Chapter 9: GIS in Action

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Understanding GIS by Case Study

- Use of GIS is **best understood** by examining case studies.
- Case studies in this chapter cover **rural, suburban, urban, and coastal** GIS applications.
- **Rural**: Gyspy Moth in Michigan
- **Suburban**: Road Accidents in Connecticut
- **Urban**: Aftermath of the World Trade Center attacks
- **Coastal**: Channel Islands of California
- **Wildlands**: Sliding Rocks in Death Valley

Case Study #1: Use of GIS to Understand Population Dynamics of the Gypsy Moth in Michigan

Contributors: Bryan C. Pijanowski
and Stuart H. Gage, Dept. of Entomology,
Michigan State University.

The Problem

- **First discovered** in the state 40 years ago.
- Gypsy moth **defoliated 280,000 ha** in 1992
- **Up from 2,800** in 1984.
- Insect is **spreading** across state.
- Impacts mostly **oak and aspen**.
- Agriculture, DNR, USDA **involved**.

The Gypsy Moth

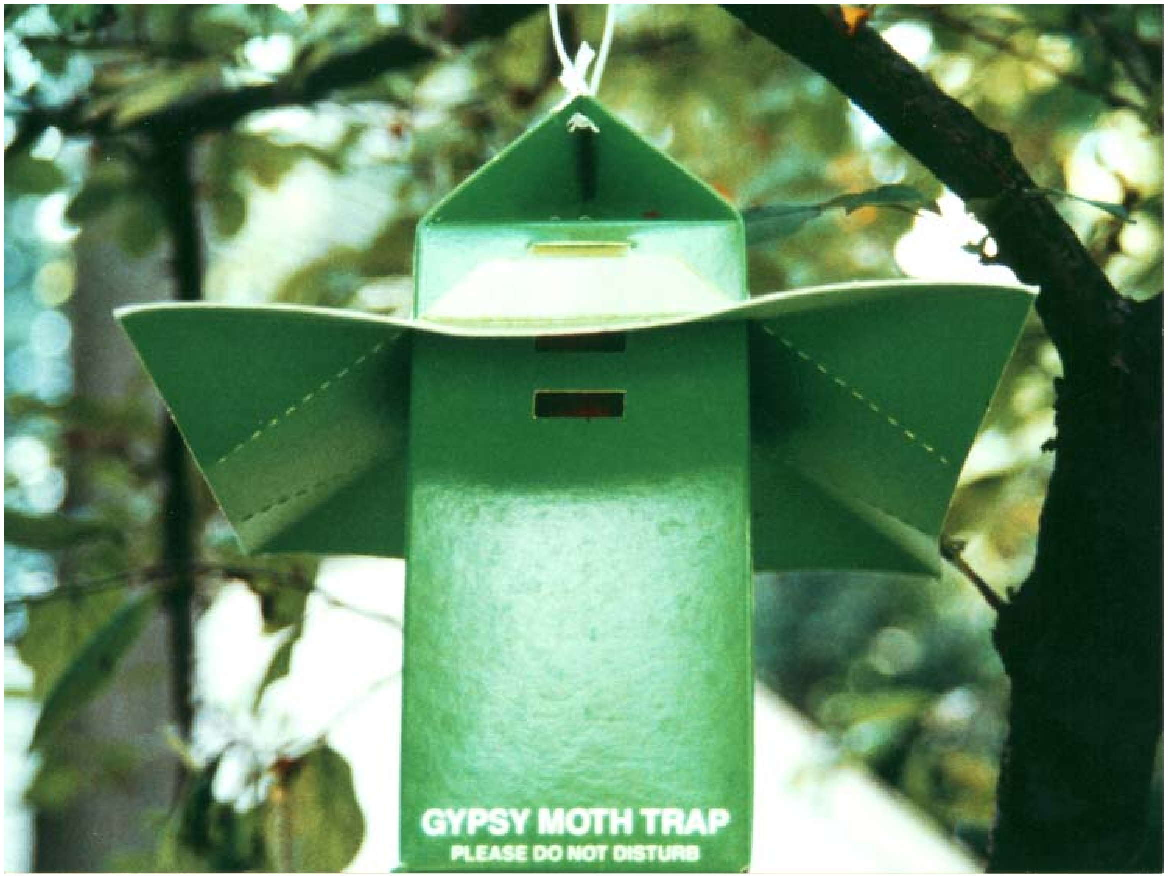
The Spread of the Gypsy Moth

- GIS has been used by Michigan State University to **monitor the spread** of gypsy moth.
- The gypsy moth has **spread over the state** from the north and east, and defoliates trees.

The Monitoring Program

- Information from the monitoring program, via a GIS in Arc/Info and IDRISI, is **used to direct spraying trees** with Bt.
- A **statewide monitoring program** uses milk carton traps in trees dispersed over a spatial grid.

A Gypsy Moth Trap

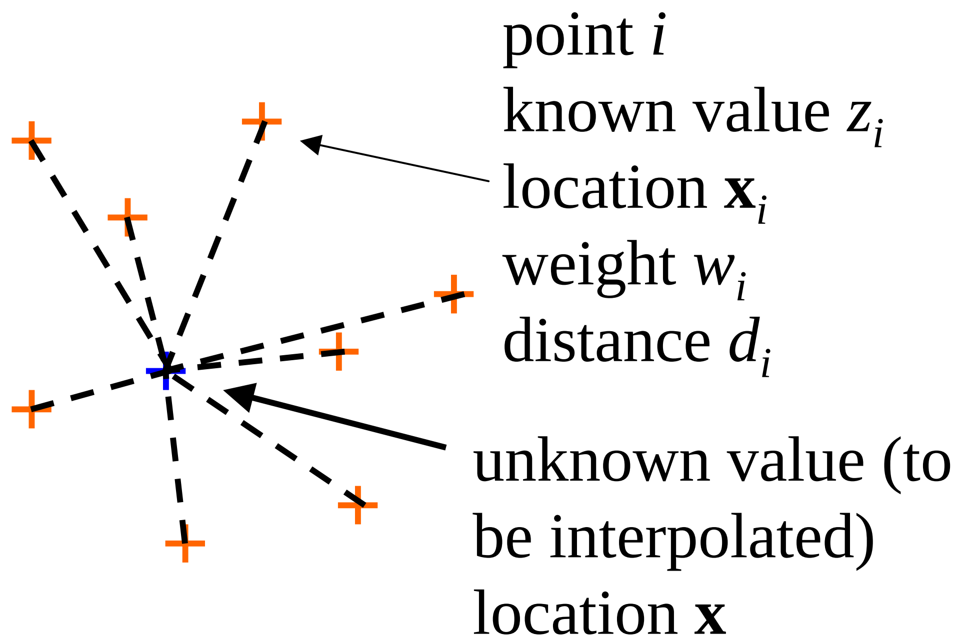


Locations of Traps for Gypsy Moths in Michigan

Data Processing

- Data are **aggregated annually** in a central GIS, forms are entered and **locations geocoded**.
- Statewide gypsy moth infestation are **interpolated** using **inverse distance squared weighting** and mapped.
- An **overlay of tree species** data is then used to **map the trees at risk of defoliation** and therefore to be sprayed.

Inverse Distance Weighting (IDW)



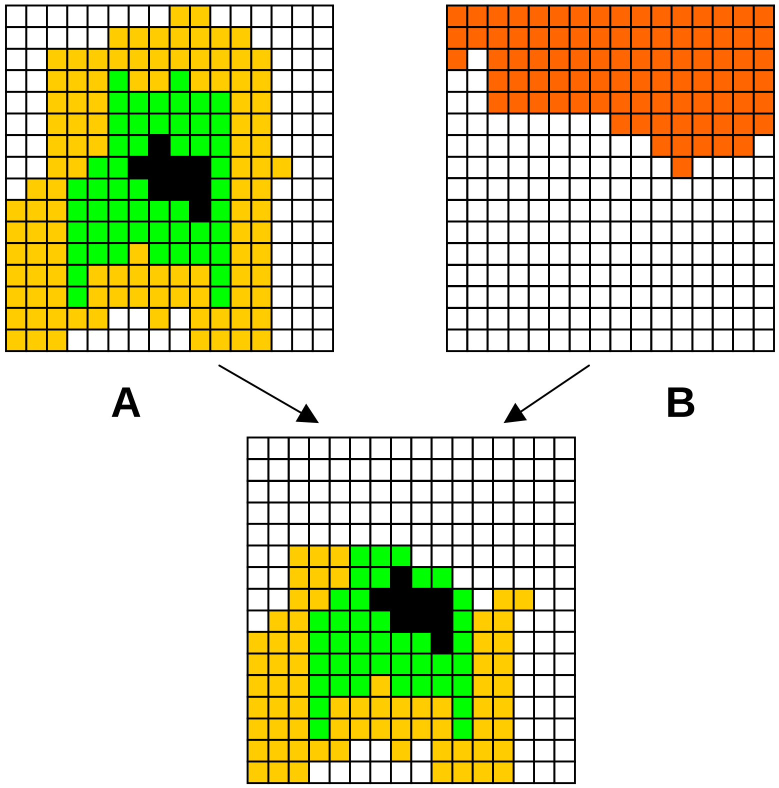
$$z(\mathbf{x}) = \sum_i w_i z_i \Big/ \sum_i w_i$$

The estimate is a weighted average

$$w_i = 1 \big/ d_i^2$$

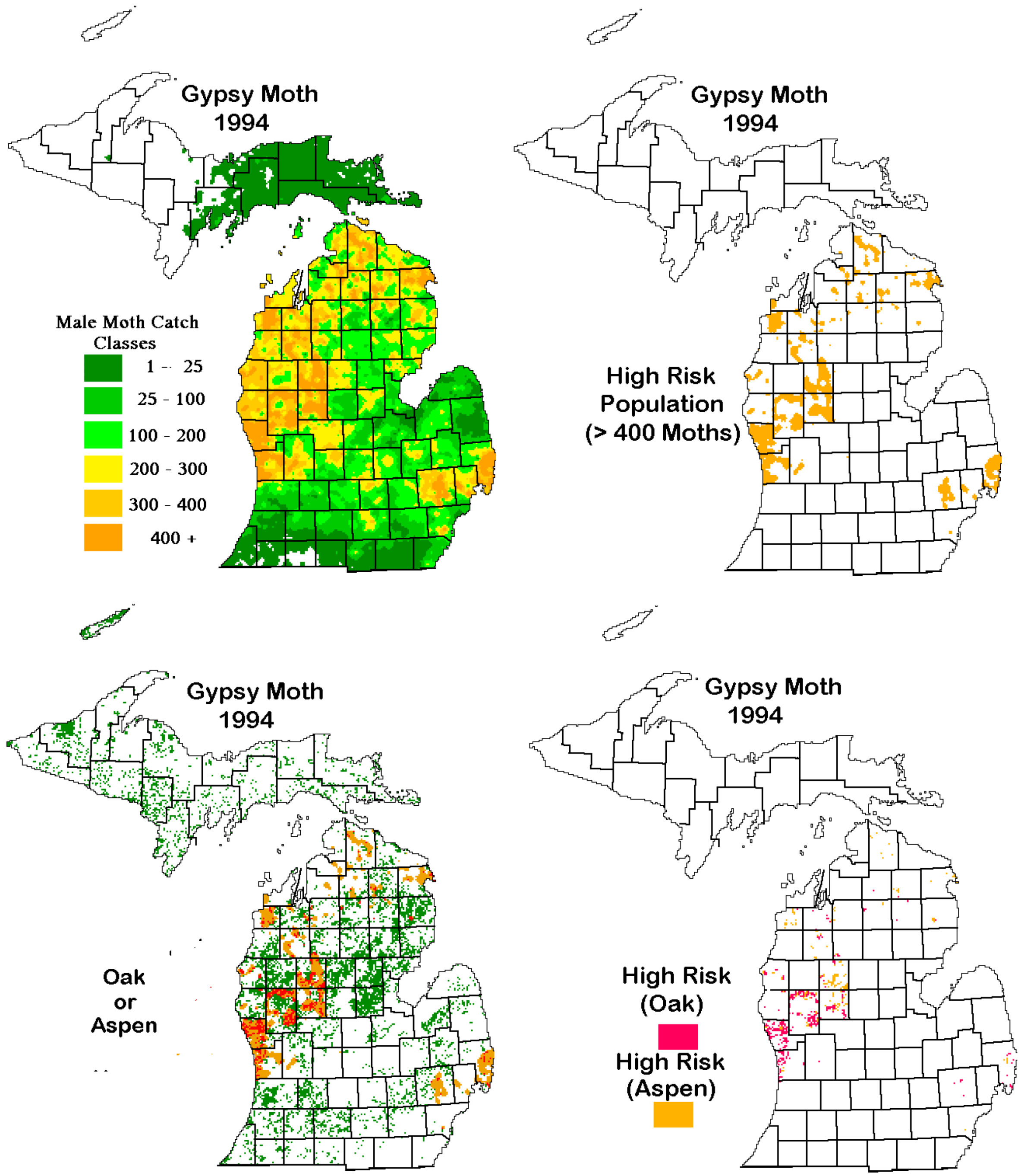
Weights decline with distance

Overlay of Fields Represented as Rasters



The two input data sets are maps of (A) travel time from the urban area shown in black, and (B) county (red indicates County X, white indicates County Y). The output map identifies **travel time to areas in County Y only**, and might be used to compute average travel time to points in that county in a subsequent step

Risk to Trees in Michigan from Gypsy Moth

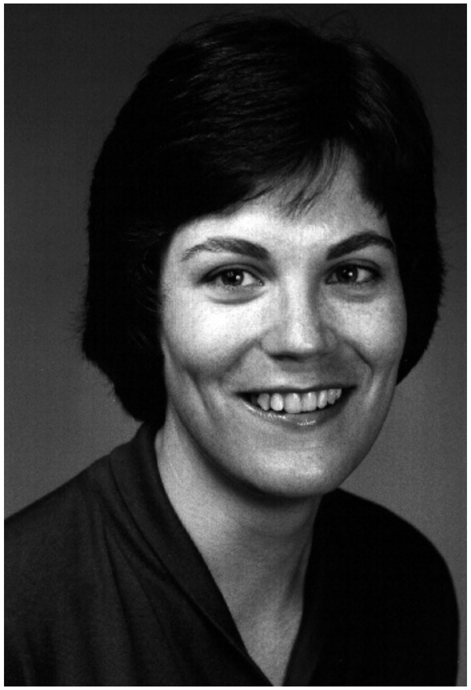


Spraying with Bt Biological Pesticide

Software Used

- Arc/Info
- IDRISI
- Also use: ER-Mapper, ERDAS, Atlas*GIS

Case Study #2: GIS and Road Accidents in CT



Contributor: Ellen K. Cromley,
Medical Geographer,
University of Connecticut.

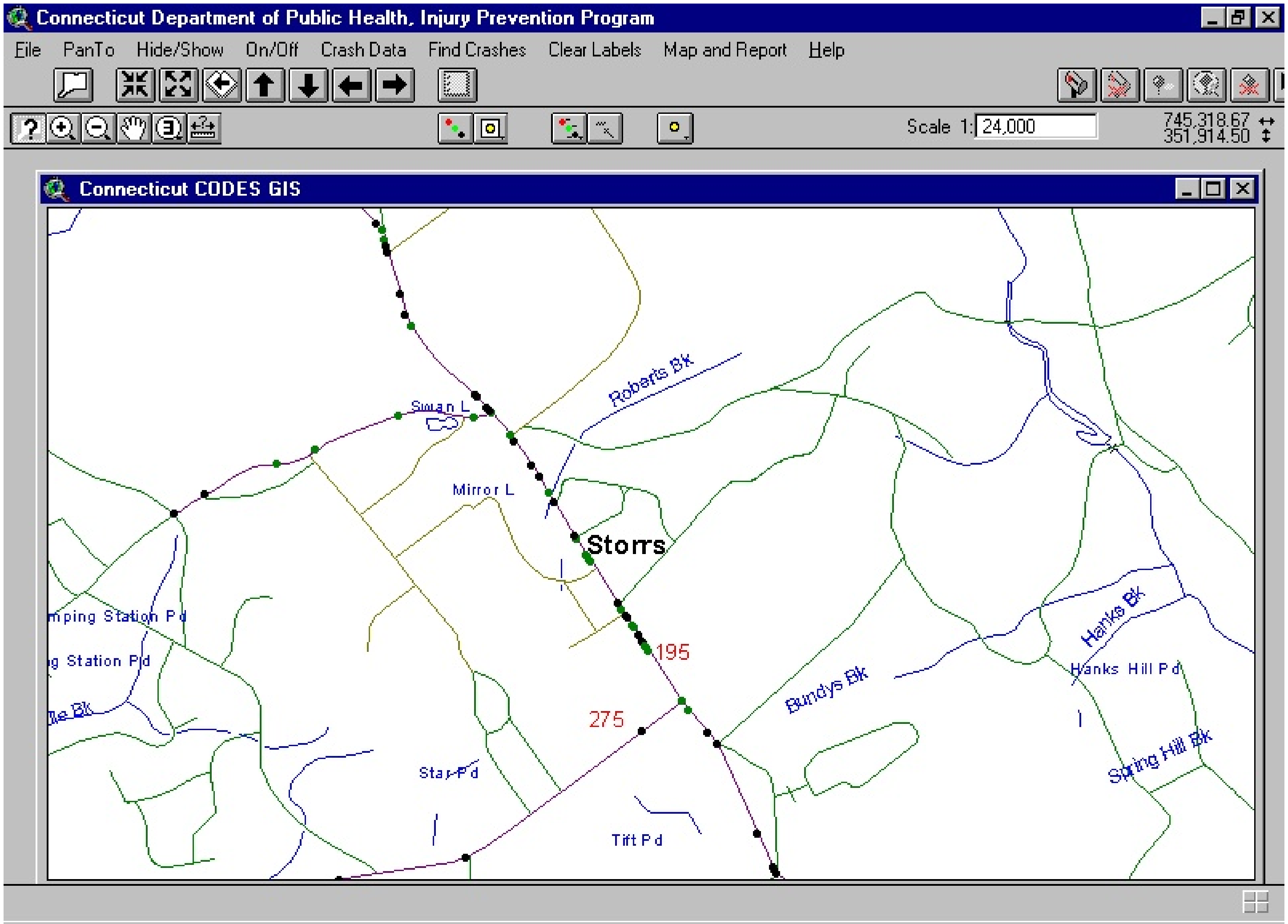
The Problem

- National need to quantify the **benefits of automotive protection systems** like seat belts and bicycle helmets.
- **Connecticut** had 72,672 crashes involving 190,143 people in 1995, and 78,407 crashes involving 202,792 people in 1996.

Crash Outcome Data Evaluation System

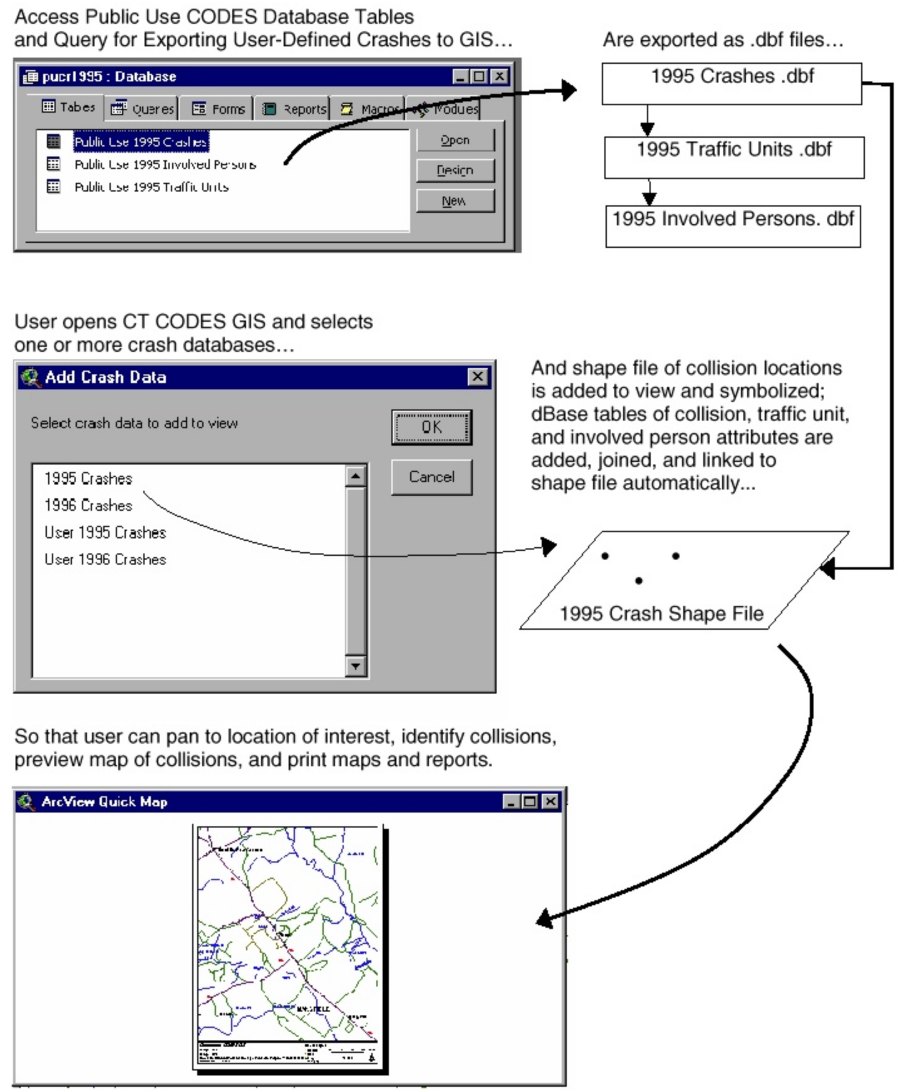
- National Highway Traffic Safety Administration funds 20 states through the **CODES** (Crash Outcome Data Evaluation System) Project.
- The Connecticut CODES Project uses GIS to **link motor vehicle crash data with medical outcome data** to develop a better picture of accidents and the effectiveness of protection systems.
- The purpose is to **create a viewing environment** for the linked crash records so that users can **explore the locations and attributes of crashes**.

Connecticut CODES GIS



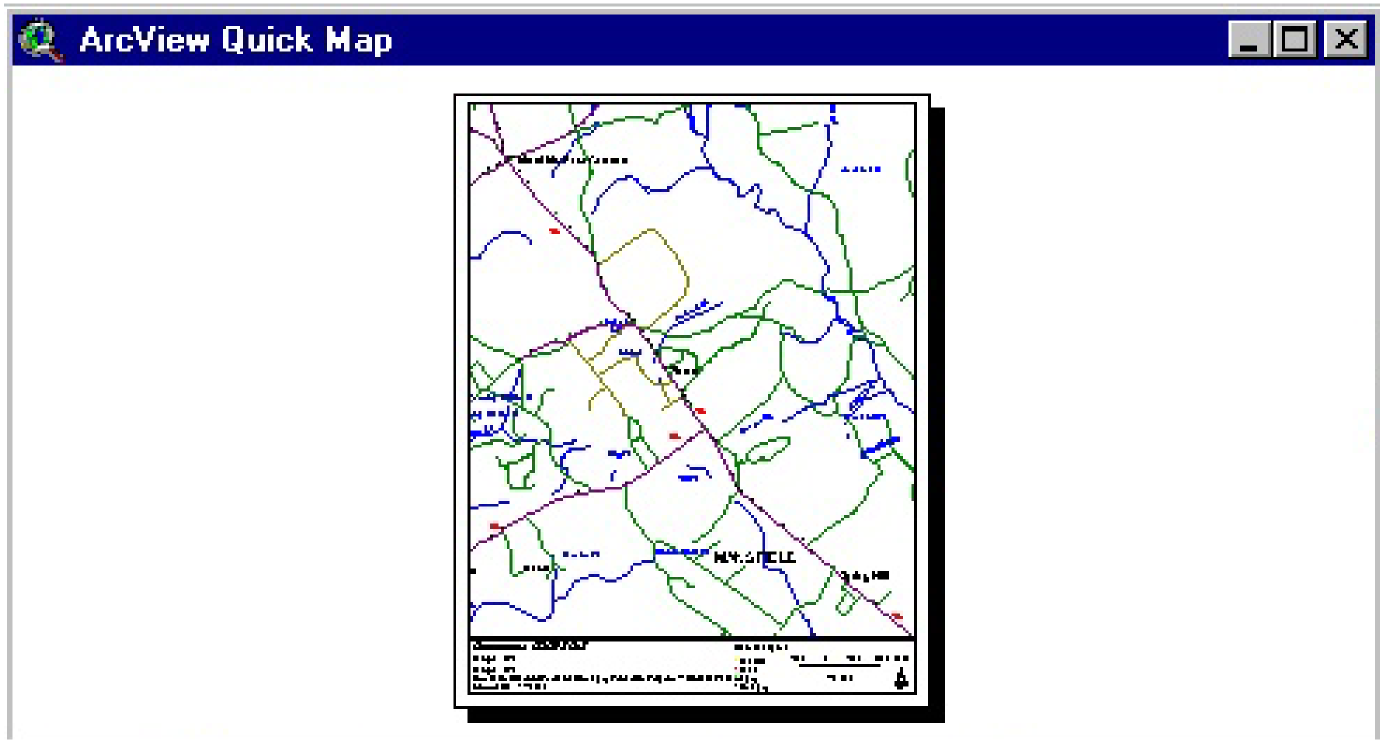
Search and Query

- Users can perform **detailed queries** to select a set of collisions, and **add them as a layer** in the GIS.
- In the GIS, users can find **where a collision occurred**, or find out **what kinds of collisions occurred** in a place.



ArcView Quick Map

•The user can pan to location of interest, identify collisions, preview map of collisions, and print maps and reports.



GIS Software Used

- CT CODES (Crash Outcome Data Evaluation System) GIS is an **ESRI ArcView application** modified with Avenue scripts to create **a tailored GIS**.
- Microsoft Access Database **links** motor vehicle crash data with medical outcome data.

Data Used in the Study

- **Motor vehicle crash data** from Police Accident reports for 1995 and 1996, coded by the Accident Records Section of ConnDOT.
- **Trauma registry, emergency department, and inpatient records** maintained by CHREF, an arm of the CT Hospital Association.
- **Mortality records** maintained by the Vital Records Section of the Health Dept.

Uses of CT CODES GIS

- Local **child safety seat** campaigns
- **Evaluation of traffic calming devices** by DOT
- **Studies of elderly drivers** in one CT county
- Research on **fatal motor vehicle collisions** in the state

Case Study 3:
GIS at the World Trade Center

- How GIS helped in the **rescue and clean-up** operations after the world's worst terrorist attack

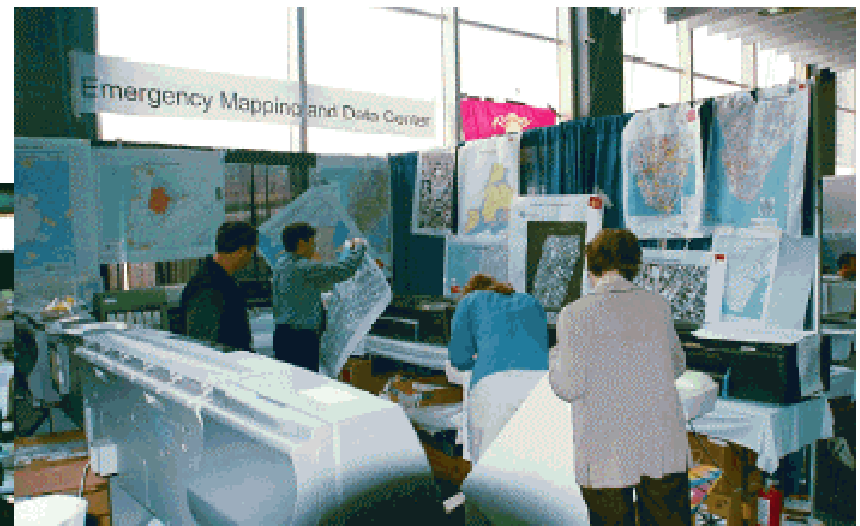
Contributor: Sean C. Ahern
Hunter College - CUNY

September 11, 2001

- "Get your staff together and **start creating maps**"
- Hunter College's **Center for the Analysis and Research of Spatial Information** (CARSI) called in to help deal with the aftermath

GIS World Trade Center Operations at Pier 92

- **GIS support** for firefighters, rescue workers, utility crews
- 24 hours a day / 7 days a week **support** for 2+ months
- 50+ **GIS professionals**



Data

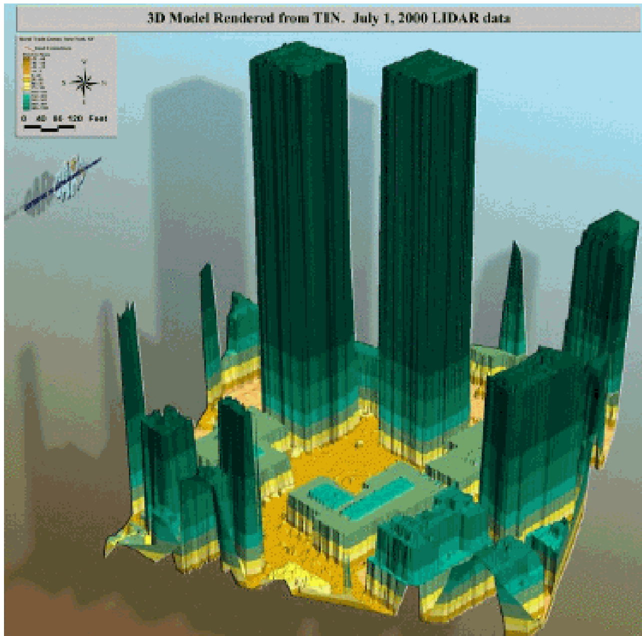
- NYCMap
  - Orthophotography
  - Planimetric maps
- Thermal imagery
- LIDAR imagery
- GPS data

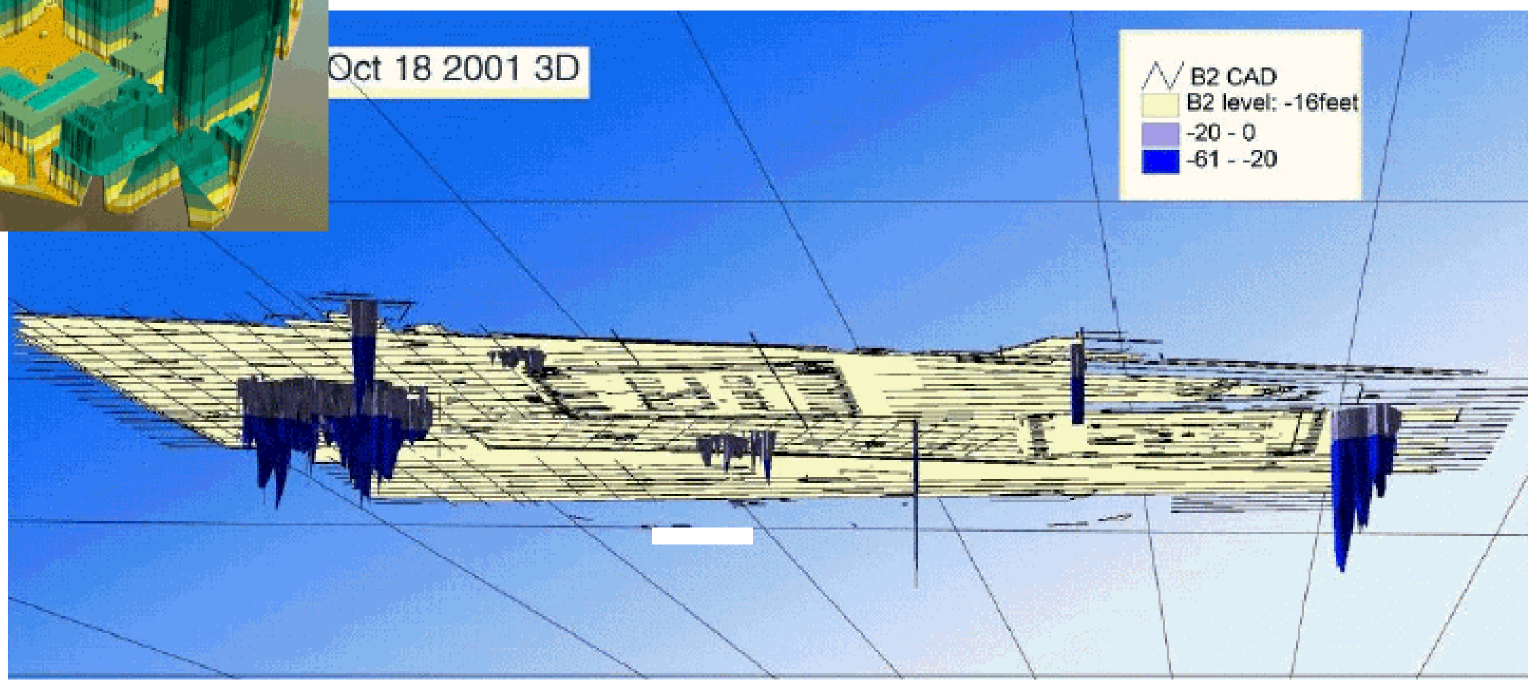
NYCMap

30 cm resolution orthophotography

Planimetric map - absolute spatial accuracy of half a meter

LIDAR

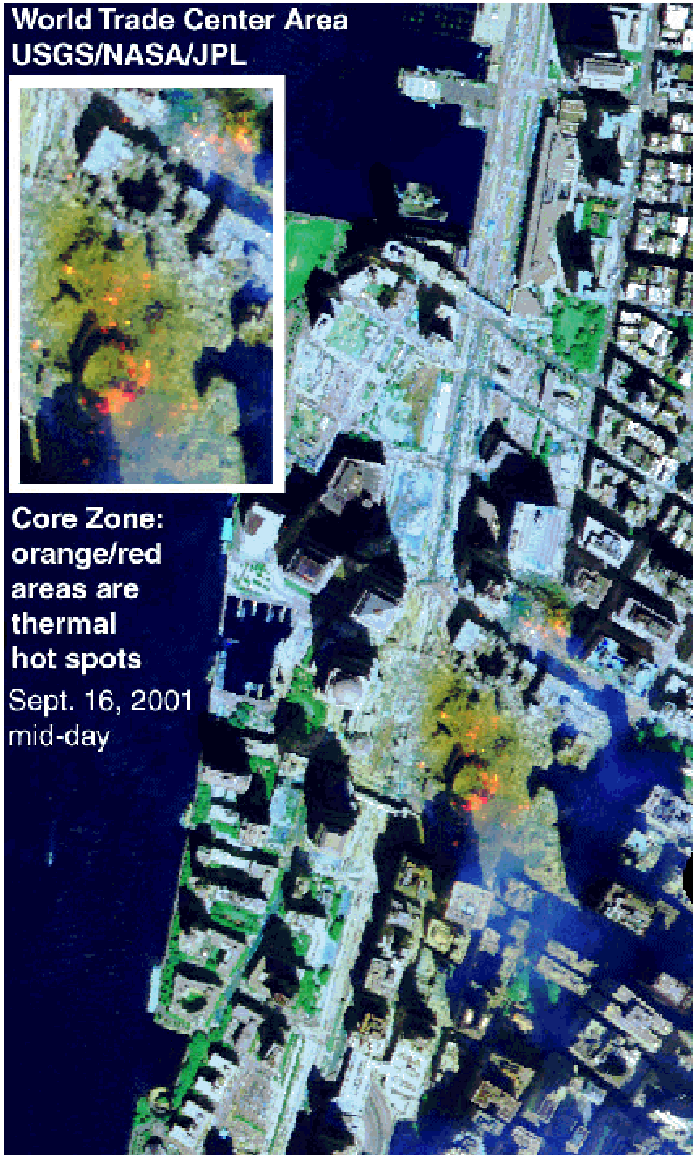

3D Model Rendered from TIN. July 1, 2000 LIDAR data
0 40 80 120 Feet

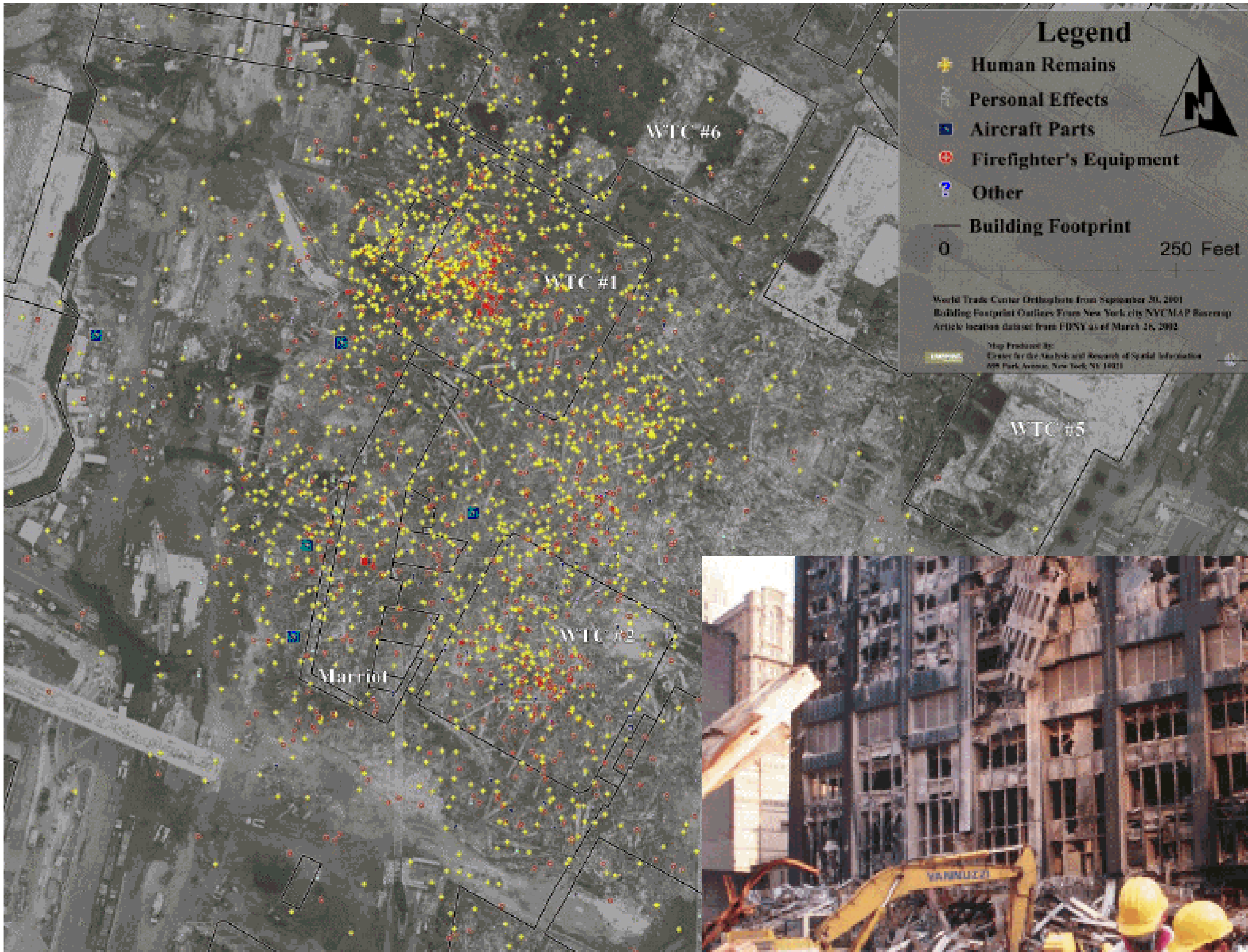

Oct 18 2001 3D
B2 CAD
B2 level: -16feet
-20 - 0
-61 - -20

Thermal Imaging

Thermal remote sensing data collected at the WTC on September 16.

Source: Roger Clark, USGS, Open File report 01-0429




Legend
Human Remains
Personal Effects
Aircraft Parts
Firefighter's Equipment
Other
Building Footprint
0
250 Feet
WTC #6
WTC #1
WTC #5
WTC #2
Marriot

GPS

Problems

- Maintaining **building status** database
- **Unique identifiers** for the buildings?
- Data **consistency**
- Data **integrity**
- **TIME!**

Lessons Learned

- NYC GIS infrastructure was **critical**
- Cities should **connect** their spatial data to its attributes!
- Need for **cartographic standards**
- Need **mobile access** to GIS
- **Version management** for multi-user environment

Case Study 4: Channel Islands GIS

- Effective Resource Management for California's Coastal Islands

Contributor: Leal Mertes,
Dept. of Geography UCSB and grad/
undergraduate students.

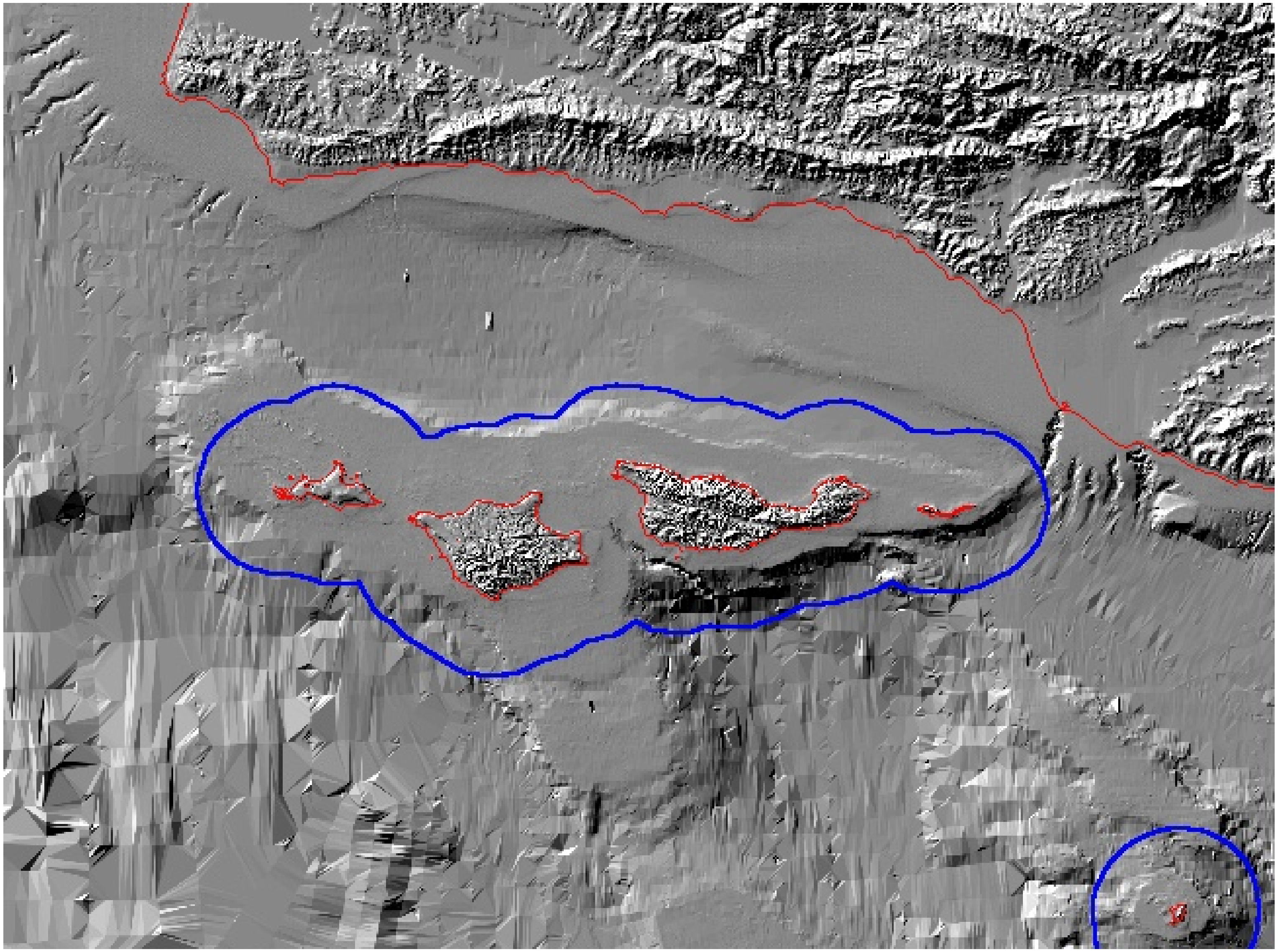
Channel Islands GIS

- **Collaborative** GIS
- **Many** contributors and developers
- **Public domain** and **mission-specific** data
  - UCSB
  - NOAA Channel Islands National Marine Sanctuary
  - Channel Islands National Park
  - Santa Cruz Island Reserve
  - UC Natural Reserve System
  - State of California Fish and Game (Oil Spill Prevention & Response)

Data layers

- Bathymetry
- Topography
- Flora and Fauna
- Archeological sites
- Sea caves
- Shipping lanes
- Oil platforms
- Geology
- Vegetation
- Soils

DEM and Bathymetry

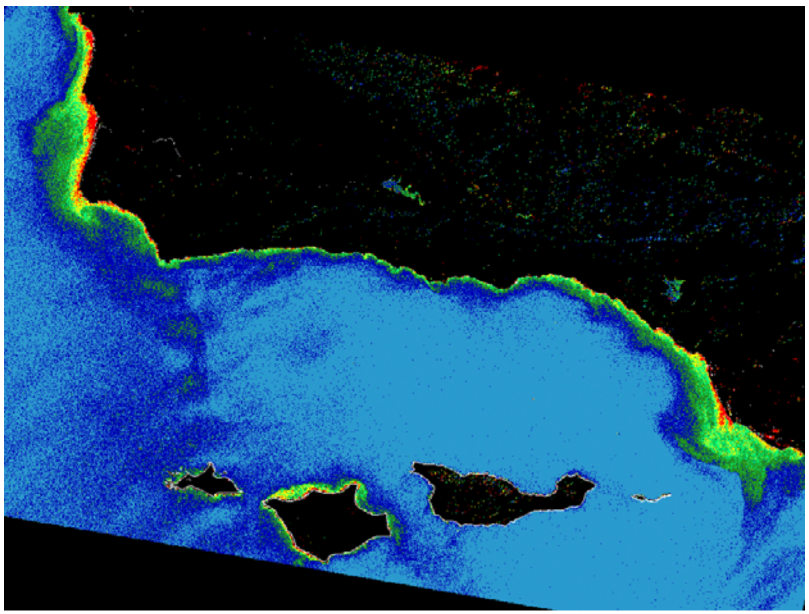


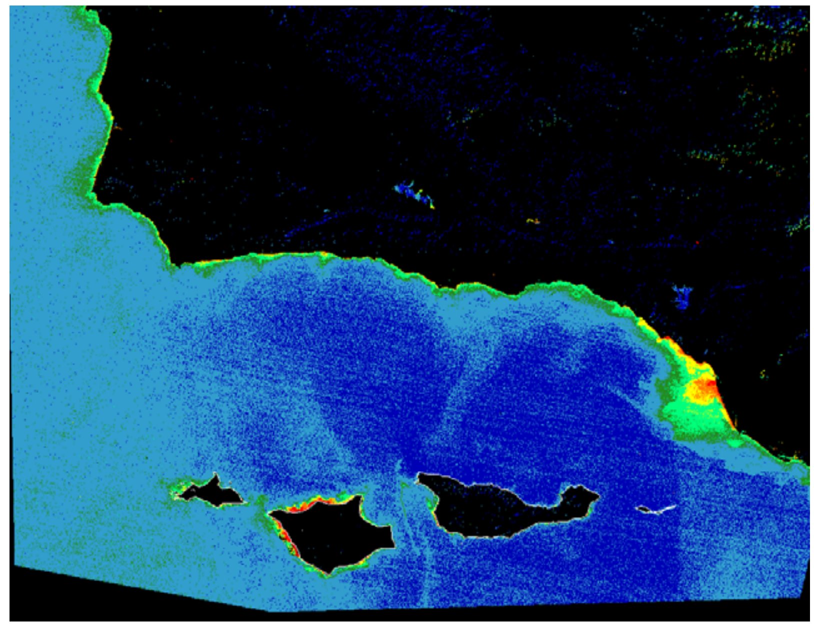
Data suite

- **Master DB** is Arc/Info and ArcView
- **Ongoing** maintenance
- Use on **computers** and on **boats**
- **Plumes and Blooms** project
- Inclusion in a **new class** on Watershed Analysis

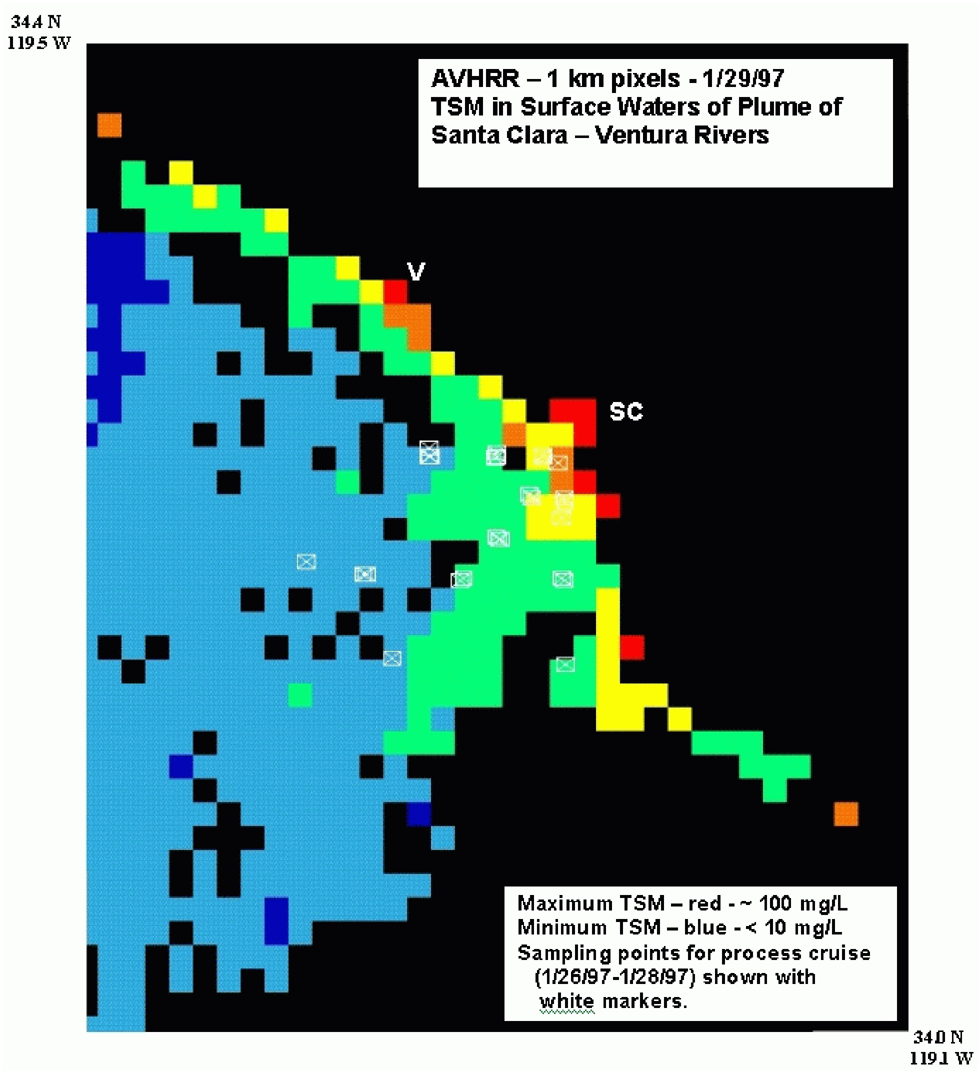
Plumes and Blooms Project

El Niño Plume Response

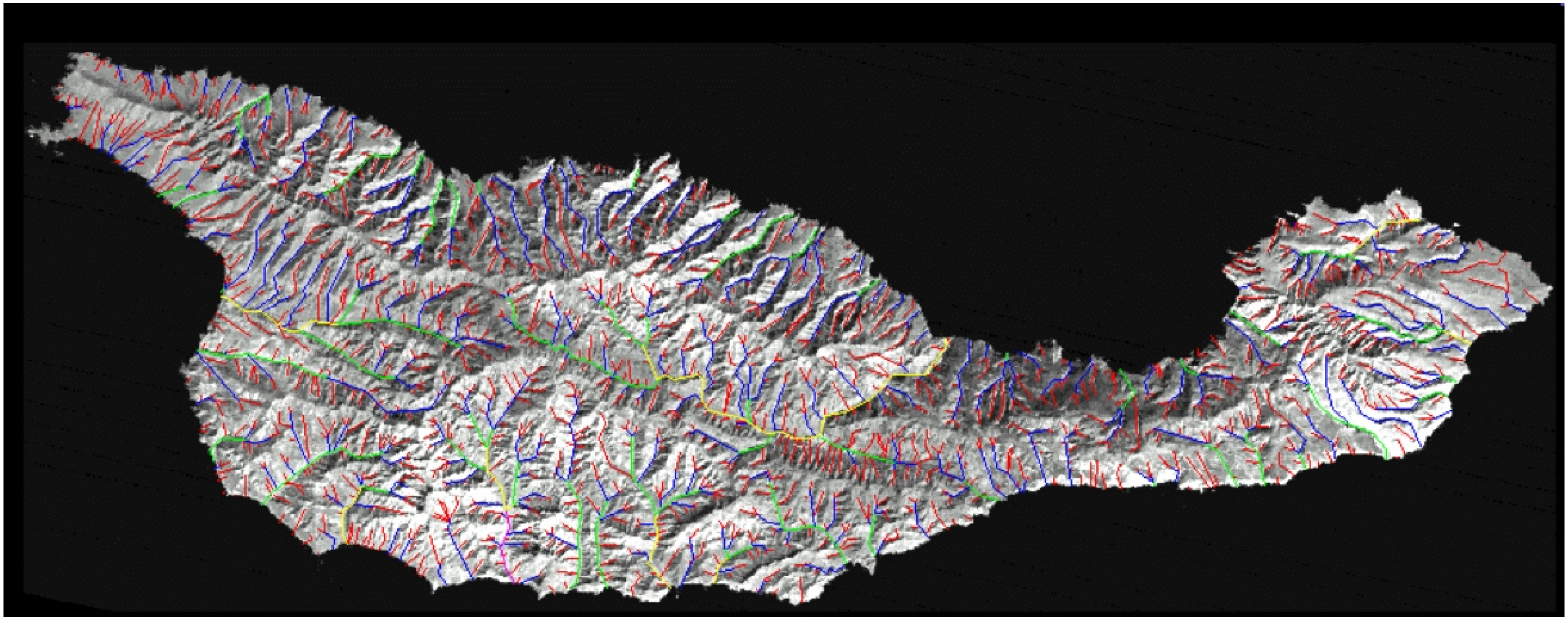




AVHRR Sediment Plume
Santa Clara/Ventura Rivers



Santa Cruz Island: Watersheds



Outcomes

- Data set constructed and used for **better environmental management**
- Highlighted **significance of high magnitude rainfall events** on water quality and ecosystems
- **Integrated** research, teaching and internships activities
- Led to **Conception Coast** project

Case Study 5: Sliding Rocks

Contributor: Paula Messina,
Department of Geology,
San Jose State University,
California.

Sliding Rock Phenomenon

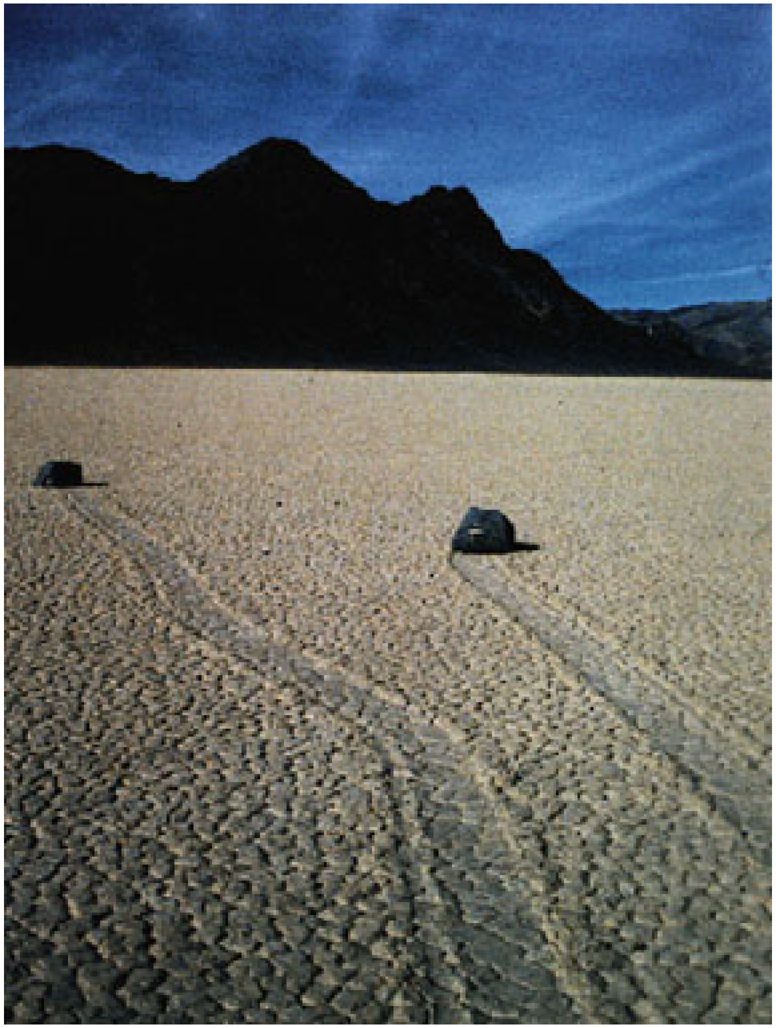
- **Recessed trails** in the playa sediments suggest that **rocks and boulders glide** across an almost perfectly flat lakebed at Racetrack Playa in Death Valley. No one has witnessed the rocks in motion.
- **Trails** are defined by lateral ridges, suggesting that the surface is saturated and pliant when the rocks move.

Sliding Rock Phenomenon cont.

- Some trails exhibit **splash marks, wakes, and bow waves**, indicating that the rocks are propelled at speeds of 2 meters per second or even more.
- The **longest trail**, over 800 meters, is fairly straight, but others record extremely chaotic activity.
- The largest boulders have **masses up to 320 kilograms**, and their trails are by no means the shortest.

“Ellen” and “Bessie”

Two rocks, “Ellen” and “Bessie”, apparently **slid** to the northwest, imprinting trails as evidence of their unusual activity.



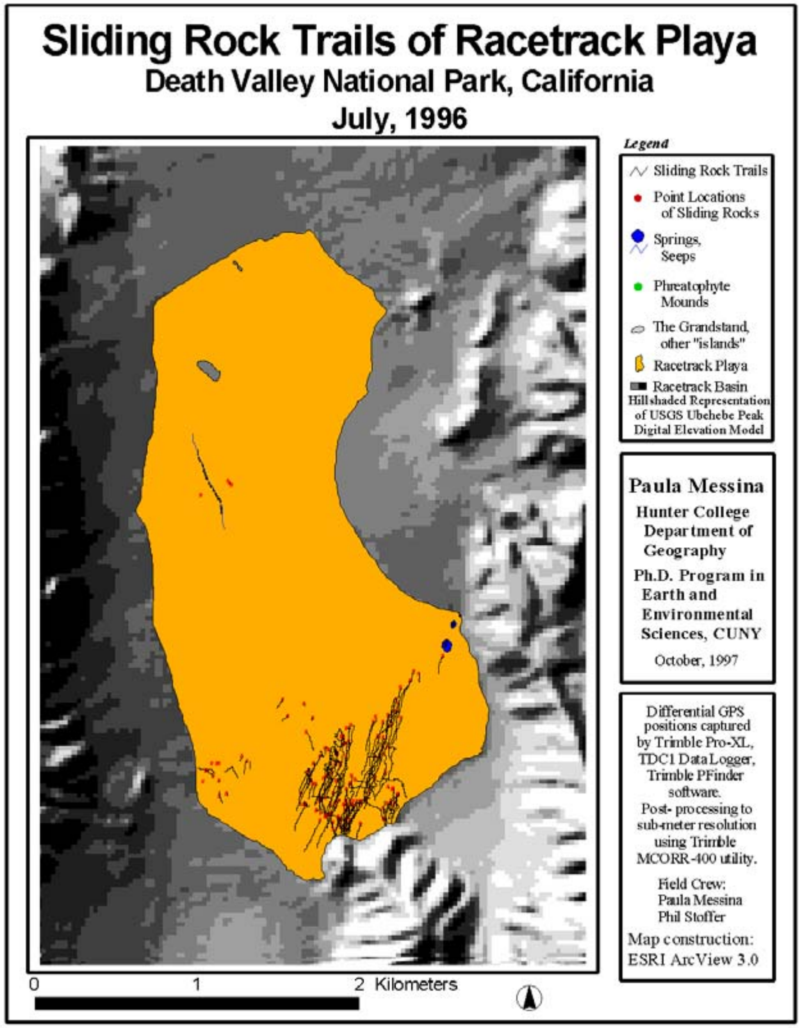
GIS, GPS and Terrain Analysis

- Dr. Messina, captivated by the sliding rocks of Racetrack Playa, used **a variety of mapping and GIS tools** to solve the mystery.
- GPS was used to **map the positions** of "sliding" rocks, and their **trails**.
- GIS was used to **find spatial patterns** in the movement of the rocks.
- She used hand-held **anemometers** to map wind vectors.
- **Terrain analysis** provided the elusive clue.

Ice vs. Wind

- Maps of a few selected trails showed significant **parallelism**, suggesting that rocks may move while imbedded in a cohesive wind-propelled ice sheet.
- While **some trails are parallel, most are not**. Does that imply that ice moves only some rocks?
- Robert P. Sharp concluded that the **wind alone**, acting over a surface "lubricated" with wet clay **may provide enough force** to set the rocks in motion.

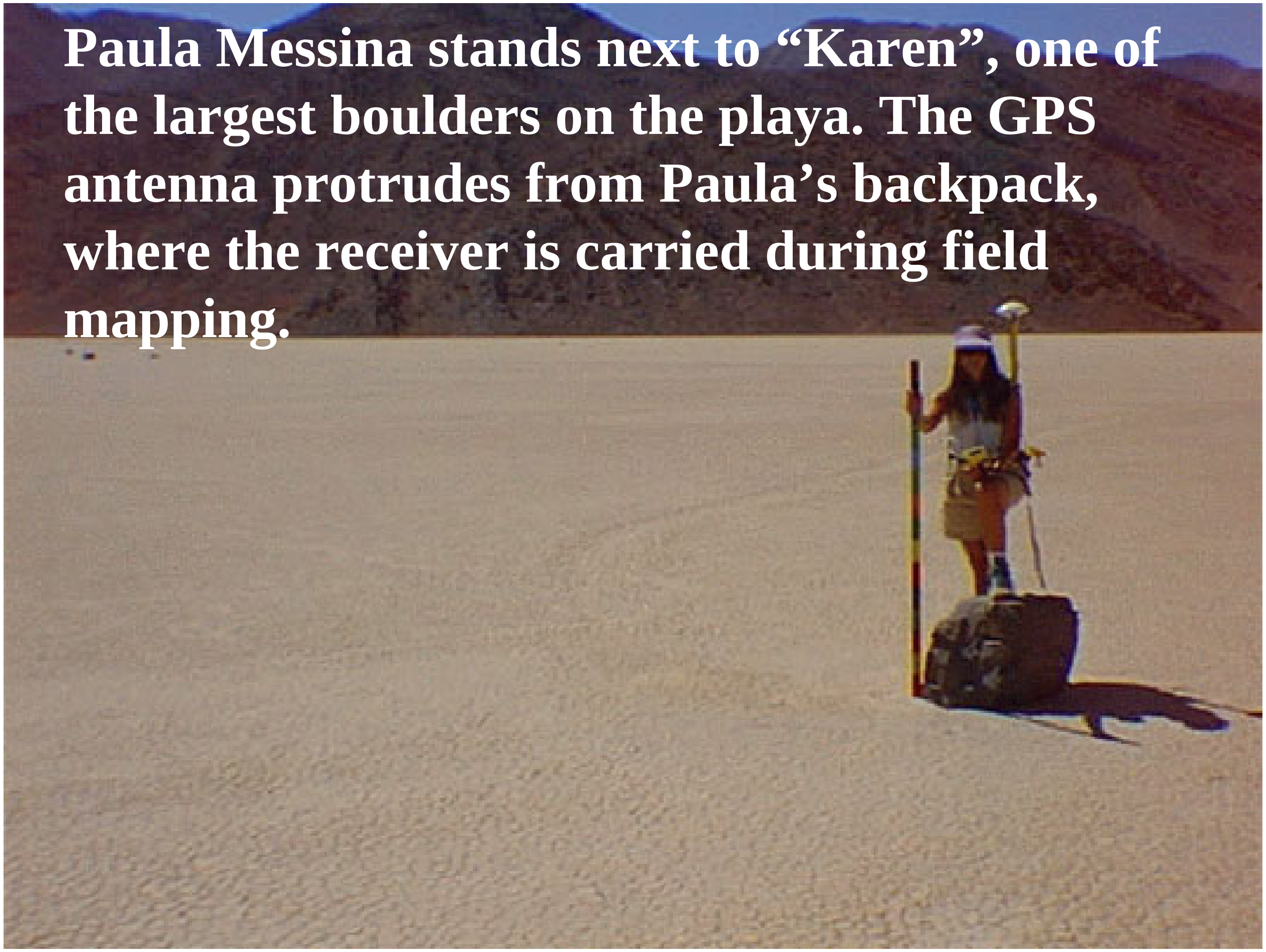
GPS and GIS to the Rescue



- The **exact locations** of all rocks and precise plans of all trails on the 667 hectare playa were captured by **Global Positioning System** (GPS), exported to ArcView GIS, and **analyzed** using a variety of spatial and statistical methods.

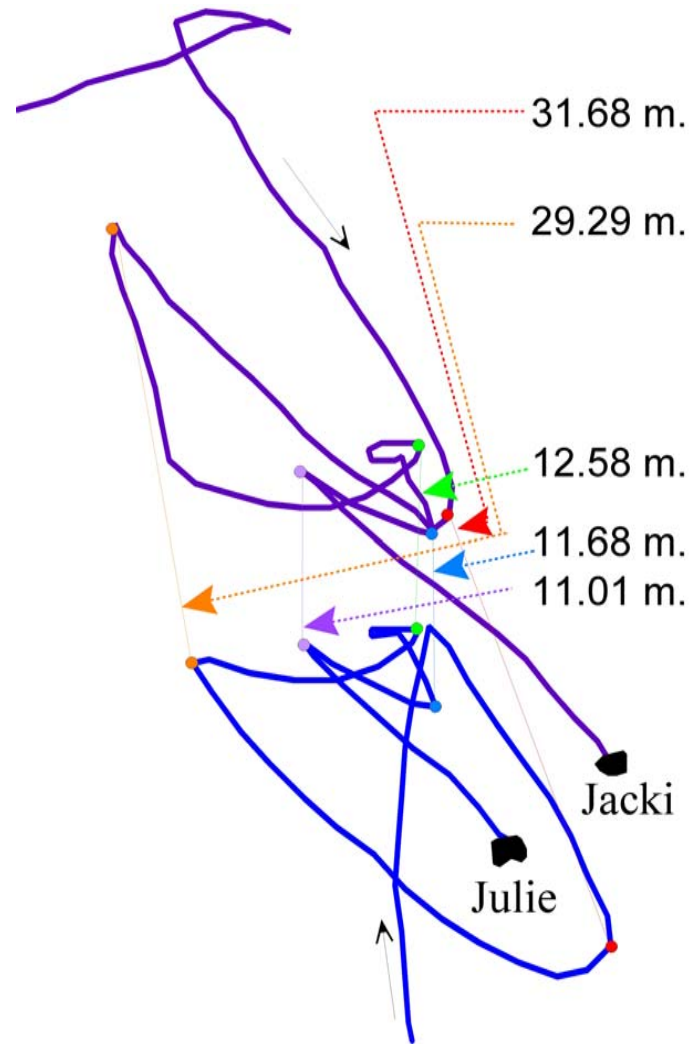
“Karen”

Paula Messina stands next to “Karen”, one of the largest boulders on the playa. The GPS antenna protrudes from Paula’s backpack, where the receiver is carried during field mapping.

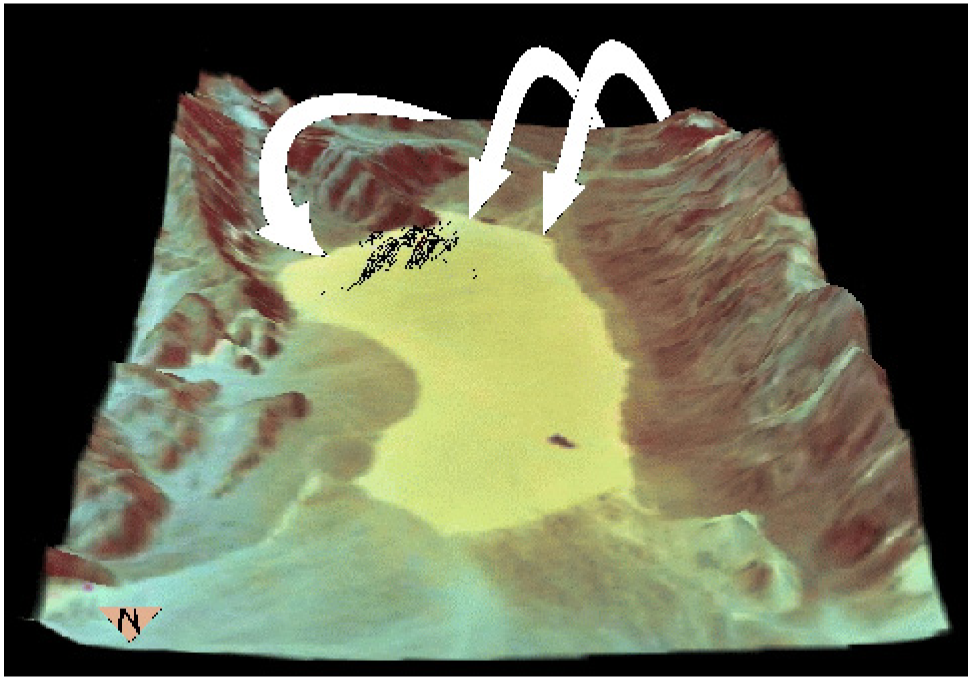


Spatial Patterns

- The trails of “Jacki” and “Julie” suggest a **high degree of similar motion**. However, although somewhat congruent, the rocks apparently converged during their journeys. There appeared to be **no correlation** between the size, shape, or lithology of a rock, and the length or straightness of its trail.



Terrain Analysis



Analysis of the surrounding terrain, using the USGS Digital Elevation Model (DEM), provided the clue that had remained hitherto elusive. The **slope and aspect** of the basin **directs airflow** along very specific vectors. Direct measurements of the wind revealed that wind speeds up to six times faster, and up to 50 degrees deviant occurred at locations only 400 meters apart.

GIS Software and Data Used

- ArcView GIS
- ArcView Spatial Analyst Extension
- USGS Digital Elevation Model (DEM)
- Global Positioning System (GPS)
- Handheld anemometers

Results

- The nature of a trail has more to do with **the location of the rock** that inscribed it than the physical characteristics of the rock itself. The Racetrack may be thought of as a **mosaic of microclimates**, with different wind regimes in adjacent locations. A few days after a rain, when fine, saturated clays coat the surface, a "near-Teflon" state supports mobilization of Racetrack Playa's rocks by wind.

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Next Topic:

The Future of GIS