Training the Trainers -
GIS Education and Emergency Responders

Mike Price
Entrada/San Juan, Inc.
In partnership with Del Mar College
Corpus Christi, TX

Abstract

The GIS-TECH program, sponsored by Del Mar College, Corpus Christi, TX, and funded through National Science Foundation grant DUE 0402435, develops standards-based GIS training curriculum for Public Safety First Responders and Emergency Managers. The hands-on training is designed for instructor-led classes and for self-study via the Internet. The curriculum teaches fundamental Geographic Information Systems skills and knowledge needed by municipal Public Safety mapping professionals performing data acquisition, data development, analysis, and map production.

The training set includes nationally available data, including USGS terrain, TIGER vectors and demographics, Insurance Services Office (ISO) protection requirements and more. It includes options for enhancement and customization with small scale locally developed data. The curriculum emphasizes modeling for the widely used Standards of Cover process for resource deployment planning that is supported by the Commission on Fire Accreditation International (CFAI). Units focus on geocoding and plotting emergency incidents, building time-based response scenarios, identification and mapping of risks, hazards and values, and more.

Incorporating widely adopted Train-the-Trainer methodology, GIS-TECH training is organized and presented in modules that may be completed individually or in small groups within a flexible timeframe. Testing at completion of each module assesses the student's grasp of concepts before continuing.

This presentation introduces the GIS-TECH program to educators and outlines the instructional series developed for emergency responders. It includes ideas for using the training modules in a public or private school classroom. The presentation also explores and addresses the educational needs and challenges of Public Safety/Emergency Management professionals.

Mike Price, President of Entrada/San Juan, Inc., a Natural Resources and Public Safety consultancy, is a licensed Engineering Geologist with over thirty years experience.

Introduction

Time is of the Essence! In our fast-paced modern world, we hear this phrase all too often. And in Public Safety and Emergency Management, it is so true! Every day, emergency services First Responders encounter structural fires, vehicle accidents, emergency medical events, and hazardous material calls where fast, safe, and well-planned actions generate tremendous benefits. During an emergency response, lives, property, and the environment hang in a delicate balance where a few minutes, gained or lost, often make huge differences.

High-quality spatial data describing our communities are now widely available. Today's Emergency Responders know that proper use of planning, infrastructure, jurisdiction, and historical information will greatly improve their performance capability and will generate and sustain positive outcomes. Geographic Information Systems (GIS) provides First Responders and their managers with critical tools to plan, prepare for, and respond to a wide variety of emergencies.

First Responders and Emergency Managers use the most accurate, current, and reliable information available to support critical on-scene decisions. The command post and scene assessment processes for Incident Commanders is very complex. Historically, "Professional Credibility" and "Experience" were primary tools used to build and support decisions to identify, deploy, and manage emergency resources. Today, emergency assessments are quickly weighted by cost, benefit, and consequence. A well-structured decision requires many facts, figures, and other pertinent information that are quickly available.

Data available to First Responders and their managers requires a high resolution street network to locate incidents on a map and to guide responding equipment and personnel to the scene. Fire hydrant and water flow measurements are mapped and provided to first-due companies. Information about hazardous substances stored at industrial sites is catalogued within emergency response plans. Historical incident response data show trends and allow managers to allocate equipment and personnel efficiently.

This presentation introduces the Del Mar College GIS-TECH program to educators and outlines the instructional series developed to teach GIS to First Responders. It includes recommendations for using the training modules in a school classroom or a professional forum. The presentation explores the educational needs and challenges of Public Safety/Emergency Management professionals.

Figure 1: GIS-TECH student and Public Safety professional models Corpus Christi, TX

The GIS-TECH Program - GIS Training for First Responders

In June 2004, Del Mar College, Corpus Christi, TX initiated the GIS-TECH Curriculum Development program, with funding through National Science Foundation grant DUE 0402435. Over a three year period, the GIS-TECH program will create and place standards-based Geographic Information Systems (GIS) training curriculum for Public Safety First Responders and Emergency Managers. The hands-on training is designed for instructor-led classes and for self-study via the Internet. Through the DACUM (Developing A CurriculUM) process, fundamental GIS skills and knowledge needed by municipal Public Safety mapping professionals were identified and training materials to teach these skills were proposed. The curriculum targets First Responder mapping technicians responsible for Public Safety/Emergency Management data development, management, analysis, map preparation, and field deployment.

The First Responder training set emphasizes nationally available data, including USGS Seamless terrain and imagery, TIGER vectors and demographics, Insurance Services Office (ISO) protection requirements and more. The initial training set studies Nueces County, TX, home to Del Mar College. Since the program uses data available nation-wide, it may be customized to meet the needs of any jurisdiction, from a single community to a multi-county regional response organization. The program includes options for enhancement and customization with small scale local data. Advanced curriculum addresses modeling for the widely recognized Standards of Cover process for resource deployment planning that is supported by the Commission on Fire Accreditation International (CFAI). Exercise include geocoding and plotting emergency incidents, building time-based response scenarios, identification and mapping of risks, hazards and values, and more.

Incorporating widely adopted Train-the-Trainer methodology, GIS-TECH training is organized and presented in modules that may be completed individually or in small groups within a flexible timeframe. Testing at completion of each module assesses the student's grasp of concepts before continuing.

In Module 1, students find, download, and process Census TIGER data available for their own jurisdiction. They learn to create a time-based street network and to map fire stations and district boundaries. Additional information, including fire hydrants, essential facilities, ISO insured structures, and fire incidents, may also be mapped. In its entirety, Module 1 is taught in two 8-hour blocks. All GIS-TECH modules are taught with ESRI's ArcGIS software and ArcGIS extensions.

Figure 2: First Responders and GIS

Curriculum Development

When finished, current GIS-TECH curriculum will include three 16 hour modules, each comprised of four to six hands-on exercises. The modules are taught sequentially and may be taught in concentrated units of 16 hours each, or as a three credit-hour equivalent (two hours lecture, two hours lab for one 16 week semester) classroom program. Materials and program support will "go to the field" assisting instructors in the Train-the Trainer mode common to Emergency Management instruction. Program developers envision a doubled program, with content expanded to include a full 96 hours (6 semester-hours) of course material.

All program materials stress GIS core competencies and expect certain prerequisite computer systems, office software, and keyboarding knowledge and skill. Pre-testing and ongoing

performance testing are planned for all modules; a customized student project will be part of advanced training. Needed skills are identified through a DACUM process and are closely associated with GIS Model Curricula and other recognized GIS training paths. Knowledge and skill objectives are tied to Fire Service and Public Safety standards for information management, resource deployment, and emergency practice whenever possible.

Materials are developed by Emergency Services mapping professionals and are tested with classroom students. Portions of the curriculum will be amenable to web-based learning and all materials will be available as digital and/or printed material. First Responder GIS-TECH materials are now being developed and will be constructed sequentially released, with Module 1 scheduled for final release in late 2005, with Module 3 scheduled for completion in mid 2006.

GIS-TECH First Responder materials will be reviewed by Public Safety/Emergency Management professionals and by Public Safety educators. The curriculum will be recommended for approval and integration into formal GIS programs at accredited colleges and universities and it will be considered for professional career development certification.

Figure 3: GIS-TECH Certificate of Completion

GIS-TECH First Responder Content

Module 1: GIS and First Responders - Mapping with Vectors

In Module 1, students learn to download, manage, and map with standard, widely available US Census TIGER data. Since standardized TIGER data is available for all US counties, it provides a consistent framework for training development. The strengths and limitations of TIGER data are closely studied so students understand the importance of data development and enhancement.

Module 1 stresses Internet use, data acquisition, data management, core GIS skills and geodatabase development. Data from local sources is not needed for this exercise. Module 1 is now through its prototyping stage and has been tested in the classroom. It is scheduled for final release in December 2005.

The outline below summarizes five Module 1 exercises and lists GIS competencies and skills taught in this unit. Figure 4 shows a sample Fires Responder ArcGIS map created by prototyping students at Bellingham Technical College.

Exercise 1.1: Introduction to GIS for First Responders

- Preview GIS Data
- Understand folders and files
- Learn data management rules
- Learn data relationships
- Study thematic legends
- Perform simple queries

Exercise 1.2: Finding, Selecting, and Downloading TIGER Data

- Find Census 2000 TIGER data on the Internet
- Download appropriate data for a county of interest
- Extract data from a zipped file and save it on a computer
- Explore metadata and technical information about TIGER data

Exercise 1.3: Studying and Processing TIGER Data in ArcCatalog

- View TIGER data in ArcCatalog
- Understand TIGER tabular data structure
- Define data projection information with ArcToolbox
- Review, create, import, and understand metadata

Exercise 1.4: Mapping TIGER Data with ArcMap

- Learn to use ArcCatalog and ArcMap together
- Understand and use coordinate systems
- Build tabular joins with CFCC codes
- Create thematic legends from data attributes
- Create a TIGER-based emergency response map in ArcGIS

Exercise 1.5: Managing TIGER Data in a Geodatabase

- Create Layer files for mapped data
- Export data to shapefiles
- Understand geodatabase structure
- Load shapefiles into a geodatabase

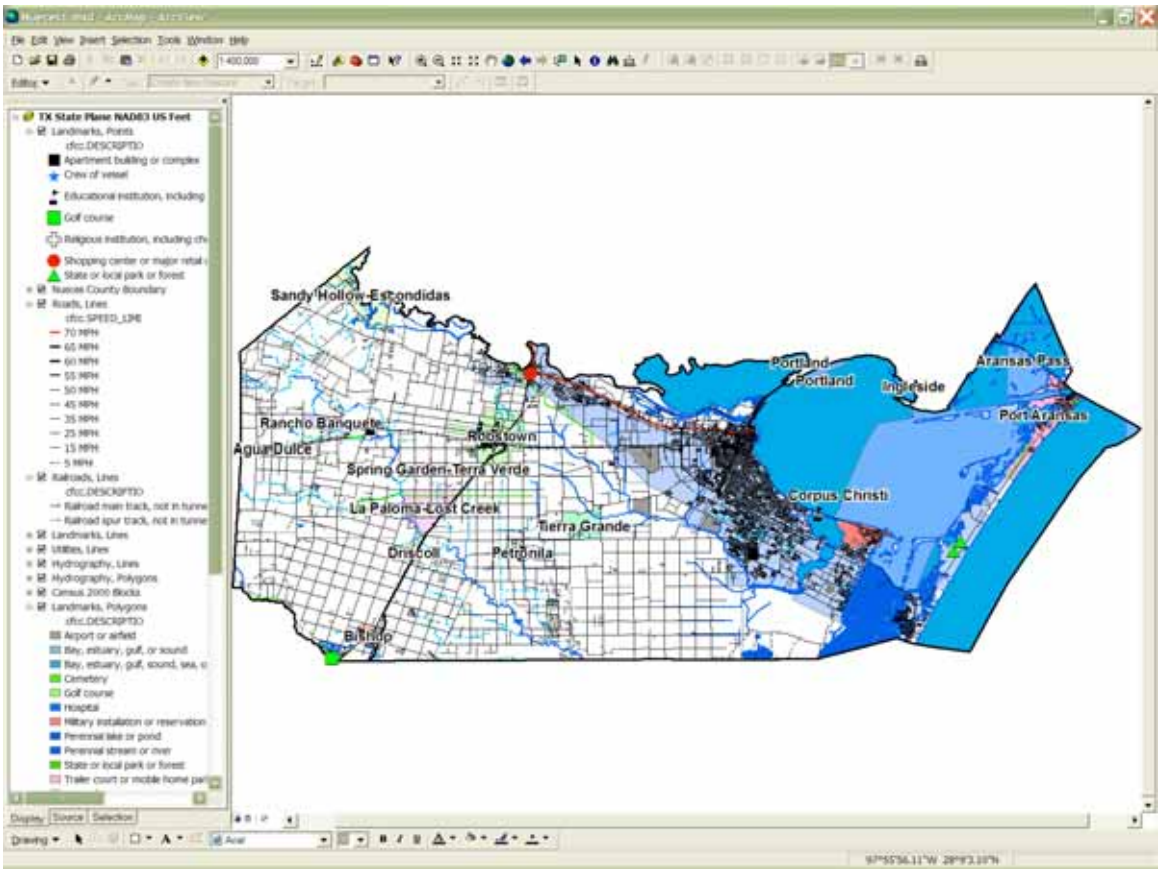

Figure 4: Module 1 TIGER Map, created by students at Bellingham Technical College, WA

Module 2: Acquiring and Modeling Digital Terrain Data

In Module 2, students learn to acquire, manage, and model digital terrain data downloaded from the USGS Seamless data site. This module, now in development, teaches "best management practice" for modeling topography, hydrology, and natural hazards.

The final exercise focuses on the Wildland/Urban Interface and teaches the student to associate data from a grid with values at risk. To prepare the student for Module 3, the final exercise introduces students to the concept of Risk, Hazards, and Values.

Module 2, outline below, will be finalized in March 2006. A sample of USGS DEM and Land Use data is shown in Figure 5.

Exercise 2.1: Finding, Selecting, Downloading USGS Seamless Data

Find appropriate Digital Elevation Model (DEM) and Land Use/Land Cover (LULC) data on the Internet
Download selected data for a county of interest
Extract DEM and LULC data from a zipped file and save it on a computer
Preview downloaded Seamless data in Arc Catalog

Exercise 2.1: Managing Seamless Data in Arc Catalog

Use ArcCatalog to understand and manage raster data

Rename and relocate raster data sets
Create hillshades for terrain data
Reproject terrain data into a local coordinate system
Use grid math to recalculate elevation (Z) values

Exercise 2.3: Mapping Seamless Data in ArcMap

Create thematic legends for DEM data
Use tabular joins to enhance LULC data
Load DEM and LULC data into geodatabase
Convert a LULC grid to shapefile polygons

Exercise 2.4: Modeling Seamless Terrain Data – Creating Contours

Create contour lines for a DEM
Map contour lines using classes and rules
Load contour lines into geodatabase
Validate grid, line, and point contour data

Exercise 2.5: Modeling Seamless Terrain Data – Deriving Slope, Aspect, and Understanding a Hazard

Derive slope in degrees and percent
Derive aspect for 8 octants
Model slope, aspect, and vegetation to define fuels
Extract data from a numeric surface and associate data with points
Develop a Slope/Fuel hazard model
Integrate grid-based hazard data with mapped building

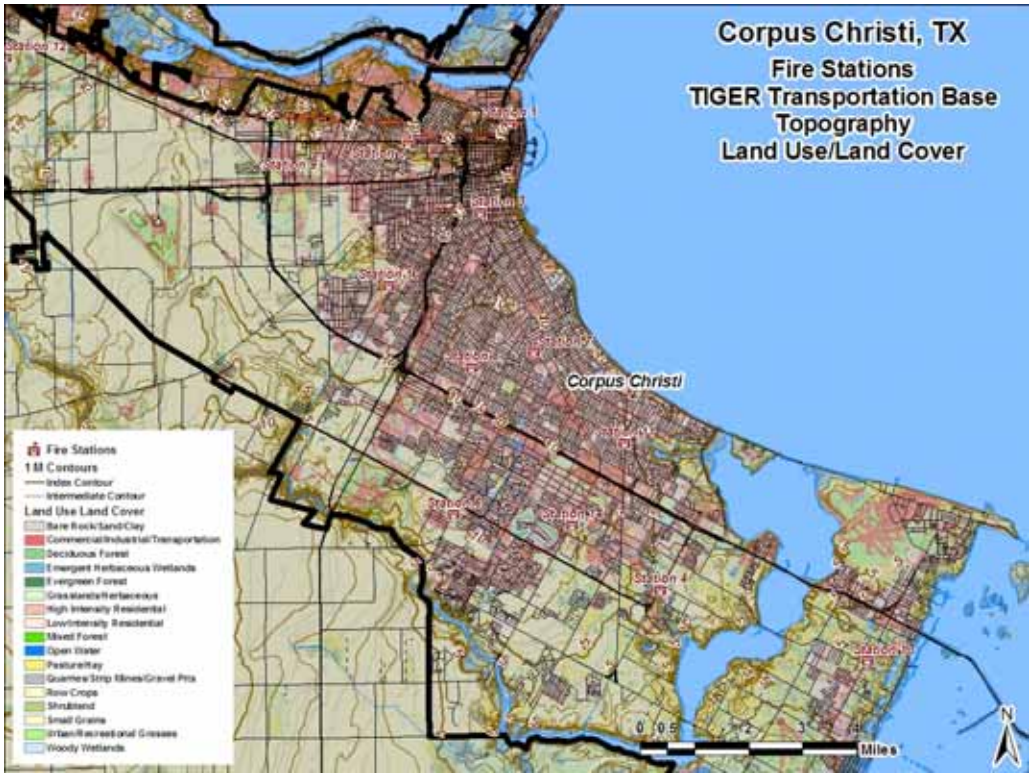

Figure 5: Module 2 Digital Terrain and Land Use Map developed during prototyping

Module 3: Mapping and Modeling Values at Risk

In Module 3, students learn to map and model Values at Risk, drawing concept and structure from the now dormant RHAVE (Risk, Hazards, And ValuEs) program and from the Commission on Fire Accreditation's Standard of Cover (SOC) methodology.

Since Module 3 addresses specific departmental needs, a local deployment needs locally provided data to function as a customized local set. Necessary information include fire station locations, networking streets (TIGER or better), fire hydrants, public and private values, community hazards, and community risk factors. The standard training set will include modified local data from the City of Corpus Christi and Nueces County, TX. A program supplement will suggest methods to create local data for training and ultimate use for emergency planning and response.

Response network creation and coverage area modeling are vital to First Responders, so Module 3 will include activities to introduce and teach analysis with ArcGIS 9.1's Network Analyst extension. Field data collection strategies will be discussed and actual GPS-collected fire station and hydrant data from Corpus Christi is mapped and modeled.

Module 3 is in its early prototyping phase and is scheduled for final release in July 2006. The preliminary task list for this module is listed below; Figure 6 is a sample Corpus Christi Emergency Response Map developed with Network Analyst, created from TIOGER data and fire station locations.

Exercise 3.1: Loading and Using High Resolution Imagery

- Load imagery into a Public Safety GIS model
- Register imagery using survey control points
- Locate critical facilities in shapefiles and on imagery
- Edit shapefile points
- Perform heads-up digitizing

Exercise 3.2: Adding GPS Data

- Load XY tabular data for fire stations and fire hydrants
- Create XY point themes for fire stations and fire hydrants
- Convert XY point themes to shapefiles
- Build thematic legends for shapefile points
- Label shapefile points

Exercise 3.3: Time-Based Networking

- Enhance vector data to support time- and distance-based network analysis
- Build or load time-based transportation networks
- Build or load ISO response areas
- Count and summarize hydrants within ISO polygons
- Join ISO hydrant counts to Fire Station points

Exercise 3.4: Geocoding Values at Risk

- Recognize and quantify Values and Risk

Create XY point themes identifying Values at Risk
Geocode historic fire and EMS incident data
Map and analyze incidents, response, and outcomes

Exercise 3.5: Mapping and Understanding Risk, Hazard, and Values

Understand Risk, Hazard, and Values from the perspective of a First Responder
Create maps showing the relationship of values to hazards
Define and understand risk from historic incident data
Analyze response data to verify best deployment of resources
Consider alternatives to obtain best use of available and proposed Emergency resources

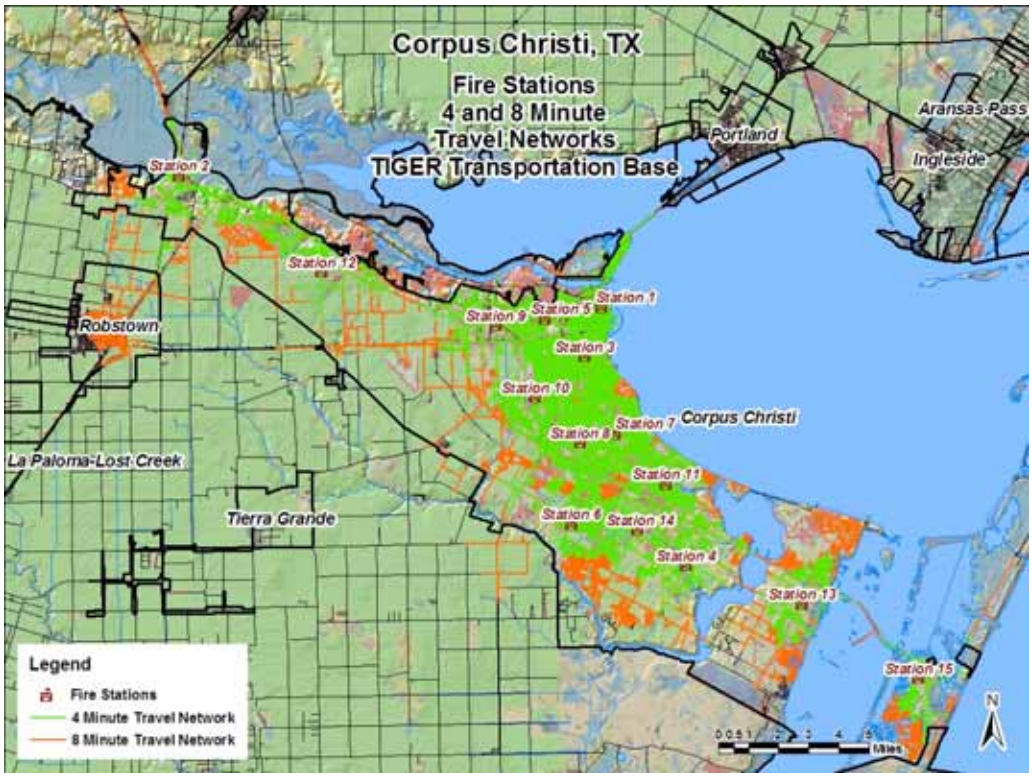

Figure 6: 4 and 8 Minute Response Networks created with Network Analyst

Summary

The GIS-TECH program, developed by Del Mar College, Emergency Management personnel, and GIS professionals, provides hands-on GIS training to empower First Responders with skills to acquire, interpret, and manage spatial information. Through GIS-TECH training, delivered in instructor-led and self-taught modules, students acquire knowledge and skills to acquire, organize, enhance, and analyze spatial data for Emergency Management and Public Safety. Upon satisfactory completion, Students will receive college credits and/or professional certification through Del Mar College or other training institutions or professional venues.

Program design allows materials to be presented in the classroom, via the Internet, and via off-line self-study. Program content will be reviewed and proposed for accreditation through accredited GIS programs of study and through professional continuing education channels.

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Figure 7: GIS-TECH developers hard at work

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Figure 8: Our first GIS-TECH First Responder graduates! Corpus Christi, TX March 2005