Firewise Modeling in the Wildland/Urban Interface with ArcGIS
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Since 1999, the National Fire Protection Association (NFPA) and Firewise Communities have utilized GIS to map, understand, and enhance safety and quality of life issues in the WUI. Field assessments, guided by NFPA WUI Standard 1144, rate the condition and survivability of homes and other structures in the Interface. GIS provides an excellent toolset to merge home assessments with natural resource data, creating and analyzing comprehensive maps and models.

This presentation applies ArcGIS 9, Spatial Analyst, and 3D Analyst to model natural resource criteria including terrain, slope, aspect, vegetation, and fuels. It shows steps used to combine natural information with structural data and values at risk criteria to build comprehensive community assessments. It demonstrates how to develop a structure point set from building footprints, and how to combine slope, aspect, fuels, and other information with the structure points. Samples of Interface maps prepared by several Firewise ArcView Communities are shown.

Introduction

Since the mid 1980's, the Wildland/Urban Interface, or WUI, has been a focal point of suburban and rural growth, with high value residential and commercial development occurring in areas of irregular topography, hazardous fuels, inadequate infrastructure, and limited public safety protection. In 1986, following serious 1985 wildfires that destroyed or damaged over 1,400 homes and cost 44 lives, the National Fire Protection Association (NFPA), and the US Forest Service formed the Forest and Rural Fire Protection Committee. A primary Committee objective was to assess and prepare recommendations to reduce the hazard, risk and casualty loss in the rapidly expanding Interface.

Today, The National Wildland/Urban Interface Fire Protection Program is sponsored by the US Forest Service, US Bureau of Land Management, National Park Service, Bureau of Indian Affairs, US Fish and Wildlife Service, National Association of State Foresters, and the NFPA. The National Wildfire Coordinating Group (NWCG) provides overall guidance for the program.

In 1999, the NWCG Wildland/Urban Interface Working Team identified two primary Interface tasks. Task 1 stressed development and dissemination of educational information to those who design, build, live in, and protect homes in Wildland/Urban Interface areas. Task 2 chartered and sustained the development and presentation of multi-disciplined workshops entitled "*Firewise Communities: Making Our Home Safer from Wildfire*." The workshops focus on interface concerns in fictional Falls County, USA and include interactive GIS-based exercises for planners, builders, community officials, fire professionals, insurance representatives, homeowners, and others active in the WUI.

Since late 1999, 32 NFPA-sponsored National Workshops have reached over 3,500 Interface dwellers, service providers, public officials and others interested in a safer WUI. Through an ESRI ArcView Grant program, 27 Interface Communities have been chosen as Firewise

ArcView Communities. Firewise Communities range in size from remote villages of just a few hundred seasonal and year-round residents to developed multi-county regions with populations in the tens of thousands.

In 2003, the Federal Emergency Management Agency (FEMA) examined the Firewise ArcView Communities program structure and approached the NFPA. FEMA wished to identify and help fund advanced software deployment of FEMA's HAZUS-MH multi-hazard modeling package within six Firewise ArcView Communities.

To aid hazard and risk assessment and mitigation, the NFPA produced and now publishes the Standard for Protection of Life and Property from Wildfire. The Standard, originally printed in the late 1990's as NFPA 299, was updated and released in 2002, coded NFPA 1144. The standard "presents basic criteria for fire agencies, land use planners, developers, and local government for planning development in areas that may be threatened by wildfire." NFPA 1144 provides standards for design and development of Firewise Communities and is a key document when identifying, assessing and mitigating Interface issues.

This presentation reviews the Firewise Program, including Workshops, the Firewise ArcView Communities, and the FEMA Firewise HAZUS-MH prototypes. On the technical side, it introduces Firewise GIS modeling in the WUI and shows modeling cases from the Falls County training set and from ArcView Firewise Communities. Some of the modeling introduced is published in ESRI's ArcUser magazine and is referenced in this article.

Firewise Workshops and Firewise Communities/USA

In early1999, the NFPA, under the guidance of the NWCG Wildfire/Urban Interface Working Team, recognized the need to reach out to WUI stakeholders with appropriate training and technical support. The National Firewise Workshop program was created to promote awareness and action by homeowners, fire professionals, planners, builders, community officials, insurance representatives, and others active in the WUI. The Firewise premise, stressed in all Workshops, is that "when adequately prepared, a house can withstand a wildland fire without the intervention of the fire service." Through the Workshop program, WUI residents were introduced to the Firewise program. They were encouraged to apply for status as Firewise/USA Communities. The Firewise/USA program encourages and recognizes Community action that minimizes potential home loss to wildfire. It teaches homeowners and fire professionals to prepare for a wildfire before it occurs. The program is designed for small communities, developments, and residential associations.

To achieve Firewise/USA status, a Community will complete five steps:

    Form a Firewise Board
    Invest at least $2 per Capita in Firewise Projects
    Complete a Community Assessment
    Create a Firewise Plan
    Host a Firewise Day

Once recognized, the Community will annually review and report their Firewise efforts. They will continue the per capita expenditure, host Annual Firewise Days, and will update and expand their Firewise Plan. By June 1, 2005 over 50 Communities nationwide attained Firewise/USA recognition.

In November, 2004, Firewise Communities hosted *Backyards and Beyond*, 2004 National Wildland/Urban Interface Education Conference, in Denver, CO. Approximately 400 WUI participants and supporters attended program update sessions, track-based educational workshops, GIS technical and modeling training, and more.
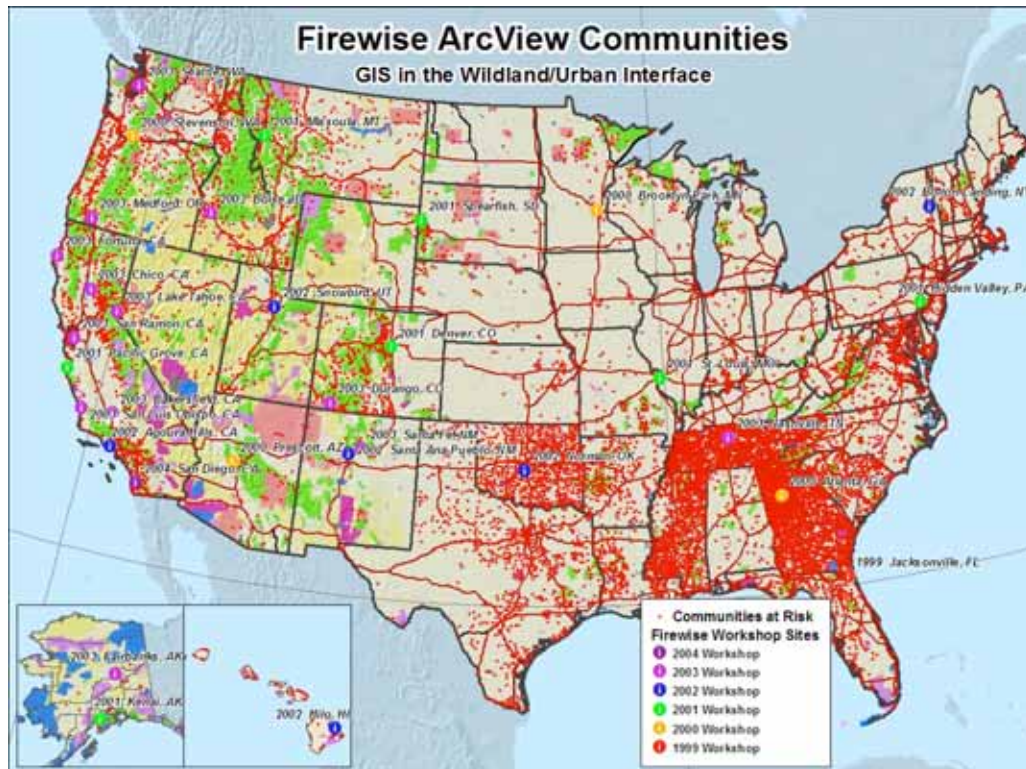

Figure 1: WUI Communities at Risk and National Firewise Workshops

Firewise and ArcView – Falls County, USA

Early in the Firewise Workshop design process, developers recognized that a dynamic mapping and teaching environment would greatly increase Workshop effectiveness and provide a standard training structure. In the beginning, paper maps were tested for effectiveness and were found to be awkward, hard to duplicate, and difficult for all participants to understand and relate to. GIS mapping and modeling was considered as a possible alternative to paper, and it quickly demonstrated many benefits. GIS maps, displayed on a screen via a projection unit, enable all participants to easily view workshop materials and to actively engage in breakout discussions. In addition to providing local detailed exercises, the GIS model incorporated a regional "county-wide" story and allowed participants to step back and contemplate the big picture. The GIS model fostered active participation by all stakeholders in attendance.

Several geographic regions were considered to develop a synthetic modeling set that would replicate WUI issues anywhere in the US. After reviewing several candidate sites, the Falls County, USA model was defined in rural central San Diego County, CA, incorporating data from Federal, state, and county providers. Extensive California Fire Resource and Assessment Program (FRAP) data and San Diego County San Diego Association of Government (SANDAG) data were adapted to establish anonymity and to match conditions across the country.

The Workshop series was a great success, with an initial 12 Workshops increasing to 32 National Workshops (Figure 1). The National Workshop program concluded in November 2003, and workshops continue at state and local levels, still using the original training set. By the end of 2003, the National Workshop had reached over 3,500 participants, giving all of them direct exposure to live GIS in small breakout sessions, aided by skilled facilitators and GIS operators. The Falls County training set was originally created with ArcView 3's Data Publisher and is now being readied for release using ArcGIS 9.1's ArcPublisher/ArcReader pair. Figures 2 and 3 are sample maps from a test ArcGIS deployment.

Figure 2: Falls County, USA Training Model

Figure 3: Bear Heights Detail, Falls County, USA

Firewise ArcView Communities

As part of their support for the National Firewise Workshops, ESRI's Public Safety Solutions group developed a grant program whereby one selected participating community from each Workshop would receive a copy of ESRI's ArcView 3 software to be used by local citizens to map, model, and understand their own Interface issues. The original grant program was designed to charter 12 ArcView Communities. As the Workshop series grew, a total of 27 Communities were created. Most communities started with ArcView 3 grant software and many have migrated into ArcGIS 8 and ultimately ArcGIS 9.1. Several Communities also acquired ArcView extension software, typically Spatial Analyst. Some Communities also obtained 3D Analyst and are considering the new Network Analyst extension. Figure 4 shows the location of all 27 Communities.

The Firewise Communities Support team actively assists ArcView Communities to solve technical issues (both hardware and software), facilitate introductions to nearby GIS resources, develop solutions for specific modeling needs, and more. ArcView Communities are connected via the Firewise Web site (www.Firewise.org/communities/arcview), by monthly conference calls, through printed media, and by team visits.

Figure 4: Firewise ArcView and Firewise ArcView FEMA Communities

The Firewise FEMA HAZUS Communities

In 2003, the Federal Emergency Management Agency (FEMA) approached the NFPA and Firewise to request a test deployment of FEMA's HAZUS-MH multi-hazard modeling software in up to six Firewise ArcView Communities. In late 2003, the Firewise ArcView Communities of Sedona, AZ, Castle Valley, UT, and Big Cottonwood, UT were selected as prototype communities (Figure 4). In 2004, Casper Mountain, WY and Santa Fe County, NM were added. A sixth Firewise FEMA candidate is now in review.

The Firewise FEMA Communities each received an ArcGIS 8 ArcView update, together with the Spatial Analyst extension. Each Community is tasked with integrating their local WUI modeling activities with broader county or regional emergency planning, preparation, and response needs. The Firewise technical team assists all FEMA Communities with data development, software instruction, and HAZUS modeling.

HAZUS-MH was recently released for ArcGIS 9.0 and is being developed for ArcGIS 9.1. The Firewise FEMA Communities have the additional challenge of staying current and proficient with software from both ESRI and FEMA.
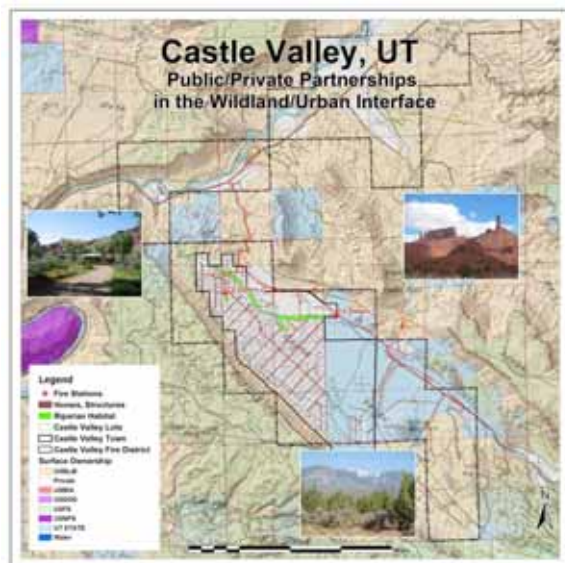

Figure 5: Public/Private Partnerships, Castle Valley, UT

Figure 6: WUI Hazards and Values, Genesee, CO

WUI Data Requirements

The Firewise Falls County model includes many data sets, listed in Table 1 below. The data was obtained with permission from several sites and was modified to create an anonymous training set. As the program evolved and as additional data became available, other sets were added to the development model. The ArcView 3 training model was finalized in late 2000 and cut to CD, so any enhancements beyond that date are not included. As the ArcPublisher model is being rewritten, newer data types, notably digital terrain data, can be included. Also, current ArcGIS 9.1 software allows the model to include data in differing coordinate systems, and makes it much easier to include Arc Grid data without requiring Analyst.

Figures 5, 6, 7, and 8 are sample WUI maps created by Firewise ArcView and Firewise FEMA Communities. In the 2005 ESRI User Conference presentation, many of the listed data will be used to demonstrate typical Wildland/Urban Interface modeling practice. Some of the processes demonstrated are described in ESRI's ArcUser magazine and are available for download from ESRI's Web site. Modeling methods and techniques will also be included in Firewise training curriculum and are intended for posting on line through the proposed Firewise University.

Table 1: Data sources for Firewise Falls County training model, with suggested sources for similar data in other locations

Framework Data			
Data Type	**Falls County, USA Model**	**Nationally Available Data**	**National Data Web Site**
Hypsography, DEM	USGS Seamless	GOS - USGS Seamless	www.geodata.gov/gos, seamless.usgs.gov
Hydrography	SANDAG	GOS - NHD	www.geodata.gov/gos
Geodetic Control	USBLM	GOS - NGS	www.ngs.noaa.gov/
Cadastral Information	UT AGRC, USBLM	GOS - USBLM	www.geodata.gov/gos
SANDAG	Grand County, UT AGRC	GOS – US Census	www.geodata.gov/gos
Transportation	SANDAG	GOS – USDOT BTS	www.geodata.gov/gos
Orthoimagery	Commercial; USGS Seamless	GOS - USGS	www.geodata.gov/gos
Hazards, Values, and Risk Data			
Data Type	**Falls County, USA Model**	**Nationally Available Data**	**National Data Web Site**
Slope, Percent	Derived	Derived	
Aspect	Derived	Derived	
Vegetation	SANDAG	USGS, State Sources	www.usgs.gov
Soils	SANDAG, USGS	US NRCS, USGS, State Sources	www.nrcs.usda.gov/, www.usgs.gov
Fuels	Derived	Derived	
Fire Regime Condition Classes	LANDFIRE, Derived	LANDFIRE	www.landfire.gov
Geology, Geologic Hazards	SANDAG, USGS, Derived	USGS, State Sources	www.nrcs.usda.gov/, www.usgs.gov
Wildland Fire History	FRAP	US GeoMAC, State Sources	http://geomac.usgs.gov/
Public Safety Responsibility Areas	FRAP, SANDAG	State, Local Sources	
Fire Incidents	CFIRS	NFIRS, State Sources	http://www.nfirs.fema.gov/
Flood Hazard	US FEMA	US FEMA HAZUS	www.fema.gov/hazus
Electrical, Gas Utilities	SANDAG	US FEMA HAZUS	www.fema.gov/hazus
Water, Wastewater	SANDAG	US FEMA HAZUS	www.fema.gov/hazus
Building Stock, Structures	SANDAG, Custom	US FEMA HAZUS	www.fema.gov/hazus
Public Safety Facilities	SANDAG, Custom	US FEMA HAZUS	www.fema.gov/hazus
Other Essential Facilities	SANDAG, Custom	US FEMA HAZUS	www.fema.gov/hazus
Demography	US Census, TIGER	US Census, TIGER	www.census.gov/geo/www/tiger
Land Use/Land Cover	SANDAG	USGS Seamless	seamless.usgs.gov
Planning and Zoning	SANDAG	Local Sources	

Table 2: Acronyms for agencies and data providers

| Agency	Full Name
CFIRS	CA Fire Incident Reporting System
FRAP	CA Fire and Resources Assessment Program
FEMA HAZUS	Federal Emergency Management Agency Hazards-US
GeoMAC	Geospatial Multi-Agency Coordination
GOS	Geospatial One Stop
NED	National Elevation Dataset
NFIRS	National Fire Incident Reporting System
NGS	National Geodetic Survey
NHD	National Hydrologic Database
NRCS	National Resources Conservation Service
SANDAG	San Diego Association of Governments
TIGER	US Census Topologically Integrated Geographic Encoding and Referencing system
UGS	Utah Geological Survey
US FEMA	US Federal Emergency Management Agency
USBLM	US Bureau of Land Management
USDOT BTS	US Department of Transportation, Bureau of Transportation Statistics
USGS	US Geological Survey
UT AGRC	Utah Automated Geographic Reference Center

Figure 7: WUI Hazards, Lake Tahoe, CA/NV
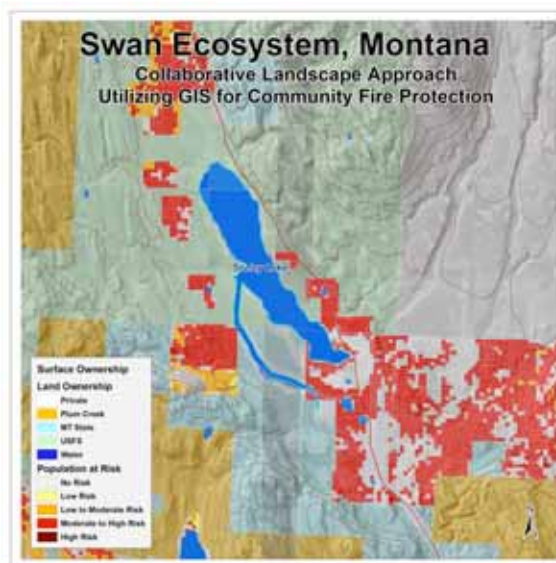
Figure 8: WUI Collaboration and Planning, Swan Ecosystem, MT

Summary

The Firewise program and its ArcView Falls County training model have long and active histories. Local WUI groups still use the original ArcView 3 model and its associated data set to train their citizens. New ArcGIS 9.1 software allows the Firewise Team to release an updated training model for easy deployment via ArcPublisher. New, enhanced, high resolution spatial data can be incorporated into the training model and used by WUI modelers.

Acknowledgements

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