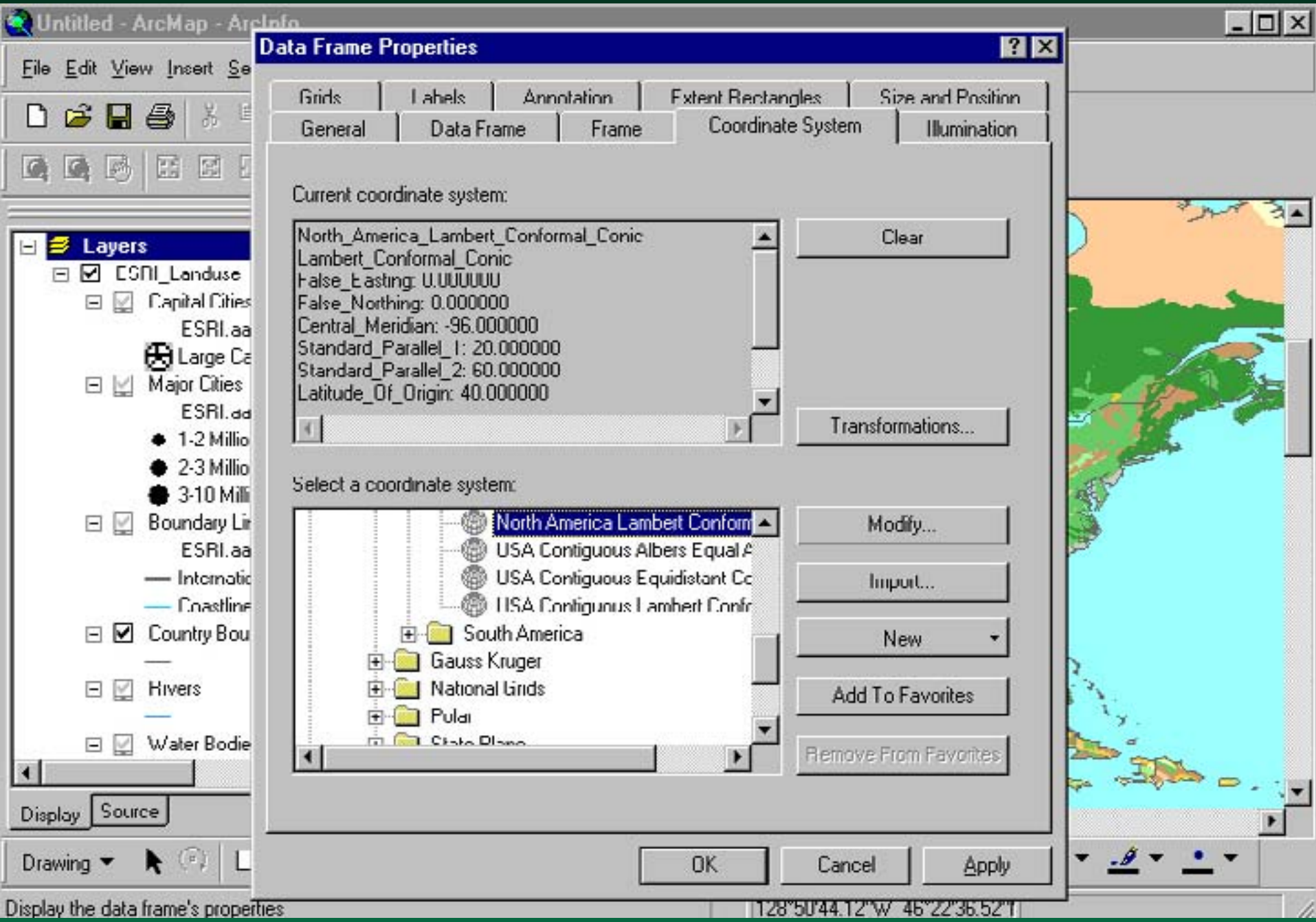
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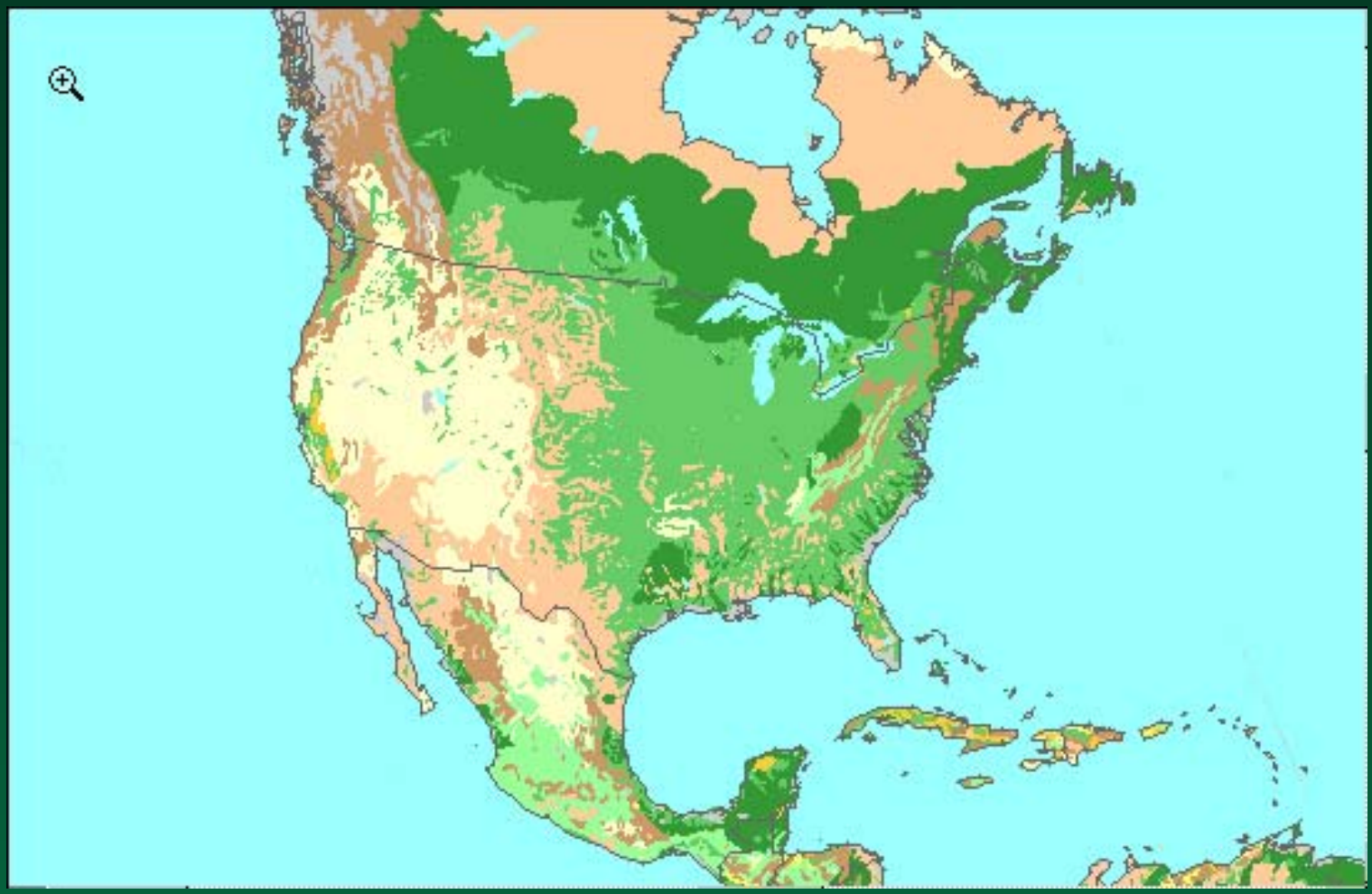

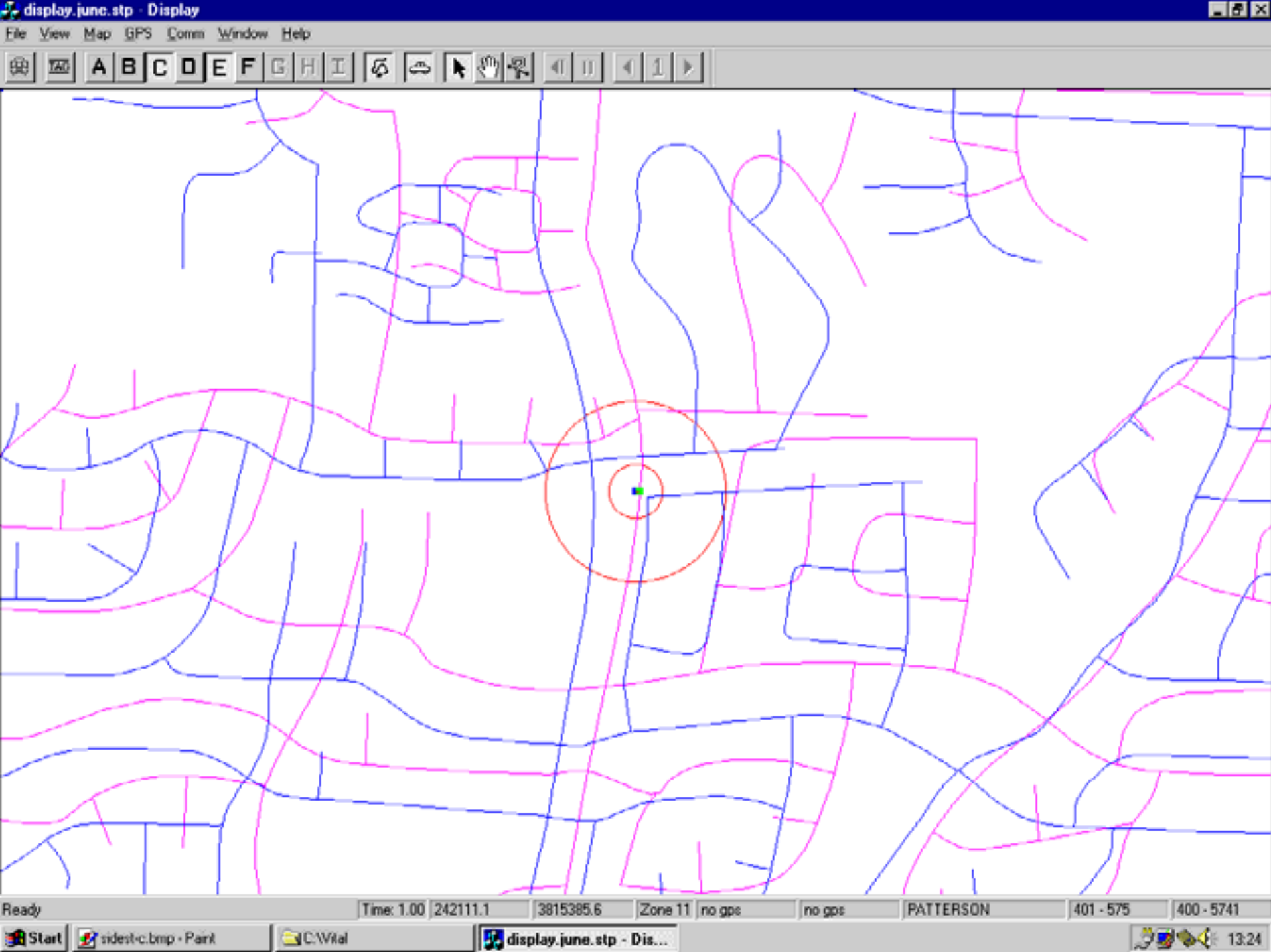
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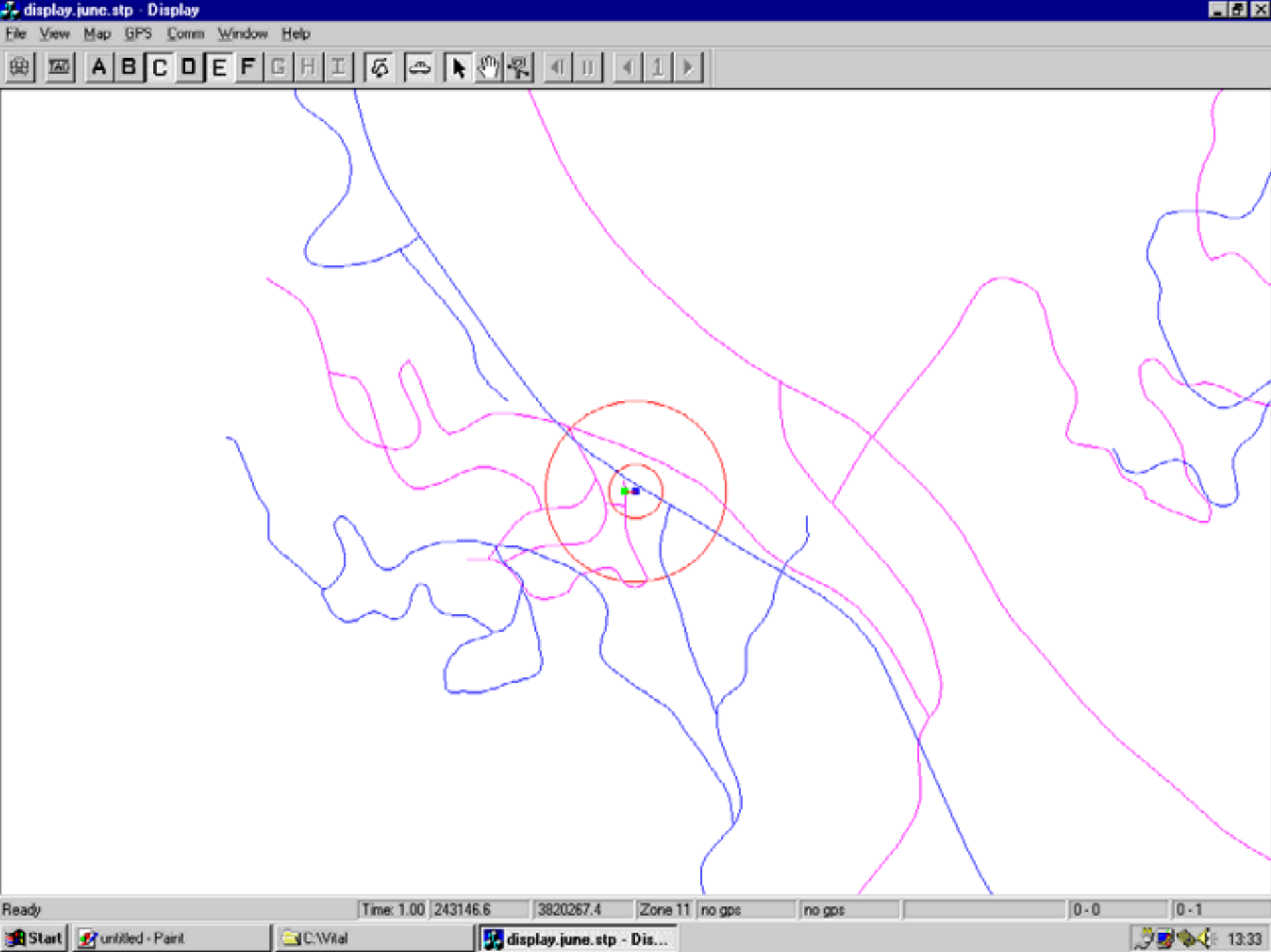
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GIS as virtual reality

- The geographer at the office desk
- The GIS database as a replacement for reality
  - the world expressed in 0s and 1s
  - the uncertainty problem: what is missing?
- Digital Earth

“Imagine, for example, a young child going to a Digital Earth exhibit at a local museum. After donning a head-mounted display, she sees Earth as it appears from space. Using a data glove, she zooms in, using higher and higher levels of resolution, to see continents, then regions, countries, cities, and finally individual houses, trees, and other natural and man-made objects. Having found an area of the planet she is interested in exploring, she takes the equivalent of a ‘magic carpet ride’ through a 3-D visualization of the terrain.”

An instance of a class

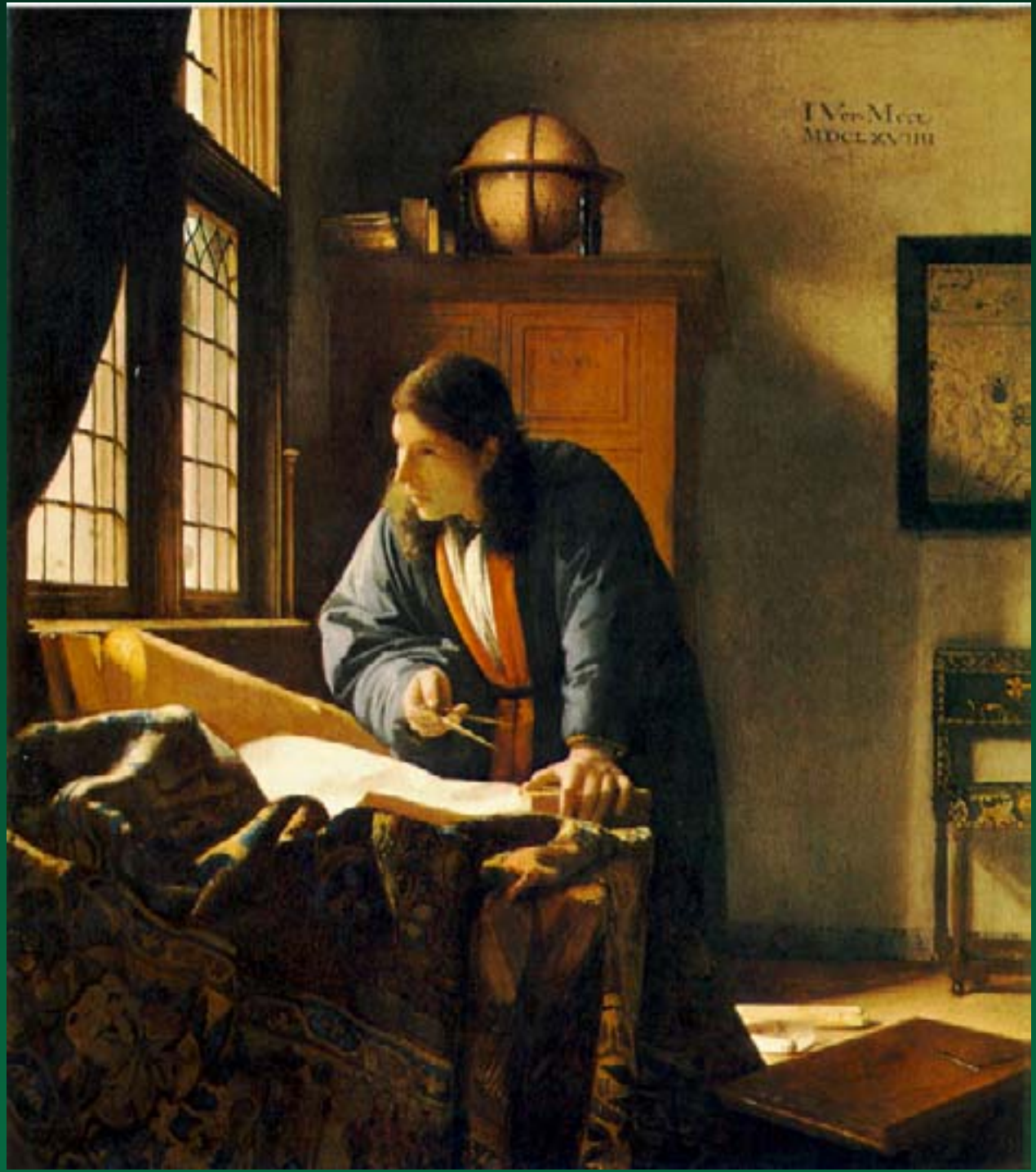
- Digital Earth
- Virtual Human
- Digital Cosmos
- Virtual Los Angeles
- Human Genome
- *Digital x*

Characteristics of digital *x*

- A large and complex real-world system distributed within a spatio-temporal frame
- A comprehensive data model providing the framework for description and representation of the real-world system
- Diverse sources of information that are integrated through the common data model
- A distributed architecture, allowing parts of the representation to be stored separately from other parts

Characteristics of digital *x* (2)

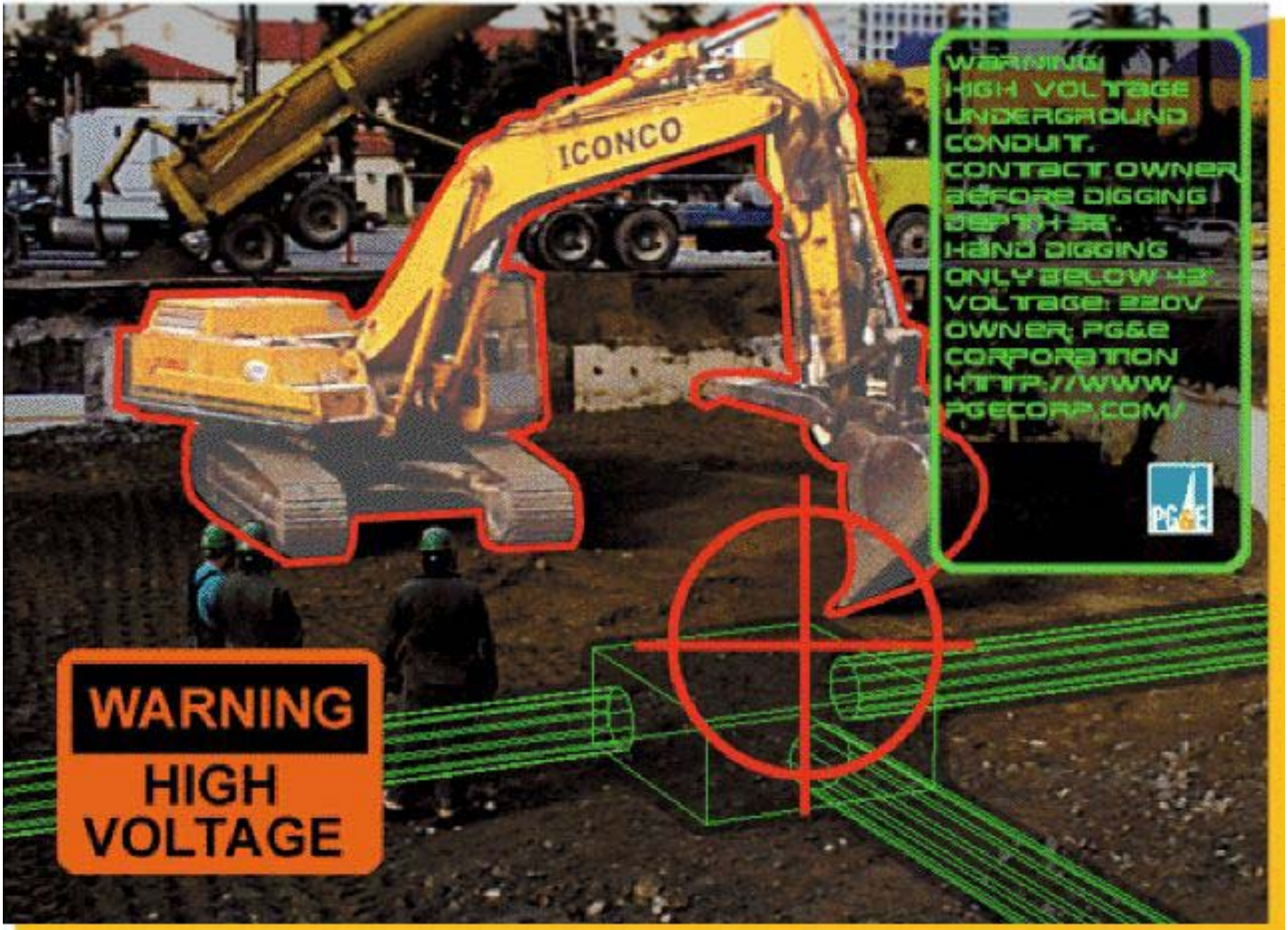
- Access mechanisms that use the spatio-temporal frame as an organizing structure and a basis for search
  - a gazetteer
- Tools for visualization and analysis
- Multiple applications and services



GIS in the field

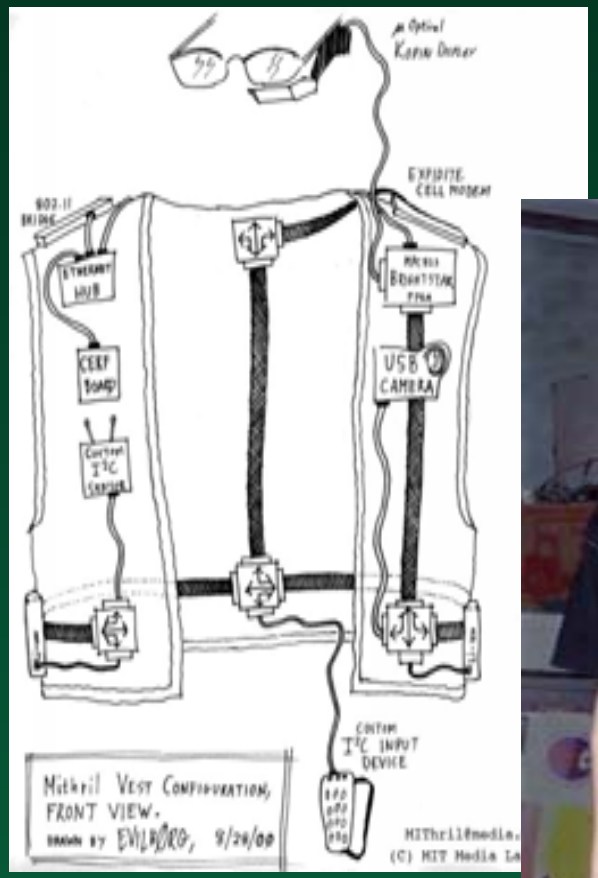
- Mobile, traveling with the user
- Ubiquitous, operating anywhere
- Augmenting the senses with information from digital representations
  - of the past
  - of what is beyond the senses
  - of the future

Figure 2 **WorldBoard might help avoid accidental disruption of buried infrastructure.**



Location-based services

- Technologies that know where they are
  - and provide information accordingly
  - move with the user
  - the cellphone, PDA, laptop, …
- Major applications
  - emergency calls
  - commercial uses
- Major concerns
  - privacy, surveillance


Optional
Kopin Driver
EXPRESS CELL MODEM
802.11 BRIDGE
ETHERNET HUB
MICRO BRIGHTSTAR PDA
CERF BOARD
USB CAMERA
Custom I²C Sensor
CUSTOM I²C INPUT DEVICE
Mithril VEST CONFIGURATION, FRONT VIEW.
DRAWN BY EVILROBO, 9/20/00
MIThril@media.
(C) MIT Media La


MIThril
Rich DeVaul
Steve Schwartz
Sandy Pentland
borglab
MIT Media Lab

CharmIT™ Developer's Kit

- CharmIT™ is built on the PC/104 specification, which has been an industry standard for embedded computing for nearly ten years
- hundreds of companies manufacture a wide variety of PC/104 hardware
- majority of components are low power and ruggedized
- CharmIT™ Developer's Kit is lower cost (approximately $2000), low power (approximately 7 watts with Jumptec 266) and offers enough computing power for most everyday wearable tasks

Head-mounted displays

Integrated Eyeglassisplays ($5000)

ClipOn Display ($2500)
-evaluation kit comes with a belt-worn, VGA interface box connected to the display by a 4’ cable
Display format: 640x480, 24-Bit color, 60 Hz refresh rate
Field of View: Approximately 16 degrees horizontal

Text input

- The Twiddler2 chorded keyboard is designed for one-handed input with an array of 12 finger keys and six thumb keys.
- Frequent users can enter text at close to two-hand touch-typing speeds.

User interface for augmented vision

Augmented: see-through map plus locator

Viewed reality

View options

Field-work applications

- Finding oneself in the field
  - recovering past sample locations
- Accessing previously collected data
  - the previous census
- Analyzing data continuously
  - progressive formation of geographic knowledge

prototype

movie

Summary

- Three phases of GIS development
  - research assistant
  - new communication medium
  - augmentation of sensory reality
- Persistent issues
  - representation
  - uncertainty
  - privacy